MANUAL

FOR

VICTORIAN

NAVAL FORCES.

—

1890.

~~Aff ^u^ Homewood~~
Bro-in-law of
[illegible]
Lieut. RANR.
1919.

See bottom of page 106.

INTRODUCTION.

Quarters.

In arranging quarters, it is necessary to consider the supply of powder, so as, if possible, to have guns at the same quarters supplied from the same magazines.

In turret ships each turret forms a quarter by itself.

When a separate crew is to be stationed to each gun, the guns will be numbered odd on the Starboard side and even on the Port side, commencing from forward in each battery or on each deck. When they are to be worked with half-crews, they will be numbered from forward aft on each side of the deck, the odd numbered guns on the Starboard side and the even numbered guns on the Port side being known as the left guns, and the others as the right guns. Guns mounted independently, as for instance, bow and stern guns, will be given names depending on their position.

Guns in turrets will be known as the right or left gun of each turret.

Action.

On the call for action, every one repairs at once to his allotted station.

The gunner in charge of magazines will obtain the keys of them, and see that the lights are lighted, everything in working order, and the powder passed up.

Charge and Projectile.

Armour-piercing guns, as a rule, are to be loaded with full charge and Palliser shot. Where Palliser shot are not supplied, the guns should be loaded with reduced charge and common shell.

Small-arm and Machine-gun Ammunition.

Small-arm and machine-gun ammunition will be supplied by men specially stationed. Ammunition should be served out at once to small-arm men; and, after the arms are provided, to the rest of the quarters.

Machine-gun ammunition should be passed up at once, and hoppers and drums filled by the men stationed.

Riggers.

Riggers provide tackles, and collision-mats, and gear; after which they would fall in at some station allotted them.

Helm.

Helmsmen, signalmen, &c., provide their arms, and repair to their stations.

Fire Brigade.

Fire brigade connect hoses to and rig all pumps required. The carpenter is responsible that the pump suctions are turned on to the sea-cocks; the engineer officer that the Kingston valves are open, that all sluice-valves and watertight doors not ordered to be left open are closed, and that the steam fire-engine is ready for use and hoses connected. The stokers of fire brigade should connect hoses and branch-pipes at the fire-main deliveries in each compartment.

Miscellaneous.

Arrangements should be made for fitting time-fuzes. Men stationed to strike down wounded, and provide whips, &c. Tubs of water should be provided at every gun for damping sponges, &c.

Provide Arms.

The order will then be given by the officer of quarters to provide arms. Every man having a rifle should provide it, placing it in the ready rack. Waist-belts, pouches, and pistols to be worn.

When guns are loaded and run out, arms provided, and quarters "closed up," the officer of the quarters reports his quarters clear.

REMARKS FOR INSTRUCTORS.

The Instructor of the Drill should bear in mind that in every change of Nos. each man has different duties from those he has previously engaged in; and, in order that they may be well executed, it is essential that each man should comprehend the object and motive of the various duties which he is called upon to perform.

When a mistake is made by any No. at the gun, the Instructor is immediately to give the word "Still," in order that every man may have his attention drawn to the error committed. The gun's crew remains perfectly steady whilst the Instructor points out the error, and corrects it. He then gives the order "Carry on," when the work is resumed from the point at which the order "Still" was given.

Great patience and the utmost precision are necessary on the part of the Instructor. On no account whatever is he to allow the gun's crew to pretend to load, or pretend to lay the gun.

The directions given by the Instructor to the men under instruction must be clear, firm, and concise.

The men should fully comprehend one part of the drill before they proceed to another.

Short and frequent drills are preferable to exercises of long duration, which exhaust the attention of both Instructors and men.

When teaching the men to aim, each time the gun is laid by the sights the Instructor is to look along them, and should he discover any error he is to call 2, who is to look along the sights and state the defects. The Instructor is then to explain what the consequences would be if actually firing at an object, and cause 1 to aim again.

This method will have the effect of ensuring the attention of 2, and of inducing him to avoid (when aiming himself) the errors he may have witnessed in 1's aim.

When the ship has motion, the Instructor is occasionally to make use of the sight not used by 1, to see that he fires at the proper moment.

Accuracy and precision should be attained before great rapidity is attempted.

No deviation from the drill will be permitted without the sanction of the Naval Commandant.

of them still in the deck of "Cerberus" at Half Moon Bay. Vic
R.S.Hale 25/1/62.

PART I.

10-INCH M.L.R. GUN.

TURRET GUN.

Description of Gun.

Calibre, 10 inches.
Weight of gun, 18 tons.
Preponderance, 8 cwt.
Length, extreme, 15 feet.
Length of bore, 12ft. 1in.
Length of rifling, 118 inches.

Number of grooves, 7.
Width, 1·5 inch.
Rifling, increasing twist from 1 in 100 to 1 in 40 calibres.

Description of Carriage, Slide, &c.

Weight of carriage, 4 tons, 2 cwt., 1 qr.
Length of carriage, 9 feet.
Weight of slide, 6 tons, 13 cwt., 2 qr.
Length of slide, 21 feet.

Scales.

Elevation.	Depression.	Distance.
Upper step, 3°	5½°	1,600 and 1,200 yds.
Middle step, 7°	0	2,000 and 2,800 yds.
Lower step, 12°	0	4,000 yards.

Sights.

Compound sights are fitted so as to show inside the turret the amount of elevation due to the distance, also the heel of the ship. The centre sight is marked for 13½° elevation and 4° depression. The side sights, 13½° elevation and 5° depression. The sight consists principally of a standard, inside of which travels a shaft with an indicator attached. The sight fits into the top, and

is raised by a hand-wheel and pinion gear, the shaft being raised by wheel gearing; the side sights are similar, but not so long; the fore sights fit into sockets in the roof of the turret with bayonet joints, and are fitted with covers.

The permanent angle of deflection being 1° 10′.

PRELIMINARY DRILL.

In Preliminary Drill the principal duties to be performed by **each of the gun's** crew are fully detailed. Too much attention **cannot be paid** to the thorough instruction of the men in these **duties, upon which** the accuracy and rapidity of the fire mainly **depend.**

The following drill is for the 10-inch M.L. guns worked entirely **by hand**; the turrets turned by steam or hand; and with the **sights** so fitted as to show inside the turret the elevation of the **gun.** The turret's crew fall in two deep, a gun's crew on each side **of the deck**; the numbers as far as 8 in the front rank, the others **in the rear** rank; the powdermen fall in on the left of the gun's **crew.** Captain of turret and 2nd captain between the crews, all **facing** inboard.

Rear rank, 9, 10, 11, 12, 13, 14, 15 P.M.
Front rank, 1, 2, 3, 4, 5, 6, 7, 8 P.M.
C. T. 2nd C. T.

All orders given by the Nos. 1, and reports from the gun's crew, are in all cases to be preceded by the words "Right" or "Left Gun."

Close Up. The turret crew place themselves as follows: Captain of turret on the centre platform; 2nd captain of turret at the pointer, in charge in the turret room, and repeats all orders when necessary. *Inside turret*—No. 1, in rear in charge of the gun; No. 2, in rear; No. 3, close to the port; No 4, in rear of 3; No. 5, in rear of 4, and so on to 7. *Outside turret*—the Nos. 8 to 13 at the running in and out winch handles; the numbers 14 to 15 at the training winch, if required.

Number. The gun's crew will call their numbers in succession.

Change Rounds. 1 takes the highest number, the remainder move round one place.

Fall Out. The turret's crews place themselves as before detailed.

Cast Loose. Captain of turret ships centre sight and sets firing gear; 1 takes off rear coupling-chains, bring-to firing gear, ships side sights, and sees gun uncoupled by clutch-lever; 2 takes off rear securing-chains, and assists to bring-to firing gear and attend rear pawls; 3 and 4 out tompion, unbar and open the port, take off front coupling-chains; 5 and 6 take off front securing-chains; 7 off turret securing-chains, 7 of right gun the after one; 5, 6, and 7 then trice up projectile; 3 and 4 step on the loading platform, 3 outside; 4 takes the worm; 3 and 4 search the gun; 1 examines the vent; 2nd captain of turret and remaining Nos. uncover turret and clear away outside; 8 unships cowls; 9, 10, 11, and 12 lower skylights and place armour covers (9 and 10 the foremost ones); 13 and 14 let down stanchions; 15 takes off port covers.

Shell-room Party.—Receive skylights and secure armour-covers.

Note.—2nd captain of turret superintends and reports when clear outside. Captain of turret trains for loading if required.

Load. 1 serves the vent; 2 attends the elevating gear and attaches the tubes; 5 receives the cartridge case from the powderman through the entry port and passes it to 3 and 4, who enter the cartridge; 5, 6, and 7 haul the projectile in front of the muzzle; 3 steps down off loading platform and guides it clear; 3 and 4 enter and unsling it; 5 passes slings to 6 and 7, who overhaul the tackle and hook on another projectile inside the turret; 9, 11, and 13 trice up projectile outside; if a

LOAD—*continued.* wad is used, 7 passes it to 3, who enters it; 4 takes the rammer and, assisted by 3, forces all home together; 3 and 4 spring the rammer; 4 returns it, and steps off loading platform; 1 then pricks the cartridge; if time-fuze is used, 2 will fit it. When the projectile is triced up, 7 will attach a gas-check.

NOTES.—When bell-ropes are used, 3 and 4 place them, all numbers assisting to ram home.

When using time-fuzes, 2 fits them, under the direction of 1; 3 uncovers the priming after the projectile is entered; the hand is to be kept over the head of the fuze until just before it is covered by the head of the rammer.

A mark on the rammer-staff indicates when the reduced charge and common shell, and, within a few inches, when the full charge and Palliser projectile are home.

RUN OUT. 3 attends the compressor; 4, 5, and 6 trice up the lifting-lever; 4 attends it; when the gun is out, 4 eases down the lifting-lever; 3 sets taut the compressor, and reports "Right" or "Left gun compressor taut," and the Nos. close up; 1, of last gun out, couples with clutch-lever for drill purposes only. If necessary to give the order "Winches," "Run out," the same Nos. occupy the same position as in running in.

TRAINING POSITION. *Under steam.*—Captain of turret attends valve-lever; 2nd captain attends turret pointer.

Using hand-gear.—14 and 15 man the winches; the 2nd captain disconnects the clutch.

The orders for training are—"Right" (or "Left"); "Right" (or "Left") "Quick," (or "Slow"); according to the direction in which the muzzles of the guns are to be trained, and the amount of training required; when the direction is on, the captain (or 2nd captain, if using the pointer) orders "Stop."

NOTE.—A mark on the upper edge of the compressor-bars indicates when the gun is "out."

—DEFLECTION, OR —KNOTS SPEED. —YARDS. The captain of turret adjusts his sight.

— BEARING. — OBJECT. When the object is named, the captain of turret trains the turret and aligns his sight; 2 under the direction of 1, attends the elevating gear, and keeps the gun laid for elevation, as shown on standard. When the sights are aligned, captain of turret orders "Well." No. 2 sets taut elevating clamp.

READY. 2 steps up on the side of the carriage, places the tube in the vent, and steps clear; 1 connects the slot and bolt, or attaches the tube-lanyard to the firing gear, sees all clear, and reports "Ready;" captain of turret repeats it, full cocks the firing key, or removes the safety-pins, after the last gun has reported.

OUT TUBE. Captain of turret half-cocks the firing key or puts in the safety-pins; 1 disconnects slot and bolt, or unhooks the tube-lanyard from the firing-gear; 2 takes the tube out of the vent, and the Nos. close up.

Before elevating or performing any operation during which the firing of the gun would injure the crew or fittings, captain of turret orders "Out tube," and proceeds as above.

READY. As before detailed.

FIRE. At the order "Fire," captain of turret fires by pressing the firing key, or pulling the lever handle, then trains the turret for loading.

MISS-FIRE (*Electrical gear*). Captain of turret, after a pause, half-cocks the firing key; 1 disconnects slot and bolt; 2 examines the vent, and places a fresh tube; 1 connects slot and bolt, and reports "Ready."

MISS-FIRE (*Mechanical gear*). 2 clears the vent if necessary, hooks another tube to the lanyard; the firing gear is re-set; 1 reports "Ready."

RUN IN. Captain of turret half-cocks the firing key, or re-sets the firing bar; 3 attends the compressor, easing it off as soon as the running-in chains are taut from the winches; 2 and 7 trice up nipping-lever; 7 attends it; 4, 5, and 6 trice up lifting-lever; 4 attends it; 8 to 13 man running-in winches; when the gun is in, 1 orders "Well"; 4 eases down the lifting-lever; 3 sets taut the compressor, and reports "Compressor taut"; 7 then eases down nipping-lever; 8, 10, and 12 unship winch-handles; 1, 2, and 7 bring-to firing gear if necessary, and the Nos. close up.

SPONGE. 1 serves the vent; 2 attends elevating gear; 3 and 4 step on the loading platform; 3 takes the sponge and, assisted by 4, forces it hard home to the bottom of the bore, keeping it there while a round turn is given; they then withdraw it; 3 returns it, and the Nos. close up.

NOTES.—The vent-server is always to be used, and 1 is to put his thumb on the top of it, keeping his hand clear, so that he may see if there is any escape of air.

When withdrawing the sponge, care should be taken to keep the staff in the upper part of the bore.

When firing, the sponge should be sprinkled with (not dipped in) water, as a saturated sponge causes an increase of the remains of the cartridge-bag after firing.

CEASE FIRING (*from the "Ready"*). Captain of turret half-cocks firing key or puts in safety-pins, and orders "Out tube." The sights are put down, the deflection-scale set at zero, and the Nos. close up.

UNLOAD. The gun is to be placed in the loading position and emptied, 6 serving the worm and extractor as required, the elevating and loading Nos. assisting. When the gun is empty the Nos. close up.

NOTE.—This order may be given to alter the charge or projectile, or to empty the gun for securing.

SECURE. The turret and guns are placed in the securing position; the securing-chains, &c., are secured, and everything replaced by the Nos. who cleared them away. When finished, captain of turret orders "Fall out."

SHIFTING STEPS. If the gun is out, 1 orders "Run in," and, when placed, "Well," names the step, orders "Raise" or "Lower" the gun, and attends the valve; 2 attends the elevating gear, inside jamming-clamp, and rear key; 3 outside jamming-clamp and keys; 4 inside front key; 5 and 6 ship pump-levers and man them, 5 in front; 7 ships the winch-handle, and attends screw-gear. In raising, 3 and 4 assist 5 and 6 on pump-levers; 2 will report to 1, when keys are in or out, "Raise" or "Lower." The outside keys are not to be placed till after the inside keys are reported in by 2; 1 will ascertain when the saddle is in line with slot of carriage, and give the order "Well"; 3 place outside keys; 1 will then ease the gun down on the keys, and order "Return stores"; 2 and 3 set taut jamming-clamp, and the previous orders will be carried out.

NOTES.—In running out with the gun on the middle or lower step, see that the gun has sufficient elevation to clear the port.

The jamming clamps are not to be set taut till the weight of the gun is on the keys.

Before firing see that the rams are clear of the saddle, screw-gear clear of the gun (by indicator), the pawls up, and chains disengaged.

PRACTICE.

GENERAL NOTES FOR M.L. GUNS.

This part comprises the different modes of firing, together with other matters connected with the working of the guns.

Modes of Firing.—No definite rules can be laid down with respect to the application of the various modes of firing. This must be left to the discretion of the commanding officer.

Responsibility of Nos. 1.—Nos. 1 of all guns are responsible, under the officer of the quarters, for all precautions being taken to ensure the safety of the guns and their crews, and generally for everything connected with the working of the guns. The officer of the quarters is similarly responsible to the commanding officer.

Accuracy of Laying the Guns.—It should be impressed upon the men that laying the gun cannot be too carefully performed, and that it requires extreme care and attention on the part of No. 1, as well as the intelligent co-operation of the gun's crew in carrying out his orders.

Rapidity of Loading.—Loading, on the contrary, cannot be executed with too much rapidity, provided neither the safety of the crew nor gun be compromised.

Exercise by Signals.—After the gun's crew have been well trained in using words of command, they should be carefully instructed in working the guns without them, and the employment of signals should be the usual practice.

Diminished Crews.—They should also be instructed in working the guns with diminished crews.

Adjustment of Compressor.—On the guns being run out for the first time, or on any change of circumstances that may render it necessary, 1 directs the proper adjustment of the compressor, so that the recoil will bring the gun into the loading position. The amount of compression required will depend on the charge, motion of the ship, and degree of roll on firing. It is important to remember that when the compressor bars and plates are wet the recoil will be increased, owing to the diminution of friction.

Lie Down.—At any time should a collision be imminent, or as a protection from raking fire, the order "Lie down" may be given, or the bugle sound one G, when the men will at once lie down as in "Director firing." When the order is given, or the bugle sound "Carry on," they will go on with the firing or otherwise, as ordered.

Time Fuzes.—When using time-fuzes they should be adjusted at the last instant. The projectile should not be rammed home until the order "Commence" is given.

"*Prepare for*" *a Firing.*—When the order for any firing is preceded by the words "Prepare for," the guns are to be laid but not brought to the "Ready," the order "Ready" being given in this case by the officer of the quarters for the first round.

Ports Open or Closed.—If it is desired to keep the ports open, the order "Ports open" is to be given, and this order is to remain in force until the order "Close the ports." In the "Cease Firing Position," with the port open, the gun is to be close out. The order for any firing may be given from the position of "Ports closed," the gun being run out and the firing proceeded with in the usual manner. The reasons for closing the ports in action may be—I. To protect the gun's crew from machine-gun fire. II. To prevent water coming in. III. To shut in the lights as much as possible at night time.

Supply of Spare Stores, and Method of Replacing Disabled Gun Gear.—No precise rule can be laid down for this exercise, as much must be left to the individual judgment and intelligence of the officer of the quarters and the Nos. 1.

Whenever anything is broken or rendered useless it is at once to be replaced by the numbers whose duty it is to attend it. 1 orders one or more of the highest numbers to fall out and provide the spare stores required, and, assisted by an armourer, to replace it.

Spare Gear.—Guns' crews are all to be acquainted with the stowage of spare stores for their guns, such as rammers, sponges, tackles, shell-whips, handspikes, and running-in ropes; they are frequently to be exercised in replacing gear at the guns supposed to be broken or rendered useless, working the guns with extempore and makeshift arrangements, disconnecting the training gear, and using tackles for training or handspikes for elevating, and controlling the gun if an accident occurs to the compressor.

Guns should not be kept out of action for a longer time than can be avoided.

General Notes for B.L. Guns.

The above also apply to B.L. guns, with the following exceptions or additions:—

Recoil Presses.—With guns fitted with Vavasseur compressors, or recoil presses, special attention is required to ensure the cylinders being properly filled and piston-rods adjusted before commencing practice.

Time Fuzes.—When using time-fuzes they should be adjusted at the last instant. The projectile should not be entered until the order "Commence" is given.

Precautions when Firing.—The carriage and slide should be marked to indicate the position of the gun when out. After firing, when the gun is out, No. 4 will hold up his hand as a signal to No. 1. No. 1 will not permit the gun to be loaded until he is satisfied that the gun is out in the firing position.

The officer of the quarters must always see that the safety arrangement is in good working order, and that the locking lever and needle-holder are in their proper position before firing.

CLEARING FOR ACTION.

ACTION.	The guns are cast loose, and everything on deck removed clear of the fire; the bugle will then sound the "Advance"; the guns will be loaded with full charge and Palliser shot, and run out. Nos. close up, and wait further orders. Should it be desired to load with any other projectile but that above-named, the "Still" must be sounded, and orders given.
EXERCISE ACTION.	As above, without powder being provided, the gun being always loaded with dummy charge and projectile.

NOTES.—Electric firing gear is invariably to be used unless otherwise ordered. The mechanical gear and tube lanyards are to be considered as auxiliary, and only to be used (except for purposes of drill) at the discretion of the officer of the turret when the electric gear is disabled. All orders are delivered through the speaking tube from the conning tower, and repeated by the officer of the turret.

A directing dial showing the description of firing and the distance of the object is placed so as to be always seen by the captain of the turret.

SIMULTANEOUS FIRING.

In this firing, the guns in each turret are fired simultaneously, the turrets working independently.

SIMULTANEOUS FIRING.	A caution. (Broadside) (Turret Salvo)

—DEFLECTION, OR —KNOTS SPEED. —YARDS. —BEARING. —OBJECT.	The captain of the turret adjusts his sight and trains, the gun is laid for the object and brought to the "Ready," as in Preliminary Drill, No. 1 giving the necessary orders.
COMMENCE.	The captain of the turret fires at his own discretion, and trains for loading; No. 1, if necessary, orders "Run in"; when the gun is in it is laid for loading, sponged, and loaded without orders; 1 then orders "Run out," and proceeds with the firing.
CEASE FIRING.	As detailed in Preliminary Drill. If the gun is in, it is to be loaded and run out.

If desired, the guns of a turret may be fired independently. In this case the cartridge of the gun that is being loaded is not to be exposed while the other gun is at the "Ready." No. 1 may fire from the side platform if ordered.

DIRECTOR FIRING.

In this firing the turret guns are fired either both turrets together or one at a time from the conning tower by means of electricity, having been previously laid by the director.

The guns are invariably laid for 800 yards distance, and concentrated on three fixed points on each broadside (bow, beam, or quarter); the corresponding marks are placed on the turret, in the turret-room, abreast of the turret-pointer.

DIRECTOR FIRING.	The captain of the turret adjusts the sight for 800 yards.
STARBOARD, OR PORT BOW, BEAM, OR QUARTER. HORIZONTAL, OR (—— DEGREES ELEVATION), OR (DEPRESSION.)	The turret is trained under the direction of the 2nd captain of turret. On receiving the elevation from the director, the gun is laid and brought to the "Ready," as in Preliminary Drill. When the guns are fired, the captain of the turret trains for loading, 1 disconnects the slot and bolt; the gun is run in, loaded and run out, as in Simultaneous Firing, and is then laid as before.

CEASE FIRING. { As in Simultaneous Firing. The slot and bolt are always to be disconnected before the tube is taken out.

DIMINISHED CREW.

When casualties occur at the gun, No. 1 is to inform the officer of the turret, who will detail Nos. to fill the vacancies. In case of the captain of the turret being removed, the officer of the turret will select a No. to fill the vacancy.

See pp. 83 to 87.
" pp. 144 to 148, 150-155
" pp. 236/241

8-INCH B.L. GUN.

Mounted in H.M.V.S. *Victoria* and *Albert*.

DESCRIPTION OF GUN.

Calibre, 8 inches.
Weight / Nominal { *Victoria*, 12·5 tons. *Albert*, 12·0 ,,
Preponderance, nil.

Length		ft.	in.
	Bore	17	4
	Rifling	13	10·82
	Chamber	3	2
	Total	18	6·5
	Over all	19	3·5

Rifling, spiral, increasing from 1 in 100 calibres at the breech, to 1 in 40 at 10·8 inches from the muzzle; remainder, uniform twist, 1 in 40.

Permanent angle of deflection, 1° 30′ to the left, to compensate for twist of rifling.

The gun is mounted on a naval carriage and slide; the carriage is of double-plated wrought iron, on permanent rollers; the elevating gear being on the friction-cone principle, attached to the left bracket on the carriage.

The slide is of the Service pattern, and fitted with a recoil press (see Page 95). A "by-pass" valve is fitted on the left of the carriage.

The gun is capable of 25° training on each bow in *Albert*, and 16° in *Victoria*.

Elevation, 13°. No depression can be allowed on account of the "whaleback" deck.

PRELIMINARY DRILL.

The gun's crew will consist of 8 men and 2 powdermen, and will fall in as follows:—

↑

P.M. P.M. 7. 5. 3. 1. 2. 4. 6. 8.

CLOSE UP. 1 in rear, facing the port; 2 on the right, in line with the sights; 3 on the left, in line with fore part of carriage; 4 on the right, in line with fore part of carriage; 5 in rear of 3; 6 in rear of 4; and so on.

NUMBER. The gun's crew call their Nos. in succession.

CHANGE ROUNDS. At the order "Change rounds," 3 becomes 4, and the remainder move round one place to the left.

FALL OUT. The gun's crew place themselves in rear of the gun, as before detailed.

CAST LOOSE. 1 and 2 ship sights and prepare firing gear; 2 provides pouch and primers; 3 and 4 unbar, open the port, and clear away front shore; 3 out tompion; 5, 6, 7, and 8 clear away securing-chains; 7 and 8 ship winch-handles for training; 7 clears away shell-whip; 8 takes down sponge and rammer; 7 and 8 trice up a projectile. When the gun is cast loose the Nos. close up.

RUN OUT. 5 attends "by-pass" valve, and eases the gun out; when out, closes it if necessary; should the gun remain stationary on the "by-pass" valve being opened, 1 orders "Tackles run out;" 3, 4, 5, and 6 hook on side-tackles; 5 and 6 bring-to, and attend falls; 7 and 8 shift winch-handles; 3, 4, 7, and 8 run out. When the gun is out the same Nos. return tackles, 5 and 6 remove side-shores, and the gun's crew close up.

LOAD. 1 and 2 open the breech, using the lever if necessary; 1 sees the bore clear, and superintends loading; 2 takes out needle-holder, and places primer; 3 places loading-tray; 5 lays the gun for loading; Nos. on the left of gun haul the projectile in line with the breech; 7 attends the tackle fall; 3 and 4 enter and unsling projectile; 8 serves the rammer; 3, 4, 7, and 8 ram home; 3 and 4 take the cartridge-case from powderman, and hold it in line with the bore; 8 presses home the cartridge, withdraws and returns the rammer; 4 tears off the shalloon; 3 returns loading-tray; 1 and 2 close the breech; 2 replaces needle-holder; 7 and 8 trice up another projectile; and gun's crew close up.

This is termed the "Cease Firing" Position.

NOTES.—When using time fuzes, 3 will screw in the thimble and pellet just before the shell is entered.

In closing the breech, care must be taken to see the breech-block close home before locking, as the threads of the screw are liable to be damaged if this precaution is not observed.

—DEFLECTION. —DISTANCE. —OBJECT. 2 and 3 adjust and attend the sights; 5 attends elevating gear and brake; 3, 4, 7, and 8 man the winches, 7 attending the brake; the gun is elevated and trained under the direction of 1, who provides the electric pistol or tube lanyard, places himself on the platform, and lays the gun for the object.

This is termed the "Training Position."

NOTES.—The orders for training are "Right" (or "Left"), "Quick," or "Slow," according to the direction in which the muzzle of the gun is to be trained. When the direction is on, 1 orders "Stop."

The orders for elevating are "Raise" (or "Lower"). When laid, 1 orders "Well."

1 is responsible that both sights are adjusted according to the charge and projectile the gun is loaded with.

If no distance should be named, 1 estimates the distance of the object, and 2 and 3 adjust the sights accordingly.

READY. 2 connects the firing gear, 1 full cocks the pistol or slacks the tube lanyard.

HALF-COCK. 2 disconnects the firing gear; 1 half-cocks the pistol, or tautens the tube lanyard.

READY. As before detailed.

FIRE. 1 fires by pressing the trigger, or pulling the lanyard smartly with a jerk; 2 disconnects the firing gear; 1 orders "Run out"; 5 attends "by-pass" valve; and when the gun is out lays the gun for loading, and the crew close up.

MISS-FIRE. *If using Electric Gear.*—1 re-cocks the firing key, and the primer is tried a second time; if after a second attempt, after a pause, 1 orders "Shift primer," 2 disconnects the "slot and bolt," and replaces the primer; 1 then orders "Ready."

If using Tube Lanyard.—1 waits a pause of at least 30 seconds, then orders "Re-cock," the primer is tried a second time; if after a second attempt, 2 replaces the primer, 1 orders "Ready."

SPONGE. 1 and 2 open the breech, using the lever if necessary; 3 places the loading tray; 6 wipes the cup and copper ring in gun; 8 serves the sponge; 3 and 4 carefully sponge the gun; 8 then provides the rammer.

NOTE.—Guns are always to be sponged whether firing blank or projectile. Two sponges are supplied, the "bore sponge" and the "chamber sponge." The bore sponge is to be thrust completely through the bore before loading for the first time, and after each round fired with a blank charge. The chamber sponge is, before loading for the first time, and after each subsequent round, to be forced to the end of the chamber, and a complete turn given before withdrawing it. Both sponges are to be saturated during the firing, and after it the chamber sponge is to be rinsed with fresh water and thoroughly dried, to preserve it.

LOAD. As before detailed.

CEASE FIRING. If at the "Ready," 1 orders "Half-cock"; 2 disconnects firing gear; 2 and 3 put down sights; gun's crew close up.

NOTE.—If while loading, or after the gun is fired, the order "Cease Firing" should be given, the loading will be completed, and the gun's crew close up. Should it be necessary for the gun's crew to leave their gun, for "boarders," to man a pump, &c., the gun will be left in the "Cease Firing" position.

CLOSE THE PORTS. Should the order "Close the ports" be given, 1 orders "Run in" (as for "Run out"); when the gun is in, 3 and 4 close the port; and gun's crew close up.

NOTE.—The ports may be closed to protect the crew from machine-gun fire, to keep the sea out, or to shut in lights at night.

UNLOAD. 2 removes the needle-holder; 1 and 2 open the breech; 3 places the loading-tray, and withdraws the cartridge, the powderman returns it; 4 and 6 receiving ejector from 8, force back projectile; 2 and 3 sling projectile; 7 and 8 return it; 5 attends elevating gear; 3 returns loading-tray; 8 returns ejector; 1 and 2 close the breech; 2 replaces needle-holder; gun's crew close up.

NOTES.—If the gun is loaded with filled shell and fuzed, it should be fired if the range is clear.

The order "Unload" may be given, to alter the charge and projectile or for securing.

SECURE. 1 sees the gun trained to the securing position; 5 and 6 place the side shores: 1 then orders "Run in," and when the gun is in, orders "Well;" 5 closes the "by-pass" valve; 1 and 2 return the sights and firing gear, 2 the pouch and primers; 3 puts in tompion; 5 and 6, 7 and 8, put on securing-chains; 3 and 4 close, bar in the port, and place front shore; 7 and 8 return projectile and winch-handles; 7 makes up shell-whip; 8 returns sponge and rammer. When everything is finished, 1 orders "Fall out."

6-INCH B.L. ARMSTRONG GUN,

VAVASSEUR CENTRAL-PIVOT MOUNTING.

DESCRIPTION OF GUN.

Calibre, 6 inches.
Weight (nominal), 4 tons.
Preponderance, 45 lbs.
Number of grooves, 28.

Length { Bore, 12 ft. 9·9 in. / Rifling, 10 ft. 2·07 in. / Chamber, 2 ft. 5·5 in. / Total, 13 ft. 10·4 in. / Over all, 14 ft. 7·2 in.

Rifling, spiral, increasing from 0 at the breech to 1 turn in 40 calibres at 5·45 inches from the muzzle, the remainder 1 turn in 40 calibres.

The gun is mounted on a central-pivot Vavasseur carriage of double-plated wrought-iron (see Page 96), the elevating gear being on the friction-cone principle attached to the left bracket, the "by-pass" valve being fitted on the right bracket of the carriage. The gun is capable of about 250° training in the *Victoria* and *Albert*, and rather more in the *Gannet*, *Batman*, and *Fawkner*. The carriage admits of 20° elevation, and 7° depression. The training gear is of the "worm" description, and is worked by means of winch-handles on each side, the brake being on the right of the carriage.

PRELIMINARY DRILL.

The gun's crew will consist of 6 men and 1 powderman, and will fall in as follows:—

P.M. 5. 3. 1. 2. 4. 6.

CLOSE UP. { 1 in rear of the gun, facing the port; 2 on the right, in line with the sight; 3 on the left, in line with fore part of carriage; 4 on the right, in line with fore part of carriage; 5 in rear of 3; 6 in rear of 4.

NUMBER. { The gun's crew will call their Nos. in succession.

CHANGE ROUNDS. { 3 takes 4, the remainder move round one place to the left.

FALL OUT. As before detailed.

CAST LOOSE. { 1 and 2 ship sights, and provide firing gear; 2 provides pouch and primers; 3 and 4 clear away securing chains; 3 out tompion, and provides loading-tray; 4 provides sponge and rammer; 5 and 6 provide and ship training winch handles and ship training stanchions, if used; 5 provides projectiles.

NOTE.—All Nos. assist to clear away any fittings that interfere with the working of the gun. Gun's crew close up.

LOAD. { 1 and 2 open the breech, using the lever if necessary; 1 sees the bore clear, and superintends the loading; 2 takes out needle-holder, and places a primer; 3 places loading-tray, receives projectile from 5, and enters it; 4 takes the rammer, and, assisted by 3, rams home; 3 takes cartridge from P.M., and enters it (if full charge, tear off the shalloon); 4 presses it home; 3 returns loading-tray; 4 returns rammer; 1 and 2 close the breech; 2 replaces needle-holder; 5 provides another projectile; gun's crew close up.

NOTES.—This is termed the "Cease Firing Position." If fuzes are used, 2 provides and fits them under the direction of 1, 3 provides and screws in thimbles and pellet, and removes safety-pin.

In closing the breech, care must be taken to see the breech-block close home before locking, as the threads of the screw are liable to be damaged if this precaution is not observed. The firing hammer should be close home to prevent its striking against the carriage.

—DEFLECTION, OR —KNOTS SPEED. —YARDS. —OBJECT. { 2 and 3 adjust and attend the sights; 5 attends the elevating gear; 3, 4, and 6 man the training winches; 2 attending the brake, if required; the gun is elevated and trained under the direction of 1, who provides the electric pistol or tube lanyard, places himself at its full extent and lays the gun for the object.

NOTES.—This is termed the "Training Position."

The orders for training are "Right" (or "Left"), "Quick" or "Slow," according to the direction in which the muzzle of the gun is to be trained. When the direction is on, 1 orders "Stop."

The orders for elevating are "Raise" (or "Lower"); when laid, 1 orders "Well."

1 is responsible that both sights are adjusted according to the charge and projectile the gun is loaded with. Should the distance be given in yards, 1 refers to the range table for elevation due to the distance if necessary, and passes it to 2 and 3.

If no distance should be named, 1 estimates the distance of the object, 2 and 3 adjust the sights accordingly.

READY. — 2 connects firing gear, 1 full cocks pistol or slacks the tube lanyard.

HALF COCK. — 2 disconnects firing gear; 1 half-cocks the pistol or tautens the tube lanyard.

READY. — As before detailed.

FIRE. — 1 fires by pressing the trigger or pulling the lanyard smartly with a jerk, and orders "Run out;" 2 disconnects firing gear, and attends by-pass valve: when the gun is out, 5 lays it for loading, and the crew close up.

MISS-FIRE. — *If using Electric Gear.*—1 re-cocks the firing key, and the primer is tried a second time; if after a second attempt, after a pause, 1 orders "Shift primer," 2 disconnects the "slot and bolt," and replaces the primer, 1 then orders "Ready."

If using Tube Lanyard.—1 waits a pause of at least 30 seconds, then orders "Re-cock," the primer is tried a second time; if after a second attempt, 2 replaces the primer, 1 orders "Ready."

SPONGE. — 1 and 2 open the breech; 3 places loading tray; 6 wipes the cup; 4 provides sponge, and, assisted by 3, sponges the gun.

NOTES.—Guns are always to be sponged, whether firing blank or projectile. Two sponges are supplied, the "bore sponge" and the "chamber sponge." The bore sponge is to be thrust completely through the bore before loading for the first time, and after each round fired with a blank charge. The chamber sponge is, before loading for the first time, and after each subsequent round, to be forced to the end of the chamber, and a complete turn given before withdrawing it. Both sponges are to be saturated during the firing, and after it the chamber sponge is to be rinsed with fresh water and thoroughly dried, to preserve it.

LOAD. — As before detailed.

CEASE FIRING. — 1 orders "Half-cock"; 2 disconnects firing gear; 2 and 3 put down sights; gun's crew close up.

NOTES.—If, while loading, or after the gun is fired, the order "Cease firing" is given, the loading will be completed, and the gun's crew close up. Should it be necessary for the gun's crew to leave their gun, for "boarders," to man a pump, &c., the gun will be left in the "Cease firing" position.

If the gun requires to be run in, 2 attends by-pass valve; 3 raises screw flap; 5 ships winch-handle; 4, 5, and 6 run in, and when the gun is in, 1 orders "Well"; 2 closes by-pass valve, and holds up his hand to 3, who disconnects screw-flap and returns lever; 5 returns winch-handle; gun's crew close up.

UNLOAD. — 2 removes needle-holder, and takes out primer; 1 and 2 open the breech; 3 places loading-tray, and draws out cartridge; powderman returns it; 4 receives ejector from 6, and forces back the projectile; 3 receives it; 5 returns it; 3 returns loading-tray; 4 returns ejector; 1 and 2 close the breech; 2 replaces needle-holder; gun's crew close up.

NOTES.—If the gun is loaded with filled shell and fuzed, it should be fired if the range is clear.

The order "Unload" may be given, to alter the charges and projectile, or for securing.

SECURE. — 1 sees the gun placed in securing position; 1 and 2 returns sights, firing gear, pouch, and primers; 3 puts in tompion; 4 raises friction-brake lever, returns sponge and rammer; 5 and 6 return winch-handles; 5 returns projectiles; all Nos. replace gear, and when finished, 1 orders "Fall out."

12½-PR. AND 9-PR. B.L. GUNS.

DESCRIPTION OF GUNS.

12½-pr.	9-pr.
Calibre, 3 inches.	Calibre, 2·6 inches.
Weight, 8 cwt.	Weight, 5 cwt.
Preponderance, 25 lbs.	Preponderance, 10 lbs.
Length of bore, 6 ft. 9 in.	Length of bore, 6 ft. 3 in.
Length of rifling, 5 ft. 7 in.	Length of rifling, 5 ft. 4 in.
Length of chamber, 11·8 in.	Length of powder chamber, 10·15 in.
Length over all, 7 ft. 7·2 in.	Length over all, 7 feet.
Number of grooves, 10.	Number of grooves, 16.
Rifling, spiral, increasing 1 in 100 calibres at breech to 1 in 30 at 7·5 inches from muzzle; remainder, 1 in 30.	Rifling, spiral, increasing 1 in 100 at breech to 1 in 35 at 3 inches from muzzle; remainder, 1 in 35.

These guns are mounted on a single-plate wrought-iron carriage, and fitted with elevating gear, on the friction-cone principle, and with a friction-compressor and iron slide mounted on chocks, and are worked by means of tackles and handspikes.

PRELIMINARY DRILL.

The gun's crew consists of 5 men and a powderman, and fall in as follows:—

P.M. 5. 3. ↑ 1. 2. 4.

CLOSE UP. 1 in rear of the gun, facing the port; 2 on the right in line with the vent; 3 on the left, close to the ship's side; 4 on the right, close to the ship's side; 5 in rear of 3.

NUMBER. The gun's crew call their Nos. in succession.

CHANGE ROUNDS. 3 takes 4; the remainder move round one place to the left.

FALL OUT. As before detailed.

CAST LOOSE. 1 ships sight, and provides tube-lanyard; 2 takes up rear flap and provides tube-pocket; 3 takes out tompion, and provides loading-tube; 3 and 4 clear away port bar and chains, and shackle on breeching; 2 and 5 clear away securing-chains and provide handspikes; 3, 4, 5, and 2 clear away side-whips and training tackles; 5 provides projectiles, and the gun's crew close up.

LOAD. 1 opens the breech, using the lever if necessary, sees the bore clear, and superintends the loading; 2 examines the vent, and hooks on a tube; 3 places loading-tube, receives the projectile from 5, and enters it; 4 rams home; 3 receives the cartridge from the powderman, and enters it; 4 presses the cartridge home, and returns the rammer; 3 returns the loading-tube, 1 closes the breech; and the Nos. close up.

NOTES.—This is termed the "Cease Firing Position." If using fuzes, 2 will provide and fit them, 3 providing thimble and pellet, which will be screwed in just before the shell is entered; 3 removes the safety-pin just before the shell is entered.

—DEFLECTION, OR —KNOTS SPEED. —YARDS. —OBJECT. 1 adjusts the sight; 3 and 4 open the port; 3 attends elevating gear; 4 the compressor; the gun is run out, trained, and elevated under the direction of 1, who retires to the extent of the tube-lanyard, and lays the gun for the object.

NOTES.—This is termed the "Training Position." Orders for **training** are "Right," or "Left," "Quick," or "Slow," and when **trained**, "Stop." When training "Quick," handspikes will be **used to** assist the tackles. Orders for elevating are, "Raise" or **"Lower,"** when laid "Well." Should the distance be given in **yards**, 1 will refer to the Range Table for elevation due to distance. **If** no distance is named, 1 estimates the distance of the object.

READY.	1 slacks the tube-lanyard, and places his left hand over the right; 2 places the tube in the vent.
OUT TUBE.	1 slacks the tube-lanyard; 2 takes the tube out of the vent.
READY.	As before detailed.
FIRE.	1 fires by pulling the tube-lanyard downwards with a jerk, bringing his left hand on the right; 3 and 4 close the port; 3 lays the gun for loading.
MISS-FIRE.	2 examines the vent, and hooks on a fresh tube; 1 then orders "Ready."
SPONGE.	1 opens the breech; 3 places the loading tube; 4 carefully sponges the gun.

NOTE.—Guns are always to be sponged, whether using blank or projectile. The sponge should be saturated during the firing.

CEASE FIRING.	1 orders "Out tube"; 2 takes the tube out of the vent; the tackles are hitched; and the gun's crew close up.

NOTE.—If while loading, or after the gun is fired, the order "Cease firing" is given, the loading will be completed, and the gun's crew close up. Should it be necessary for the gun's crew to leave their gun, for "boarders," to man a pump, &c., the gun will be left in the "Cease firing" position.

UNLOAD.	1 orders "Run in"; when the gun is in, 1 opens the breech; 3 places loading tube; 4 provides ejector, and forces back projectile; 3 receives it; 5 returns it; P.M. returns cartridge; 3 returns loading tube; 4 returns ejector; 1 closes the breech, and the Nos. close up.

NOTES.—If the gun is loaded with filled shell and fuzed, it should be fired if the range is clear. The order "Unload" may be given to alter the charge and projectile, or for securing.

SECURE.	1 sees the gun placed in the securing position, the flaps put down; then everything is returned and secured by the Nos. that cleared it away. When everything is finished, 1 orders "Fall out."

PRACTICE.

FOR ALL B.L. GUNS.

Attention is called to the general notes to "Practice" for all guns, which will be found on Pages 11 to 13.

CLEARING FOR ACTION.

ACTION.	The guns are to be cast loose, run out, and loaded, and the crew close up.
FOR EXERCISE. ACTION.	As above, without powder being provided. The guns are to be loaded with projectile and dummy cartridge.

INDEPENDENT FIRING.

In this firing, the Nos. 1 should seize the most favorable opportunity of delivering their fire. To be effective, it is requisite that they should experience no difficulty in laying the guns by sight as soon as they are out.

INDEPENDENT FIRING.	A caution.
—DEFLECTION, OR —KNOTS SPEED. —YARDS. —(*Name the Direction, if necessary*). —(*Name the Object*).	The gun is laid for the object as taught in Preliminary Drill. 1 orders "Ready."

NOTES.—Training and elevating should be carried out together; 1, when he sees the object, lays the gun, using words of command for "Elevating," and signals for "Training."

"Object" alters, train at the "Ready." "Elevation" or "Distance" alters, "Half-cock," relay, and come to the "Ready."

COMMENCE.	1 fires at his own discretion, and orders "Run out." When the gun is out, 4 at 8-inch guns, or 2 at 6-inch guns, holds up his hand as a signal to No. 1; the gun is then laid for loading, sponged, and loaded without orders. 1 then proceeds with the firing.

NOTES.—When the ship has motion, the gun should be fired a little before the sights come on with the object.

Should the motion of the ship require it, or No. 1 require the gun to remain in after firing, he directs 5 to close the "by-pass" valve at 8-inch guns, or 2 at 6-inch guns.

If necessary, at 8-inch guns, the slide may be secured with shores, and the direction of the object brought on by the helm.

CEASE FIRING. { As detailed in Preliminary Drill. If the gun is in, it is to be run out and loaded.

EXERCISE BY SIGNALS.

After the gun's crews have been well trained in the different firings, they should be made thoroughly conversant with the following system of signals, which should be used instead of the words of command for which they stand during exercise at quarters, unless smoke, darkness, or some such absolute necessity, renders the word of command necessary.

This method possesses the great advantage of enforcing silence, and compels the gun's crew to fix their attention on No. 1.

ORDERS.	SIGNALS.
RIGHT (OR LEFT).	The left arm to be extended to the front, above the right, the palm of the hand turned in the direction towards which the slide is required to be moved.
RIGHT (OR LEFT), QUICK.	As for "Right" (or "Left"), but moved quickly in the required direction.
WELL.	In running in or out, 1 raises his right arm perpendicularly, palm of the hand to the front.
STOP.	In training, drop the hand. If at the "Ready," turn the palm of the hand down.
READY.	1 slacks the tube lanyard.
OUT TUBE.	1 shakes the tube lanyard.

The gun is run in and out without orders.

Words of command are to be used for elevating.

When using electric gear, words of command are used for "Ready" and "Out tube."

DIMINISHED CREW.

When casualties occur, 1 directs the highest Nos. to fill the vacancies, except in the case of 1 or 2 being removed, when the vacancy should be filled by the lowest original No., or a specially selected man.

Example.

I. With a full gun's crew, fall out 1; 2 takes 1, and directs 3 to take 2, and the highest No. at the gun to take 3.

II. With a full gun's crew, fall out 1 and 2; 3 takes 1, and then directs 4 to take 2, the highest No. to take 3, and the next highest to take 4.

In all cases of exercise with diminished crews, whatever additional work they may have to perform, the Nos. will continue their duties as if with a full gun's crew, unless otherwise specified.

The following table shows the changes in the duties of the several Nos. of the gun's crew, and the additional work to be performed by them (when working the guns with diminished crews):—

Duty.—8-inch Gun.	8 Men.	6 or 7 Men.	5 Men.	4 Men.
"By-pass" Valve	5	5	5	3
Rammer ...	8	1	1	1
Ram Home ...	3, 4, 7, 8	1, 3, 4, 7	1, 3, 4	1, 3, 4
Projectile ...	7, 8	5, 7	3, 5	3, 4
Winches ...	3, 4, 7, 8	3, 4, 5, 6	2, 3, 4, 5	2, 3, 4
Loading-tray ...	3	3	3	3
Wipe cup and ring	6	6	2	2
To elevate ...	5	5	5	3

Duty.—6-inch Gun.	6 Men.	5 Men.	4 Men.	3 Men.
"By-pass" Valve	2	2	2	2
Sponge & Rammer	4	4	4	1
Ram Home ...	3, 4	3, 4	3, 4	1, 3
Projectile ...	5	5	3	3
Winches ...	3, 4, 6	3, 4, 5	3, 4	2, 3
Loading-tray ...	3	3	3	3
Wipe cup ...	6	2	2	2
Elevate	5	5	3	3

PROJECTILES AND CHARGES.

Guns.	Weight.	Length.	Nature of Powder.	Charges. Full.	Charges. Reduced.	Shell. Common. Weight.	Shell. Common. Burster.	Shell. Shrapnel. Weight.	Shell. Shrapnel. Burster.	Shell. Segment. Weight.	Shell. Segment. Burster.	Shot. Palliser. Weight.	Case. Weight.	Case. Balls.
	tons.	ft. in.		lb.	lb.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	No.
10-inch M.L.R.	18	15 0	Pebble R.L.G.	70	44	377 12	20 4	404 9	1 9	.. ..	.. ..	.. ..	143 0	193
			Prismatic	60	40							400 0		
8-inch B.L.	12	19 3	Pebble	100	..	168 0	12 0	180 0	0 10	177 0	3 0	180 0	180 0	432
			Prismatic	..	65									
6-inch B.L.	4	14 7	Pebble	42	..	75 0	5 0	80 0	0 5	77 0	3 0	80 0	70 0	320
			Prismatic	..	30									
12½-pr. B.L.	cwt. 8	7 7	R.L.G.	..	lb. oz. 3 12	12 8	0 7	12 8	0 1	12 8	0 4	..	12 8	150
9-pr. B.L.	5	7 0	R.L.G.	..	2 8	8 11	0 4¾	9 0	0 1	8 15	0 1	..	9 0	108

The full and reduced charges for the 8-inch B.L. Guns are in two half-charges.

64-Pr. M.L.R. GUN.

[*The following Drill is inserted in the present edition to enable those Guns mounted in H.M.V.S. "Nelson" and the Reserve Drill Rooms to be exercised with uniformity.*]

PRELIMINARY DRILL.

The following drill is for 64-pr. M.L.R. guns, mounted on truck carriages with beds and quoins.

The guns are arranged in pairs, each gun being distinguished as the Left (or Right) gun of the pair.

Truck guns are numbered consecutively from forward aft, on each side of the deck, the odd-numbered guns the starboard side, and the even-numbered guns on the port side being known as the Left guns, and the others as the Right guns.

The crews fall in two deep in rear of the left guns as follows :—

↑

Front Rank — P.M., 9, 7, 5, 3, 1, 2, 4, 6, 8.
Rear Rank — 11, 13, 14, 12, 10.

The guns' crews place themselves as follows, turning towards the ship's side :—

CLOSE UP. { 1 in rear of the gun ; 2 on the right of 1, clear of the recoil ; 3 close to the ship's side, on the left ; 4 close to the ship's side, on the right ; 5 in rear of 3 ; 6 in rear of 4 ; and so on in succession.

NUMBER. { The guns' crews call their numbers in succession.

Both Sides. The guns' crews take their places as follows:—The odd numbers at the left guns, and the even numbers at the right guns.

1	remains	1	2	becomes	1
3	becomes	2	4	,,	2
5	,,	3	6	,,	3
7	,,	4	8	,,	4
9	,,	5	10	,,	5
11	,,	6	12	,,	6
13	,,	7	14	,,	7

Number. As before detailed.

Right (or Left) Guns. The guns' crews take their places at the right (or left) guns, as in "Close Up."

Starboard (or Port) Guns. The guns' crews man their left guns, or those opposite, according to the side named.

Fall Out. The guns' crews place themselves in rear of the guns as before detailed.

Notes.—At the order "Fall Out," when both sides are manned, the numbers place themselves in rear of the guns they are at, in single rank, powdermen between the guns. Guns that are cast loose are always to be left with the side-tackle falls bracketed by 3 and 4, who are responsible that they are unbracketed on closing up at the gun.

The following details are given for a full gun's crew, with the exception of casting loose and securing. The duties with both sides manned are the same as when working with diminished crews:—

Cast Loose (7 men). 1 and 2 trice back the upper half-port; 5 and 6 raise the breech of the gun with the handspikes to clear the lower half-port, 1 withdrawing the quoin; 1 then clears away tube lanyard and vent-server; 2 and 7 clear away and hook on preventor tackle, 2 mousing the hook of the outer block; 5 and 6 place handspikes; 5 provide projectile, and 6 the sponge, rammer and worm; 3 to 6 clear away the breeching and side tackles, 5 and 6 shifting the inner blocks to training loops; the gun is then run in; 2 chokes the luff of preventor tackle; 3 and 4 put down lower half-port, 3 takes out tompion; 6 gives the worm to 4, who searches the gun, while the worm is being withdrawn, 1 examines the vent; 6 takes the rammer, and the powderman closes up; 5 drops back to the projectile.

Cast Loose (7 men)—*continued.*

Note.—When the gun is secured with the preventor tackle under the brackets, all numbers except 1 clear it away before performing their other duties.

Load. 1 serves the vent; 2 attaches a tube; 3 enters the cartridge, then receives the projectile and wad from 5, and enters them; 6 gives the rammer to 4, and returns the worm (or sponge); 3 and 4 ram home, 4 springs the rammer; 6 returns it; 3 and 4 step out; 1 removes the vent-server and pricks the cartridge.

Notes.—Whenever the position of the gun requires it, 3 and 4 are to interchange duties.

When using time-fuzes 3 uncovers the priming after the projectile is entered; the hand is to be kept over the head of the fuze until just before it is covered by the head of the rammer.

A mark on the rammer-staff indicates when the charge and projectile are home.

Run Out. Right rear man attends the preventor tackle, the remaining numbers run the gun out by the side-tackles. When the gun is out, 5 and 6 raise the breech of the gun, 1 squares the quoin, 3 and 4 coil down the side-tackle falls, and the numbers close up.

Notes.—This is termed the "Cease Firing Position."

If the ship is rolling, 3 and 4 choke the luff of the side tackles when the gun is out, and at the order, "Reeve Preventor Tackle," the preventor tackle is rove through a ring-bolt, and attended by both rearmen.

—Deflection, or —Knots speed, —Yards. 1 and 2 adjust the sights.

Note.—If no distance is named, 1 estimates the distance; 1 and 2 adjust the sights accordingly.

—(*Name the Direction, if necessary.*) —(*Name the Object.*)

When the object is named, 7 and 8 pick up the handspikes turning outwards from the gun, and man them in front, 9 and 2 in rear; the right rear man attends the preventor tackle, the remaining numbers man the side-tackles, 11 and 12 inside, the other numbers outside; the gun is trained for the object under the direction of 1, who retires to the rear with the tube lanyard.

NOTES.—This is termed the "Training Position."

The orders for training are "Right" (or "Left"); "Two Handspikes Right" (or "Left"); or "Right" (or "Left") "Quick;" according to the direction in which the muzzle of the gun is to be trained, and the amount of training required; when the direction is on, 1 orders stop. At the order, "Two Handspikes Right" (or "Left") 1 makes up the tube lanyard, and falls to the rear, 7 (or 8) works the handspike inside the bracket, 9 (or 2) mans the side-tackle fall. At "Stop" the numbers resume their former position.

When the order "Right" (or Left") is followed by the word "Quick," 1 renders the breeching through the neck ring, 3 (or 4) assisted by the other numbers shift the side tackle to the side tackle bolt of the next port, all the numbers man it except the right rear man, and 4 (or 3) who attends the opposite tackle, the handspikes being manned as in "Two Handspikes Right" (or "Left"); at "Stop" the side tackle is replaced, and the numbers resume their former positions.

If there is not sufficient room in rear of the gun to allow 1 to use a tube lanyard of the proper length, he should stand so as to be able to spring off to the left on firing.

ELEVATE, OR BY SCALE ELEVATE, HORIZONTAL, OR—DEGREES ELEVATION, OR DEPRESSION.

7, 8, and 9, place the handspikes on the steps of the carriage and raise the gun off the quoin 2 withdraws it, 1 orders "Raise" (or "Lower") bringing the top of the foresight in line with the object through the notch in the rear sight; at "Well" from 1, 2 presses in the quoin, and signals to 7 and 8; the numbers then resume their former positions.

When the scale is used, 1 repeats the elevation, 2 lays the gun by scale, 10 attending it.

NOTES.—1 is responsible that the gun is never fired with more depression than the port will admit of.

2 attends quoin, bed, and depression-chock, if required.

READY.

1 slacks the tube lanyard, and brings the left hand over the right; 2 places the tube in the vent; the numbers let go the side-tackle falls.

OUT TUBE.

1 drops his left hand, 2 takes out the tube.

READY.

As before detailed.

NOTES.—When necessary to train the gun at the "Ready," the handspikes only are used, the opposite one being used for checking the training.

At the order "Ready" or "Out Tube," 8 withdraws his right foot and handspike, to allow 2 to step up clear of the recoil.

If the ship is rolling, the side-tackle falls are kept in hand until the moment of firing, 1 raising his left hand as a signal for them to be let go.

FIRE.

1 pulls the tube lanyard downwards with a jerk bringing the left hand smartly on the right; after the gun is fired, 1 makes up the tube lanyard, 7 and 8 ground the handspikes.

MISS-FIRE.

2 examines the vent, and hooks a fresh tube to the lanyard; 1 then orders "Ready."

RUN IN.

All the numbers man the preventor tackle, except 1, and 3 and 4 who overhaul the side tackles. When the gun is in, 1 orders "Well;" the right rearman chokes the luff of the preventor tackle, and attends it.

SPONGE.

1 serves the vent; 6 serves the sponge to 4 who, assisted by 3, forces it hard home to the bottom of the bore, keeping it pressed home while a round turn is given; 4 then withdraws it; 6 takes the rammer, and the powderman closes up; 5 drops back to the projectile.

NOTES.—The vent-server is always to be used, and No. 1 is to put his thumb on top of it, keeping his hand clear, so that he may see if there is any escape of air. When withdrawing the sponge care should be taken to keep the staff in the upper part of the bore. When firing, the sponge should be sprinkled with (not dipped in) water, as a saturated sponge causes an increase of the remains of the cartridge bag after firing.

CEASE FIRING.	1 if at the "Ready" orders "Out Tube," the handspikes are grounded, the sights put down, the deflection scales set to zero, and the numbers close up.

NOTE.—If while loading, or after the gun is fired, the order "Cease firing" is given, the loading will be completed, and the gun's crew close up. Should it be necessary for the gun's crew to leave their gun for "boarders," to man a pump, &c., the gun will be left in the "Cease Firing Position," with falls bracketed.

OFF REAR TRUCKS.	7 and 8 place the handspikes under the rear axletree cleats; 9 and 2 take off the trucks. The numbers then resume their former positions.
REPLACE REAR TRUCKS.	7 and 8 place the handspikes under the rear axletree cleats, 9 and 2 replace the trucks. The numbers then resume their former positions.

NOTE.—The rear trucks may be taken off to diminish the recoil, or to give greater control over the gun in running in or out. They may also be taken off to give extreme elevation.

UNLOAD.	The gun is run in and emptied, 6 serving the worm and extractor as required. When the gun is empty the numbers close up.

NOTE.—The order unload may be given to alter the charge or projectile, or for securing.

OUT-BOARD SECURE (7 MEN).	3 puts in the tompion, 1 sees the gun run out square in the port, 3 and 4 haul up and secure the lower half port, the gun is laid horizontal, the tackles are secured, and the stores returned by the numbers who cleared them away; 5 returns the projectiles. When everything is finished, 1 orders "Fall out."

NOTE.—The inner blocks of the side-tackles are hooked to the bracket loops. The falls are rove through the side-tackle bolts and training loops, and frapped. The preventor tackle is hooked to the training loop and the bolt in the ship's side on the right of the gun, hauled taut and hitched. As an additional security in a heavy sea-way, the preventor tackle should be passed under the rear part of the brackets, hooked to the bolts in the ship's side, hauled well taut and secured. With breechings rove through the neck-ring, the hitch should be cast off on the right of the gun, the end hauled taut round under the cascable, and secured.

PRACTICE.

This part comprises the different modes of firing, together with other matters connected with the general working of truck guns.

If the order is given to man the "Port," "Starboard," "Right," or "Left" guns from both sides being manned, the guns that are left are to be placed in the "Cease Firing Position."

The notes to practice at other guns (see Page 11) also apply to truck guns.

CLEARING FOR ACTION.

ACTION.	The guns are to be cast loose, wormed, loaded with full charges and filled common shell, and run out.
FOR EXERCISE ACTION.	As above without powder being provided, the guns are to be loaded with projectile and dummy cartridge.

INDEPENDENT FIRING.

In this firing the Nos. 1 must seize the most favorable opportunity of delivering their fire. To be effective it is requisite that they should experience no difficulty in laying the guns by sight as soon as they are out.

This firing should not, therefore, be practised when only occasional glimpses of the object can be obtained, owing to smoke, darkness, &c.

INDEPENDENT FIRING.	A caution.
—DEFLECTION, OR —KNOTS SPEED. —YARDS. —(*Name the Direction, if necessary*). —(*Name the Object*).	The gun is trained for the object, 1 then orders "Elevate," lays the gun, and gives the order "Ready."
COMMENCE.	1 fires at his own discretion, and (if necessary) orders "Run in." When the gun is in, it is laid for loading (if necessary), sponged, and loaded without orders; 1 then orders "Run out," and proceeds with the firing.

CEASE FIRING. As detailed in Preliminary Drill. If the gun is in, it is to be loaded and run out.

BROADSIDE FIRING.

In this firing the guns are laid for the same elevation, and are fired simultaneously. It is used at moderate distances whenever it is required to direct the broadside from a particular gun.

BROADSIDE FIRING.—GUN DIRECTING. A caution.

—DEFLECTION, OR —KNOTS SPEED. —YARDS. —(*Name the Direction, if necessary.*) —(*Name the Object.*) The gun is trained for the object under the direction of 1. All Nos. 1 then order "Elevate Rest," except 1 of the directing gun who lays for the object; at "Well" 2 gives 1 the elevation by scale or quoin, who repeats it to the officer of the quarters, and gives the order "Ready."

HORIZONTAL, OR —DEGREES ELEVATION OR DEPRESSION. The officer of the quarters repeats the elevation to the remainder of the Broadside, who lay accordingly, and come to the "Ready."

STAND-BY. 1 of the directing gun raises his left hand perpendicularly, and as the sights are coming on, brings it smartly down, as a signal to the officer of the quarters to give the order "Fire."

FIRE. 1 fires, and proceeds as in Independent Firing, and when the gun is out, re-lays as before.

CEASE FIRING. As in Independent Firing.

NOTES.—If the object alters, train at the ready. If the distance alters, the guns are not to be re-laid for elevation unless No. 1 finds that his sights do not come on, and reports accordingly.

If at any time No. 1 of the directing gun finds that his sights will not come on, he reports "Sights do not come on" to the officer of the quarters, who then gives the order "By the Directing Gun," when the guns are re-laid for elevation.

MODE OF PROCEDURE IN CHANGING FROM ONE DESCRIPTION OF FIRING TO ANOTHER FROM THE READY.

FROM INDEPENDENT FIRING, TO	Broadside Firing—Gun Directing.	"Out Tube," 2 of directing guns reads off elevation by quoin (or scale), the other guns "Elevate Rest," &c.
FROM BROADSIDE FIRING—GUN DIRECTING, TO	Independent Firing.	If necessary, re-lay for elevation.

SHIFTING BREECHINGS.

SHIFT BREECHINGS. The gun having been loaded and run out, and if necessary trained clear of the breeching bolts, No. 1 gives the order "Shift Breechings;" 3 and 4 hitch the side-tackle falls; 3, 4, 7, and 8 cast off the old and secure the new breeching; 5 and 6 bring up the spare breeching on their respective sides, and give the ends to 3 and 4; 6 returns the old breeching, 1 unsnatches and snatches the breeching. When the hitches are formed, 1 proceeds to lay the gun.

NOTES.—The breeching is rove from right to left, and hitched close up to the bolts; the seizing is passed with the first a racking turn, and the remainder round-about turns towards the hitch, the ends being secured in the usual manner.

The breeching should be marked to indicate the proper position of the hitches, and also in the centre, which mark should be about 10 inches to the right or left of the neck-ring when the gun is trained on the bow or quarter; 1 is not to come to the "Ready" until 3 and 4 hold up their hands as a signal that the breeching is secured.

In shifting breechings from the "Ready" position, 1 orders "Out Tube," trains the gun if necessary, and proceeds as above.

Shifting Trucks.

Shift the Right (or Left) Fore-Truck.	7 (or 8) places his handspike under the rear axletree cleat; 9 (or 2) takes off the rear truck; 7 (or 8) stands on the arm of the axletree; 8 (or 7) places his handspike under the fore axletree, using the spare truck as a glut; the Nos. on that side of the gun assist at the handspike; 2 (or 9) provides and shifts the truck, forcing the small quoin under the fore axletree to keep the weight of the gun off the truck. When the fore truck is shifted, the opposite rear truck is replaced.

Notes.—1 passes the small quoin to 2 (or 9), who returns it to 1 when the truck is shifted.

If the rear trucks are off, the rear truck on the same side as the fore truck to be shifted must be put on, instead of the one on the opposite side being taken off. If at the "Ready," 1 orders "Out Tube," "Shift the Right (or "Left") fore truck." At that order the gun is run in clear of the sweep piece, the truck shifted, and the gun run out. The handspikes are not grounded to run the gun in. A truck may be shifted while loading.

Shift the Right (or Left) Rear Truck.	8 or 7 places his handspike under the rear axletree cleat, 2 (or 9) shifts the truck.

Note.—If at the "Ready" 1 orders "Out Tube," "Shift the Right (or "Left") Rear truck."

Supply of Spare Stores, and Method of Replacing Disabled Gun Gear.

Attention is called to the remarks on this subject on Page 13. The following are specially applicable to Truck Gun Exercise:—

I. The gun should not be kept out of action for a longer time than can possibly be avoided.

For example—

(A) Rammer lost overboard; the sponge should be used instead, until another rammer is provided.

(B) The training loop carried away; use the side loop until a strop is provided.

II. If gear carries away, which places the gun out of control, it is to be secured at once, so as to prevent further damage:—

For example—

(*a*) If the preventor tackle is carried away when the gun is being run in, 1 orders "Run Out," rearman provides spare preventor tackle.

(*b*) If a side-tackle is carried away while training with the ship rolling, the opposite fall should be bracketed, or the gun run in, until a new tackle is provided.

(*c*) If the breeching carries away on recoil, hitch the side-tackle falls while the gun is in and loading.

III. A disabled gun should be placed so as not to interfere with the working of adjacent guns.

EXERCISE BY SIGNALS.

Orders.	Signals.
Right (or Left).	If at the breech of the gun 1 extends his right (or left) arm to the front in line with the shoulder, the palm of the hand turned in the direction towards which the breech of the gun is required to be moved. If at the extent of the tube lanyard, the left arm is to be extended to the front above the right, the palm of the hand as before detailed.
Two Handspikes Right (or Left)	As for "Right," (or "Left"), the directing arm raised to an angle of 45°.
Right (or Left) quick.	As for "Right" (or "Left"), but moved quickly in the required direction.
Elevate.	The arm extended to the front, the palm of the hand up or down, according as the breech of the gun is to be raised or lowered.
Rest.	The upper arm extended in line with the shoulder, and the fore arm raised perpendicularly, palm of the hand to the front.

STOP. In training or elevating, drop the hand; in running in or out, 1 raises his right arm perpendicularly, palm of the hand to the front. If at the Ready, turn the palm of the hand down.

READY. 1 slacks the tube lanyard.

OUT TUBE. 1 shakes the tube lanyard.

NOTES.—The gun is run in and out without orders. When the executive order for the firing is given the gun's crew at once get into the training position without orders.

On being directed to "Use Words of Command" signals are discontinued until the order "Exercise by Signals" is given.

In "Broadside Firing—Gun Directing," if the directing gun requires training after the order "Stand by" has been given, 1 gives the necessary orders for training.

EXERCISE WITH DIMINISHED CREWS.

When casualties occur, 1 directs the highest numbers to fill the vacancies, except in the case of 1 or 2 being removed, when the vacancy should be filled by the lowest original number, or a specially selected man.

Examples.

I. With a full gun's crew—Fall out 1; 2 takes 1, then directs 3 to take 2, and the highest number at the gun to take 3.

II. With a full gun's crew—Fall out 1 and 2; 3 takes 1, then directs 4 to take 2, the highest number to take 3, and the next highest to take 4.

III. (Continuing II)—Fall out 1; 2 takes 1, then directs 5 to take 2 (the original 3 and 4 having been removed), and the highest number to take 5.

In all cases of exercise with diminished crews, whatever additional work they may have to perform, the numbers will continue their duties as if with a full gun's crew, unless otherwise specified.

WITH 9 OR 8 MEN. 1, 3, and 4 assist to run in; 8 mans the side tackle at the order "Right (or "Left") Quick." After unhooking the preventor tackle, 5, 6, 7, and 2 attend handspikes; 7 and 2 attend trucks.

If a truck requires shifting with the gun in, it is done after the loading is completed.

In shifting a fore truck with the gun out, 5 and 6 man the preventor tackle to run the gun in.

WITH 7 MEN. As with 8 men, except 2 attends preventor tackle, and assists 7 in shifting breeching; 1 attends preventor tackle, while 2 is shifting the truck.

NOTE.—If the gun has to be trained so much as to require preventor-tackle being hooked to another rear bolt, 2 unhooks it, and then mans the handspike or right side tackle; when the training is completed, 2 hooks the preventor tackle in line with the gun, assisted by 1.

WITH 6 MEN. As with 7 men; except 2 attends trucks.

IN CLEARING FOR ACTION.

WITH 6 MEN. As with 7 men; except that 1 assists 2 with preventor tackle.

WITH 5 MEN. As with 6 men; except that 3 and 4 attend handspikes; 2 serves worm and rammer to 4.

WITH 4 MEN. As with 5 men; except 3, provides and brings up the projectile.

Securing with 4, 5, or 6 men is similarly performed.

The remaining sections are inserted for information only.

TRANSPORTING.

TRANSPORT. 3, 4, 5, and 6 cast off the breeching, and place the ends on the gun; 7 and 8 unhook the side tackles from the ship's side, and place them over the gun; 9 and 2 provide handspikes from the disengaged guns; 1 then orders "Run in," and when in, "Four Handspikes Right" (or "Left") if necessary; the right rear man, assisted by the other numbers, hooks the preventor tackle to the transom loop; all the numbers man it, except 1, and 2, 7, 8, and 9 who assist with the handspikes.

NOTE.—The gun may be transported either muzzle or breech first; 1 if necessary, using the small quoin to check the gun; 9 and 2 work the handspikes under the fore axletrees. When the gun is at the new port, 1 and 2 trice back the upper half-port 6; provides the sponge, rammer, and worm.

DISMOUNTING.

DISMOUNT. The gun is trained to the required position, and run in; 1 unships the side tangent sights, makes up the tube-lanyard; the gun is then placed fair under the dismounting bolts, housed, and run up, 1 taking out the quoin and bed, and throwing back the depression-chock; 2 and 9 hook and attend the dismounting tackle; 11 and 12 hook the runner; 3 and 4 pass the muzzle-lashing; 5 and 6 throw back the cap-squares, unspan the breeching, and place it over the trunnions. All the numbers man the dismounting tackle except 7 and 8, who assist with their handspikes until of no further use. When the muzzle-lashing is passed, 1 orders "Dismount," and when high enough "Well." The numbers then close up; 1 replaces the quoin, bed, and depression-chock.

NOTE.—Four turns of the muzzle-lashing are passed, and the end twice hitched on the bight. At guns without a swell to the muzzle, 3 and 4 place the dismounting tompion.

MOUNTING.

RE-MOUNT. The gun is lowered into the carriage under the direction of 1; 3 and 4 cast off the muzzle-lashing; 5 and 6 on cap-squares; the gun is then run out, the dismounting gear returned by the numbers who provided it; 1 replaces sights, and the numbers close up.

SHIFTING CARRIAGES.

SHIFT CARRIAGE. The gun is dismounted, as before detailed; 7 and 8 unhook the side-tackles, 14 the preventor tackle. When the carriage is clear, 1 orders "Carriage back." The new carriage is then placed under the gun; 7, 8, and 14 hook the tackles, and the gun is re-mounted in the usual manner. When the gun is out, the Nos. close up.

NOTE.—If the breeching is rove through the carriage, 4 and 6 cast it off, and the numbers on the left of the gun haul it through. When the gun is out, the breeching is re-secured as in shifting breechings.

DRILL FOR 4·7 INCH, 36-PR. OR 45-PR. QUICK FIRING GUN.

The drill laid down for Q.F. guns is similar to that for machine guns. Each pair of guns requires a crew of 6 men and 2 powdermen.

When one side only is manned the highest numbers provide projectiles and ammunition, and keep up the supply.

The gun's crew fall in in single rank in rear of the starboard guns.

P.M. P.M. 5. 3. ↑ 1. 2. 4. 6.

The gun's crew place themselves as follows:—

CLOSE UP. 1 in rear of the gun; 2 on the right in line with the sight; 3 on the left in line with the sight; 4, 5, and 6 in rear.

NUMBER. The gun's crew call their numbers in succession.

CHANGE ROUNDS. At the order "Change rounds," 3 becomes 4, and the remainder move round one place to the left.

BOTH SIDES.

Starboard Guns.			Port Guns.		
1	remains	1	2	becomes	1
3	becomes	2	4	,,	2
5	,,	3	6	,,	3

NUMBER. The gun's crew call their numbers in succession.

FALL OUT. The gun's crew fall out in single rank in rear of their guns.

STARBOARD (OR PORT) GUNS. The gun's crew close up at the named gun.

The following drill is for both sides manned:—On the bugle call "Action," the gun's crew repair to their stations "Both Sides," clear away their guns, and open the ammunition; so that, if necessary, all the guns can be worked at once.

ACTION. No. 1 ships sights, clears away tube lanyard and electric firing gear, sees the training and elevating gear in working order, opens the breech, examines the firing pin and extractor; 2 and 3 open the port and clear away securing-chains (if fitted), raise the shield, and train the gun outboard, 1 giving the necessary orders; 3 enters the projectile and cartridge, 2 closes the breech. Powdermen provide ammunition. After the cartridge is entered, another round is provided.

NOTES.—The cartridge is not to be entered until the gun is trained outboard. When only one side is engaged, Nos. 4, 5, and 6 keep up the supply of ammunition.

—DEFLECTION, OR —KNOTS SPEED. —YARDS. 1 carefully adjusts the sight; if speed-sight is fitted to trunnions, 3 adjusts it.

—OBJECT. COMMENCE. 1 on the left lays the gun for elevation and direction, and fires at his own discretion, keeping the gun bearing on the object; the gun is reloaded, and the firing continued.

NOTES.—No. 1 is to see that the gun is close out before firing each round. If necessary to train, 2 and 3 assist at the gun, 2 attending the brake if required.

MISS-FIRE. 1 orders "Re-cock," and the cartridge is tried a second time; if after a second attempt, after a pause, 2 opens the breech, 3 carefully removes the cartridge; if it has been struck, it is to be thrown overboard; if not, a new striker is to be inserted.

CEASE FIRING. 1 discontinues the fire; 2 opens the breech; 3 carefully removes the cartridge and returns it, if uninjured, to the ammunition-box; gun's crew close up.

NOTE.—If the gun's crew are required to leave their guns, the breech-block is to be closed. For drill purposes, when not using tubes, No. 1 will give the order "Fire" to represent the firing of the gun.

SECURE. 2 closes the breech; 1 replaces the firing gear; the sights and deflection scale are set to zero; the gun is trained to the securing position, and everything returned and secured by the numbers that cleared it away. When everything is finished, 1 orders "Fall out."

DIMINISHED CREW.

WITH 2 MEN.—1 works the breech-block, and 2 loads.

NOTES.—Great care is necessary in loading not to open the breech-block too far, as the extractor prevents the cartridge from going home; it would then be forced into its place by the breech-block or the firing pin, which would be likely to fire the cartridge. If the projectile becomes jammed in the gun, or it is necessary to unload, a blowing charge is used to fire it away, or an extractor is used. Miss-fires may occur through the fouling in the gun, which requires looking to and cleaning. Great care should be taken to see the gun close out before firing, or the rubbing contacts will not be in place, and the gun cannot be fired. In loading for mechanical firing, No. 2 first closes the breech to force the cartridge home before putting in the primer, as in closing the breech the gun is likely to be fired if the breech-block takes against the primer. Care should be taken not to open the breech-block too far when placing the primer for mechanical firing, as the extractor will withdraw the cartridge.

DRILL FOR NORDENFELT 6-Pr. QUICK-FIRING GUN.

The following drill is for the 6-pr. Nordenfelt gun on recoil mounting:—

The gun's crew consists of 6 men, who fall in in single rank in rear of the starboard gun.

5, 3, ↑ 1, 2, 4, 6.

The crew place themselves as follows:—

Close Up. 1 in rear of the gun; 2 on the right in line with the sight; 3 on the left in line with the sight; 4, 5, and 6 in rear.

Number. The gun's crew call their number in succession.

Change Rounds. At the order "Change Rounds," 3 becomes 4, and the remainder move round one place to the left.

Both Sides.

Starboard Gun.	Port Gun.
1 remains 1	2 becomes 1
3 becomes 2	4 ,, 2
5 ,, 3	6 ,, 3

Number. The gun's crew call their numbers in succession.

Fall Out. The gun's crews fall out in single rank in rear of their guns.

Starboard (or Port) Guns. The gun's crew close up at the named gun.

The following drill is for both sides manned:—

On the bugle call "Action," the guns' crews repair to their stations "Both Sides"; clear away their guns, and open the ammunition; so that, if necessary, all the guns can be worked at once.

Action. 1 ships sights, sees the elevating gear, firing pin, and main-spring in order; 2 sees the training gear clear and wheel connected, sets the index to fire by trigger, and opens the breech-block; 3 provides cartridge and enters it; 2 then closes the breech block; Nos. close up.

Notes.—Should the gun be fitted to secure inboard, 1 and 2 first open the port and train the muzzle outboard, then close the port. The cartridge is not to be entered until the gun is trained outboard.

When only one side is engaged, Nos. 4, 5, and 6 keep up the supply of ammunition.

—Deflection, or —Knots Speed. —Yards. 1 adjusts the sight.

—Object. Commence. 1 lays the gun, and fires at his own discretion keeping the gun bearing on the object; 2 opens the breech by a quick motion of the lever; 3 places a fresh cartridge in the gun; 2 then closes the breech, and the firing is continued.

Notes.—If necessary to use the training gear, 2 attends it, 1 giving the necessary orders.

Care must be taken in loading that the point of the projectile does not strike the entrance to the chamber.

Miss-fire. 1 orders "Re-cock," 2 re-cocks without moving the extractor or jarring the cartridge, and the cartridge is tried a second time; if after a second attempt, after a pause, 2 opens the breech, 3 carefully removes the cartridge, which is to be thrown overboard if the cap has been struck, or a new striker inserted if it has not.

Cease Firing. 1 discontinues the fire; 2 opens the breech; 3 returns the cartridge, if uninjured, to the ammunition-box.

Note.—If the gun's crew are required to leave their guns, the breech-block is to be closed.

SECURE. { 2 closes the breech; 1 eases the spring by pulling the trigger; the sights and deflection scales are set to zero; (the gun housed inboard if required); the ammunition returned by the numbers who provided it. When everything is finished, 1 orders "Fall out."

DIMINISHED CREWS.

WITH 2 MEN.—1 works the breech lever; 2 loads.

NOTES.—It is to be distinctly understood that if a supply of ammunition is placed near the gun, one man can work the gun.

If necessary, the firing lever can be set to act by the same motion of the lever that closes the breech, but this will seldom, if ever, be necessary on service; therefore, the index should always be set to fire by trigger.

ACCIDENTS.

The following accidents may possibly occur during practice with these guns, and in case of such occurrence the action detailed will prove efficacious:—

1. If in loading the cartridge appears too large, and will not permit the breech to close readily, do not endeavour to force it home, but take it out and use another.
2. If a cartridge or case jams, and will not extract, force it out from the muzzle; in the case of a cartridge, taking great care that the cap does not strike against anything whilst coming to the rear.
3. If the extractor breaks, dismount the mechanism and replace the extractor.
4. If the firing-pin, main, or sear-spring break, dismount the mechanism, and replace the broken part.
5. If the gun constantly misses fire, open the breech, examine the firing-pin and cap of cartridge. If everything appears correct, dismount the mechanism and change the main-spring.
6. If cartridges enter with difficulty, examine the edge of the chamber for burrs in the metal; if any are found to exist, remove them with a file.
   NOTE.—Care must be taken in loading that the point of the shell does not strike the entrance to the chamber.

7. If a cap should be pierced, open and close the breech, and try if the trigger works; if not, dismount the mechanism, and pour some water on the firing-pin, for the purpose of removing the dirt, which causes it to stick. Clean all parts and put them together, after having examined the main-spring.
8. Should a cartridge miss fire when the cap is fairly struck, it is on no account to be returned to the box. If considered desirable, another attempt may be made to fire it; if not, it should be thrown overboard.

1-INCH NORDENFELT (MARK III.) GUN DRILL.

(In Melb. museum)

The following drill is for the 2-barrel and 4-barrel Nordenfelt guns, on ship's mounting.

The gun's crew fall in in single rank, in rear of the Starboard gun :—

5. 3. 1. 2. 4. 6.

The gun's crew place themselves as follows :—

Close Up. 1, in the rear of gun; 2, on the right, in line with sight; 3, on the left, in line with sight; 4, 5, 6, in rear.

Number. The gun's crew call their Nos. in succession.

Change Rounds. 3 takes 4, the remainder move round one place to the left.

Both Sides.

Starboard Gun.			Port Gun.		
1	remains	1	2	becomes	1
3	becomes	2	4	,,	2
5	,,	3	6	,,	3

Number. The gun's crew call their Nos. in succession.

Fall Out. The gun's crew fall out in single rank, in rear of their guns.

Starboard (*or* Port) Guns. The gun's crew close up at the named gun.

The following drill is for both sides manned:—On the bugle call "Action," the guns' crews repair to their stations "Both Sides," clear away their guns, and open the ammunition; so that, if necessary, all the guns can be worked at once.

Action. 1 sees elevating and training gear clear, then raises the cover and feels each extractor and firing-pin to see they are uninjured; 2 sees drill-stop off, releases the hand lever, and tries the mechanism; 3 provides, fills hoppers and places one.

Note.—*To fill a Hopper.*—Place it base upwards between the knees, with the highest side to the left. Draw the slide so that cartridges can be entered, and then fill each compartment with 10, holding each cartridge with the right hand at the bullet end and guiding the rim into the slot with the left. When the compartments are full, push in the slide.

The drill-stop is only to be used for drill, and is intended to save the wear of the firing-pins and mechanism. When it is in use, neither dummy nor live cartridges can be worked through the gun.

When only one side is engaged, Nos. 4, 5, and 6 keep up the supply of ammunition.

—Deflection, or —Knots speed. —Yards. 2 and 3 adjust and attend the sights.

—Object. 1, using the left sight, lays the gun, working the training wheel with his right hand and elevating wheel with his left; 2 draws back hand lever, forces it forward half way, and fires by order of 1 by forcing it right forward, then, instantly drawing it back to its full extent, repeats the operation. When the hopper is empty, 3 replaces it with a full one.

Commence.

Rapid Firing. 2 works the mechanism continuously after 1 has given the first order "Fire." Should it be necessary to cease firing for a short time to allow smoke to clear away, or to allow 1 to re-lay his gun, 1 will order "Rest," and rapid firing will be continued at his order "Carry on."

Note.—If when the motion of the gun platform is very quick the elevating gear is not required, 1 can fire the gun himself, looking along the right sight and working the training wheel with his left hand.

CEASE FIRING. 2 discontinues the fire, and puts the drill stop on; 3 removes the hopper, pushing in the slide as he does so; 1 then opens the cover and removes any cartridges that may be in the gun, leaving the cover open; 3 returns the cartridges and fills the empty hoppers.

SECURE. 1 closes the cover; the sights and deflection scales are set to zero; 2 fixes the hand lever by its catch; 1 trains the gun to the securing position, and when everything is finished orders "Fall out."

DIMINISHED CREW.

WITH 2 MEN.—1 places and removes the hoppers.

NOTES.—It is to be distinctly understood that with the hoppers filled one man can work the gun. After every practice the guns are to be closely inspected, in order to ascertain that they are empty. Loose cartridges should be returned to Nordenfelt Magazine in a Nordenfelt ammunition-box.

'45-INCH GATLING GUN DRILL.

The gun's crew consists of 6 men, who fall in in single rank in rear of the gun.

The drill and notes for the '45-inch Gatling Gun are the same as for 1-inch Nordenfelt, with the following exceptions:—

ACTION. 1, in rear, sees elevating and training gear clear, raises the cover and feels each extractor and firing-pin in succession, to ascertain that they are not damaged, and that they move correctly; 2, on the right, ships handle on crank shaft, puts safety-bolt to "Fire," and turns slowly forward and tries the action, which will be indicated by hearing ten firing-pins strike, then puts safety-bolt to "Safety;" 3 provides and places a drum.

NOTES.—No. 2 should notice the number of lock nearest him, and after ten rounds has been fired the lock ought to be in nearly the same position.

When only one side is engaged, Nos. 4, 5, and 6 keep up the supply of ammunition.

—YARDS. 2 and 3 adjust and attend sights.

—OBJECT. COMMENCE. 1, using the left sight lays the gun, working the training wheel with his left hand and elevating wheel with his right—2 seizes the crank handle with his right hand and fires by order of 1 by turning steadily forward. When the drum is empty, 3 replaces it with a full one.

RAPID FIRING. 2 works the mechanism continuously after 1 has given the first order "Fire." Should it be necessary to cease firing for a short time to allow smoke to clear away or to allow 1 to re-lay his gun, 1 will order "Rest," and rapid firing will be resumed at his order "Carry on."

NOTES.—Should the multiplying gear be required, which will *rarely* be necessary, 1 disconnects elevating and training gear and lays the gun by means of the elevating lever; 2 ships crank handle on the end of main shaft.

When the motion of platform is such that the elevating gear is not used, or where the distance is likely to remain the same, the stops on elevating arc are to be placed close to crosshead, and brakes set taut.

CEASE FIRING. No. 2 discontinues the fire; 3 removes drum; 4 returns it; 1 raises the cover and takes out any cartridges left in the gun, 2 turning the crank-handle backward; 2 and 3 down sights; 2 returns crank-handle; 3 returns cartridges.

DIMINISHED CREW.

With 2 men, 1 places and removes drum. (See also notes to 1-inch Nordenfelt, Page 56.)

DRUM, HOW FILLED.

Turn the drum with the filling-slot up, and sight-hole to the left; open the sight-hole, place a piece of wood under the catch to raise it out of the way, take hold of a cartridge at the bullet end and guide it into the grooves; then place one in each compartment, and so continue until you can see the base of a cartridge through the sight-hole, when the drum is filled, and sight-hole closed.

The drum has 21 compartments, which revolve round, carrying the cartridges with them; running round the drum inside are two spiral grooves (one each side), in which the base of cartridge and bullet rest. Each ring of cartridges rests in its own part of the groove, the upper part of which keeps it clear of the tier above. The object of this is to keep each cartridge entirely separate from the others, and, at the same time, it only allows one to fall out of each compartment at a time, and before the second can fall out the compartment has to make a complete revolution.

The action of the drum is made automatic by the projections on cartridge carrier taking against the compartments, turning them round in succession, so as to discharge a cartridge from each.

·45 GATLING, MOUNTED ON FIELD CARRIAGE.

The drill for ·45 Gatling Gun, mounted on field carriage, without limber, is similar to that laid down for ship mounting, with the following addition.

The gun's crew consisting of 12 men, fall in five yards in front of the drag-ropes, turning to the front, as follows:—

↑

8. 6. 4. 2. 1. 3. 5. 7.
10. 12. 11. 9.

NUMBER. The gun's crew call their Nos. in succession.

NOTE.—When the gun's crew are required to move without the gun, they are to be told off and wheeled up into two sections, the odd Nos. forming the right, the even Nos. the left, 1 and 2 taking charge of sections.

FORM THE ORDER OF MARCH. A caution.

DOUBLE MARCH. No. 1 places himself on the right in line with the axle-tree; 2, 4, 6 on the left drag-rope outside, 2 being the rear No.; 3, 5, 7 on the right drag-rope outside, 3 being the rear No.; 10 and 11 on the handspike; 8 and 12 on the left drag-rope inside, 12 being the rear No.; 9 on the right drag-rope inside.

CHANGE ROUNDS.

1	becomes	3	10	becomes	12
3	,,	5	12	,,	8
5	,,	7	8	,,	6
7	,,	9	6	,,	4
9	,,	11	4	,,	2
11	,,	10	2	,,	1

GUN'S CREW TO THE FRONT. 1 places himself five yards in front of the drag ropes, turning to the front.

DOUBLE MARCH. The gun's crew fall in on No. 1.

FORM THE ORDER OF MARCH. As before detailed.

THE GUN WILL ADVANCE. A caution for the marker, or No. 6, in his absence, to select points to march on.

QUICK (OR DOUBLE) MARCH. The gun's crew move direct to the front at named pace.

RIGHT (OR LEFT) INCLINE.	The direction is changed an eighth of a circle to the right or left.
RIGHT (OR LEFT) TAKE GROUND.	The direction is changed a quarter of a circle to the right (or left) at the double.
RIGHT (OR LEFT) WHEEL.	The gun's crew change direction by gradually circling round until the order "Forward" is given.
RIGHT (OR LEFT) REVERSE.	The direction is changed half a circle to the right (or left) at the double.

NOTE.—When the order to "Incline," "Take ground," or "Reverse" is given from the halt, the gun's crew move off in the required direction at the order "——— March."

HALT.	The gun's crew halts, 12 assisting at the handspike, the Nos. then tauten the drag-ropes, 10 and 11 ground the trail.
ACTION FRONT, (RIGHT, LEFT, OR REAR).	The gun is reversed to the "Right," or takes ground to the "Right" (or "Left") by order of No. 1, 3 and 4 manning the wheels; 1 then orders "Halt;" 1, 2, 3, 4 as laid down for ship mounting, 5 attending the handspike; remaining Nos. ground drag-ropes, 10 and 11 the handspike, unsling their rifles, turn outwards and form up in line with the axle-trees, even Nos. on the right, odd Nos. on the left.
COMMENCE, OR CEASE FIRING.	As laid down for ship mounting, the Nos. above 5 commencing and ceasing fire by order of the Officer of Division.

NOTE.—In action if any considerable change in direction of the fire is required, the order is "Action ——," the gun Nos. move the gun round, and the other Nos. wheel up or back so as to keep in line with the axle-trees.

GUN FORWARD.	1 mans left trail handle, 2 the right, 3 and 4 the gun wheels, 5 the handspike.
QUICK MARCH.	The gun moves forward.
HALT.	The Nos. resume their places as before.

NOTE —The gun is relaid for the object after the order is given to "Halt." If necessary the drag-ropes may be used to assist the gun, the order being "Man drag-ropes," when the drag-ropes should be reversed and manned.

GUN BACK.	As in gun forward, except that the Nos. turn to the rear.
QUICK MARCH.	The gun moves to the rear.
HALT.	The Nos. resume their places as before.
FORM THE ORDER OF MARCH.	The Nos. above 5 sling arms.
DOUBLE MARCH.	As before detailed, 10 and 11 take up handspike.
DESCENT OF AN INCLINE.	1 orders "Halt," "Reverse drag-ropes;" 3 and 4 man the wheels until reaching the descent; 1 orders "Quick march."

NOTE.—When the incline is very steep, the wheels should be locked by 3 and 4, or, if necessary, the gun and carriage may be taken down separately.

DISMOUNT.	1 places himself at the trail plate-eye; 6 and 7 unship hopper-boxes; 3 and 4 in front, 2 and 5 in rear, prepare to lift the gun; at No. 1's order "Lift," the gun is lifted out of the carriage and placed on the ground to the front; No. 1 then again orders "Lift," 6 in front and 7 in rear lift at the axle-trees; 3 and 4 out linch-pins and off washers, 3 in front and 5 in rear at the left wheel, 4 in front and 2 in rear at the right wheel, take off the wheels. The several parts are lowered to the ground, the Nos. sitting on them.
REMOUNT.	The carriage is first mounted, then the gun placed in it, and the boxes replaced, the Nos. occupying the same stations as in "Dismount."

USE OF DEFLECTION SCALE.

When the ship is moving, the deflection scale must be used. Allow 5′ deflection for each knot of speed. An allowance for wind across the range, or for the speed of the enemy, may also be made on the deflection scale.

The following rules for applying deflection are to be observed :—

For the Speed of Ship.—Move the scale aft if on hind sight; forward if on trunnion sight.

For the Speed of the Enemy.—Move the scale the same way the enemy is moving.

If two ships are going in the *same* direction, the difference of their speeds must be used, and, if in *opposite* directions, the sum of their speeds.

For Wind.—Move the scale to windward.

When using guns with deflection leaf on the trunnion sights, 2 and 3 adjust and attend both hind and trunnion sights. The adjustment of the trunnion sight is not to be altered until a new speed is named.

PISTOL (ENFIELD).

NOMENCLATURE.

1. Body.
2. Barrel.
3. Barrel-joint screw.
4. Cylinder.
5. Cylinder axis.
6. Cylinder axis keeper-screw.
7. Catch.
8. Catch-spring.
9. Catch-screw.
10. **Extractor.**
11. **Hammer.**
12. Hammer axis-screw.
13. Lever.
14. Main-spring.
15. Pawl.
16. Plate.
17. Plate-screw.
18. Stock.
19. Stock-screw.
20. Shield.
21. Shield-spring.
22. Shield-screw.
23. Shield-screw keeper-screw.
24. Swivel-studs.
25. Trigger.
26. Trigger-spring.
27. Trigger-spring rivet.
28. Trigger-axis screw.
29. Top-strap.
30. Top-strap screw.

Names of Principal Parts for Drill Purposes.—Body, barrel, **cylinder**, cylinder axis, catch, hammer, extractor, pawl, plate, **stock**, stock-screw, shield, trigger, and guard.

Weight of pistol, 2lbs. 8½oz.
Length of pistol, 11⅞ inches.
Length of barrel, 5⅞ inches.
Number of grooves, 7.
Twist of rifling, 1 turn in 22 inches.
Diameter, ·45 inch.
Weight of charge, 18 grains.
Weight of bullet, 265 grains.

TO STRIP A PISTOL.

Unscrew stock-screw, lift off stock, unscrew strap-screw, unscrew plate-screw, and lift off plate.

Full-cock the hammer, and press fork of cramp over the main-spring; release the trigger, and take out the main-spring.

Draw pawl out of slot, and lift the tripper off its axis, then lift the hammer and the lever off the axis.

Take out barrel-joint screw (or axis); take off barrel, and draw off the cylinder.

Take out the cylinder axis keeper-screw, unscrew and remove the cylinder axis, draw out catch-screw, and catch and spring.

Remove shield spring, take out shield-screw keeper-screw, and remove shield screw.

NOTES.—The hammer axis and also the cylinder axis has a left-handed thread.

The trigger axis has a right-handed thread.

After stripping a pistol, all the parts should be thoroughly cleaned before replacing.

TO ASSEMBLE.

Proceed the reverse way to stripping, being very careful that the screws, &c., are all in their proper places before screwing them hard up.

NOTE.—There is a lubricating hole (which is closed by a screw) on the rear part of body (on the right), in case at any time the pistol works stiff, for oiling the gear without taking the pistol to pieces.

EXERCISE.

The men are to be in single rank, with the pistols in the holsters, and numbered from right to left.

The Instructor will here explain the principal parts of the pistol the men will come in contact with during the drill.

TO LOAD AND FIRE BY NUMBERS.

BY NUMBERS, READY. Seize the handle of the pistol with the right hand.

TWO. Take the pistol from the belt, and seize the handle with the left hand, holding the pistol nearly upright, the forefinger pointing to the muzzle between the trigger-guard and the cylinder; and drop the right hand to the side.

THREE. Open the breech with the forefinger and thumb of the right hand, then carry the hand to the pouch, take hold of a cartridge at the rim, put one into each chamber, pressing them well home with the thumb, turning the cylinder at the same time with the forefinger of the left hand; then close the breech, and drop the right hand to the side.

FOUR. Full cock with the thumb of the right hand; then pass the pistol into the right hand, holding it upright, with the forefinger outside the trigger-guard.

PRESENT. Point the pistol a few inches below the object, with the arm slightly bent, placing the forefinger round the trigger, but without pressing it.

TWO. Raise the muzzle until the top of the foresight is brought in line with the object through the notch on the backsight, pressing the trigger at the same time without the least motion of the hand, eye, or arm, until the hammer falls, keeping the eye fixed on the object.

THREE. Bring the pistol back upright in the right hand, and pass it into the left hand, holding it as in the second motion of the "Ready," then drop the right hand to the side.

READY. Complete the fourth motion of the "Ready," as before detailed.

TO HALF-COCK, WHEN AT THE "READY."

HALF-COCK. Pass the pistol into the left hand, holding it as in the second motion of "Ready," half-cock, and drop the right hand to the side.

TO RETURN THE PISTOL TO THE BELT.

RETURN. Return the pistol, and drop the hands to the sides.

NOTE.—If at the "Ready," first half-cock.

TO UNLOAD.

Before unloading, the squad is to be turned "Half-right."

UNLOAD. Seize the pistol with the right hand, holding it nearly horizontal, and pointing to the left-front, press back the catch with the thumb of the right hand, and open the barrel with the left hand; then, holding the pistol as in the second motion of the "Ready," open the breech, throw out empty cylinders, withdraw the cartridges, and return them to the pouch; then close the breech, replace the barrel, and return the pistol to the belt; lastly, drop the hands to the sides.

To Load and Fire, in Quick Time.

Ready.	In four motions.
Present.	In three motions.

Note.—When the men are required simply to load, the command will be "Load," and they will perform the first three motions of the "Ready;" when the word "Ready" is given to men already loaded, they will proceed with the fourth motion.

INDEPENDENT FIRING.

Independent Firing.	A caution.
Commence.	Each man comes to the "Ready," and "Present," independently of his right or left-hand man, and continues firing without re-loading, until all the chambers are discharged. He then re-loads, and proceeds as before.
Cease Firing.	Complete the loading and "Return."

The pistol can be fired without full-cocking by merely pressing the trigger each time; but this should only be resorted to when time does not admit of full-cocking it, as the increased pull of the trigger has a tendency to render the aim uncertain.

Men should be exercised in firing with the left hand as well as the right; and should be taught that, when time permits, a more accurate aim may be taken by supporting the pistol with the left hand.

INSPECTION OF PISTOLS.

For Inspection Draw Pistols.	Draw the pistol from the belt and open the barrel, as taught in "Unload." After the officer has inspected the pistol, each man will close the barrel and hold the pistol as in the second motion of the "Ready."
Return.	As before detailed.

CUTLASS EXERCISE.

This Exercise is formed on the following principles:—

I.—That the "First Guard" is the most advantageous position which a man armed with a cutlass can assume for the purpose of "Attack" or "Defence."

II.—That as a Point can be returned with far greater rapidity and with much more deadly effect than a Cut, a Point is invariably to be returned instantly after having guarded a Cut, or parried a Point, delivered by an opponent.

III.—That after delivering a Cut or Point, the "First Guard" is to be immediately resumed ready for instant defence or attack.

The exercise consists of two diagonal "Cuts," one "Point," and three "Guards."

The division fall in in two ranks at close order, files nearly touching, with swords sheathed, and are numbered from right to left.

If with drill swords, without scabbards, the swords are to be held in the left hand as if sheathed.

Note.—The Instructor is himself to perform each movement before the class, taking care that it is correctly performed before passing on to the next.

Draw.	At the word "Draw" grasp the hilt with the right hand and the scabbard with the left, the rear rank stepping back one pace at the same instant.
Swords.	At "Swords," draw out smartly, and rest the sword on the right shoulder in a sloping position, keeping the fore arm horizontal; this being the position of "Slope Swords."
Return.	At the word "Return," grasp the scabbard with the left hand, and enter the point one inch.

SWORDS. At "Swords," return the sword smartly, and then drop the hands by the side, the rear rank taking a pace to the front at the same instant.

NOTE.—The front rank is marched across the deck and turned about, or single rank is formed in the usual manner.

PREPARE FOR EXERCISE. A caution.

FROM THE RIGHT (LEFT, or No. — FILE) —— MARCH. The named file remains steady, the remainder turn outwards and step off, each man glancing over the inner shoulder towards the named file; and when at three paces from the position in which the man in his rear has halted, he will halt, turn inwards and dress up, or back, as necessary, to give room for cutting.

HALF-RIGHT AND LEFT TURN. The ranks turn so as to point the right foot directly towards the Instructor.

NOTE.—The instructor directs the class to turn towards him in order to observe their manner of cutting and guarding, and to afford them a target to aim at.

INWARDS TURN. The ranks turn towards each other.

HALF-RIGHT AND LEFT TURN. As before detailed.

CHANGE ARMS. Pass the sword into the left hand and bring it to the "Slope" on the left shoulder, at the same time turn on the heels so as to point the left foot directly towards the Instructor.

CHANGE ARMS. Change the sword back to the right side, making the corresponding turn on the heels.

INWARDS TURN. As before detailed.

ON THE RIGHT (LEFT, or No.— FILE), CLOSE. A caution.

—— MARCH. The front rank close to within two paces of the rear rank, and then both ranks close on the named file.

THE CUTTING PRACTICE.

CUTTING PRACTICE. A caution.

GUARD. Step back with the left foot, bend both knees, and at the same time drop the point quickly to the front, raising the arm fully as high as the shoulder, and keeping it loose and free, with the elbow slightly bent, hilt in line with and covering the elbow; the left arm behind the back.

NOTE.—It will be found convenient, whilst teaching the cutlass exercise to bring the class from the "Guard" to the position of "Rest," by dropping the point of the sword on the ground outside the toe of the right foot, edge to the rear, straightening the knees, and dropping the left hand to the side.

CUT ONE. Step smartly out one short pace with the right foot, keep the left foot firm, the body upright, and straighten the left knee; at the same instant cut diagonally downwards from right to left, from the position of "Guard."

GUARD. Step back smartly one short pace, and form "Guard" as before detailed.

CUT TWO. As in "Cut One," but delivered from left to right.

GUARD. As before detailed.

SLOPE SWORDS. Come to the position of "Attention," bringing the left foot up to the right, and "Slope" as before.

NOTE.—The Instructor is at the end of each section (that is, after "Slope Swords") to direct one or more files to "Prove," upon which they come to the position of "Guard," go through what has just been taught, and "Slope" without further orders. The Instructor will then give the order "Change Arms," and put the class through the section with the left hand in the same manner, cautioning them that in the position of "Guard" with the sword in the left hand, the right foot is to the rear, and the right arm behind the back.

THE GUARDING PRACTICE.

GUARDING PRACTICE.	A caution.
GUARD.	As before detailed.
SECOND.	The hilt should be just above the crown of the head, the point of the sword to the left front, and slightly drooped, the edge upwards, to the front.

NOTE.—The Instructor will, as often as may be necessary, bring the class back to the "Guard" by giving the order "First."

THIRD.	The hilt should be off to the right and midway between the elbow and the shoulder, elbow close to the body, the blade with the point raised and bearing away to the left front.

NOTE.—The Instructor, will, as often as may be necessary, bring the class back to the "Second" Guard.

SLOPE SWORDS.	As before detailed.

NOTE.—The Instructor is to explain to the class that the First Guard defends the right side from the elbow downwards, that the Second Guard defends the crown of the head and the whole of the left side, and that the Third Guard defends the right side above the elbow.

THE POINTING PRACTICE.

POINTING PRACTICE.	A caution.
GUARD.	As before detailed.
POINT.	Step smartly out as in "Cut One," and deliver a point as quickly as possible for the centre of the breast without altering the direction of the edge, remaining out with the arm extended.
GUARD.	Step smartly back and form First Guard.
PARRY.	Parry as quickly as possible upwards and to the left by forming Second Guard, and (without pausing an instant) downwards and to the right by forming First Guard.

SLOPE SWORDS.	As before detailed.
GUARD.	As before detailed.
SECOND.	Form Second Guard, as detailed in the "Guarding Practice."
POINT.	As before detailed.
GUARD.	As before detailed.
PARRY.	As before detailed.
SLOPE SWORDS.	As before detailed.
GUARD.	As before detailed.
THIRD.	Form Third Guard, as detailed in the "Guarding Practice."
POINT.	As before detailed.
GUARD.	As before detailed.
PARRY.	As before detailed.
SLOPE SWORDS.	As before detailed.

NOTE.—In pointing, the arm is never to be drawn back, which causes delay and gives warning to the opponent; but the point should be instantly delivered from each Guard, with the utmost rapidity, at the centre of the breast.

THE GENERAL PRACTICE.

The General Practice is intended to teach the delivery of each Cut or Point from the First Guard (which is the best position a man armed with a cutlass can assume for attack or defence), and that immediately the Cut or Point has been delivered the First Guard is to be resumed.

GENERAL PRACTICE.	A caution.
GUARD.	As before detailed.
CUT ONE.	As before detailed, in the Cutting Practice.
GUARD.	As before detailed.
POINT.	As before detailed, in the Pointing Practice.

PARRY.	Step back smartly, and Parry as before.
CUT TWO.	As before detailed, in the Cutting Practice.
GUARD.	As before detailed.
POINT.	As before detailed, in the Pointing Practice.
PARRY.	As before detailed.
SLOPE SWORDS.	As before detailed.

NOTE.—At inspections, the General Practice should be gone through as above, and the whole of the division proved with each hand.

THE ATTACK AND DEFENCE PRACTICE.

The object desired to be obtained by the Attack and Defence Practice is to impress on the men that, having guarded any Cut or Point delivered by an adversary, they should *instantly* return a Point at the breast, and, having delivered the Point, at once resume the position of "First Guard," ready for immediate attack or defence.

ATTACK AND DEFENCE PRACTICE. } A caution.

FROM THE RIGHT (LEFT, or NO. — FILE), —— MARCH. { The front-rank man of the named file turns about, the rear-rank man stands fast; the remainder turn outwards and step off, each man glancing over the inner shoulder towards the named file, and when at one pace and a half distance from the position in which the man in his rear has halted, he will halt and turn inwards

FIRST SECTION.

Instructor.	Front (or Rear) Rank.	Rear (or Front) Rank.
FIRST SECTION. HEAD, POINT, AND GUARD.	A caution.	A caution.
GUARD.	As before detailed.	As before detailed.

First Section—*continued.*

Instructor.	Front (or Rear) Rank.	Rear (or Front) Rank.
FRONT (or REAR) RANK. HEAD.	Step smartly out a short pace with the right foot, and "Cut One" at head.	Defend the head with the Second Guard.
POINT.	Step smartly back a short pace with the right foot, and Parry by forming First Guard.	Step smartly out a short pace with the right foot, and deliver a Point as quickly as possible for the centre of the breast; remaining out with the arm extended and the edge of the sword up.
GUARD.	As before detailed.	Step smartly back a short pace with the right foot, and form "Guard," as before detailed.
SLOPE SWORDS.		

NOTE.—This Cut may be delivered lower at the thigh.

SECOND SECTION.

Instructor.	Front (or Rear) Rank.	Rear (or Front) Rank.
SECOND SECTION. ARM, POINT, AND GUARD.	A caution.	A caution.
GUARD.	As before detailed.	As before detailed.
FRONT (or REAR) RANK. ARM.	Step smartly out a short pace with the right foot, and "Cut Two" at the arm.	Defend the arm with the Third Guard.

Second Section—*continued.*

Instructor.	Front (or Rear) Rank.	Rear (or Front) Rank.
POINT.	Step smartly back a short pace with the right foot, and Parry by forming Second Guard.	Step smartly out a short pace with the right foot, and deliver a Point, as detailed in First Section.
GUARD.	As before detailed.	Step smartly back a short pace with the right foot, and form "Guard," as before detailed.
SLOPE SWORDS.		

NOTE.—In cutting for the arm, the swords are to be disengaged from each other, so as to leave the breast of the rank that cuts open to be pointed at.

THIRD SECTION.

Instructor.	Front (or Rear) Rank.	Rear (or Front) Rank.
THIRD SECTION. LEG, POINT, AND GUARD.	A caution.	A caution.
GUARD.	As before detailed.	As before detailed.
FRONT (or REAR) RANK.		
LEG.	Step smartly out a short pace with the right foot, and "Cut Two" at the leg.	Defend the leg with the First Guard.
POINT.	Step smartly back a short pace with the right foot, and Parry by forming Second Guard.	Step smartly out a short pace with the right foot, and deliver a Point, as detailed in First Section.

Third Section—*continued.*

Instructor.	Front (or Rear) Rank.	Rear (or Front) Rank.
GUARD.	As before detailed.	Step smartly back a short pace with right foot, and form "Guard," as before detailed.
SLOPE SWORDS.		

NOTE.—In cutting for the leg, the swords are to be disengaged from each other, so as to leave the breast of the rank that cuts open to be pointed at.

FOURTH SECTION.

Instructor.	Front (or Rear) Rank.	Rear (or Front) Rank.
FOURTH SECTION. POINT, POINT, AND GUARD.	A caution.	A caution.
GUARD.	As before detailed.	As before detailed.
FRONT (or REAR) RANK.		
POINT.	Step smartly out a short pace with the right foot, and deliver a Point, as detailed in First Section.	Parry the "Point," by forming the Second Guard.
POINT.	Step smartly back a short pace with the right foot, and parry the "Point" by forming First Guard.	Step smartly out a short pace with the right foot, and deliver a Point, as detailed in First Section.
GUARD.	As before detailed.	Step smartly back a short pace with the right foot, and form "Guard," as before detailed.
SLOPE SWORDS.		

In Quick Time.

The foregoing Sections of the Attack and Defence Practice are also to be performed in quick time, the Instructor denoting the point of attack, for example :—

Instructor.	Rear Rank.	Front Rank.
Attack and Defence Practice, in Quick Time.	A caution.	A caution.
Guard.	As before detailed.	As before detailed.
Rear Rank.	A caution, to show which rank is to attack.	A caution, &c.
Thigh.	"Cut One" at the thigh, parry the Point by forming Second Guard, and resume the Guard.	Defend the thigh with Second Guard, return "Point," and resume the Guard.
Slope Swords.		

LOOSE PLAY.

The men being perfect in the foregoing exercises, should now commence loose play. Only two opponents are to engage at the same time, the Instructor watching most carefully for any defects in their modes of attack and defence, and pointing them out. When a hit is received, the man hit is at once to recover to the Guard, and then drop the point of his sword in acknowledgment.

It is most important that the following points should be very clearly explained to the men :—

The eye should be fixed on that of the opponent, the weight of the body divided equally on both feet, the proper distance kept by advancing or retiring with rapidity; every effort to be used for the purpose of taking off the attention of the opponent and causing him to expose a weak point. It must *especially* be remembered that a Point can be returned very much quicker than a Cut, and with far more effect; therefore, when a man has guarded a Cut or Point, he should *instantly* return a Point at the breast, and then assume the First Guard, as being the best position from which to attack or defend. During the attack, if a man sees a weak point in his opponent more open to the delivery of a Cut than a Point, he should, of course, attack with a Cut, but having guarded a Cut or Point, he should always return a Point *instantly*.

INSPECTION OF CUTLASSES.

Draw Swords. As before detailed.

Port Swords. Bring the sword to a slanting position in front of the body, edge to the right, and seize it with the forefinger and thumb of the left hand, the fingers closed, both elbows close to the body.

Slope Swords. As before detailed.

Return Swords. As before detailed.

AIMING INSTRUCTION AND TARGET PRACTICE.

Aiming Instruction.—Too much attention cannot be paid to this important subject, on which the ultimate success or failure of a ship in action greatly depends. Every opportunity should be taken of putting petty officers and seamen through courses of aiming instruction, supplemented by target practice. Men showing the requisite steadiness, nerve, and ability to become good shots should be carefully noted, with a view to their employment as captains of guns. It should be understood that great gun firing takes place under one or other of the following conditions:—

(1) From a *fixed* platform at a *fixed* object.
(2) From a *fixed* platform at a *moving* object.
(3) From a *moving* platform at a *moving* object.

Any course, therefore, undertaken with the object of training the eye and developing men's power of shooting, should embrace successively these three conditions. The following course of aiming instruction has been found effective, and should be carried out if possible with the "gun numbers" before the annual target practice at Easter, or with other petty officers and seamen whenever convenient:—

(1) *Aiming Drill with any Fixed Gun at a Black Board and Disc.*—This has the effect of training the eye, and eliminating or reducing "personal error," which should be carefully noted. With notch and nipple sights a "half sight" should always be used for this exercise. The instruction should be carried out as follows:—The board, painted half black and half white, should be erected at about 20 paces from the gun. A disc of tin with a hole in the centre, secured to the end of a short stick, and painted black on one side and white on the other, should be held by a man in front of the board in a fixed position whilst the man under training lays the gun for the centre of the disc. When the gun is laid the man with the disc withdraws it, first marking with pencil through the centre hole its first position on the board. The man laying the gun then casts his eye along the sight, and motions to the man with the disc to replace it in line with the sights. When the man laying the gun is satisfied that the disc is in line with his gun-sights, he signals "Well," a second mark is made through the hole in the disc, and the disc is withdrawn. The distance between the first and second pencil-marks is the man's "personal error," which should be carefully noted for each round.

(2) *Aiming Drill at an Aiming Target with a Gun on Fixed Platform.*—The gun is trained off the object, and at the order "Commence" is laid as rapidly as possible for the target and fired. The instructor gives the order "Still," looks along the sights and notes the error, calling the attention of other numbers at the gun to it at the same time. This practice enables the men to acquire the habit of training a gun readily and quickly for a fixed object.

(3) Practice with projectile (or Morris's tube cannon) at a fixed target from a fixed platform.

(4) Practice with projectile (or Morris's tube cannon) at a towing target from a fixed platform.

(5) Practice at a towing target from a gun mounted in a steam-boat, or at a fixed target from a gun mounted in a boat steering round a buoy.

The time to be devoted to these instructions depends entirely on the exigencies of the service, but should time be available the following number of days and rounds to be fired is recommended for a class of 14 men:—

1st. Instruction, at least 2 days.
2nd. Instruction, at least 2 days.
3rd. Instruction, at least 6 rounds per man.
4th. Instruction, at least 10 rounds per man.
5th. Instruction, at least 10 rounds per man.

Target Practice.—**The following standard rules should be impressed on officers and men:—**

(1) Accuracy is of greater importance than rapidity.

(2) Accurate elevation should be the first consideration, as it is more difficult to obtain than accurate direction.

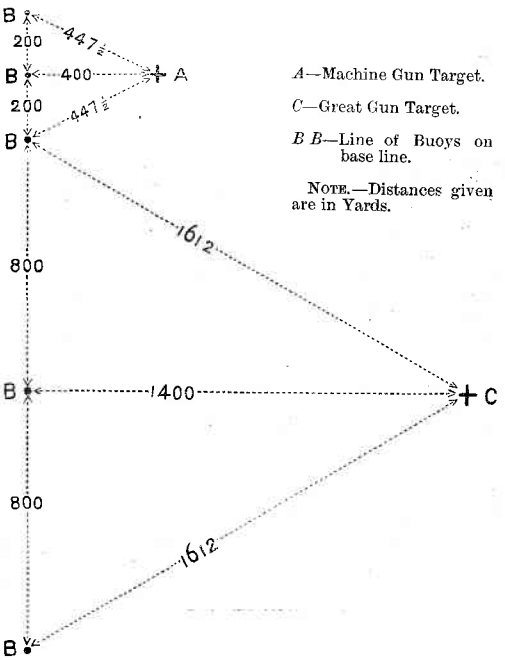
(3) Always train in advance of a moving object before laying for elevation, and again, if necessary, before firing. Due stress should also be laid on these rules during the course of aiming instruction.

At target practice the target should, if possible, be of such a size that no points should be given unless the target is actually struck. As such targets are not, however, always available, the following scale of points is inserted for guidance :—

Elevation.					Direction.	
Under 1,500 yds.		Over 1,500 yds.			At all Ranges.	
From Short.	To Over.	From Short.	To Over.	Points.	Right or Left.	Points.
Yds.	Yds.	Yds.	Yds.			
	Hit direct.			12		
5	50	5	30	6	Under 5 yards ..	4
15	80	10	50	5	From 5 to 10 yards.	3
25	110	15	70	4	From 10 to 15 ,,	2
30	130	20	90	3		

Note.—All ties to be decided by counting back.

The annual target practice should be carried out as follows, the targets being placed as in accompanying sketch. The great gun target will be 40 feet long by 15 feet high; the machine gun target, 10 feet long by 5 feet high. Targets will be moored head and stern.



A—Machine Gun Target.

C—Great Gun Target.

B B—Line of Buoys on base line.

Note.—Distances given are in Yards.

Palliser Projectiles are to be used in turrets of *Cerberus*, all other guns to use common shell, filled with water. Actual expenditure of rounds is not fixed. Full charges to be used throughout the practice (except where disallowed by order).

Great-Gun Firing.—The ships will steam along the long base at full speed, or that indicated. "Commence firing" will be sounded on passing the first buoy, and the distance given (1,612 yards). On passing the second buoy, No. 1 falls out, as if disabled, and No. 2 takes his place. On passing the third buoy, "Cease firing" will be sounded. In the *Cerberus*, the captain of the turret will fire during the first run, the second captain during the second run.

Only actual hits on the target will be counted.

Machine-Gun Firing.—The ships will steam along the short base, and the firing will be proceeded with as for great guns. The captain of the gun fires throughout the run.

"*Cerberus*"—*Turret and Machine-Gun.*—In the former, the ship will steam twice past the target whilst each turret is engaged; in the latter, once past the target for each gun's crew of six men. Full speed is to be maintained.

"*Victoria*" *and* "*Albert.*"—The competition with 8-in. guns will be fired with ship stationary, or closing or opening from target as ordered—conditions being the same for both ships. Four rounds should be fired—No. 1 firing the first two, No. 2 the last two rounds. The 6in.-guns will be fired during one run past the target for each gun, and once for each machine-gun's crew (of six men). A speed of eight knots to be maintained.

"*Gannet,*" "*Batman,*" *and* "*Fawkner.*"—The firing from 6in. and machine-gun's crews (of five men) will be carried out in the same manner as for *Victoria* and *Albert*. Full speed to be maintained

"*Nelson.*"—Truck gun 64-pr. M.L.R. will be carried out with the ship stationary, target at a fixed distance, six rounds per gun, the prizes being awarded for rapidity and accuracy. The ship's company will be formed into gun's crews for the purpose of competing, adhering, as far as possible, to the stationing in the Mobilization Sheet.

* M.H.T. Steam Hopper Barges

PART II.

GUNS AND MOUNTINGS.

"Cerberus"

DESCRIPTION OF TURRETS.

The slides for the turret carriages are fixtures built into the turret; the slides are formed of two upright plates with a piece of T iron riveted between them at top, the flange of which forms the bearing surface of the carriage, and at the bottom they are connected to the deck by angle-iron.

The training is effected by the revolution of the turret itself, In order to admit of a sufficient number of men being employed, the running in and out gear is worked by several winch handles outside the turret, while by means of a clutch the shaft of the gear of one slide may be connected with that of the other, so that if necessary the winch handles at both sides of the turret (*i.e.*, of both slides) may be applied to run back the same carriage. The elevating gear consists of a train of gearing attached to the cascable of the gun. It can be worked by one man, and is adapted for use with the axis of the gun at different heights.

The turret armour is 10 inches by the ports, and 9 inches elsewhere; it is secured by means of bolts and nuts to an oak backing from 11 inches to 9 inches thick. The backing is secured to upright angle-irons round the turret. An inner lining is formed of ⅜-iron with a space of 10 inches from the backing to prevent splinters from being driven into the turret when struck by a projectile.

Diameter of turret outside, 26ft. 6in.
Diameter of turret inside, 21ft. 5in.
Height outside from flaps, 5ft. 5·5in.
Height inside from deck to crown, 8ft. 8·5in.

TURRET SIGHTS.

Each turret has five "man-holes," one centre, two intermediate and two wing. The centre and wing man-holes are fitted for a fore-sight and a hind-sight. The sights are so adjusted that a vertical plane through any pair of sights will be parallel to a vertical plane passing through the axis of the gun and slide. When the hind-sight is set at zero, and the ship on an even keel, the plane passing through the notch of the hind-sight and the top of the fore-sight is horizontal; the sights are also of sufficient height to allow of the line of sight clearing the edge of the turret when the hind-sight is at its maximum height.

NOTE.—This description is retained, as these turret sights are still kept in the Service as "spare." For a description of the compound sights now in use, see page 5.

THE 10-INCH M.L.R. GUN OF 18 TONS.
(MARK I.)

This gun consists of an "A" tube, a "B" tube, a breech coil, triple coil, trunnion-ring, a triple coil in front of the trunnions welded together; and cascable screw.

CONSTRUCTION.

1. The Inner Barrel.—This is a solid-ended tube of steel, which is greatly increased in tensile strength by heating the roughly-bored tube to the required temperature in a vertical furnace, and then plunging it into a bath of rape oil, in which it is allowed to cool or soak for about twelve hours. The tube then undergoes a second boring, after which it is subjected to a hydraulic pressure of $3\frac{1}{2}$ tons on the square inch. If no flaw is detected, the tube is considered safe and sound.

2. The "B" Tube.—This is composed of two single and slightly taper coils united together. The coils are made and welded in the usual manner; the "B" tube is shrunk on over the inner barrel of steel.

3. The Breech-coil.—The breech-coil or jacket consists of a triple coil, a "C" coil, and a trunnion-ring. The triple coil consists of three concentric coils, each coil being shorter than the one it surrounds, and the middle one coiled in the reverse direction so as to break joints. The triple coil is then placed in a furnace for about ten hours, at the end of which time it is at welding heat; it is then placed under a powerful hammer, and the whole welded together. The "C" coil is a triple coil constructed in a similar manner. The trunnion-ring is made of slabs of iron, consecutively welded together on the flattened end of a porter bar, and gradually formed into a ring.

All these parts—breech-coil, "C" coil, and trunnion-ring—being prepared, the trunnion-ring is heated to redness and dropped on to the shoulder of the breech-coil, and while the trunnion-ring is hot the "C" coil is dropped down upon the front of the breech coil through the upper portion of the trunnion-ring which was left projecting; the trunnion-ring thus forms a band over the joint, and in cooling contracts round both coils and grips them sufficiently tight to allow of the whole mass being placed in a furnace, where it is raised to a welding heat in about thirteen hours. The mass is then quickly placed on its breech-end under a most powerful hammer, and thoroughly welded; the body is then turned in a very powerful lathe to the required shape, and rough and fine bored; the female thread for the cascable screw is then cut, the jacket is subsequently heated for about ten hours, and shrunk on to the inner steel barrel and "B" tube.

4. The cascable screw is made of the best scrap-iron. The operation of screwing it into the breech-coil requires great care, as the front must bear evenly against the end of the steel barrel or "A" tube; one round of thread is turned off the end of cascable screw, so that an annular space may be left there, which, in connexion with a channel cut along the cascable screw and across the thread, forms a gas escape, to give warning in case the "A" tube should split at the end. After the cascable screw has been finally screwed in, a hole is drilled and tapped through the male and female threads in a slanting direction on the left side, and a plug is screwed in. The gun is then fine bored.

As a rule, a length of about two calibres is left unrifled for the powder-chamber. The unrifled part should be as long as can be allowed, provided that no air space is left between the smallest charge used and the base of the projectile, as rifling tends to weaken the tube, and the seat of the charge should be the strongest part of the gun.

Two parallel lines are cut across the vent-field to indicate the unrifled part of the bore. Similar lines are engraved on the top of the gun to denote the position of the centre of gravity.

On the left trunnion are the initials of the gun factory; the register number of the gun, by which it is registered in the department, records the numeral signifying its pattern and the year of proof.

The nature of the material of the inner tube is stamped on the face of the muzzle, as is also the number of the tube as entered in the registry of manufacture.

These guns being mounted in turrets in the Victorian Navy, the vent is placed on the right or left hand side as convenience demands.

10-INCH M.L.R. MOUNTINGS.

HYDRAULIC PUMP.

On the outside bracket of each gun carriage is attached a reservoir, which is filled within two inches of the top with fresh water; and the addition of a little soft soap or washing soda will cause them to work well, and will keep the packing in good order.

See the rams are close down before putting the liquid into the reservoir.

To Raise the Gun.

Shut off the stop-valve, ship levers on crank spindle, and by its means the plunger is worked to and fro, being a double action pump; at the end where the lever is forced down a vacuum is created, and the liquid is drawn up through an inlet-valve into the pump. At the opposite end the lever is up, and the liquid in the pump is forced through a stop-valve into the copper pipe leading into the cylinders, under the rams, thus raising them with the weight of the gun.

To Lower the Gun.

The stop-valve is loosened, which allows the liquid in the cylinders to pass back through the copper pipe into the reservoir

NIPPING LEVER

Is connected to an iron shaft passing through the brackets of the carriage, on which are two eccentrics which work in the upper part of a link, the lower part of which is connected to the lifting-block, over which the endless chain passes. Underneath the bottom plate of the carriage are fixed two sprocket-plates, having six sprockets projecting downwards. On moving the lever, which fits on to the end of the shaft, the eccentrics are turned, bringing the lifting-block close up, so that the sprockets take into the links of the endless chain and hold the gun for running in or out.

The nipping lever is not to be let go until the compressor is set taut.

LIFTING LEVER

Is an iron shaft passing through the brackets of the carriage, and has two eccentrics fitted into two gun-metal rollers. By pulling up the lever on the end of the shaft the eccentrics are turned in the rollers, and the rear end of the carriage is raised up clear of the slide, also placing the weight on the fore rollers. When running the gun in or out, the lifting lever is to be let go before setting taut the compressor, and at any time if the gun is going out too fast.

COMPRESSOR.

Long flat bars are placed between the sides of the slide, and are attached to the deck of the turret by means of a bolt passing through their inner and outer ends, which allows motion to the bars. Short plates of the same depth pass through, and are attached to the lower part of the carriage. These plates fit into the spaces between the bars attached to the turret deck, and the whole can be tightly compressed together by means of short levers (called rocking-levers) acting on the two outside plates in the carriage, and are worked by means of a wheel and handle on the outside end of the compressor-shaft, which passes through both brackets of carriage. On the shaft are two male threads, also two gun-metal cylinders, which have female threads, and two lugs over which the eyes of the rocking-levers are attached. A bolt passes through the centre of the rocking-levers and through the ends of a saddle on the bottom plate of carriage; the toes of the rocking-levers fit into two square bolts. By turning the wheel on the end of compressor-shaft towards the breech of the gun, the male thread on the shaft, working in the female thread of the gun-metal cylinders, draws them outwards, forcing the toes of the rocking-levers inwards with the bolts, which compresses bars and plates together and holds the gun and carriage; turn the wheel towards the muzzle of the gun, the gun-metal cylinders are drawn inwards on the shaft, the bolts are clear of the plates, and the gun is free to move on the slide.

When firing full charges, the compressor is to be set up by a lever supplied for that purpose. The compressor-bars should be kept free from oil or grease.

A mark on the upper edge of the compressor-bars indicates when the carriage is "out."

NEW PATTERN B.L. GUNS.

The present class of breech-loading ordnance dates from 1880, the system being known as that of the "Interrupted Screw."

The earliest breech-loading guns of this nature did not affect construction, though by use of the breech-loading system it became possible to improve the form of construction a good deal. At the same period the manufacture of steel was brought to great perfection, the result being the present all-steel method of construction.

There are altogether five systems of construction, viz. :—

I. Steel tubes, with wrought-iron hoops, E.O.C. (Elswick Ordnance Construction).
II. The second pattern consists of steel tubes and wrought-iron jackets, R.G.F. 1st (Royal Gun Factory).
III. Steel tube, with steel and wrought-iron coils, R.G.F. 2nd.
IV. Steel tube and steel coils, R.G.F. 1st steel.
V. Steel tubes, breech-piece, and steel hoops, R.G.F. 2nd steel.

For example of System I., the 6-inch 80-cwt. gun, the powder-chamber is coned down at each end, so as to get a small breech-screw and the Elswick cup system of obturation.

For example of II., the 6-inch 81-cwt. guns, the jacket is of wrought-iron, the trunnions are welded on, and the steel tube is much thicker. The powder-chamber is not coned at the breech end with the Elswick cup system of obturation.

In III., which is the 9·2-inch 18-ton gun, Mark I., the inner tube is of steel, with wrought-iron coils, and inner coils of mild steel, with the cup system of obturation. Mark II. is the same, but has the De Bange pad system of obturation.

In IV., which is the 8-inch gun of 11 tons, Mark I. and II., the inner coil is of steel, with mild steel breech-coil, and the trunnion-coil of forged steel is threaded to screw on to the breech-coil. In this gun the powder-chamber is cylindrical.

In V., which is a 6-inch gun of 84 cwt., Mark III., the breech-screw closes into the breech-coil, and not into the inner "A" tube, the object being to equalize the strain on the "A" tube and breech-coils.

The breech-piece is trepanned from a solid ingot of steel, and outside the breech-piece are placed exterior hoops ; the trunnions form a hoop, which is kept in place by a key-ring in two halves, and over the key-ring is shrunk the "C" hoops to keep the two halves together.

In some cases the trunnion-coil is threaded, and a locking-ring of gun-metal screwed on to keep it in place.

The 25-ton gun is of steel, the inner tube surrounded by steel hoops, over the powder-chamber being a wire-coil of peculiar construction.

The 43-ton B.L. gun is similar in construction to the 9·2-inch gun, but has a key-ring in two halves, the same as the 6-inch, in System V.

All the newer guns of the breech-loading system are what is called chambered guns, the powder-chamber being much larger than the bore, the object being to enable a very large charge to be used, and to bring less strain on the gun, the fore end of the chamber being coned down to meet the size of the bore.

NOTE.—The B.L. guns of the Victorian navy are constructed by Messrs. Armstrong and Mitchell, of the Elswick Ordnance Company ; the 8-inch guns of *Victoria* and *Albert* are similar in construction to System IV. ; the 6-inch guns to System V. but have the trunnion-coil threaded, and a locking-ring of gun-metal.

DESCRIPTION OF 8-INCH B.L. GUNS.

(*Mounted in "Victoria" and "Albert."*)

This gun is made of steel, in ten parts; the inner tube being of solid steel, bored out to the required calibre, and is the full length of the gun (except the breech-block). Over the inner end is placed the inner breech-coil, which terminates in front of the trunnions; three small coils or jackets are in rear of the trunnion-ring, and form the outer breech-coil or jacket. The breech-block closes into the breech-coil or jacket, and not into the inner tube, and is of solid steel, and fitted to close on the interrupted-screw principle. To the front end is fitted a disc and obturator (see

page 108), and vent-bolt. At the rear end is fitted the firing hammer. The vent-bolt is recessed at the rear end for the reception of the primer.

A steel band is fitted over the rear end of the gun to carry the elevating gear, and it also strengthens the gun.

The gun is rifled, on the polygroove system, with 33 grooves, and a spiral increasing twist of from 1 in 100 calibres at the breech to 1 in 40 at 10·8 inches from the muzzle, the remainder a uniform twist of 1 in 40.

The gun is vented axially, and has a central firing arrangement placed in the centre of the breech-block, which is of steel, and called the "needle-holder;" and it is also fitted with an interrupted screw, by which it is fixed in its position in the breech-block, a small stud on one side guiding it in place through a groove. To secure it when in position, it is turned to the left 60° by means of the handles, and the stud prevents it from coming out. For mechanical firing, the needle-holder contains a steel needle, which is free to travel forward a fixed distance, and when struck by the hammer it returns to its normal position by the pressure of a spiral spring placed between a shoulder formed in the adaptor and collar, in the front end of the needle-holder. The rear face of the collar rests against a shoulder in the needle-holder, which prevents the needle falling out. The adaptor* is fixed into the front end of the needle-holder, and is fitted with claws to hold the base disc of the primer in such a position that when the needle-holder is inserted in the gun the primer fits accurately into its chamber in the vent-bolt.

For electric firing, the needle is removed from the needle-holder, and the front end is fitted with an electrical adaptor, slotted on one side to facilitate the insertion of the primer, with the wires attached into the needle-holder.

The firing hammer is of bell-crank form, and secured to the rear end of the breech-block with a pin and split-spring; to its shorter arm the firing lanyard is hooked; the longer arm carries the head, a projection which comes into contact with the needle when the lanyard is pulled.

* A new pattern "adaptor" is now being brought forward (7/90), and which will probably supersede the present one. The primer fits into the adaptor, which constitutes a collar. The adaptor is detachable from the needle-holder, and is secured to the head of the needle-holder by a bayonet joint and spring. The same adaptor is used for electric firing.

The front end of the breech-block is fitted with a steel disc and obturator, which is secured in position by means of the vent-bolt. The steel disc has a flat surface, which is placed next to the breech-block, the other side being slightly curved, and fits against the flat side of the obturator. The disc is also marked to prevent its being put on the wrong way; flat face next to breech-block. (See description of obturator, page 108).

Secured to the rear end of the gun is a metal breech-ring, to which is fitted the mechanism for opening and closing the breech. The carrier or platform is hinged to the breech-ring, with pin, washer, and keep-pin, and is kept in position by lever-catches and springs. On the breech-block being withdrawn, the catch acts automatically, and when the block is clear of the gun the carrier is unhooked from the breech-ring, and swings clear of the breech of the gun. Another spring and catch keeps the breech-block in position while loading, or steady if the ship has much motion.

After the loading is completed, the carrier is brought up to the gun and kept in position by the clip retaining-lever, which hooks on to the breech-ring. At the same moment the pressure on the tumbler-arm causes the withdrawal of the catch which holds the breech-block on the carrier; the breech-block is then pushed into the gun, and the locking-lever turned down to the left through an angle of 45° till the bracket on the end of breech-block comes in contact with a stop on the breech-ring. The lever is then turned down, which causes the cam on the boss to lock itself into a recess in the rear face of the gun, and prevents any movement of the breech-block at the moment of firing.

Should there be any difficulty in putting the locking-lever down by hand, the small tube-lever (with hook used for extracting the needle-holder) will give ample power.

The tube-lever can also be used for starting the breech-block after firing, should it become necessary in unscrewing.

When the breech block has been unscrewed after firing, it can be started when withdrawing it from the gun by turning down the locking-lever when the cam on the boss bears against the face of the gun.

Safety-Arrangements.

A safety-arrangement is provided which prevents the gun from being fired until the breech block is properly closed, and the needle-holder is in its proper position. This arrangement consists

of a bell-crank lever and a sliding-guard, which are attached to the breech-screw in such a manner that the upper arm is acted upon by the stud on the boss of the locking-lever.

When the breech is open, the sliding-guard attached to the bell-crank lever is in such a position that the projection on the head of the firing-hammer will strike it if an attempt is made to fire the gun, and the hammer will then be prevented from striking the needle in the needle-holder.

The rear face of the needle-holder is formed with a projecting rim, slotted away in one place to the width of the shank of the hammer; this acts as an additional safety-arrangement, and prevents the hammer striking the needle except when the needle-holder is secured in proper firing position.

When the breech-block is moved into proper position for firing, and the locking-lever has been turned down so as to lock the breech-screw, a projecting stud on the boss of the lever engages the upper arm of the bell-crank lever, and raises the sliding-guard out of reach of the hammer, which is then free to strike the head of the needle.

SIGHTING.

The gun is fitted for sights on both sides, the tangent scales (or side sights) being graduated up to 12°, and marked in distance of yards for full and reduced charges, the former up to 7,700 yards, the latter 7,000 yards; each sight is fitted with a deflection scale marked to $\frac{1}{2}$° each way, in divisions of 5′ on the rear face. The tangent scale is inclined to an angle of 1° 30′ to the left of the vertical, to compensate for deviation of projectile due to the twist of rifling.

For use of deflection scale, see pp. 61 and 62.

THE TRUNNION SIGHTS.

These sights consist of a steel pillar, with a gun-metal socket and collar; the top of the sight is hog-backed, the socket permanently fixed in the gun, and the pillar and collar each lock into it with a bayonet joint, so that when once the sight is fixed in its true position it cannot be moved without first raising the collar and turning the pillar round a quarter of a circle.

THE CARRIAGE AND SLIDE.

The carriage is made of wrought-iron, and is mounted on permanent rollers. It is fitted with frictional elevating gear on the left, and a self-acting recoil-press. The carriage admits of 13° elevation and 5° depression.

The slide is of wrought-iron, and the surface on which the carriage runs is placed at an angle of 4°, which is sufficient to cause the gun to run out of itself when the by-pass valve is opened. It is held by a front pivot, and fitted with training and running-in gear, worked by means of winches at the rear end of the slide.

The training gear consists of a worm-shaft at the rear part of the slide, and gears into a worm-wheel attached to the training-shaft, which works a pinion in the training-rack in the deck. The slide can be trained 25° each way in the *Albert*, 16° each way in the *Victoria*.

ELEVATING GEAR.

The elevating gear is fitted on the left of the carriage, and is worked by means of a hand wheel, bolted on a spindle, passing through the carriage cheek, and having a pinion formed on it outside, which works the spur (or cone) wheel. This wheel is carried on a spindle, but is free to rotate on it. The outer face has a coned recess, into which is fitted a metal cone. The part of the spindle carrying the cone is hexagonal, and the cone consequently rotates with it. The spindle passes through a bush fixed in the cheek of the carriage, and has on its inner end a pinion, which engages the elevating arc fixed to the side of the gun. A dished spring is placed on the spindle next the cone. The outer end of the spindle is screwed for the nut, which forces the dished spring against the face of the cone.

This causes sufficient friction between the spur (or cone) wheel and the cone to elevate or depress the gun, but will allow the pinion-spindle and cone to revolve without putting all the gear in motion.

A friction brake is provided for holding the spur-wheel when the requisite elevation or depression is given, the rubbing pieces being forced up against the face of the spur-wheel by moving the handle of the clamp.

RUNNING-IN GEAR.

For running the gun in, the winch handles are shipped on the pinion-spindles of the winches for running in, on the sides of the slide; tackles are then hooked to the front loops of the carriage and the rear loops of the slide, and the falls passed over the V pulleys on the winches; the gun can then be run in and out quite easily.

SECURING GEAR.

In the *Victoria* the gun is secured by means of chains to the deck, the front chains being secured to a band round the muzzle of the gun, and the rear chains to a half-band on the breech end of the gun.

The carriage must be run in until the buffers are against the brackets on the slide; the securing chains are then set up, the slide is further secured by shores of wood. Clip plates are placed at the fore part, which engage a clip racer, and prevent the slide from tipping. The "by-pass" valve should be closed.

In the *Albert* the securing chains are of the "side" pattern.

RACERS.

The racers are of gun-metal, and are secured to the deck by means of gun-metal coach screws, except the joints, where galvanized bolts are provided, to go through the deck.

Care must be taken that the racers are laid very level, in one plane, and well bedded.

WEIGHT.

	tons.	cwt.	qr.	lbs.
Carriages, with recoil cylinder and rod... ...	3	8	2	0
Slide	2	11	0	0
Racers, racks, and deck fittings	0	9	0	7
Total	6	8	2	7

In order to preserve the carriage in working order, the axles, spindles, pinions, and all bearings must be kept clear of clotted oil and rust, and well lubricated. Should the carriage have been stationary for any length of time before practice is carried out, the gun should be run in and out.

ELECTRIC-FIRING GEAR.

A description will be found in Victorian Torpedo Manual, 1889.

8-INCH RECOIL CYLINDER.

The recoil cylinder is made of steel, and is fixed to, and recoils with, the carriage. Passing through the cylinder is a piston-rod which is attached to the slide at the front and rear. On the centre of the rod is a piston fitted with a recoil-valve loaded by means of a strong spiral spring which is screwed up and compressed to the required amount by the nut. The front and rear ends of the cylinder are connected by a pipe, fitted with a "by-pass" valve (on the left of the carriage.)

The cylinder is provided with a filling hole and drain hole, which are closed by screw plugs.

It is also fitted with an air cock.

NOTE.—If the piston is taken to pieces, great care must be taken to refix the nuts into their correct positions, and replace the set screws. The lift allowed for the valve is only ·0247 inches, and an error in replacing these nuts may be serious.

The pistons are packed by the screwed rings.

Action of the Recoil Cylinder.

When the gun recoils, the water in the front end of the cylinder is forced through the holes in the piston against the resistance offered by the valve and passes to the other side of the piston, thus absorbing the force of recoil. As soon as the recoil is overcome the water flows along the pipe from the rear through the "by-pass" valve into the front of the cylinder, thus allowing the gun to run out automatically.

The carriage is then ready for firing without any attention being required. If the gun is required to remain in at the end of recoil, the "by-pass" valve should be closed before firing, by reversing the handle from the front to the rear.

Filling the Recoil Cylinder.

With the gun at extreme recoil, open the "by-pass" valve and remove the air plug, then pour in the liquid at the filling hole in the rear end of the cylinder, until it overflows at the front end, after which replace the plug in the fore end, and continue pouring until the cylinder is full, then allow the carriage to run out, when it will be ready for firing.

The liquid recommended to be used in the recoil cylinder is Rangoon oil, such as is used in the British service. Any pure oil will however answer, or failing oil, distilled water, or a mixture of glycerine and distilled water.

DESCRIPTION OF 6-INCH B.L. GUN OF 4 TONS.

Mounted in "Victoria," "Albert," "Gannet," "Batman," and "Fawkner." Steam Torpedo Barges.

This gun differs in construction from the 8-inch gun, not being **made in** so many parts, but its general principles are the same.

It is built up of steel hoops or jackets, except the trunnion-jacket, which is of wrought-iron. It is in seven parts, namely, the inner tube of steel, over the breech end of which is placed an inner breech-coil, extending as far as the centre of the trunnion-ring, and met by another coil in front of the trunnions; over this is placed the trunnion-ring (or coil), and buts against a shoulder on the inner coils; the front end of the trunnion-ring is threaded and a metal locking-ring is screwed on, which keeps the trunnion-coil from shifting; in front of the trunnions is another coil, being let into it and secured; over the rear end is placed the outer breech-coil, and, with the breech-block, completes the gun. Round the powder-chamber is placed a wrought-iron band to carry the elevating gear, and this also strengthens the gun.

The system of breech-closing is the same as the 8-inch gun, except that the lever is turned to the left 60° in locking.

DESCRIPTION OF 6-INCH B.L. VAVASSEUR MOUNTINGS.

The carriage is on the hydraulic system, and is of steel, with a forged steel recoil cylinder fitted on each side. It is fitted with bearings for the gun trunnions, and with frictional elevating gear on the left side.

The gun is secured by metal cap-squares, which slide in grooves, and are retained in position by steel pins.

The carriage admits of 20° elevation and 7° depression.

SLIDE.

The slide is of the central-pivot type. It is fitted with cast-iron front and rear rollers, which run on a steel racer cast on the pivot plate. It is also fitted with rollers on the upper surface of the cheeks which carry the carriage. Clips are fixed on the roller-brackets, which engage the racer to prevent the slide from tipping.

A steel shield 1¼ inches thick is bolted to the front of the slide, to protect the men from machine-gun bullets and splinters of shell.

RUNNING-IN GEAR.

The gear is fitted on the left side, and consists of a screw-shaft, **which** passes through a guide-bracket fixed on the carriage.

On the bracket is hinged a screwed flap, which is engaged to **the** shaft by forcing its thread into that of the shaft by means of **the** iron lever. It will then remain in gear while the carriage is **run** in. The screw-shaft is worked by means of winch gear at the **rear** end of the slide. The screw-flap must be out of gear before **the** gun is fired.

TRAINING GEAR.

The training gear is worked by means of winch handles at each **side** of the slide.

On turning these handles the pinions engage intermediate **wheels**, which gear into similar wheels keyed on the worm-shaft.

The worm is keyed on the shaft, and engages the training-rack **fitted** on the pivot-plate.

THE FRICTION GEAR.

The lever is attached to the clamping nut, which is screwed on **to** a bush on the shaft. This bush is prevented from revolving by **means** of a key, which engages the base-plate of the slide.

ACTION OF THE FRICTION LEVER.

On the lever being raised the nut is screwed outwards and jams **against** the lower wheel, thus forcing the worm-shaft outwards **until** the worm jams against the bed-plate. This causes sufficient **friction** to prevent the carriage taking charge if the winch handle **should** be left when the ship is rolling.

ELEVATING GEAR.

Elevation is obtained by a shaft, with hand-wheel transmitting **motion** through a worm and worm-wheel to a spindle pinion, **which** gears into the steel graduated arc.

The worm-wheel and the spindle-pinion are connected by a **series** of friction-plates, the friction between which is regulated by **a nut and** spring washer, so as to allow sufficient slip, and prevent **damage to** the gear from concussion in firing.

The shaft is fixed to the slide by the bracket, and allows the **worm to** slide along it on recoil to the groove, which marks the

limit of extreme safe recoil. The hand-wheel remains stationary, thus enabling the gun to be laid and fired simultaneously.

An adjustable pointer indicates the degrees of elevation and depression on the graduated arc.

The recoil is checked by tension and compression buffers, which are connected by a pipe with suitable valves, to control the running out or to keep the gun in at the end of recoil.

The right hydraulic buffer is in tension, and has its piston-rod fixed to the front of the slide; the left, being in compression, has its piston-rod fixed to the rear part of slide.

VALVE BOX.

The valve box is fitted with a non-return valve and a "by-pass" valve.

There are two ports in each piston, which are open when the gun is out, and are gradually closed during recoil by means of a rotary valve on the face of the piston, which is turned by two studs running in rifled grooves in the buffers. By this means the pressure in the buffers is kept nearly constant during recoil.

ACTION OF RECOIL BUFFERS.

During recoil the left buffer piston-rod entering the buffer displaces part of the fluid, which flows through the pipe past the non-return valve into the space in the right buffer left by its piston-rod. At the end of recoil the running-out valve being non-return, immediately closes, and prevents the backward flow of the fluid, which can only return through the "by-pass" valve.

By closing the "by-pass" valve the fluid will remain in the right buffer, and prevent its piston-rod entering, thus retaining the carriage in on recoil.

By means of the "by-pass" valve the running out can be controlled.

The running-out valve is loaded by steel springs, the pressure of which can be regulated to counteract any running-in tendency of the carriage when the ship is rolling.

NOTE.—Two volute-spring buffers are fixed to the front of slide.

ELECTRIC-FIRING GEAR.

A description will be found in Victorian Torpedo Manual, 1889.

DESCRIPTION OF THE 12½-PR. B.L. GUN.

The "A" tube is a solid ingot of steel, highly tempered, and bored out to a diameter of 3 inches, and is the full length of the bore of the gun, viz., 6ft. 9in.; it is then turned down on the outside till the thickness of the tube is 1·25 inches at the muzzle and 2 inches at the breech. The breech end is then bored out to 4·20 inches in diameter, which gradually decreases till the diameter of the bore is reached, viz., 3 inches at a distance of 13½ inches from the breech end, thus forming the powder-chamber; the rear end of this is further coned out for a distance of 3 inches to form a seating for the obturating pad.

The trunnion-jacket is prepared of forged steel, and shrunk into position; the front end is then tapered down to nothing, it is 1 inch in thickness and 18 inches in length.

The breech-coil is prepared of coiled steel, and shrunk into position; the fore end of it overlaps the trunnion-jacket ·5 of an inch, and the rear end is flanged down on to the rear end of the "A" tube; the breech end of the gun is turned down for the breech-ring to be fixed in flush, forming the rear face of the gun. The coil is 2 inches thick and 15 inches in length.

The breech-ring is a gun-metal casting, and is secured to the rear face of the gun with five screw bolts; on its right side is a bracket for the platform, and a slot for the reception of the tangent scale, and on the left there are two recesses for the reception of the elevating-arc axles, and in rear on the lower side is a steel catch for retaining the platform in position when it is close up to the gun; there are also two stops, which prevent the locking-lever being moved beyond the required angle; the slot in the rear face of the gun is for the boss on the locking-lever to fit into when the breech is properly closed.

The platform, which is a gun-metal casting, is attached to the breech-ring by means of a joint bolt, and on its underneath side is fitted the platform catch, which is a lever pivoted nearly in its centre; the front end is turned down so as to form a grip, and just in rear of this there is a projection upwards in which a recess is fitted to contain a stud, around which is placed a spiral spring which always has a tendency to keep the catch down; in rear of the pivot is a knuckle on the lever, which passes through the platform, and is acted on by the projection in the slot on the breech-block, which bears the rear end down and frees the catch, and allows the platform to come to the rear and swing to the right

to the loading position. Should the platform remain stationary at any time after the breech-block is withdrawn, place the thumb of the left hand on the lever under the rear end of the platform, and bear down; this will free the catch, and allow the platform to swing to the right.

The breech-block is of forged steel, and is turned down to gauge, and threaded with a left-handed thread, which is then divided into three sections (the rear end of the "A" tube is enlarged and fitted with a corresponding divided thread, into which the breech-block locks); it is then pierced through the centre; the hole is of two sizes, the smallest being in front, forming a shoulder in the centre; on the rear face of the block is fixed a gun-metal casting, through the centre of which is a hole to correspond with the hole in the block. Across the face of it is a handle by which the block is worked, and on its upper side is a bracket for the locking-lever, which is connected by a joint bolt, and has a cam on the boss which fits into a slot in the rear face of the gun, thereby locking the block in the firing position; this lever is kept up by means of a spiral spring and stud, which are acted upon by the lever being forcibly pulled up or down.

To close the breech, bring the platform close up to the gun, and free the catch and push the breech-block close in; then turn the locking-lever over to the stop on the left through an angle of 60°; then turn the lever down, thus locking the breech with the cam on the boss in the slot in the rear face of the gun, which prevents the breech-block moving when the gun is fired.

To open the breech, raise the locking-lever till the cam on the boss is free from slot in the gun, then bring the lever perpendicular, thus unscrewing the breech-block; then draw the block on to the platform, free the catch and swing it round to the right.

Should there at any time be any difficulty in putting the locking-lever down by hand, the small tube-lever supplied for that purpose will give ample power. The tube-lever can also be used in starting the breech-screw after firing, should this action be found necessary in unscrewing. When the breech-screw has been unscrewed after firing, it can be started when withdrawing it from the gun by bearing down on the locking-lever, thus causing the cam on the boss to bear against the face of the gun, and bringing the block to the rear. In firing, the threads of the breech-screw should be kept properly clean and free from dust or grit, and well lubricated.

The gun is sighted on the right side, and is provided with two sights, viz., one tangent scale of steel, graduated up to 15°, with head forged solid, and is fitted with a bronze sliding-leaf marked in tens of minutes for deflection up to 1° on either side. This leaf is fitted with a milled-edge thumbscrew for clamping. It has a V-shaped notch for rough laying, and is pierced with a small hole for fine-sighting at long ranges.

The trunnion-sight consists of a pillar, collar, and socket of gun-metal; the socket is permanently fixed in the gun. The pillar is screwed into the socket, and prevented from leaving its true position by the collar, which is sliding, and fitted with a key which drops into a recess in the socket. The head of the pillar is cylindrical, and bored horizontally to receive a bush, on which are fixed cross wires, thus forming a reading window for use with the small hole in the deflection-leaf when fine-laying is needed. Above the cylindrical window the pillar terminates in a hog-backed sight, for use with the V-shaped notch on the deflection-leaf.

The bush carrying the cross wires is removable, being held in its position in the pillar with a screw with part of the head filed off. Spare bushes are carried, and should the wires become damaged the bush can be replaced.

The gun is rifled with 10 flat grooves, at equal distances apart. The rifling is spiral, increasing from 1 turn in 100 calibres at breech to 1 turn in 30 calibres at 7·5 from the muzzle, the remainder uniform, 1 in 30. Length of rifling, 5ft. 7·5in.

Venting.—The gun is vented vertically, being fitted with a removable steel vent, held in position by a nut on the top of the gun. A copper washer, which acts as a gas-check, is placed between the head of the vent and the bore of the gun. When the vent-channel becomes worn by firing, it should be removed, and replaced by another, before the channel has become so much enlarged as to allow the gas to act upon the metal of the gun. The lower part of the vent-channel is contracted where the greatest wear takes place. The operation of removing the vent is performed by unscrewing the nut, when the vent will fall into the chamber of the gun. On being withdrawn, a new vent and copper washer is inserted from the inside, and secured by the nut. Two spare vents are supplied with each gun.

DESCRIPTION OF 9-PR. B.L. GUN (5 CWT.)

The "A" tube is a solid ingot of steel, highly tempered, and bored out to 2·6 inches in diameter, and is the full length of the bore of the gun, viz., 6ft. 3in. It is then turned down on the outside till the thickness of the tube varies from ·75 of an inch at the muzzle to 1·25 at the breech, having a series of shoulders formed on the outside to form butts for the coils and jackets to be set into. The breech end is then bored out to 3·55 in diameter, which gradually decreases till the diameter of the bore is reached, 2·6 inches, at 10·7 inches from the breech end, thus forming the powder-chamber. The rear end of this is further coned out for a distance of 1·5 inches to form a seating for the obturating pad, and also to facilitate loading.

The inner jacket is prepared of coiled steel to gauge, and shrunk into position on the first shoulder of the "A" tube, being put on from the front. The front end of this jacket is recessed for ·25 of an inch for the reception of the inner edge of the trunnion-ring. It is 1·1 inch in thickness, and is 8·65 in length.

The trunnion-ring is prepared from forged steel to gauge, and shrunk into position in front of inner jacket on to the second shoulder. The rear end is set into the inner jacket for ·25 of an inch, and the front edge is recessed for ·25 of an inch for the reception of the outer jacket. It is 1 inch thick, except in line with trunnions and shoulder, and is 5·25 inches long, and is recessed on the right side for the reception of the trunnion-sight.

The outer jacket is prepared of coiled steel to gauge, and shrunk into position in front of the trunnion-ring, which overlaps the rear end for ·25 of an inch, its front end being turned down to nothing. It averages 1 inch in thickness, and is 10·75 inches long.

The breech-coil is prepared of coiled steel, and shrunk into position, being recessed at both ends. The front recess allows the coil to overlap the inner jacket ·25 of an inch, and the rear recess allows the breech-ring to be set into it for ·25 of an inch. Its thickness is 1·3 inch, and it is 11·12 inches in length, the front and rear ends being rounded off.

The breech-ring is a gun-metal casting, similar to 12½-pr., but that it extends along the "A" tube for 3·25 inches, and the front edge is set into the breech-coil ·25 of an inch.

Remainder as for 12½-pr., except rifling.

The gun is rifled with 16 flat grooves, at equal distances apart. The rifling is spiral, increasing from 1 turn in 100 calibres at the breech to 1 turn in 35 at 3 inches from the muzzle, the remainder 1 in 35.

DESCRIPTION OF 12½-PR. AND 9-PR. MOUNTINGS.

The naval carriage is made of wrought-iron, single plated, and consists of two brackets, bottom plate, transom, and rear stays. The brackets are fitted with brass trunnion bearings and breeching bushes, and are connected together by the bottom plate, transom, and rear stays. Under the bottom plate is fitted the guides (angle iron), one on either side, which are to keep the carriage running parallel with the slide. The clips are bolted on at the front and rear of the bottom plates, passing through the guides. These clips are to prevent the carriage jumping. The carriage is also fitted with iron cap-squares, and cap-square keys.

Elevating gear is fitted on the left side, and consists of an arc with teeth on its front edge, and is fixed to the gun by means of two elevating pivots that screw into the recesses in the breech-ring on the gun.

A gun-metal bush is bolted to the outside of the left bracket, which has formed on its outer end a male screw thread on which the clamp-lever works.

The elevating-spindle is passed through the bush from in out, and on its inner end is forged a pinion, which gears into the elevating-arc. The spindle is made hexagonal for a portion of its length after it has passed through the bush, and upon this part is fitted a steel friction cone. The elevating hand-wheel is bored to fit the cone, and is forced on to it by the pressure of the dished steel spring, which is compressed by means of the nut screwed on to the extremity of the spindles. This causes sufficient friction between the hand-wheel and the cone to allow of the gun being depressed, but permits the pinion-spindle and cone to revolve when the gun is fired without setting the hand-wheel in motion, and thus overstraining the gear. The elevating gear is clamped into position when the requisite elevation or depression has been given by moving the clamp-lever, the head of which is forced up against the back of the steel cone by its travel on the screwed part of the bush.

The slide is made of wrought-iron girders, connected together by plates and angle-irons, and is fitted at the front and rear with wood blocks on the under side, which bear on the deck; the upper surface of the slide on which the carriage rests is placed at an angle of 5°, which allows the gun to be run in or out very easily. It is mounted on a front pivot, and trained by means of rope-tackles and handspikes.

Compressor Gear.

There are two compressor-plates on each side of the carriage carried by brackets fixed outside the brackets of the carriage, and one compressor-bar and wood-filling on either side of the slide girder. These engage each other alternately, and are clamped together by means of a bolt passing through the carriage and the plates, having on its left extremity a head and threaded at the right extremity for a nut, which is furnished with a lever for tightening it up against the plates, thereby setting up sufficient friction to regulate the recoil. Care must be taken to adjust the compression to suit the varying condition of the bars, so that as long a recoil as is consistent with safety may be secured. This will prevent the gear being unduly strained. The compressor-bars must on no account be oiled, and, if wet, fine sand or ashes should be sprinkled over them; the friction will be more regular and effective if the plates are slightly rusty. The gear should never be left unclamped when firing, as there is no self-acting arrangement provided for clamping it, and the carriage and slide would be severely strained should the full energy of recoil be allowed to drive the carriage against the spring-buffers at the rear of the slide.

Training Gear.

The gun is trained by means of tackles hooked to bolts at the rear end of slide, and to bolts on the ship's side. Hand-spikes are used to assist the tackles if found necessary.

Running-in and out Gear.

To run the gun in, the side ropes are hooked to the bolts at the rear end of slide, and passed over a sheave carried on the outer compressor-plates on the carriage, and by hauling on the ropes the gun is run in. To run out, the side ropes are hooked to the

bolts on the fore end of slide, then as for run in. The compressor is always to be eased before the side ropes are hauled upon.

Securing Gear.

The slide is secured by means of flaps dropped over pivot bolts fixed in the deck. The flaps are fixed to the front and rear of the slide. The carriage is secured to the slide by clamping the compressor, and the gun is secured to the carriage by clamping the elevating gear. The whole is further secured to the deck by the securing chains, which hook over the cap-squares, and are shackled to bolts screwed into the deck for that purpose. The chains are set taut by means of a screw purchase.

Weights of 12½-pr. Mounting.

	Cwt.	qrs.	lbs.
Weight of carriage, complete	4	1	3
Weight of slide, complete	5	0	18
Total	9	1	21
Weight of gun, carriage, and slide, complete	17	1	21

Weights of 9-pr. Mounting.

	Cwt.	qrs.	lbs.
Weight of carriage, complete	2	3	2
Weight of slide	3	2	14
Total	6	1	16
Weight of gun, carriage, and slide, complete	11	1	16

In order to preserve the carriage and slide in working condition, the axles, spindles, and pinion, and all bearings, must be kept clear of clotted oil and rust, and be well lubricated. Should the carriage have been stationary for any length of time before practice is carried out, it should be run in and out, and the compressor clamp lever worked backwards and forwards while the carriage is in motion to clear away any excess of rust that may have been formed.

GENERAL INSTRUCTIONS FOR B.L. GUNS.

The guns should, as far as possible, be examined regularly by a properly instructed officer after firing every 50 rounds with projectiles.

The bores of guns from which practice is carried on should be kept slightly oiled to prevent rusting. At the close of each day's practice they should accordingly be washed and slightly depressed, and, as soon as dry, oiled with a sponge, the muzzles being then closed with tompions.

When guns are not likely to be used for some length of time, the whole of the sights, the obturator cup, vent-bolt, and firing hammer should be removed and kept in store, the holes in the guns being filled with a plug of greased tow to keep out water and dirt. These plugs can be readily removed when it is required to fit the sights, &c., to the guns, and particular attention should be paid to the prevention of rust or grit accumulating in the sight recesses, &c.

The sights and other fittings should be kept clean, free from grit, and oiled; the sliding-leaf and elevating-nut of the tangent scales, as well as the collars of the centre, fore, and trunnion sights, should have free play.

The exposed portions of the sights are bronzed if made of gun metal, and blued if of steel. This is done to preserve them from corrosion, and on no account are these parts to be burnished or cleaned in such a manner as to remove the bronzing or blueing.

The bore and all working parts must at all times be kept slightly oiled, and perfectly free from rust.

During firing, the male and female screws of the breech must be kept perfectly clean, and free from dirt, and should be washed well with soft soap and water, or well greased with a mixture of lard oil and tallow.

Preservation of Guns, Carriages, and Projectiles.

The following General Orders have been issued to the Permanent Naval Force of Victoria:—

General Order No. 55, *of* 14*th April*, 1890.

The Fleet Engineer, Gunnery Officer, and Chief Gunner in charge of stores are to examine, every twelve months—or oftener if desirable—the guns and carriages appropriated to the Victorian navy, a report duly signed by them being furnished to the Naval Commandant. The only refers to a Victorian "Navy"

The annual examination is to take place as soon as convenient after the Easter cruise of each year.

General Order No. 58, *of 7th May*, 1890.

Attention is called to Articles 808, &c., pages 320 to 322 of Queen's Regulations and Admiralty Instructions of 1887, relative to the preservation of guns, carriages, and projectiles, of which the following General Order is a *précis*:—

Guns.—The only part of a gun which may be bright polished is the face of the piece. In B.L. guns, especially, no part of the breech mechanism must be bright polished. If supplied bright, it is to be kept clean by the careful use of oil only. If required to remain for a time without being cleaned, it is to be coated with white lead and tallow as usual. The bores should be kept absolutely clean and free from rust, and nothing should be kept in them when unloaded except the tompion.

Carriages and Slides.—No portion of the fixed parts are ever to be burnished or kept bright.

The whole of the working parts of the carriages and slides, especially of the compressor and running-in gear, are to be kept in a state of thorough efficiency. Running-in chains should be well cleaned and oiled at least once a week and the whole of the compressor gear should be taken apart and thoroughly cleaned once a month. No working part, bearing, or screw-thread is ever to be bright polished, and all such parts as are supplied bright are to be kept clean by the careful use of oil only.

If required to remain for a time without being cleaned, they should be coated with a mixture of white lead and tallow as usual.

Slides should be lifted every six months or oftener (where possible), and the under and interior surfaces of slides and carriages carefully cleaned, all rust being removed by scraping, as the process of corrosion is not stayed by painting over rusty surfaces. Wherever the iron is exposed, it should be repainted.

Valves of recoil presses, of hydraulic gun-mountings, should be examined once a quarter, and a notation as to their condition entered in the Engine-room Register.

Projectiles.—Colour and marking should be retained as usual. Studs should be preserved from injury, so that the original form of the loading and driving edges may be maintained, and that they are kept free from paint.

Projectiles are not to be polished with brick or other substance likely to wear away the metal.

OBTURATORS.

THE ELSWICK CUP.

(For 8-inch or 6-inch B.L. Guns.)

The system of obturation adopted for the Armstrong breech-loading guns is known as the Elswick Cup.

(1.) It consists of a steel cup, the rim or lip of which bears against a copper seating let into a groove at the rear end of the powder-chamber. The seating is made of tough copper expanded into the groove, and bored to fit the cup by means of special tools.

(2.) The back of the cup (or obturator) is flat, but rests on the curved face of the steel disc attached to the breech-block; when the pressure of the gas acts on the cup, it is bent over the curved surface of the disc and expanded in circumference, fitting the copper seating, and thus preventing any escape of gas to the rear.

(3.) The cup and disc are fixed to the breech-screw by the vent-bolt; the cup is screwed on to the bolt, which is inserted into the breech-screw and fixed with a nut and spring-washer.

(4.) When it is required to replace the obturator-cup by another, unscrew the collar of the vent-bolt with the forked key supplied for the purpose. In this case, care must be taken to replace the disc with the engraved side next the breech-screw.

(5.) The cup should be adjusted to bear against the shoulder in the gun. This can be tested in closing the breech by moving the lever of the breech slowly until the cup is in contact with the shoulder in the gun; the lever at this point should, with 6-inch guns, be about ·5 inch* from the stop, so that some force is required to fully close the breech by bringing the lever against the stop.

*This distance varies according to the nature of gun. With guns smaller than 6-inch it will be less than ·5 inch; and with larger guns, more. The screw is adjustable, so as to obtain the proper degree of tightness; but a limit of ·2 inch either way should not be exceeded.

(6.) With ordinary care, the cups and copper seating are not liable to injury, but should the edge of the cup accidentally get burred or notched, it should be replaced with a spare one; slight injuries to the edge of the cup can generally be removed with a dead-smooth file.

(7.) If the flat face of the cup should, by repeated firing, lose its flatness and become hollow, so that the edge does not bear against the shoulder in the gun, and the lever can be brought against the stop without resistance being felt, it may be packed up by inserting, between the cup and disc, one of the small copper discs supplied for the purpose. These discs are of two thicknesses, to meet the different degrees of hollowness. The disc between the cup and vent-bolt should be reduced in thickness the same amount as the disc inserted between the cup and the disc.

(8.) Occasionally a cup may crack from various causes, or expand permanently from being too soft. In either case the opening of the breech of the gun will be difficult, but the screw can be withdrawn by driving a wooden wedge between the lever and the breech of the gun, or by using a tool made specially for this purpose. If the cup is cracked or expanded, it should be exchanged for a new one. The copper seating in the gun should be carefully examined to see that it has not been injured.

(9.) It may happen, after repeated firing, that the copper seating for the obturating cup will become expanded: this is caused by the copper becoming condensed, or being more perfectly forced home into the groove than was accomplished at proof. If the ordinary sized cup be used, under these circumstances, it may become injured from not receiving sufficient support from the seating. Two cups ·005 inch larger in diameter are supplied with each gun, and, when it is found by trial that one of these can without difficulty be entered into the copper seating, it should be substituted for the smaller size.

(10.) When the gun is not in use, the cup should be removed from the breech-screw and kept in a dry place, oiled and free from rust. A lever is supplied to close and open the breech-screw should it be a little tight; there is also a claw on the small end of the lever to start the needle-holder after firing, if required.

DE BANGE PAD.

(For 6-inch B.L. guns.)

In this system, a large mushroom-headed piece of steel is fitted to the breech-block, the stalk (or spindle) passing through it. The mushroom-head fits the bore closely, and between it and the face of the breech-block on the stalk (or spindle) is placed the pad; this is a ring of asbestos and grease, enclosed in a canvas bag, and pressed into shape by heavy hydraulic pressure.

It is held in its place by two plates (or discs) of block tin, which fit loosely over the spindle. Steel discs are supplied for backing up the pad. When required, these can be placed on the spindle between the face of the breech-block and the tin plates, thus causing the pad to go further into the gun when the breech is locked.

On firing, the head is forced back by the gaseous pressure, and causes the pad to expand, tightly fitting the bore, and completely stopping all escape of gas to the rear.

The pad is sufficiently elastic to regain its shape on the cessation of pressure, and any tendency to stick hardly affects the unlocking turn being given, as the pad does not turn with the spindle in consequence of its loose fit; also, since the chamber is slightly coned over the seat of the pad, if it can be once started, small opposition will be felt to the withdrawal of the breech-block. For this purpose, the locking-lever is constructed so as to form a "prize" whereby the starting is effected.

New pads should not be used when firing blank or reduced charges; in these cases old pads should always be employed.

After a new pad has been employed during the firing of two rounds with full charges, it may be used for either blank or reduced charges.

The pad should be kept well greased, and, if time admits before firing, it should be taken off the stalk, and well greased all round.

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

If a pad gets too soft after firing, put it in cold water until fit for use.

The centre of the mushroom is fitted with a vent-bolt for the primer, and a needle-holder.

A strong spiral spring is put on the spindle and adjusting nuts, to set up with.

(For 12½-pr. and 9-pr. guns.)

This obturating-pad consists of an asbestos wad, with a hole through the centre; on either side of this wad fits accurately a soft metal disc (composed of lead and tin), whose outer edges are protected by a brass ring. The pad fits accurately into the rear end of the "A" tube, which is coned out for the purpose; it is placed in front of, and secured to, the breech-lock.

The obturating-spindle has a dome-shaped head, is of forged steel, and its smaller end is threaded with a right-handed thread, on to which screws a keep and adjusting nut.

The obturating-spindle spring is a powerful spiral spring, made to fit around the obturating-spindle, and into the recess in the centre of the breech-lock.

To mount the obturator, place the pad in front of the breech-lock, pass the obturator-spindle through the pad into the breech-lock, place obturator spindle-spring, then screw home the adjusting nut, push the breech-block into the gun, and adjust the nut so that it requires moderate force to place the locking lever in the locking position; then screw home the keep nut.

Action of the obturator on the gun being fired.—The gas generated in the gun presses against the dome-shaped head of the obturating-spindle, forcing it to the rear; the circumference of the obturating-pad is thereby expanded, so as to tighten against the surface of the bore, which is coned out to receive it, thus forming a gas-tight joint.

In closing the breech, great care must be taken that the platform is close up to the gun before the catch is freed, to allow the block to move forward, whereby the obturating-pad is liable to be damaged against the female thread of the breech-screw. Care is also to be taken that the head of the obturating-spindle attached to the breech-screw, together with the obturating-pad, are kept uninjured, and free from burrs. Should any notches or burrs occur, or be observed, the damaged part should be removed, and replaced by another one.

QUICK-FIRING GUNS.

DESCRIPTION OF 4·7-INCH (120M/M) QUICK-FIRING GUN.

DESCRIPTION OF GUN.

Calibre, 4·724 inches.
Weight nominal, 41½ cwt.
Length of bore, 75ft. 9in.
Length of rifling, 14ft. 3in.
Length of chamber, 1ft. 3·5in.
Length, total, 16ft. 2·1in.
Length over all, 16ft. 6·1in.

Number of grooves, 22.
Rifling, spiral, increasing from 1 turn in 100 calibres at breach to 1 turn in 34·352 calibres at 6·65 inches from the muzzle; the remainder 1 turn in 34·352 calibres.

The gun is constructed entirely of steel, and is designed for obtaining great rapidity of fire. For this purpose it is mounted in a special mounting, and is not provided with trunnions, but is carried by a saddle which encircles the gun, and in which it slides when recoiling. This saddle is provided with trunnions, on which the gun and saddle are balanced. The breech of the gun is surrounded by a breach ring, which has a projecting arm on it for connecting the gun with the recoil cylinder of the mounting. The mechanism for closing the breach is on the interrupted screw system, so arranged that it can be quickly opened or closed by two movements. The gun is provided with electrical firing gear, connected with an electrical pistol fixed to the mounting in a convenient place, so that the man laying the gun can fire while looking over the sights. It is also provided with a percussion arrangement for mechanical firing, which can be quickly and easily attached to the gun in case of failure of the electrical gear. The gun sights are fixed to the gun saddle, and do not therefore recoil with the gun. The ammunition used is put together in a similar manner to that in breech-loading small arms. It consists of a metallic cartridge case, which contains the powder, the base of the projectile resting against the muzzle end of this case.

BREECH MECHANISM.

The breech of the gun is closed by a screw formed in two steps, the front step being tapered and of less diameter than the rear; both steps have three portions of their thread removed, each one-sixth of a turn; the threads on one step standing opposite to the blank spaces on the other, this arrangement distributes the strain all round the circumference of the breech screw. The interior of the gun at the breach is prepared in a similar manner, and admits of the breech screw being swung into place, and locked by one-sixth of a turn. The breech screw has hinged to its rear face a locking lever, by which it is rotated when locking or unlocking; this locking lever is provided with a cam at its hinged axis, which (when the breach screw is locked, and the locking lever is being turned down) enters a recess in the face of the gun, and so prevents any rotary movement of the screw when the gun is fired. The breach screw is supported by a carrier on which it is free to revolve for one-sixth of a turn; this carrier is hinged to the right-hand side of the breach ring, so that the screw can swing clear of the breech opening for loading. When the breech is open, the screw is prevented from turning on the carrier by a spring catch, which is fitted to the carrier; this catch engages a notch in the screw as it is withdrawn from the gun; when closing the breech this catch comes in contact with the face of the gun, thus releasing the screw and leaving it again free to revolve. The locking-lever is also prevented from being turned down into its locked position until the screw is properly engaged in the gun, as until the screw is in this position a projecting edge on the carrier locks the cam. When the screw is in the locked position the cam enters a groove in the carrier, thus freeing the lever. A small tube lever is supplied to ship on to the locking-lever to give additional power should any stiffness occur.

CARTRIDGE EXTRACTOR.

The cartridge is extracted by means of a cam, which acts upon the flange of the cartridge case when the breech is opened, and forces the case out sufficiently to make it quite free in the gun, whence it can be drawn out by hand with the special extractor which lays hold of the primer. The cam is on the end of a spindle, which passes through a hole in the right side of the gun. To this spindle is attached a lever, to which is connected a rod. When the breach is nearly full open, a projection on the hinge of the

carrier forces in the rod and slightly revolves the spindle, causing the cam upon its end to partially extract the case. A spring contained in the box returns the spindle into its normal position as soon as the breech is partially closed, thus allowing the cartridge case to go right home when inserted into the gun.

MECHANICAL FIRING GEAR.

The mechanical firing gear consists of a percussion lock. The lock consists of a sliding piece containing the hammer actuated by a main spring. The hammer is retained in the "cocked" position by the trigger, one end of which gears with the sliding hammer-guard. On the outer surface of the guard are two parallel projections, placed immediately under two similar projections on the hammer. A lanyard bolt, having one side bevelled, and corresponding with the end of the hammer-guard, is placed in the carrier. When the lanyard bolt is pulled, the guard is pressed and acts on the arm of the trigger, thus releasing the hammer, at the same time the projections on the guard are moved from under the hammer and allow it to fall on the firing needle. The guard, which is acted on by a spring, prevents the hammer coming in contact with the needle, except when the lanyard bolt is pulled. The lock is attached to the carrier by sliding it into the slot, and securing it by the spring bolt. The safety gear, which is acted upon by the cam on the locking-lever, draws back the needle, as before described, and prevents the gun being fired except when the breech is properly closed.

When firing with this gear the percussion primer is placed in an adapter, bored out to receive it, which screws into the hole at the base of the cartridge case.

NOTE.—A description of the electric firing gear will be published as addenda to *Victorian Torpedo Manual, 1889*.

SIGHTING.

The carriage is fitted for sights on the left side, and is provided with two sights, viz.:—

(*a*) One breech tangent sight, and

(*b*) One fore-sight.

(*a*) The tangent sight is of steel, fitted with one aluminium strip on the left side, and with a steel sliding window and adjusting clamp collar. The bar is rectangular in section, and is inclined at an angle of 1° 20′ to the left of the vertical, to compensate for deviation due to twist of rifling.

The crosshead gives 2° deflection right and left, and is fitted with a screwed deflection window of H form, with a horizontal wire stretched across.

If any correction in deflection is required on account of wind, or any other cause, it can be given by moving the deflection window in the required direction.

Attached to the rear face of the crosshead is a removable aluminium scale-plate, with a speed scale in knots up to fifteen knots an hour, calculated from the time of flight of the projectile for a mean range of 1,000 yards.

The clamp-collar is fitted in the carriage, and is furnished with "Stuart's" clamp.

The clamp consists of a sliding collar containing a driving spindle with a spiral tooth cut on its end. This tooth gears into the rack on the bar, and is actuated by a small milled wheel. The clamp can be put out of gear by drawing back the milled wheel, which draws the spiral tooth out of gear, when the bar can be quickly raised or lowered, as required, by hand.

(*b*) The fore sight consists of a gun-metal socket and collar, with pillar and crosshead. The crosshead is furnished with a nut traversing right and left by a screw, and having an upright blade terminating with a spherical bead.

A removable aluminium bronze scale-plate, with a speed scale in knots up to fifteen knots an hour, is attached to the rear face. The crosshead is also provided with a movable screw stud, to prevent the nut being traversed in a wrong direction when in use.

The socket is permanently fixed in an arm projecting from the carriage, and the pillar and collar each lock into it with a bayonet joint. To remove the sight, the collar should be raised and the pillar turned a quarter of a circle, when the sight can be lifted out of the recess.

INSTRUCTIONS FOR 4·7-INCH QUICK-FIRING GUN.

The guns should, as far as possible, be examined regularly, by a properly instructed officer, after firing every 150 rounds with projectiles, or 300 rounds of blank ammunition.

Attention is called to General Instructions for B.L. Guns, p. 106, which also apply to quick-firing guns.

DESCRIPTION OF HYDRAULIC AUTOMATIC-CENTRE PIVOT MOUNTING FOR 4·7 INCH 120 M/M. QUICK-FIRING GUN.

This mounting is designed so that—

1st. The gun always recoils in the line of fire; the object of this to reduce the strains on the mounting, and on the ship's deck, when firing at high angles of elevation.

2nd. To place the training and elevating under the direct control of the man who sights and fires the gun. By this means much greater rapidity and accuracy of fire can be obtained, and both the elevating and training gear can be worked up to the moment of firing.

The mounting admits of 20° elevation and 7° depression, and it can be trained as easily when the ship's decks are inclined as when level.

The recoil cylinder is designed so that the pull of the gun during recoil produces approximately a uniform pressure in the cylinder, the length of the recoil being about 9 inches.

The mounting consists of—1st. A gun-metal carriage or saddle, including hydraulic recoil cylinder, trunnions, spring box, and other parts and fittings complete. 2nd. A cast-steel revolving bracket, including trunnion bearings, upper roller path, live roller ring and rollers, pivot and racer plate, circular and flat shields, training and elevating gear; and other parts and fittings complete.

CARRIAGE.

The carriage is a single casting of gun-metal, and comprises the frame through which the gun recoils, the hydraulic recoil cylinder, trunnions, spring-box, and reserve oil-tank. The trunnions of the carriage are supported by bearings cast in the revolving frame in which they turn, the carriage moving with the gun when it is elevated or depressed. The hydraulic recoil cylinder is directly underneath the gun; it is provided with a piston and rod forged in one piece. The piston rod passes through a gland at the rear of the cylinder, and is fitted to a projecting arm on the breech of the gun. The cylinder is also fitted with a valve-key, controlling ram, drain-hole, and air-hole. The action on firing is as follows: The gun slides back within the carriage, the force of the recoil being transmitted by the arm on the gun to the piston, and the resistance offered by the oil (with which the cylinder is filled) to

the motion of the piston gradually overcomes the force of the recoil. The valve-bar is of such a form as to produce, by varying the size of the opening in the piston during recoil, an approximately uniform pressure in the recoil cylinder. The controlling ram is fitted to regulate the velocity of the gun when returning to the firing position. The spring-box is cast under the front part of the carriage; it contains two spiral springs for the purpose of returning the gun to, and retaining it in, the firing position after recoil. Two long bolts connect the projecting arm of the gun with a crosshead at the front of the springs. These springs can be readily removed or replaced by unscrewing the bolts, and drawing the springs out of the box through the hole in the flat shield. The reserve oil-tank is cast on the right side of the carriage, and is always in free communication with the recoil cylinder; any leakage which may occur from the cylinder is filled up from the tank, a suitable filling hole is provided at the top. The carriage is provided with bosses for the reception of the sights, and for dismounting purposes. A guard-plate is also fitted to it for the protection of the man laying the gun. A removable stop key is fitted in the right hand side of the carriage, to limit the rearward movement of the gun when it is being drawn back for packing the glands, &c. This key must be removed if it is required to dismount the gun from the carriage.

INSTRUCTIONS FOR FILLING THE RECOIL CYLINDER.

Depress the gun, and take out the filling and air plugs on the right side of the carriage. Fill through the filling hole in the reserve oil-tank until the oil overflows through the air-hole; replace the air-plug, and fill in until the oil overflows through the air-hole; replace the air-plug, and fill in until the oil overflows at the filling hole; then replace the filling plug.

About nine pints of buffer oil are required to charge the cylinder and reserve oil-tank.

REVOLVING BRACKET, ETC.

The revolving brackets consist of two steel castings, provided with flanges for attachment to the upper roller path and flat shield. It is also provided with trunnion bearings and cap-squares for the carriage. The left revolving bracket is fitted for the training and elevating gear brackets.

The upper roller path is a single steel casting, and is riveted to the revolving brackets, and bolted to the flat shield. At the

centre is a hole through which the pivot-pin passes; the lower portion is circular in form, and is arranged to form a protection to the live rollers, upon which it runs. A hand hole provided with a cover-plate admits of the ready examination and removal of the rollers.

Three forged steel-clips, two front and one rear, are bolted to the upper roller path to prevent the mounting from jumping. They overlap the projecting edge of the lower roller path, and are readily removed when required.

The live roller ring is fitted with eighteen rollers of forged steel, which run between the upper and lower roller paths. The pins for these rollers are secured to the ring by nuts and split pins.

The pivot and racer plate is a steel casting, having a hole at its centre in which is securely fitted the forged steel pivot pin; this pivot takes the pull due to the recoil strain, and the top of it is fitted to receive the training gear worm-wheel. On the outer edge of the pivot plate a roller path is formed for the live rollers.

Elevating Gear.

The elevating gear is carried by a gun-metal bracket fixed to the left hand revolving bracket. It is actuated by a hand wheel, which is placed in a convenient position to be worked by the man laying the gun. The hand wheel drives, by means of a pair of mitre wheels, a worm which works the worm-wheel. On the inner end of the spindle carrying this worm-wheel a pinion is fixed, which gears with the elevating arc attached to the carriage.

The elevating gear is provided with a frictional driving arrangement as follows:—The boss of the worm-wheel is hollow, and contains a series of nine friction rings, five of which are of steel, and are keyed to and turn with the shaft, while the remaining four are of manganese bronze, and are keyed to and turn with the worm-wheel. These friction rings are placed alternately, and are pressed together by means of a spring steel washer and a nut on the extreme end of the shaft. By adjusting this nut the rings are pressed together sufficiently to produce the requisite friction to prevent the gun running down at extreme recoil, but at the same time allows the gun to move slightly when fired, without giving motion to the whole of the gear. The nut is to be tightened up if the gun runs down when fired. An adjustable pointer is fitted so that the amount of elevation may be read off the back of the elevating arc, which is graduated for that purpose.

Training Gear.

The training-gear consists of a gun-metal worm-wheel, fitted on to the pivot pin. Into the worm-wheel works a worm driven by a hand wheel placed in a convenient position for the man laying the gun. The worm-wheel is provided with a hollow boss, into which nine friction plates are fitted, five of which are of steel, and are keyed to the pivot pin; the remaining four are of manganese bronze, and are keyed to and revolve with the worm-wheel. These friction plates are compressed by means of a bevel wheel screwed on the end of the pivot pin, a spring washer being placed between. This wheel is revolved by means of a small pinion and spindle, provided with a handle at one end. The pinion is removable, and can be readily shipped or unshipped, and the wheel screwed down or raised as desired. When the wheel is screwed down, sufficient friction must be caused between the friction plates, so that the worm-wheel will revolve the mounting. When the bevel wheel is raised, the friction between the friction plates is removed, and the mounting can then be revolved by means of the shoulder piece, which is fitted to support the man laying the gun.

Shields.

The mounting is fitted for its own protection, and that of the men working the gun, with an outer circular shield of steel-plate, 1¼ inches thick, and an inner flat vertical shield of steel, 3 inches thick, both of which are provided with apertures for laying the gun. The roof of the outer shield is hinged, and admits of being easily placed, and fixed by a suitable lever and securing-pin in three positions, viz.:—"Shut," "Intermediate," and "Open." This permits of a more extended view when using the gun at night. The hinged shield may be easily removed, leaving a clear overhead space for dismounting the gun and carriage.

Preservation of Mounting and Fittings.

To keep the mounting in working order, the axles, shafts, pinions, and all bearings should be kept clear of clotted oil and rust, and be well lubricated. The recoil cylinder should be kept filled with oil to prevent rust in the internal parts, and the exposed portions of the piston-rod should be covered with a mixture of white lead and tallow, to prevent them from rusting. The lubricators on the top of the carriage should be kept filled with oil.

Before firing the cylinder should be examined to see that it is full. The piston-rod and all working parts should be cleaned and oiled.

The roller path should be kept free from dirt or any obstruction.

WEIGHTS.

	Tons.	cwt.	qrs.	lb.
Gun saddle or carriage	0	12	3	0
Mounting, with elevating, training gear, and rollers	0	17	1	0
Three-inch shield	0	10	3	0
Circular shield	0	18	0	0
Pivot plate	0	5	3	0
Total	3	4	2	0

DESCRIPTION OF NORDENFELT 6-PR. QUICK-FIRING GUN.

MARK I.

The material used for all portions of this gun is oil-tempered steel, carefully selected.

MECHANISM.

The mechanism is made of steel, and consists of the following principal parts :—

a.—Action lever.
b.—Action cam.
c.—Breech block.
d.—Wedge.
e.—Extractor.

DESCRIPTION OF MECHANISM.

Action lever has a vertical one-third circle motion from front to rear. It is one piece with the main axis.

Action cam is connected to the main axis, and has a slot, a part of which is concentric, with the arc described by the action lever. On the rear upper part of the cam is a bearing, corresponding to one on the under part of the trigger.

Breech block carries the firing pin, main spring, and trigger. The firing pin has bevelled projections or cocking lugs on its base for the wedge to act on, and on its under part is a lug by which the trigger retains it. The main spring is flat, of great power and strength. The trigger pivots on its pins, and its motion is regulated by a safety lug, moving round a corresponding lug on the wedge. On the arm of the trigger are two lugs, one above and one below ; the former is acted on by the wedge, the latter by the action cam.

The wedge has a vertical motion in the breech. On its lower end is a pin, which fits in the slot of the action cam.

The extractor lever is connected to the double extractor, working on both sides of the cartridge case. The tongue of the extractor lever abuts on the extractor-cam lever, which is on the main axis.

ACTION OF THE MECHANISM.

The action of the mechanism is as follows, supposing the gun to have just been fired, and therefore the action lever in its most forward position :—

Lever moved back.

1st. The lever carries the action-cam slot over the action pin in the part which is concentric to its own motion, and therefore no movement of the mechanism takes place.

2nd. The part of the action-cam slot, which is not concentric to its own motion, now engages the action pin, forcing the wedge down, which, acting on the bevelled firing-pin projections, forces it back, and compresses the main or firing spring. When the firing-pin lug is clear of the trigger, the wedge bearing acts on the upper-trigger lug, forces up the trigger, which catches and retains the firing pin.

3rd. When the action pin has reached the end of the cam slot, the extractor lever begins to be forced back by its tongue, being met by the raised portion of the extractor-cam lever, and the empty cartridge case is thus slowly started. The action pin having reached the end of the action-cam slot, the lever still moving back causes the breech block to rotate and fall back to the rear, and at the latter part of this movement brings the tongue of the

extractor-cam lever in contact with the extraction lever, and thus throws the empty cartridge case rapidly to the rear. The lever is now at its furthest position to the rear.

Lever moved forward.

1st. The breech block is brought up and carried forward, pushing a fresh cartridge into the barrel.

2nd. The cartridge being quite home, the action-cam slot engages the action pin in the part of the slot which is not concentric, and forces the wedge up into position; the action pin then passes into the concentric portion of the action-cam slot.

3rd. The forward motion of the lever continuing, the bearing on the action cam is brought into contact with the under lug on the trigger, pushing the trigger up, thus relieving the firing pin and firing the gun.

The gun may be fired "at will," if this last movement of the lever is prevented, by means of the "drill stop," which is fixed to the right side of the breech, and is so arranged that, when placed in the position marked [*firing by trigger*], the forward motion of the lever is stopped just before the action cam is brought into contact with the trigger. Firing of the gun *at will* is effected by pulling the trigger.

The gun cannot be fired before the breech is secured by the wedge—

1st. As the inclined surface inside the wedge is formed in such a manner that the firing pin cannot be made to strike the cap of the cartridge until the wedge is quite home, and supported by the entire bearing surface. If the trigger is pulled before the breech is secured, the cocking lugs on the firing pin strike on the inclined surface of the wedge, and the point cannot strike the cap of the cartridge.

2nd. The safety lug on the trigger is behind the corresponding lug on the wedge until the wedge is fully home, and the sear-nose of the trigger can consequently not be forced to release the firing pin before the breech is secured.

Mounting and Dismounting the Mechanism.

Dismounting.

1st. Place the drill stop in the position marked for taking out the mechanism.

2nd. Move the lever as far forward as possible. Withdraw the lever 1 or 2 inches, so that the axis is freed from its bayonet joint.

3rd. Move the lever to the rear as far as possible.

4th. Withdraw the lever completely, a man holding his hands beneath the mechanism in order to receive it.

With training, this operation may be performed by one man, who would steady the mechanism with his left hand whilst withdrawing the lever with his right. When the lever is withdrawn, he would support the mechanism with both hands.

5th. Place the mechanism on a support, with its left side downwards; unscrew the action pin, and remove the action cam.

6th. Turn the mechanism with the wedge downwards, and draw the breech block out backwards.

7th. Ease the main spring by pulling the trigger, take out the spring, by gently tapping its lower part, towards the left, with the hammer-like handle of the action pin.

8th. Remove the firing pin and trigger.

Mounting.

The mounting or putting together the mechanism is performed in the reverse order to that of dismounting.

1st. Insert the firing pin and trigger.

2nd. Insert the main spring from behind with half its breadth underneath its holder on the breech block, and drive it forward by the action pin as far as it has to go, and then to the right till it is home.

3rd. Place the wedge with its bearing surface downwards, force the breech block into the wedge, with a strong push of both hands, as far as it will go.

4th. Turn the mechanism with its left side downwards, insert the action cam, and screw in the pin, and let the end of its handle stop underneath the lug on the right-hand side of the breech block, which will thereby prevent it from sliding down.

5th. Lift the mechanism, and place it in the breech in the position that it is in when the breech of the gun is fully open.

6th. Insert the lever in a position corresponding to that of the mechanism, viz., in its extreme rear position.

7th. Turn the handle of the action pin so as to allow the wedge to slide, and insert the lever until the key can be felt to be engaged in the corresponding grooves in axis, viz., about 1 or 2 inches from fully home.

8th. Lock the mechanism by moving the lever into its extreme forward position.

9th. Keep the lever in its extreme forward position, and force it close home.

10th. Place the "drill stop" in the position marked "firing by trigger."

NOTE.—Before commencing firing, it should always be seen that the "drill stop" is in the proper position.

MOUNTINGS.

There are at present two descriptions of mountings for these guns, viz.:—

1. The recoil mounting.
2. The non-recoil mounting.

Recoil Mounting.

The gun is mounted on a lever, which is fork-shaped, and constitutes the bearings for the trunnions. This lever is pivoted, about the centre, on a bolt passing through the brackets of the carriage, and the lower end of the lever is connected to the piston rod of a combined hydraulic and spring buffer.

The elevation is effected by means of a hand-wheel and cog-wheel transmission, working a single elevating screw. The training is given by a pinion gearing into a horizontal racer attached to the deck.

The cylinder of the hydraulic buffer is grooved, and a constant pressure maintained during the recoil. It is desirable to see the cylinder filled with oil before the firing commences.

After recoil, the gun returns instantly to the firing position without any blow or rebound, and without causing any alteration in the training or elevation.

Non-Recoil Mounting.

Is not supplied to the Victorian naval service.

SIGHTS.

Hind Sight.

The hind or tangent sight is of steel, marked in yards, and fitted with a deflection leaf graduated in degrees; it ships into a gun-metal socket on the left of the gun, placed at an angle with the plane of the axis, which corrects the sight for permanent drift. The sight is raised and lowered by means of a milled screw in the socket, which gears into a ratchet on the sight, and is provided with an automatic break, which prevents the elevation being altered by the shock caused by firing.

Fore Sight.

Fore sight of steel; is of the usual form of naval fore sights, and is screwed into its place on the gun.

Speed Sights.

Speed sights are of steel, of the usual form, graduated as requisite for speed of ship and of enemy.

PARTICULARS OF GUN AND MOUNTING.

MARK I.

Guns.

Calibre	2·24 inches.
Length of bore, including chamber	95 ,,
,, ,, from base of projectile to muzzle ...	84 ,,
,, gun over all	110·45 ,,
Rifling—number of grooves	24
,, width of lands	·074 inches.
,, depth of grooves	·012 ,,
Twist	From 1 in 180 to 1 in 30 calibres.

Ballistics.

Velocity—muzzle	1,870ft. second.
,, at 1,000 yards	1,296 ,,
Total energy—muzzle	145·4ft. tons.
,, at 1,000 yards	69·8 ,,

Penetration into Wrought Iron.

At the muzzle	4·75 inches.
,, 500 yards	3·94 ,,
,, 1,000 yards	3·26 ,,
,, 1,500 yards	2·75 ,,

Mountings, &c.

	Cwt.	qrs.	lbs.
Weight of gun	5	3	15
Recoil Carriage:—			
Weight of carriage complete, with racer	8	1	0
,, shield	4	0	0

INSTRUCTIONS FOR 6-PR. NORDENFELT QUICK-FIRING GUN.

The guns must be kept clean, free from rust, and undefaced.

Brick-dust or substances of like nature must never be used on any part of the gun.

The parts of the mechanism must not be scraped or roughened in any way, but must be kept lightly oiled, as a protection from rust.

After firing, every part of the gun must be thoroughly cleaned, the mechanism dismounted, washed with fresh water and soap, well dried, and then lightly oiled.

When all parts of the gun are cleaned, dried, and oiled, the mechanism may be mounted, and the gun should be protected from the weather.

Attention is called to General Instructions for B.L. Guns, page 106, which also apply to quick-firing guns.

MACHINE GUNS.

DESCRIPTION OF 1-INCH NORDENFELT GUN. 4-BARREL, MARK III.

ACTION OF THE MECHANISM.

Handle moving to the rear.—1. The friction-roller traverses the concentric part of the action plate, and the action block remains steady. The spring and the heel of the lever acting on trigger-comb drives it from right to left.

2. As the movement continues, the toe of the action lever acts on the locking-bolt plate, and withdraws the bolts, leaving the action block free.

3. At the moment these bolts are withdrawn, the friction-roller engages in the straight part of the action plate, and the action block begins to move back, drawing with it the breech-plugs, which extract the cartridge cases.

4. When the breech-plugs are clear, the friction-roller on the action block bears against the forked lever, and so pushes the carrier to the left.

The bevelled side of the tenons of the hammers press against the bevelled side of the teeth of the trigger-comb, and thus carry it to the right.

The empty cartridge cases fall to the ground, and are replaced by filled ones. The tenons of the hammers pass behind the hammer stud of the trigger-comb which is driven to the left by the spring, or by the triangular cocking piece as the action block moves forward.

The handle is now as far back as possible, and the lock in its furthest position from the barrels.

Handle moving forward.—The handle next moves forward with the following effects:—

1. The friction-roller on the action lever acts on the action plate, and moves the action block to the front. The friction-roller on action block, pressing against the fork, drives the carrier to the right, thus placing cartridges in line with the barrels.

2. The action block advances to the front, and the spiral springs are compressed by the hammers, which are kept back by the trigger-comb. The breech-plugs push the cartridges into the barrels.

3. When the cartridges are quite home the action block stops, and the toe of the action lever causes the locking-bolt plate to drive the locking bolts into the holes in the gun-frame, so that the breech-closing is complete.

4. The action lever now begins to carry the trigger-comb to the right.

Each hammer is released in turn from the tooth which retains it, and the striker pertaining to it is driven forward in consequence.

The second barrel from the right fires first, next the third barrel from the right, next the right hand barrel, and lastly the left hand.

The action of the drill-stop is this: the hand lever is brought up by it before it has completed the back stroke, so that the hammers cannot pass behind the trigger-comb. Thus the gun is not full cocked, because the springs are not compressed when the action block moves forward.

Sights.—There are three patterns of sights at present in use, viz., one which is graduated as far as 1,800 yards and without any deflection leaf; another, a later pattern, which is graduated as far as 1,900 yards and fitted with a deflection leaf, by which 1° 30′ deflection can be obtained either right or left, this deflection leaf is moved by a horizontal screw fitted with a milled head; and a third, intended for long ranges, graduated from 1,900 to 3,000 yards. These sights are interchangeable.

Instructions for keeping the Gun in Working Order.

To take off the action block.—The gun's crew should be instructed as follows:—No. 1 places himself on the left, and No. 2 on the right of the gun. If the hopper is on, No. 1 releases the hopper catch and takes off the hopper, No. 2 opens the spring lock, and No. 1 raises the cover.

No. 2 draws back the hand lever until the breach-plugs are well clear of the cartridge receiver; No. 1 puts his right hand and No. 2 his left hand through the cartridge slots, raise the cartridge receiver straight up, and No. 2 carries it off to the right side.

No. 2 brings forward the hand lever with his left hand, taking care that the springs are released, until the extractors come within one inch from the centre crosspiece; No. 1 takes hold of the left breech-plug with his right hand, and No. 2 the right breech-plug with his left hand; both raise the action block until the breech-plugs are clear of the centre crosspiece, taking the greatest care that the extractors do not catch against the centre crosspiece or the hopper strip; draw the action block forward until the rear end is clear of the cover arms; raise the action block straight up on end, and carry it off to the left side.

To replace the action block.—Proceed in the reverse way.

Cleaning and Oiling.

To clean and oil the gun.—The gun's crew should be specially trained to keep the gun in good working order, and great care should be taken to prevent the accumulation of rust, grit, and dust. Use Rangoon oil often, but a little at a time to prevent it from clogging.

The mechanism should be cleaned and oiled every morning; and the chambers cleaned and oiled whenever an opportunity offers during firing.

The barrels and chambers are cleaned without removing the action block, by simply opening the cover, pushing the hand lever into the "Ready" position, and cleaning from the muzzle with tow on the cleaning-rod, and then oiling the chambers from the breech.

When the mechanism is to be cleaned and oiled, the action block should be taken off, and the trigger-comb lifted out by hand; then clean hammers and firing-pins, putting on little or no oil, and see that they move quite freely in their channels; clean off all clogged oil and put on fresh oil on the trigger-comb rests, studs, and into the friction rollers, action plate, locking bolts and plate, on the sliding surfaces of the frame for action block and cartridge receiver, on the cocking-cam, on the working surface of the cartridge receiver lever, on the trunnions, and into all the oil holes of the crosshead; feel that the locking bolts run freely; then re-assemble the gun.

Spiral Springs.

The gun's crew should be instructed how to shift spiral springs, hammers, firing-pins, and extractors.

To change spiral springs.—The action block need not be dismounted; bring back the hand lever to its rearmost position; unscrew the thumbscrew until the shoulder is free; raise the spring bar gradually and let it fall to the left, the chest being placed close behind the action block, so that the spiral springs do not jump out of the gun; change any desired spring, replace the spring bar, and screw home the thumbscrew.

To take out a firing pin.—First remove the extractor.

To change an extractor.—The centre of the extractor spring must be held down firmly, and the extractor screw then taken out. Before putting in an extractor, care must be taken that the firing-pin is right forward, so that the lug on the rear end of the extractor is behind it; then by pressing down on the centre of the extractor the screw may be replaced.

INSTRUCTIONS FOR WORKING THE GUN.

The gun is always to be examined before firing, to ascertain—

1. That the extractors are in working order, and not broken.
2. That the firing-pins are not jammed by rust or otherwise.
3. That the trigger-comb works properly, and the springs are in place.

Elevating Screw too easy.

In case the elevating screw becomes too easy or runs down when firing.—Tighten the adjusting-break screw until the elevating hand-wheel requires a suitable force to move it, without making it too stiff to be easily worked round.

Miss-fires.

In case of repeated miss-fires during firing.—If the caps have not been struck, it is probable that the hand lever has not been moved fully backwards as far as it will go, in which case the gun has not been cocked, or that the hand lever has not been moved fully forwards as far as it will go, in which case one or more hammers have not been released, and the corresponding cartridges have been passed through the mechanism without being fired.

If the percussion caps have been insufficiently struck, it is probable either that a spiral spring, a hammer head, or a firing-pin has broken (in which case exchange the broken part), or that the firing-pin or its hole has not been cleaned.

If the percussion cap has been fairly struck, but has not fired the powder, it is probable either that the cartridge has got damp, or that the cap has been too deep set or its fulminate disturbed.

Jams.

In case the hand lever is checked when firing by any obstruction no violence must on any account be used, but the handle should be gently drawn backwards and forwards once or twice as far as it will go, when the obstruction will probably be cleared away.

Extractor Springs breaking.

It sometimes happens that an extractor-spring breaks during practice.

Since the extractor and its spring consists of one piece of metal, if the spring breaks the extractor becomes detatched, in which case proceed with the firing, leaving the corresponding column of the hopper empty, or, if there is time, put in a new extractor.

In case one barrel is injured or disabled, the remaining barrels can still be fired without difficulty by only filling the compartments of the hoppers which correspond to the barrels which are in good condition.

Without emptying any of the columns of the hopper it is easy to continue firing (at ordinary elevations) with the remaining barrels or barrel, when others are jammed by an empty cartridge case failing to extract, in the following manner:—After cocking the gun and pushing the hand lever forward, it is brought up by a fresh cartridge striking against the base of the jammed cartridge case, then the hand lever should be brought back somewhat sharply a sufficient distance to extract the fresh cartridge, which is in the way, and it will be found that the action lever can now be pushed forward, and the gun fired as usual. If much verdigris has formed on a cartridge case it will be found very difficult to extract after firing, and most probably the rim will tear away. Such cartridges should not be fired unless well oiled all over.

If the obstruction causes a jam, so that the hand lever cannot be moved either backwards or forwards, put the hand underneath the cartridge receiver, and remove any fired case which may hang jammed. If the jam is still not cleared off, remove the action block, as above described, and find out and remove the cause of the jam.

If the gun becomes unsteady, so that the volleys fired cause the muzzle to jump, tighten well home the upper pivot-bolt nut. If this is **not sufficient**, screw hard home the elevating pin, ease the **check nuts, tighten** pivot screws into the elevating nut, and **screw up the check** nuts again. If the gun is still unsteady, the **cone must be raised**, the check nut below the pivot-bolt eased, the **lower pivot-bolt** nut screwed home as hard as possible, the **check nut tightened**, and the cone screwed down again. If the **hand lever** becomes loose, drive home the taper pin, and see that the split pin is fixed.

When not actually firing, the drill-stop should always be in action, as otherwise the firing-pins are liable to be damaged by repeated snapping.

FAILURES THAT MAY OCCUR WITH THE GUN.

1. If an extractor is broken or fails to act, the cartridge will be fired, and the empty case will remain in the chamber, and will prevent a loaded cartridge from entering the barrel.

When this occurs, the hopper should be removed, and replaced by a fresh one, with that column empty which corresponds to the barrel with the broken extractor, or the firing may be continued by adopting the method previously mentioned. If time permits, shift the extractor.

2. If the firing-pin fails to act, the cartridges will pass through the mechanism unfired.

3. If the extractor and firing-pin both fail, a loaded cartridge will be left in the chamber, and the point of the bullet of the next cartridge will take against its base.

The firing should stop and the hopper should be removed. The loaded cartridge should be driven back with the cleaning rod, care being taken that it is not driven hard against the breech-plug.

The firing may be continued with the other barrels, using a hopper with one empty column.

Whenever a jam occurs in consequence of a *loaded* cartridge remaining in a barrel, the corresponding column of the hopper should be left empty, unless there is time to rectify the defect by removing the cause of failure.

INSTRUCTIONS FOR MOUNTING THE GUN AND FOR TAKING IT TO PIECES.

The following instructions are for the use of armourers, who should alone be permitted to take the gun to pieces:—

Cone.

To mount the cone.—Screw home as tightly as possible the pivot-bolt nut and check nut underneath the cone; then place the cone, and screw tight all nuts and screws along the base angle-iron; tighten down all pivot screws with screw-driver.

Crosshead.

To mount the crosshead.—Place the crosshead on the pivot, put washer on the pivot-bolt, and screw down the upper pivot-bolt nut as tightly as possible; ease the check nuts on the elevating pivot screws; see that these pivot screws are screwed home so that the elevating screws are steady; then tighten check nuts. If the training spindle is not fixed, place the worm in its position, with the keyway upwards; then push the spindle home with the key upwards; fix the collar with taper pin.

To mount the gun.—Raise trunnion caps, run down the outer elevating screw as far as it will go, and the inner elevating screw until the arrowhead on the threads meets the arrowhead on the upper surface of the hand-wheel collar, place the gun with the trunnions in their bearings; close the caps and fix them by the keys; fit the eye of the inner elevating screw to the hole in the frame, and screw home the elevating-pin. If the hand lever is not fitted on the gun, put it on the lower end of the axis pin; drive in taper pin and put in split pin.

To dismount the gun crosshead and cone, proceed in the reverse way.

To remove breech-plugs.—First remove the extractors, then unscrew the plugs.

To replace a breech-plug.—Screw it in, and when home replace the extractor; it then serves to prevent the plug from unscrewing.

To remove the barrels.—Take out the bolts in the front crosspiece; slip the front crosspiece forwards off the muzzles. The barrels can be unscrewed as soon as the front crosspiece is removed.

To remove the rear crosspiece.—Dismount the mechanism, drive out the cotters, and pull out to the rear.

To remove the centre crosspiece.—Dismount the mechanism; remove the barrels and the rear crosspiece; push the rear ends of

the frame outwards with the knees until the centre crosspiece can be taken out of its sockets, then pull it out to the rear.

To replace barrels, rear crosspiece, and centre crosspiece.—Proceed in the reverse way.

To test springs.—The springs in the gun should be tested at fixed intervals, and re-set if required, or replaced by spare springs. The extractor-spring is tested by ascertaining that the extractor hook will stand 8 lbs. pull outwards before it can be moved, and that the firing-pin when out has to be pushed by 2 lbs. before it recedes. The tumbler-spring should be strong enough to necessitate a pull of 16 lbs. to the right before it can be moved.

The test for the trigger-comb spring is 4 lbs.

Accuracy.—The mean absolute deviation at 300 yards is about 5·3 inches.

WEIGHTS AND DIMENSIONS.

Weight of gun	447 lbs.
,, mounting	373 ,,
,, hopper, empty	20 ,,
Total weight	840 ,,
Barrels, number	4
,, calibre	1 inch.
,, length, extreme	35·48 inches.
,, ,, from base of bullet to muzzle ...	33·25 cal.
Rifling, description	Henry.
,, number of grooves	11
,, twist in calibre uniform	1 turn in 35 inches.
,, length of	31·37 inches.
Hopper, number of columns	4
,, ,, cartridges in each column ...	10
,, weight filled	48 lbs.
Length of gun, action block forward	57·0 inches.
,, ,, action block back	64·25 ,,
,, from pivot to rear of action block when back	30·75 ,,
Width across trunnions	20·14 ,,
Height from bottom of cone to centre of trunnions	20·75 ,,
,, ,, to top of hopper	35 ,,
Elevation	17°
Depression	30°
Motion of cartridge carrier	$\frac{7}{8}$-inch.

DESCRIPTION OF 1-INCH NORDENFELT GUN, 2-BARREL, MARK I.

These guns have two barrels; their axes lie in a horizontal plane and are parallel to each other. The breech ends are screwed into the centre cross-piece, the muzzles are supported by the front cross-piece, which is keyed to the frame by the cotters.

The interior of the barrel is in all respects similar to those in Mark III. Nordenfelt, 4-barrel, 1-inch guns.

The frame extends some distance to the rear of the barrels, and forms a casing in which lies the mechanism for loading, firing, and extracting; the casing is closed at the top by the cover, which is pivoted to the centre crosspiece by the joint screw, and fastened by the cover lock. The bottom of the casing is closed partly by the underplate and partly by the breech block.

Inside the casing is the action block, breech block, and cartridge carrier.

The breech block carries the firing pins and extractors; it is formed of a cam-plate and two plungers; on the upper surface of the cam-plate are two angular studs, which give motion to the cartridge carrier, and two cocking studs, which engage the hammers and cock the gun. The breech block is driven backward and forward by the action lever, the friction roller on which runs in a slot in the cam-plate.

The action block carries the hammers, lock springs, trigger comb, and spring bar. It lies behind the cartridge carrier, and has two channels, into which the plungers retire when the breech block is drawn backwards. When the breech block is in its most forward position the action block is acted upon by the tail end of the action lever, and moved to the right, bringing the solid portions of the block to support the plungers, and at the same time bringing the hammers in line with the firing pins.

The cartridge carrier lies immediately behind the centre cross-piece, it has two chambers or recesses, in which it receives the cartridges from the cover, its motion is transverse, being taken to the left, as the breech block retires, to receive a supply of cartridges, and to the right as the breech block again advances, to bring the cartridges in line with the barrel chambers, into which they are pushed by the plungers, which fill the recesses in the cartridge carrier.

It will be seen that while the breech block is in the cartridge carrier, the cartridge carrier remains stationary, and the action block is moved, whereas when the breech block is in the action block, this remains stationary, and the cartridge carrier is moved.

The gun is fed from a hopper which is attached to the cover by the hopper catch.

The hopper contains twenty cartridges in two columns of ten each; the cartridges are placed in the hopper from the bottom, a slide keeping them in position whilst being carried to the gun. The act of putting the hopper on the gun opens the slide, and brings the columns of cartridges over openings in the cover through which they fall to the cartridge carrier.

The hand lever by which the gun is fired has a stem and wing which pass into the socket of the action lever; the wing also rests upon a flange formed on the boss of the underplate, and so keeps the hand lever in position without the aid of pins or keys.

Sighting.—The fore-sight is dovetailed to the front crosspiece. The tangent sight is fitted with a deflection leaf, and slides in a bracket attached to the cover; it is graduated up to 1,900 yards. A long range sight graduated up to 3,000 yards can also be used. The tangent sights are interchangeable with the left hand or spare tangent sights supplied with 1·0 inch 4-barrel Nordenfelt Guns.

The drill stop is so arranged that, when the handle is brought over to the right, the hand lever cannot complete its backward stroke, so that the gun cannot be cocked; neither can the cartridge carrier be moved to the left. The drill stop should always be used unless the gun is being fired, otherwise the hammers and firing pins are likely to become damaged.

The shield consists of a $\frac{1}{4}$-inch steel plate, 30 inches high and 33 inches wide; it slides into grooves cut in the cap squares and crosshead of the cone-mounting. (None yet supplied, 7/90.)

The cone-mounting consists of the cone, crosshead, elevating gear, and traversing gear.

The cone fits into the Service holding down ring; it is *not* to be released from the ring by means of the gun frame, but by blows with the end of a wooden handspike upon the lugs upon the cone.

The crosshead is fitted to receive the trunnions of the gun; it also carries the elevating gear, and the worm and spindle of the traversing gear.

The elevating gear consists of telescopic right and left hand screws, working in a nut pivoted to the gun; it is furnished with a brake.

The crosshead can be removed from the cone without taking out the worm and spindle, by first taking the nut from the pivot bolt, then turning the crosshead until a flat upon its edge corresponds with a line upon the top surface of the cone; it may then be lifted off.

ACTION.

Supposing the gun to have been fired and the handle to be at its full extent forward.

The motion of the lever to the rear first carries the action block over to the left, allowing the spring to force the trigger comb back, the friction roller at the same time passes round the curved part of the slot in the camplate; the tail end of the action lever, having now taken the action block fully over, leaves it stationary while the friction roller upon the forearm of the action lever, coming to the straight part of the slot, draws back the breech block, and with it the empty cartridge cases, which fall through openings in the bottom of the cartridge carrier; the right-hand angular stud now engages a similarly bevelled surface upon the cartridge carrier and forces it over to the left, where it receives a supply of cartridges from the cover.

During the rearward movement of the breech block the hammers have been carried back by the cocking studs and the lock springs compressed, the hammers have forced the trigger comb to the left, and the spring has returned it to position when the hammer heads were behind the studs.

The hand lever is now at its rearmost position.

The motion of the hand lever now being reversed, the breech block moves forward leaving the hammers held by the trigger comb. The left-hand stud moves the cartridge carrier over to the right, thus placing the cartridges in line with the barrel chambers, into which they are pushed by the advancing plungers. The friction roller now enters the curved part of the slot in camplate, while the tail end of the action lever carries the action block to the right; here the end of the trigger comb comes in contact with the frame and is forced in, releasing the hammers and firing the gun.

INSTRUCTIONS FOR ARMOURERS IN STRIPPING AND ASSEMBLING GUN.

Turn back the cover, draw back the hand lever until the action block is the same distance from each side of the frame, then with the fingers of the left hand inserted in the trigger comb recess,

and the thumb and fingers of the right hand grasping the trigger comb, lift the action block straight out. Draw back the breech block fully and lift out the cartridge carrier. Lift out the breech block; lift out the action lever, and the hand lever can be taken from the gun.

To strip Action Block.—Drive out the spring bar with a *piece of hard wood* and hammer, draw out the springs and hammers, push out the trigger comb spring and take out the trigger comb. The firing pins may be pushed out of the breech block with the brass wire drift.

Assembling.—Reverse the above operations, taking care to put all the parts in square, and not to use any force.

The barrels are not to be taken from the gun unless for the purpose of rebrowning, or for some cause rendering their removal absolutely necessary.

To strip the Cone Mounting.—Take the nut from pivot bolt, turn the traversing hand wheel until a flat edge at the rear of the crosshead corresponds with a line upon the top of the cone; the crosshead may now be lifted away from the cone.

In assembling the mounting, see that the arrows on the nut and elevating screws coincide.

To replace an Extractor.—Take out the breech block, press on the centre of the extractor, and take out the screw; put in a new extractor and reverse the operation.

To replace a Firing Pin.—Push out the firing pin with the brass wire drift, and insert a new one; *it is not necessary to remove the extractor to do this.* The lug at the tail end of the extractor should always bear upon the neck of the firing pin so that it requires a pressure of about 2 lbs. on the point of the firing pin to force it back into the breech block. It should require a pull of not less than 8 lbs. to lift the hook end of the extractor off the plunger. A very little practice will enable the Armourer or any of the gun's crew to feel with the thumb that these weights are correct.

Cleaning Gun.—When cleaning the gun turpentine or oil is to be used; on no account may emery cloth or any cutting substance be allowed. In oiling before assembling, use rangoon oil sparingly. Oil the parts all over, but do not put enough to allow it to run into drops or it will clog.

It is a good plan before assembling the gun to try the parts in their places *separately*, to see that they work freely; for instance, try the cartridge carrier without the breech block, the action block without the action lever or breech block, the firing pins without the extractors, the hammers without the springs, &c., &c.

The inside of the barrels must be kept well oiled; this should be done every day. It is *very* important that the barrel chambers are kept clean and bright; they should be oiled immediately after the firing ceases.

Misfires may be caused by a weak lock-spring, or by the firing pin, hammers, holes in plungers, or hammer channels being dirty or clogged with oil. Lock springs should weigh between 10 lbs. and 12 lbs. when compressed $4\frac{3}{4}$ inches or when in firing position; before the spring bar is put into the action block the springs should stand through about 1 inch.

When firing the lever must be taken fully backward and forward until brought to a stop. The men should be trained to make a slight pause, both at the end of the forward and rearward motion.

WEIGHTS AND DIMENSIONS.

Weight of gun	180 lbs.
,, cone mounting	170 ,,
,, shield	65 ,,
,, hopper	13 ,,
Total weight	428 ,,
Weight of hopper containing 20 cartridges	27 ,,
Barrels, number	2
,, calibre	1·0 inch.
,, extreme length	35·48 ,,
Rifling, description	"Henry"
,, No. of grooves	11
,, twist uniform	1 turn in 35 inches.
Length of gun, extreme	52·75 inches.
Height from bottom of cone to centre of barrels	16·375 ,,
Elevation, extreme	15°
Depression	20°

DESCRIPTION OF ·45-INCH GATLING GUN.

Description of Gun.

Length of gun (total), 51 inches.
Length of barrel, 31·95 inches.
Length of rifling, 28·79 inches.
Calibre, 0·45.
Nature of rifling, Henry.
Number of grooves, 7.
Twist of rifling, uniform, 1 turn in 22 inches.
Weight of drum, filled, 28 lbs.
Weight of drum, empty, 16¾ lbs.
Weight of bullet, 480 grains.
Weight of charge, 85 grains.
Total weight of cartridge, including case, 1·8 ozs.
Elevation, 55°.
Depression, 65°.

Sighting.

Each gun is provided with two tangent sights, marked up to 2,000 yards, and two fore-sights.

From 1,250 yards to 1,450 yards, the left sight is obscured by the cover catch.

The main features of the gun are as follow :—

There are 10 barrels and 10 corresponding locks. In working the gun, the barrels and locks revolve together; but, irrespective of this motion, the locks have a forward and backward motion of their own. The forward motion places the cartridges in the barrels and closes the breech at the time of each discharge, while the backward motion extracts the empty cartridge cases after firing.

The gun is loaded and fired only when the barrels are in motion from left to right; that is to say, while the crank handle is being worked forward.

When the gun is in action there are always five cartridges going through the process of loading, and five cartridges in different stages of being extracted, and these several operations are continuous while the gun is being worked. Thus, as long as the gun is fed with cartridges, the several operations of loading, firing, and extracting are carried on automatically, uniformly, and continuously.

The gun is fed by means of a metal drum, having two studs on its lower part, which fit into two slots on the cover. The drum has 21 compartments, with about five cartridges in each—about 105 rounds in drum.

To Obviate Stiffness in Working.

Should the gun be found stiff in working, it is probably due to one or other of the following causes :—

1. Cartridges which may have some defect, such as large in gauge, rim too thick, or body of case bulged in loading.
2. End of barrel burred up. This is caused by working the gun without cartridges, the lock snapping drives the end of the lock into the chamber, and throws up a burr at entrance. This can be removed by a burnisher, or by a stick and emery.
3. Insufficient freedom in shaft. This will be obviated by easing the cascable knob.
4. Steel seating on face of cam becoming indented.
5. Lubrication of locks. Should a cartridge burst at the base, a deposit will be left in the carrier or lock disc, and prevent the free working of the lock. In this case, the lock should be removed and the part cleaned.
6. Worm and worm-wheel may require cleaning and oiling.

Jamming of Cartridges.

Should jams occur in firing, it is due probably to a badly-constructed or damaged cartridge.

The most common of these mishaps may arise from a missfire, when, if the gun be very foul, the bullet may remain in the barrel when the cartridge case is extracted, so that the succeeding cartridge cannot be placed in its proper position. In this case, the bullet should be driven out of the barrel from the muzzle with a cleaning rod.

Another cause of jam is due to a cartridge splitting in firing, and leaving on extraction a portion in the barrel. This is easily removed by the cleaning-rod—a steel rod, split at one end.

Should a jam occur which cannot be remedied immediately, the lock belonging to the barrel where the jam has occurred should be removed, and the firing may then go on with nine barrels.

General Directions.

Before men are allowed to fire the Gatling gun rapidly, they should be carefully and thoroughly drilled to its use, and should be capable of rectifying any slight impediment to a steady and continuous fire.

No man should on any account get in front of the gun when in action, whether loaded or unloaded.

Names of Parts.

The gun is surrounded by a gun-metal casing, which has the trunnions in the centre, a cover for cartridge carrier on top, and brackets for fore-sights and elevating arc. A circular disc closes the front, and a cascable plate closes the rear, of the casing.

The following are the parts working from the muzzle :—

1. Main Shaft.—Passes through whole length of casing.
2. Front Disc.—Closes the front part of casing. It has ten holes into which the muzzles tightly fit. The cylindrical part of disc fits over, and is keyed to main shaft.
3. Front Collar.—Is in rear of, and close to, front disc, and assists to support front end of barrels by means of ten slots, in which the barrels rest.
4. Rear Collar.—Is similar to front collar, and supports rear end of barrels close to rear disc.
5. Rear Disc.—Rear end of barrels fit into this disc.
6. Cartridge Carrier.—Is immediately in rear of rear disc. It has ten slots for carrying the cartridges, and is supported in front by the rear disc and in the rear by the lock disc. There is also a hole running horizontally through it for the steady-pin, which assists to keep it steady while it is revolving.
7. Lock Disc.—Supports front of locks by means of ten holes, in which they work. It also supports rear part of cartridge carrier, and carries the steady-pin, which passes through carrier and rear disc.
8. Lock Collar.—The cylindrical part of this is keyed to main shaft. It has ten slots with projections, into which the grooves of locks fit. This prevents the locks from falling out in revolving.
9. Cascable Plate.—The cylindrical part of this plate passes on, but it is not fixed to, the main shaft, and carries on its upper part "the guide piece," on which the lock rests on entering. The rim of the plate has six interrupted threads, which fit into six similar threads on the rear part of gun casing, and is secured by being turned to the right about 30°.
10. Cascable Collar.—Is a small collar which fits on main shaft in rear of cascable plate. It has several small slots in the rear part.
11. Cascable Knob.—This knob is threaded, screws on main shaft, and carries a spring catch by which it is secured to the collar. It also adjusts the main shaft.

Worm-wheel.—Has a featherway, and fits on main shaft.

Worm.—Has a featherway, fits on crank shaft, and gears into worm-wheel.

Crank Shaft.—Passes through bracket of cascable plate and worm.

Cocking-cam.—This is a steel cam, slotted away at the front part, that takes the rear end of needle (preventing it from being pushed forward with the lock, thus compressing the spring), which is released by the time the lock is in front of the steel seating, and fires the gun.

Safety Bolt.—Is an arrangement by means of which the cocking-cam is drawn back, thus preventing the springs from being compressed and the gun being fired.

Cam (large).—This cam is made of gun-metal, and tightly fits inside the gun casing. It has two steel seatings ; also two spiral slots, by means of which the locks are pushed forward or back as the main shaft is revolved.

Cover.—Is made of gun-metal, and hinged to the frame. The opposite end is secured to the frame by a catch. On its under side are two unloading strips, which rest on the solid part of the cartridge carrier ; these take against the body of the empty carriages, forcing them upward and out of the gun. The cover also carries a stop for the drum catch.

Note.—The cover has also four ribs on its under side for the same purpose.

Strengthening Piece.—A piece of gun-metal, with four ribs, which pass between the projections of cartridge carrier and keeps it firm while firing.

Elevating Gear (*Frictional*).

Wheel.

Spindle.—Has a feather, which fits into worm.

Worm.—Is in two parts, and has a featherway.

Worm-wheel.—Is coned out on its inside part for taking the cone.

Adjusting and Check Nuts.—On end of spindle.

Shaft.—The shaft passes through from right to left, and carries the clamp-wheel, steel washer, worm-wheel, cone, pinion, cylinder, and nut.

Arc.—Marked in deg., 55° elevation, 65° depression.

Stops.

Brake.

Crosshead with trunnion caps and keys.

Traversing Gear.

Traversing Plate.
Wheel.—Same as for elevating.
Spindle.—Same as for elevating.
Worm.—Same as for elevating.
Worm-rack.
Stops.—Same as for elevating.
Adjusting and Check Nuts.—Same as for elevating.
Brake.—Same as for elevating.
Pedestal.

NOTE.—On the clamp-wheel being set taut, the washer is forced against the worm-wheel, which in its turn is forced on to the cone, tightly fitting it. The cone, being a fixture on the shaft, causes the shaft to revolve; that in its turn drives the pinion which works the elevating arc.

SHIFTING LOCKS.

Turn the crank handle backward until the number of lock required to be shifted is in line with the mark on casing; then take out button, draw out the lock, and place in spare one, looking out that the grooves of lock take in projections of lock collar; then place in button, and try action.

SHIFT EXTRACTORS.

Remove the lock, raise the studs of extractor from the lock, then push extractor forward until clear of the flanges on lock, then place spare extractor.

SHIFT NEEDLE OR SPRING.

Remove the lock, unscrew keep-screw, then shift needle or spring as required.

DISMOUNT THE GUN.

Remove the locks, cascable knob, and collar, crank-shaft worm, worm-wheel, cascable plate, safety bolt; drive out pin, and remove lock collar, slide off lock disc, drive out large cam (with wood), remove cartridge carrier, then draw out from muzzle end the main shaft, barrels, and discs; drive out pin, and remove main shaft; remove barrels from discs and collars.

TO REMOUNT.

Place the numbers of barrels in line with the numbers on rear disc, then proceed reverse way to dismounting.

PART III.

AMMUNITION.

MAGAZINES.

Magazines.—Iron ships' magazines, with their handing-rooms and light-rooms, are built as an iron tank or water-tight compartment of $\frac{1}{4}$-inch iron plates, stiffened with angle irons and lined inside with two thicknesses of teak everywhere; the first lining nearest the iron is $1\frac{1}{2}$ inches thick, and the second $\frac{3}{4}$-inch at the sides and crown. The flat is 2 inches and 1 inch respectively. The first lining is secured to wood quartering attached to the back of the angle irons, from 3 to 4 inches from the iron plates, so as to leave an air-tight space between the wood and iron, which is sometimes filled with fire-proof cement. The joints of the first lining are tongued and grooved (iron-tongued), the second plain joints breaking the joints of the first.

Handing-room.—The handing-room should be inside the iron tank, and partitioned off by a bulkhead of $2\frac{1}{2}$-inch teak, lined on each side with teak planks; all fastenings to be of copper. The doors should be 3 inches thick, and lined with copper, and to open outward from the magazine. Holes are made in the doors to pass the cases through. They should be once and a-half the diameter of the bore of the largest gun in the ship. All cartridge-cases, tackles, and screens are kept in the handing-room.

Precautions necessary in a Magazine on Going into Action.—Open the scuttles and let down the pockets, pass the cases from the "ready" rack, pass in the empty cartridge-cases, loosen the

lid of the powder-cases; magazine screens to be hung round the hatchways. See the leaden floors of the handing-rooms sprinkled with water, which is supplied from a tank fitted there. Magazine men will always wear the shoes provided for them, and kept in the magazines.

Flooding Cocks.—All magazine flooding cocks are kept locked; keys in charge of commanding officer.

"Cerberus."

FORE MAGAZINE

Will stow 135 full charges on Port side, and 153 reduced charges on Starboard side. The Light-rooms are at each end.

AFTER MAGAZINE

Will stow 84 full charges on Starboard side, and 84 reduced charges on Port side. The Light-rooms are at each end.

The charges are placed in zinc cylinders, which are stowed one over the other on permanent platforms fitted in the bays and stacks so as to divide the weight. Voice-tubes are led to the magazines for communicating orders to the magazine men from the fore and after part of battery deck.

"Victoria and Albert."

FORE MAGAZINE

Magazine.—The fore magazine is built of wood, and is a watertight compartment, in direct communication with the upper deck and magazine door below. When the magazine door is opened, a fearnought screen is fitted to cover the hatch on the upper deck, through which the supply of powder is received, the door being kept closed.

Lighting.—The light-rooms are placed in the fore compartment (lower deck), and are outside the magazine, giving light through a bull's-eye into the passage of the magazine.

Flooding.—The flooding arrangement is from a sea-cock to the bottom of the magazine, through a stop-cock worked from the upper deck.

Ventilation.—The magazine is ventilated from the upper deck, the ventilators being fitted with one or two diaphragms of wire-gauze, to prevent fire from passing down.

Stowage.—In this magazine are stowed the charges for the 8-inch gun, 50 Full and 50 Reduced, and bursting charges for all shell.

AFTER MAGAZINE.

Magazine.—The after magazine is constructed on the same principle as the fore magazine.

Lighting.—The light-box is placed outside, and lit from the engine-room.

Flooding.—As in the fore magazine, but worked from the engine-room.

Ventilation.—As in the fore magazine.

Stowage.—In this magazine are stowed the charges for 6-inch gun, 50 Full and 50 Reduced.

SHELL-ROOMS.

Shell-rooms are constructed on the same principle as magazines, and are also flooded in the same way. Voice-tubes are led to the shell-rooms for communicating orders; they are close to the voice-tubes of the magazine.

The shells are stowed on billets of wood, hollowed out slightly for a projectile, this being used to separate them from each other, so as to pass the slings round them for raising.

"Cerberus."

The shells are transported from the bays to the hatch by means of a rail overhead, fitted with a travelling purchase, and from the hatch to turret by a hand-winch, which is fitted with chain purchase.

The first supply of shell taken from the shell-room is from the "ready" rack, immediately under the hatch; they are stored heads up, with slings on ready for hoisting.

"Man and arm boat" gear is stowed in the shell-rooms; also fuzes, fuze implements, metal-lined cases containing fire-works, and life-buoy portfires.

The fore shell-room stows 194 projectiles, fuzes, and fireworks.

The after shell-room will hold 167 projectiles.

"Victoria" and "Albert."

FORE SHELL-ROOM.

Shell-room.—The shell are supplied to the hatch by means of tackles and a travelling purchase, and from thence to the gun by the shell-whip.

Lighting.—The shell-room is lighted from a light-box placed outside.

Flooding.—The shell-room is flooded from the sea-cock as the fore magazine, and is worked from the upper deck.

Stowage.—100 projectiles for 8-inch gun, viz.:—Palliser, 45; common, 30; shrapnel, 10; segment, 10; case shot, 5.

AFTER SHELL-ROOM.

Shell-room.—The shell are supplied to the upper deck by means of an iron davit and tackle.

Lighting.—As in the fore shell-room.

Flooding.—The shell-room being in the same compartment as the after-magazine, is not fitted with separate flooding arrangement.

Stowage.—100 projectiles for 6-inch gun, viz.:—Palliser, 40; common, 40; shrapnel, 10; segment, 5; case shot, 5.

SMALL-ARM MAGAZINES.

"CERBERUS."

Magazine.—The machine-gun and small-arm magazine is the starboard side of fore-steerage.

Lighting.—The light-box is placed in light-room passage.

Flooding.—It is flooded from the upper deck.

Stowage.—It contains all ammunition for 6-pr. Nordenfelt Quick-firing guns, 1-inch Nordenfelts, M.-H. rifles and pistols.

"VICTORIA AND ALBERT."

Small-arm Magazine.—Is practically part of the fore shell-room.

Flooding.—It is flooded from the fore shell-room.

Stowage.—It contains all ammunition for 1-inch Nordenfelt guns, M.-H. rifles and pistols. There is also a fuze locker containing fuzes and fireworks.

MANUFACTURE OF PROJECTILES.

PROJECTILES FOR M.L.R. GUNS.—(STUDDED PROJECTILES.)

Palliser Shot.

These projectiles are specially intended for the penetration of wrought-iron and steel plates, which offer a great resistance to the passage of the shot. In order that the greatest penetration should be obtained from the projectile, it is necessary that its construction should be strong, its head of the best form suited to penetration, and the metal hard and unyielding, It is essential that the shot should not set-up or bulge, and that none of the work should be wasted in heating it.

Iron.—Different mixtures of Ridsdale and Cwmbran iron have been used in combination with about 20 per cent. of store scrap-iron for manufacturing these projectiles, and since 1874 projectiles have been cast of iron consisting of old gun and shell iron.

Casting.—The projectiles are cast head downwards, so as to insure density and soundness in the head. The head is cast in an iron chill or mould, in which, by virtue of the conducting power of the metal, the molten mass is rapidly solidified, and all, or nearly all, the carbon remains chemically combined with the iron, so that the head is composed of white iron. The iron thus rendered white possesses generally the qualities of ordinary white iron; that is, intense hardness and crushing strength and considerable brittleness.

It is necessary for the body of the projectile to have a hard unyielding metal, though not quite so hard as, and more tenacious than, the head. If the body was of soft metal, while the head

was hard, there would be considerable loss of power on impact, owing to the setting-up of the soft metal. This point is gained by casting the bodies in sand, sand being a bad conductor; the bodies have time to cool gradually, and the carbon in the iron has time to partly separate in a free condition. Extractor-holes and stud-holes are formed at the same time.

Core.—The core is formed on a hollow spindle, to allow for the escape of gas. The core-box in which it is formed is divided vertically into two parts, which can be opened or closed as required. The spindle has a cast-iron ring fixed to its base, having vertical grooves and also horizontal steps running round its exterior, in order to unite it firmly with the metal of the projectile in casting. At the base of the spindle and below the cast-iron ring is placed a sand and coal-dust ring, which forms an undercut recess between the cast-iron ring and the base of the projectile. When the core is finished, the box is drawn asunder and the core removed. The projectiles remain in the mould until they are sufficiently set, for about an hour. When the projectiles are sufficiently cooled the core is scraped out, and while hot they are lacquered internally, and are tested by water pressure of 100lbs. to the square inch, and the bases are carefully hammered all over with sharp-pointed hammers to detect flaws.

The body is ground down to the final dimensions on a revolving grindstone, as the metal is too hard to be turned.

The cast-iron bush is tapped in the base for the gas-check plug or base-plug; the studs are then pressed in one at a time, turned and planed to correspond with the rifling. A lead ring is hammered in, sealing the junction of the bush and body, the studs trimmed by hand, and the interior cleaned out; the gas-check or base-plug (smeared with equal parts of cocoa-nut oil and ground chalk), which is not interchangeable, is screwed in.

Finally, the projectiles are gauged and examined.

Marks.—On the base of a projectile will be found "Palliser Shot," also the calibre of the gun, and if there are two guns of the same calibre the weight of the gun is added, the month and date of casting. Also the Roman numeral and nature of iron employed; the month and year will be found on one of the rear studs, and also a X and the numeral. The general form of chilled projectiles are from 2 to $2\frac{1}{2}$ calibres in length, their heads struck with a radius of $1\frac{1}{2}$ diameters.

Common Shell.

Iron.—The quality of the iron mainly depends on the quantity and condition of the carbon associated with it. The various impurities, such as sulphur, silicon, phosphorus, &c., which are generally found in pig-iron, are more or less injurious. Sulphur is thought to diminish the strength, but is sure to be present, as the coke which is used for fuel is not free from it. Phosphorus is said not to be so injurious, and increases its fusibility and hardness, while silicon is said to diminish its strength. Cast-iron generally contains from 2 to 5 per cent. of carbon.

The metal employed is melted in cupola furnaces.

About 1½ cwt. of coke and ½ cwt. of chalk is used to 10 cwt. of iron. The use of the chalk is to combine with the silica; if it was omitted, the silica would combine with the iron and cause a loss.

Moulding.—The material used is sand and coal-dust, brought to the desired consistency by mixing green sand and burnt sand in equal proportions, with ⅛ coal-dust added.

The shell are cast base down, as most strength is required there to resist the shock of discharge.

Core.—The core is formed in cast-iron boxes, which represents the interior of the shell, but have an allowance made for the shrinking of the metal. They are formed on perforated iron spindles, supported by small pegs of wood or cast-iron rings, with arms nicked so as to break easily. Spun-yarn is wrapped round the spindle. Both yarn and pegs are charred by the heat, which allows the core to break up readily and separate from the spindle. A projection round the neck of the core makes a groove in the neck of the shell, which facilitates breaking-off in trimming.

Fuze-hole.—The shell has its nose cut to proper length, and turned down to the proper curve. The fuze-hole is then bored out to proper size, tapped, and has a recessed groove cut at the bottom. The gun-metal bush is then screwed in, and violently jammed home to expand into the recessed groove. It is then tapped with a screw-thread, G.S. gauge, and countersunk to the depth of ·2 inches.

Extractor Holes.—The extractor holes in the head are bored, and the body, if too large, ground down by grinding stones.

Stud Holes are bored one at a time, and undercut.

Lacquering.—The lacquer consists of resin, spanish brown, plaster of paris, and turpentine, is poured in hot (a gun-metal bush being screwed into the fuze-hole to prevent the lacquer filling up the threads of the proper bush), and immediately poured out again.

Studs.—The gun-metal or copper studs are pressed in; they have a concave hollow in the lower part, which causes them to expand into the undercut holes. The studs are turned down to project the required distance from the shell, then planed, the loading and driving side to fit the rifling. Lastly, all studs are filed, trimmed by hand, and the projectile is weighed and gauged.

Marking.—The shell is stamped and painted black, on the body the letters R. ⩚ L.; also the numeral will be found above one of the front studs in all calibres above the 64-pr. inclusive; and upon 7-inch and upwards a X, to indicate the studs have been planed as well as turned.

The general form of common shell is about 3 calibres in length, with ogival head, 1½ diameters radius, for studded projectiles.

Shrapnel Shell.

Casting.—The method of casting the body is similar in most respects to that given for common shell. The mould and core for the body are the same, except that as the body consists of a cylinder open at the top and closed only at the bottom, the top of the core is so formed as to fit without leaving any space between it and the top of the mould.

The shell consists of a hollow body of cast-iron, with a head made of elm, covered with a light shell of Bessemer metal. The body is weakened internally by six longitudinal grooves running down the entire length of the interior. The base is formed into a chamber to contain the bursting charge. Over the mouth of the powder-chamber rests a disc of iron or diaphragm. The diaphragm is pierced in the centre, and partly tapped to take a wrought-iron tube, which is screwed into it. This tube is tapped at the top to take a gun-metal primer, used to assist in carrying the flash of the fuze to the bursting charge in the chamber. On the diaphragm are placed sand shot, which are fixed by resin being run in among them, brown paper being laid round the inside of the shell. Over the shot and resin is placed a kamptulicon disc. The wood head is bored out to contain a tin socket, fitting round the iron tube of the body, and holding a gun-metal bush of G.S. gauge.

STUDLESS PROJECTILES.

Studless projectiles are manufactured in the same way as the studded projectiles, except having no studs; and the base, instead of being flat, is rounded and cast with undercut flutings. The flutings somewhat resemble a raised pattern of fluted and truncated willow leaves with sharp edges, the leaves pointing to the rear, and intercepted by two undercut rings, serving to still better attach the gas-check to the projectile. The heads are struck with a radius of 2 diameters; they are marked on the base thus, "R. ∧ L. 10in.," and date of casting.

PROJECTILES FOR B.L. GUNS.

CAST-IRON PROJECTILES.

The projectiles for the new breech-loading guns on the interrupted screw system are distinguished from the old pattern lead-coated ones by the term B.L., the latter being known as R.B.L.

The projectiles for B.L. guns, except case shot, are struck with a radius of two calibres.

Rotation is imparted by means of a driving band of copper slightly larger than the bore of the gun, so that it is compressed into the grooves as the projectile moves through the bore of the gun.

This band is driven into a groove near the base of the projectile, by hydraulic pressure, while running in a lathe.

Base plugs of lead are used for all B.L. shell, having a hole in the base to seal the joint when the base plug is screwed in; when hammered out, they fit tightly into the under-cut recess in the base of the shell.

All B.L. projectiles have the calibre of the gun and mark of the projectile on the base.

All B.L. shell for 6in. and upwards have a hole in the base as well as in the head; this enables the turning and fitting to be done more easily, and also allows for filling the shell from the base, the joint being sealed by the lead disc.

In all B.L. common shell the interior of the walls is very nearly parallel to the walls of the exterior, with only a slight thickening toward the base, the walls being of the minimum thickness to withstand the shock of discharge.

All B.L. shell (common) of 6in. and upwards have their bursting charges in bags, and are filled through the base.

The construction of cast-iron projectiles for B.L. guns is similar to that already described for M.L. guns.

Case Shot.—Case shot for B.L. guns are similar in construction to M.L., but have studs on the base. The latest pattern have the bottom made of a disc of copper projecting over the sides; this acts as a driving band in the gun.

STEEL PROJECTILES.

Cast steel shell are now manufactured for all B.L. guns of 6in. and upward, and for lighter natures forged steel is used.

The manufacture is as follows:—

Common Shell.

The cores of all steel shell are now made up of hay-band, wound round the spindle and covered with loam until it is brought up to the proper size and shape, dressed, baked, &c.

The wrought-iron bush for lifting hole is cast with the shell; the moulds are made one day, placed in an oven, and used next day. All these shell are cast point downwards, and the mould made much longer than required so as to insure the purest metal for the shell.

After the moulds are prepared they are placed in a circular pit. A few minutes before the metal is ready a quantity of silicon is thrown in; and when quite ready, the metal is drawn from the furnace into a large ladle holding about 4 tons. It is then lifted by a hydraulic crane and placed over each mould; an opening called a shutter in the bottom allows the steel to run into the moulds, each shell is allowed to cool and then taken out of the mould, the *dead head* is cut off, the shell is then annealed in an oven, and finished by fitting the base piece, bush, &c., ground, lacquered, and marked.

Chilled Shot.

The steel chilled shot are allowed to cool in sand pits, so that the whole of the shot may cool together. These shot are also cast solid; before cooling, a hole is punched in the base of the shot, about one-third its diameter in size, and two-thirds its length; it is then re-heated and forged, finally it is heated a third time, and tempered with water.

After tempering, the shot is so hard that a new file produces no effect upon it. Tempering the projectile is done by placing it on a revolving platform, when it is taken from the furnace,

on its base. A fountain of cold water flowing up into the interior, a jet of cold water is turned on the head every now and then; the process lasts about half-an-hour.

The core is bored out after tempering.

The tests :—Mechanical strain, 80 tons per square inch.
Elasticity, 7 to 11 per cent.

Shrapnel Shell.

Shrapnel shell are made to carry the burster in the head; the body is cast without a bottom, which is attached, after the shell is built up, by pins to the body. The action of the bursting charge slightly checks the velocity of the bullets, and acting through them blows off the base of the shell. The body then slides over them and drops to the ground or in the water, the bullets continuing their course with very slightly reduced velocity. Steel shrapnel shells are not intended to burst.

DISTINGUISHING MARKS ON PROJECTILES.

All shrapnel shell will be painted with a red tip 1-inch deep.

All steel shot will have a white band ½-inch wide painted round the head.

All steel common shell are distinguished by a white ring, painted round the head, midway between the shoulder and the fuze-hole, and on the base as follows :—

$$\frac{15}{S\ 5\ 2A}$$
$$\frac{}{89}$$

Date of casting, in middle.
Initial of foreman in charge of steel furnace, on left.
Second cast from A furnace, on right.

In the case of steel shrapnel, the white band will be immediately below the red tip.

C.S. will be stamped on the base of cast-steel, and F.S. on the base of forged steel projectiles.

All filled shell will have a red band ½-inch wide painted round the head; in the case of steel shell this band will be immediately below the white band, and in the case of cast-iron shrapnel, this band will be ½-inch below the red tip; they are also marked with the date of filling, and at stations which have monograms it is to be painted on the shell.

Filled shell will be marked with the word "bag," if a bag is used for the bursting charge, and a red disc 1-inch in diameter if shalloon primers have been used, and with the letter P if filled with pebble and fine grain mixture.

The colour of the paint will be red on a black ground and black on a red ground.

Palliser shot (formerly shell) which have been weighted up with sand, will have the letter W stencilled on them in white on the head, and also stamped on the base-plug.

Shells which are to be used for practice will be marked "*Practice.*"

Shells which have been emptied will be marked on the head with the letter E in red paint.

Shells filled with water should have the plugs filled with white lead.

Segment shell have a 1-inch white band immediately below the head.

INSTRUCTIONS FOR FILLING SHELL.

The following instructions for filling shell apply in all cases, with these exceptions :—

1. Common shell for B.L. guns are filled from the base or fuze-hole as supplied. All others are filled through the fuze-hole in the usual manner.
2. No bags are used in filling shells for the 12½-pr. and 9-pr. B.L.

Common Shell.

The shell is to be placed upon its point, which may be inserted in a block of wood hollowed for the purpose, or in any convenient place to steady it. No special pattern of block is necessary ; it can be provided on the spot, and the recess cut by any carpenter.

To remove the plug, the shell is to be held firmly by one man while another applies the removing wrench to the plug, and unscrews it. Place the filling-rod in the bag, and fold the latter round the rod ; insert it through the plug-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 plug-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 the funnel in the neck of the bag, pressing the funnel well down into the plug-hole ; pass the filling-rod down

through the funnel, and gradually pour in two or three pounds of powder; 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. Then re-insert the funnel and rod as before, and continue the filling. The filling-rod should be moved up and down while pouring in the powder to facilitate its passage through the funnel, the powder in the shell being tamped on at the same time. The use of a large mallet against the side of the shell (any piece of wood will answer the same purpose) will materially assist in getting the maximum amount* of powder into the shell.

When the shell is quite full, withdraw the funnel and filling-rod, and tie the neck of the bag with two half-hitches of twine close to the top of the plug-hole. Cut off the superfluous choke, and push the neck of the bag well down, and to one side of the plug-hole; then screw in the plug as required.

No preparation of the bag by pricking or otherwise is necessary.

Segment Shell.

The operation of filling segment shell is the same as that described for common shell, except that the shell is stood on its base, and the burster-bag and charge are inserted through the fuze-hole. In this case care must be taken to push the choke of the bag well down to one side, out of the way of the flash from the fuze.

Shrapnel Shell.

Remove the plug from the fuze-hole, and, after seeing that the fuze-hole is clear from dirt, grit, &c., insert the funnel, and pour in the bursting charge; this must be done gradually, for if the whole of the powder is put in at once the tube may become choked. Shake the shell from side to side on its base until the whole of the powder has passed down the tube, taking care that none of the powder is left at the bottom of the fuze-hole; drop in the metal primer, and by means of the large diaphragm shrapnel screwdriver screw it tightly into the tube; then screw in the fuze-hole plug.

Note.—The bursting charge for B.L. gun shrapnel is in the head.

* A very much larger bursting charge can be got into any shell by mixing F.G. with the usual L.G. powder, or by filling with pebble, and the interstices between the pebbles with F.G. powder. Great care should be exercised in the use of the filling-rod.

GAS-CHECKS.

Gas-checks are circular discs of copper of the same diameter as the shell which they are supplied for use with. They are slightly convex to the rear, so that the pressure of the powder-gas on firing flattens it, and so helps to expand the metal of the flange, thus sealing the windage.

Their principal use is to prevent the gas, on the first ignition of the charge, from rushing over the projectile, which causes the metal of the gun immediately over the seat of the shot to be eaten away by erosion, forming very irregular grooves.

Fixing Gas-checks with Plug and Nut.

Unscrew the nut and remove it; then apply the "wrench removing-plug" to the gas-check plug, and screw it well up in the direction of the arrow, to insure its being well home.

When unscrewing the nut, if there is any tendency for the plug to unscrew also, the "wrench removing-plug" should be 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" until the nut binds against the gas-check. With Mark II. gas-checks, the nut will be screwed down to the shoulder of the plug.

With gas-checks having projections for studded projectiles, see that the projections are in line with the studs before screwing the plug home.

Projectiles fitted with Gas-checks Rotating without Plugs.

These gas-checks are automatic, and become fixed to the projectile when the gun is fired. When fitting the gas-check before loading, place it on the base of the projectile and strike it with a pointed hammer or chisel, so as to make an indent at two or three points on that part which surrounds the neck of the projection on the base of the projectile.

All gas-checks are marked, either by stamping or in casting, with the nature of ordnance they are to be used with.

GUNPOWDER.

Gunpowder has, since its invention centuries ago, been practically the only agent used for the propulsion of projectiles; other compounds have at various times been proposed and partially used as substitutes for gunpowder, but for naval and military purposes gunpowder may be said to be so far the only substance used in guns and small arms.

The composition of gunpowder has varied at different times and with different nations, but it has always consisted of the same three ingredients — viz., saltpetre, sulphur, and charcoal. In England the following proportions are used for black powder :—

Saltpetre, 75 parts.
Charcoal, 15 ,,
Sulphur, 10 ,,

And for brown powder the following :—

Saltpetre, 79 parts.
Charcoal, 18 ,,
Sulphur, 3 ,,

The exploding temperature of gunpowder is 600° Fahr.

The physical properties thus influencing the behaviour of fired powder are—

Density,
Hardness,
Size of grain,
Amount of glaze,
Moisture.

The gradual firing or ignition of charges in guns is of the utmost importance. No gun could stand the shock of the whole force being at once generated. In heavy rifled guns greater attention has been given to this, and has resulted in the use of slow-burning powders.

By using prismatic and cocoa prismatic powders we are able to give greater charges without increasing the strain on the gun.

The action of gunpowder is due to the rapid decomposition of the saltpetre by the charcoal; the actual effect is, that the charcoal is consumed by the oxygen of the saltpetre, with which it combines in the act of burning, forming carbonic acid gas; the sulphur also undergoes partial oxidation.

By the burning of the charcoal the oxygen in the saltpetre becomes separated from another gas, nitrogen, with which it was previously combined, and combines with the carbon, the two forming a large volume of heated gas of great expansibility.

The explosive force of gunpowder is due to the sudden evolution of these two heated gases, carbonic acid and nitrogen. In a mixture of saltpetre and charcoal alone, this action is comparatively slow. Sulphur is therefore added to render it more rapid, an effect which it produces on account of its ignition, at a much lower temperature than either saltpetre or charcoal.

When a charge of powder is exploded in the bore of a gun, to all appearance there would seem to be an instantaneous generation of the whole force. This, however, is not the case, as a certain time is necessary for the complete combustion of the charge. This gradual firing is of the utmost importance, for were the whole of the charge ignited instantaneously there would not be time for the action to be distributed over the particles of metal at any great distance before those in the immediate vicinity of the explosion were forced out of the sphere of the action of the cohesive force, and consequently the gun, unless of enormous strength, would burst.

Although it is very necessary to employ (comparatively) very slow-burning powder for the heavier guns, it is equally important to use a quick powder for the smaller nature, because the projectiles of the latter move away so readily.

By a combination of air-spacing to diminish the maximum pressure in the bore of the gun, and chambering to shorten the cartridge, very large charges can be burnt in the heavy long guns, while the projectile receives a well-sustained pressure during all the time it is passing through the bore, and it leaves the muzzle with a very high velocity, ranging far and accurately.

Recent experiments with later powders, such as cocoa prismatic, point to the possibility of giving up air-spacing, and filling the whole of the large chamber of a modern gun with a very slow-burning powder, which will give a well-sustained pressure without an undue strain on the gun.

Experiments are being carried out at the present time with smokeless powders, which will make great changes in the nature of the charges for all guns.

Gunpowder is usually designated under three classes :—

I. Service.
II. Blank.
III. Shell.

Service powder consists of all new powder, and all made up charges for firing projectiles. All powder found serviceable and uninjured, and powder that has been repaired.

Blank.—All powder unfit for class I.; for firing salutes; and if required, for mining purposes; also for filling shell.

Shell.—For the bursting charges of all shell; also for making P. mixture, for shell, combined with fine grain.

Description of powder used in the Victorian Naval Service, and charges it is used for :—

(1) *Prism.* 1, *Brown.*—This is similar to the black prismatic, and is used for all large charges; the prisms are built up in regular layers to form a cartridge, which is regular in form when finished.

(2) *Prism.* 1, *Black.*—This is similar to the last-named, except in composition and colour, and is used for all B.L. charges of 6 inches and above, and as primers for cartridges of brown powder.

(3) *Prism.* 2, *Black.*—This differs from the last only in the size of the prisms; it is used for the heavy M.L. guns.

(4) *Pebble* (P^2).—This powder is used for charges for M.L. guns, and for reduced charges for B.L. guns.

(5) *P.*—This is similar to the last, and used for all charges for M.L. guns; it differs in size of grain and density only.

(6) *R.L.G.*—This is the powder most in use for charges for all M.L. and B.L. guns of the smaller natures, and may be used where P. is not available; the charges of P. powder are considerably larger than the charges of R.L.G. for the same gun. A full charge for a 10-inch gun would be 70 lbs. of P. or 60 lbs. R.L.G.

There are four classes of R.L.G. used for different natures of guns.

(7) *L.G.* (or large grain).—This is an unglazed powder, and was used for all smooth-bore charges, and for charges of M.L. guns up to 9-inch. Also for filling common and double shell, and bursters of shrapnel when carried in the head.

(8) *M.G.* 1.—This is for use with machine guns, and is highly glazed; at present used for the 1-inch Nordenfelt gun.

(9) *R.F.G.*[2]—This is used for M.H. rifles and machine guns of rifle calibre, and is a slow-burning powder.

(10) *R.F.G.*—This powder is used for small-arm blank cartridge, and bursters of shrapnel shell where F.G. is not available.

(11) *F.G.* (or fine grain) is used for bursters of shrapnel shell, and is no longer made.

(12) *Pistol.*—This powder is used for all pistol cartridges, and bursters of shrapnel shell; being quick in action, it is especially suitable for the latter purpose.

The latest class of powder used in the Royal Naval Service is the following:—

S.B.C.—Slow-burning cocoa for larger natures of B.L. guns.

E.X.E. (extra experimental) used for 6-inch B.L. guns.

Selected Pebble, for quick-firing guns.

Q.F. Grains about ·5-inch square, $\frac{3}{10}$ thickness, about 270 to the lb.; density, 1·75; used in Q.F. guns as may be ordered.

Hexagonal indented, for 3-pr. and 6-pr. Q.F. guns.

MAKING AND FILLING CARTRIDGES.

FOR M.L.R. GUNS AND B.L. GUNS.

The material used for making up cartridges is silk cloth, and it is divided into three classes :—

No. 1 is used for cartridges below 14 lbs. in weight.
No. 2 for cartridges between 14 lbs. and 85 lbs.
No. 3 for cartridges above 85 lbs.

Test of Class 1 = 50 lbs.
Test of Class 2 = 100 lbs.
Test of Class 3 = 300 lbs.

Serge is used for the smaller natures of guns, until the supply is used up.

It is also used for the bursting charges of shell.

A new material, called dowlass, a fine description of canvas, is used for the bursting charges of steel shell.

The cartridges should be cut so that the width of the material runs in the width of the cartridge.

The cartridges, before being sewn, will be printed in black with the nature of the gun, charge, &c., and with lines for the hoops and seams. All marking on cartridges will be done with printer's ink.

All cartridges will be made up with their edges overlapping 1¼ inches, and sewn together with three rows of stitches, with the following exceptions, viz., the 7-pr. M.L. cartridges, the edges of which will overlap 1 inch, and will have two rows of stitches; and the 12-pr., 9-pr., and 6-pr. B.L. exercising and saluting cartridges, the edges of which will be simply hemmed together and turned inwards. Serge cartridges will be sewn with worsted, and silk-cloth cartridges with sewing silk or twist.

Filling Cartridges.—Care will be taken to see that the cartridge-bags are properly dry before being filled, and the proper charge will be carefully weighed out and inserted in the bag by means of the "funnel, copper, cartridge." They will then be choked by drawing together the mouth of the cartridge into several pleats with a brass needle, threaded with three strands of worsted for serge cartridges, or with silk twist for silk-cloth cartridges; the silk twist being doubled for 9-inch cartridges and upwards. After drawing together the mouth of the cartridge, three turns will be taken round the pleats, and the choke thus formed will be further secured by passing the needle five times through it alternately above and below the turns, thereby stitching down the turns round the choke at four points equidistant from each other.

Hooping, with Braid Hoops.—Draw the braid through the serge or silk cloth until the knot of the loop comes home to the serge or silk cloth, the single end being already passed through the loop from underneath. Pass the single end to one side of, and under, the loop, then draw the hoop tight, and keep it so by placing the forefinger of the left hand firmly on the loop, bringing the running end between itself and the loop, and not on the single end, otherwise the knot will slip. The maintenance of the proper form of the cartridge depends on the hooping being thus secured; the centre hoop is secured first, and then alternately until completed.

Filling Cartridges with Prismatic Powder.—A zinc envelope, open at both ends, having as many sides and of the same length as the finished cartridge, is used in building them up. This envelope just fits tightly into the interior of the empty silk cartridge. It is provided with a movable wooden bottom. On this bottom the prisms are built up carefully by hand till the envelope contains the required number of layers of prisms; the cartridge-bag is drawn over the envelope, the latter up-ended, and the wooden bottom withdrawn. The envelope itself is now slid out between the prisms and the cartridge bag, leaving the latter closely round the prisms. The cartridge is sewn to the exact shape of the built-up prisms.

In each end a hole is fitted with open net-work, and these holes have a small piece of red shalloon shellaced over them to protect the powder in store and transit. The piece of shalloon which covers the rear end of the cartridge, used in axial vented guns, is detached before loading.

Cartridges are distinguished from each other by being marked, with printer's ink, the calibre of the gun intended for, the weight of the charge, and the nature of the powder. It is marked P. if pebble powder; R.L.G. if rifle large grain.

Thus—10-inch M.L., 70 lbs. P.
10-inch M.L., 60 lbs. R.L.G.

If Pebble is used in a cartridge marked R.L.G., the lines R.L.G. will be obliterated, and *vice versâ* if R.L.G. is used.

Drill cartridges for M.L. guns are of wood, covered with raw hide. The B.L. cartridges are of wood, with a thick covering of felt covered with leather, and have a metal plate at the bottom where the flash from the friction-tube strikes.

FUZES.

Fuzes are classed under two heads:—

1. Time.
2. Percussion.

Time Fuzes.

Time Fuzes, when used.—Where the distance is accurately known, and it is desired to burst the shell in the air, time fuzes are the best to use.

This is the case when firing shrapnel at bodies of men or boats, as owing to the construction of the shell the bullets retain their direction, and to obtain the best effect the shell should be burst in the air some distance in front of the object.

When firing against unarmoured ships or fortifications, or where the distance is not accurately known, percussion fuzes should be used.

Disadvantages.—As regards the use of time fuzes, the following disadvantages are incurred:—

1. The distance must be known or the effect of the shell is frequently lost, either from bursting too soon or from being fitted too long.

2. The same effect may be produced by irregularity of burning, owing to deterioration in the fuze, or atmospheric conditions.

3. They require fitting.

Wood Time Fuzes.

Material.—Seasoned beech-wood is used as the material of the body, which is made conical, this shape having an advantage over the cylindrical form, as there is less risk of the fuze setting into the shell on the shock of firing, and it is more easily inserted.

Channels.—The fuze-composition is contained in a channel, which is central or eccentric according to the number and position of the powder channels, which are used in all fuzes.

Powder channels are essential in fuzes, for shrapnel shell, where the bursting charge is not immediately surrounding the fuze, and consequently a strong flash is required; and also in the case of common shell when the fuze is bored short, because the flash would be obstructed by the side of the fuze-hole.

If only one powder channel were used, it is obvious that there would not be room for the side holes to be bored in a fuze reading to tenths of inches of fuze-composition, the diameter of each side hole being ·125 inches. By the use of two powder-channels we are, therefore, enabled to graduate the fuze just twice as finely as we could do with one powder-channel; and in the 15-second, for similar reasons, there are six.

The powder-channels are connected at the bottom by a groove, filled with quick-match to cause them both to act at the same time, giving a strong downward flash.

In all these fuzes the last hole in the row is bored through into the composition, to insure the action of the fuze when fixed in the shell without preparation.

Ignition.—Wood time fuzes with M.L. guns should not be uncapped till the shell is placed in the bore. The heads are closed, otherwise they would burn much quicker on account of the pressure of the air, and would be more likely to be extinguished on graze.

In nearly all M.L. guns the fuze is ignited by the flash of discharge.

In the 10-inch M.L. guns the fuze may also be fired by a detonating arrangement in the head.

In all wood time fuzes, a small hole is bored in the top of the fuze-composition; this renders ignition more certain.

The channel containing the fuze-composition has a paper lining, as in hot climates the wood was found to shrink.

Time of Burning.—Fuze-composition burns at the rate of about 1 inch in 5 seconds; mealed powder at the rate of 1 inch in $2\frac{1}{2}$ seconds, twice as fast as fuze-composition.

Metal Time Fuzes.

There are several patterns of these fuzes, but they differ mainly in size and time of burning. They have been much improved of late, are fast superseding wood time fuzes, and have several important advantages. Metal time fuzes are of two kinds, "time" and "combination." The former are constructed for use as time fuzes only; the latter combine the action of a time fuze with that of a percussion fuze.

Advantages.—They can be set to very small intervals, a point of the greatest importance; they can be altered again after fitting; they are open to inspection, so that the officer or No. 1 of a gun can see that they are correct; they can also be fitted at the gun. This is of great importance, especially with shrapnel shells.

"Percussion" Fuzes.

Percussion fuzes are employed in shells intended to act against solid obstacles, such as wooden ships, earthworks, brick or stone walls, buildings, &c.; and they are also used against boats or troops exposed.

Fuzes of this class are useful in firing trial shells to ascertain the range, as the effect of the burst is easily seen.

Safety-pins are used in all fuzes that act on graze, and serve to protect the "feathers" in the fuze, which only come into action when the safety-pin is withdrawn, guarding against risk while the shell is being rammed home.

All percussion fuzes are tapped with a screw-thread, to fit into the fuze-hole of the shell. A fuze having its screwed portion conical, can be screwed home much more rapidly than any other form, as the fuze will enter some distance into the fuze-hole before the screw takes.

There is no necessity for a shoulder, as the fuze cannot be screwed too far home.

A great advantage of percussion fuzes is that they require no preparation beyond withdrawing the safety-pins in those which act on graze.

The following are the fuzes used at present in the Victorian Naval Forces:—

FUZE TABLE.

	Fuze.	Nature of Shell and Gun.	How used.
Wood Time.	15 sec. Wood Time without detonator.	Common and Shrapnel for 10-inch M.L. guns.	With Common Shell when distance is known against unarmoured ships, earthworks, buildings, &c.
		Common for 64-pr. M.L. gun.	With Shrapnel Shell, against boats and men exposed.
	15 sec. Wood Time, with detonator.	Common and Shrapnel for 10-inch M.L. guns.	As 15 sec. without detonator.
Metal Time.	Large.	Common, Shrapnel, and Segment Shells for 6-inch and all B.L. guns above.	As 15 sec. without detonator. Segment Shell being used for the same purpose as Shrapnel.
	Medium.	Common, Shrapnel, and Segment Shells for 6-inch and all above at medium ranges.	As Metal Time Large.
	Small.	Common, Shrapnel, and Segment Shells for all B.L. guns below 6-inch.	As Metal Time Large.

FUZE TABLE—*continued.*

	Fuze.	Nature of Shell and Gun.	How used.
Metal Combination.	*Large.	Common, Shrapnel, and Segment Shells for 6-inch B.L., and all B.L. guns above.	As Metal Time Large. The combination of percussion with time enables these fuzes to be also used as percussion fuzes.
	*Medium.	Common, Shrapnel, and Segment Shells for 4-inch B.L., and all B.L. guns above, at medium ranges.	As Combination Large, but when used for Time at medium ranges.
	*Small.	Common, Shrapnel, and Segment Shells for all B.L. guns below 6-inch.	As Combination Medium, but at shorter ranges.
Metal Time and Percussion.	†Middle.	Common, Shrapnel, and Segment Shells for 6-inch B.L., and all B.L. guns above.	As Medium Combination, and is probably intended to supersede it; this is a 15-sec. fuze.
	‡Short.	Common, Shrapnel, and Segment for the smaller nature of B.L. guns.	As for Middle Time and Percussion, intended to supersede the Medium Time, and Medium Combination.

Metal Percussion.	Petman's General Service Marks I., II.	Common Shell 10-inch M.L. gun.	Against Earthworks or unarmoured Ships; this fuze is obsolete and is superseded by the Direct Action.
	R. L. Mark II.	Common, Shrapnel, and Segment Shells for 6-inch B.L. gun, and all below.	For Common Shell against unarmoured Ships and Earthworks; for Segment or Shrapnel against men exposed.
	Small Percussion Marks I., II.	Common, Shrapnel, and Segment Shell for 4-inch B.L., and all below.	As for R.L. Mark II. Intended to supersede it.
	Direct Action Marks II., III.	Common Shell, 10-inch M.L. gun.	Against Earthworks or unarmoured Ships, &c., this fuze is intended to supersede Petman's General Service Fuze.
	Naval Concussion Large.	Common Shell for 6-inch B.L. guns, and all above.	Against unarmoured Ships, Earthworks, &c.
	Naval Concussion Small.	Common Shell for all B.L. guns below 6-inch.	As for Naval Concussion Large.
	Bolt Percussion.	Common, Shrapnel, and Segment Shells for all B.L. guns.	Common against Earthworks, and unarmoured Ships. Shrapnel and Segment against men exposed.
	Base Percussion Steel and Gun Metal.	For 6-Pr. Nordenfelt Q.F. gun pointed Steel Shell and Common Shell.	These fuzes are supplied in the shell. The steel, on all occasions on which the pointed Steel Shell is required. The gun-metal one is used in Common Shell, but these two fuzes are interchangeable.

NOTES.—* These Combination Fuzes are intended to take the place of the Metal Time.

† This is intended to replace the Medium Combination, and fuzes will probably be eventually issued to replace the large and small combination.

‡ This fuze is not at present supplied to Victorian Navy, but will probably be in use shortly.

DESCRIPTION OF FUZES.

15-second Wood Time Fuze.

The body of the fuze is made of beech wood, and conical in shape. It has the composition channel in the centre of the fuze, driven with 2″ of slow-burning composition (1 inch in 7½ seconds). Above this is a ·75″ pellet of mealed powder, having a hole bored down its centre to a depth of ·55″. There are six powder channels, connected at the bottom by quick-match placed in an annular groove, and pressed into the bottom of each channel.

The bottom hole of one channel is bored through, and threaded with quick-match; the paper scale on the exterior gives intervals of ½ seconds and ¼ seconds of time. This fuze burns at rest about 15 seconds; when fired from rifled guns, 13 to 14 seconds only.

The upper part of the composition-bore is closed by a metal plug, screwed permanently into it, flush with the top of the fuze. From the centre of this plug projects downwards a copper pin, round which are looped small pieces of quick-match, the ends passing through two escape holes which are provided in the side of the head of the fuze for the escape of flame from the burning composition.

The quick-match is laid in a groove round the head of the fuze, and is covered with, first, a tape band, then a strip of thin sheet copper, which is covered with another strip of tape, one end of the copper band on either side being left exposed and loose.

Action.—The tape and copper band is stripped off on loading. The flash of discharge ignites the quick-match, and the flame passing through the escape holes sets fire to the fuze-composition, which burns down until it reaches the hole that has been bored into, when the flame ignites the powder in the powder channels, and fires the bursting charge of the shell.

This fuze has a white paper covering and a black head, and is marked spirally, from 1 to 30, in half-tenths of fuze, corresponding to quarter-seconds of time.

In the latest patterns the scale of marking is placed so that it can be read from point to head to facilitate fitting.

15-second Wood Time Fuze with Detonator.

This fuze is similar to the above fuze, but has a detonating arrangement in the head, and is used from M.L. guns with gas-checks.

METAL, TIME.

LARGE.

The principal parts of this fuze are the body, of white metal; collar, of gun-metal; nut, thimble, and pellet, of gun-metal.

The lower part of the body is tapped to the G.S. gauge and pitch (14 threads to an inch), and is hollowed out for the reception of the magazine or blowing chamber, which contains a small bag of F.G. powder; the bottom is closed with a screw plug, which is filled with pressed F.G. powder and pierced. A small hole is made in the centre of the plug, and closed with a thin disc of brass.

The projecting rim of the fuze is graduated for lengths of fuze in inches and tenths up to 5·6 inches.

The fuze-composition is pit-mealed powder, pressed into a groove round the upper part of the body of the fuze, and burns at the rate of 1 inch in 2·6 seconds, and can only burn in one direction, from left to right.

The top of the fuze is hollowed out, and contains a steel needle, under which is placed a pellet of mealed powder, which is in communication with the composition through a channel in the side of the fuze, which is filled with quick-match.

The movable collar is of gun-metal, and has a leather washer to cover the groove of composition. At one part of the collar is a channel, with a small bag of F.G. powder, which communicates with a groove of pressed mealed powder round the interior, and marked on the outside with an arrow ↑. This groove is connected by a vertical fire-hole with the magazine or blowing chamber, and primed with mealed powder, pierced.

The collar is kept in its place by a nut which screws on to the neck and is fitted to take the Armstrong key, and the body has a small hole on the outside for screwing the fuze into the shell, and also a mark which shows the commencement of the composition.

The fuze is ignited by means of the thimble and pellet (or hammer) made of gun-metal, and fitted to screw into the top of the fuze.

The pellet (or hammer) is a hollow cylinder, containing cap-composition and mealed powder, and is kept in position by a brass suspending wire passing through the thimble and pellet.

The thimble is hollowed out for the reception of the pellet. It is pierced with four fire-holes, is threaded at the bottom to screw into the nut, and has a groove cut for the ends of the suspending wire.

The thimble is not to be screwed into the fuze until it has been fitted, and at the moment of loading.

The fuze is set by loosening the nut with the Armstrong key, and turning the collar till the arrow head cuts the desired length of fuze composition, as shown by the graduations on the outside of the fuze. The fuze may be set to half-tenths if required.

Action.—On the shock of discharge the suspending wire is sheared, and the detonating composition in the pellet strikes the needle point, which ignites the fuze. The flame passes to the fuze-composition by the channel of quick-match, and burns round to where the arrow is set, when the flash communicates with the groove of mealed powder in the collar, and passes through the channel in the neck of the fuze through the vertical fire-hole into the magazine, ignites the bag of F.G. powder and bottom pellet of powder, blows out the brass disc, and ignites the bursting charge of the shell.

NOTE.—Great care is to be taken, after the thimble and pellet is screwed in, that the shell is not dropped, particularly on its base.

Supply.—Each fuze is supplied wrapped in waterproof paper, in a tin box hermetically sealed by a tin band, having a wire for opening, painted *blue*, and marked, "Fuze, Time, Large Pattern."

The thimbles and pellets are supplied separate from the fuzes, in tin boxes painted *drab*, and marked, "Thimbles and Pellets."

MEDIUM.

This fuze is similar in construction to the large fuze, but is smaller, and is graduated in inches and tenths up to 5 inches of fuze-composition, which burns at rest 7·6 seconds. The action is the same as the large fuze The thimbles and pellets are smaller. They are supplied the same as the large fuze, and marked "Fuze, Time, Medium."

SMALL.

This fuze is similar in construction to the large fuze, but is smaller, and is graduated in inches and tenths up to 4 inches of fuze-composition, which burns at rest 7·6 seconds. The bottom plug is not filled with F.G. powder, but closed by a thin disc of brass only. The action is the same as the large time fuze. The thimbles and pellets are smaller. They are supplied the same as the large fuze, and marked "Fuze, Time, Small."

METAL COMBINATION.

LARGE.

This fuze is a combination fuze of large pattern. It is similar in construction to the medium pattern (see below), but has a "steady" ring over the pellet to keep it in position. It is marked the same as the "large" time fuze.

MEDIUM.

This fuze is a combination fuze, and graduated to 5 inches, and burns about 11·1 seconds. The time arrangement is the same as the large time fuze. The concussion arrangement is contained in the bottom part of the fuze. It consists of a white metal pellet or hammer, containing the detonating composition, and a gun-metal guard, suspended by means of a brass shearing ring, which is fitted round the pellet, and rests on a projecting rim. The ring is divided, so as to be free to expand. The pellet is hollowed out to receive the detonator and a pellet of mealed powder, pierced. The detonator is kept in position by the edges of the pellet being turned down over it. The upper part of the pellet has a feather edge, which sets up into a recess in the metal guard.

The interior of the guard is recessed for the feather edge of the pellet, and fitted with a shoulder, which rests on the shearing ring. A steel needle is fitted to the interior of the fuze, and pointing downward. The bottom is closed with a screw plug and a thin brass disc.

The action of time arrangement is the same as in the large fuze.

The action of concussion arrangement is as follows:—On the shock of discharge, the guard sets back the brass ring over the projecting rim of the pellet or shears it off, and the feather edge is dovetailed into the recess, locking the guard and pellet together, which remain in the bottom of the fuze during its flight. On graze or impact, the pellet and guard fly forward, the detonating composition comes in contact with the needle-point, and igniting, the flame passes to the pellet of mealed power, blows out the disc, and ignites the bursting-charge of the shell.

If it is required as a percussion fuze only, thimble and pellet are not required; the arrow on the collar must be set between the zero point and the extreme length of fuze-composition, care being taken that it is not set too near the zero point, to avoid premature explosion.

Small thimbles and pellets are used with medium or small time and combination fuzes.

Supply.—The same as large time fuzes. Box painted *red*, marked "Fuze, Time. Mark II. Medium pattern."

SMALL.

This fuze is similar to the medium pattern, and is graduated to 4 inches of fuze-composition, which burns at rest 7·6 seconds, and is supplied the same as the other fuzes. Box painted *drab*, marked "Fuze, Time. Mark II. Small pattern."

MIDDLE TIME AND PERCUSSION.

This fuze consists of a body, composition-ring, dome, and nut. It has two safety-pins, and is similar to the short time and percussion (see below) in all respects, except as to size, weight, marking, and length of composition.

The extra length of composition is obtained by increasing the diameter of the fuse, and consequently its weight. The differences are, the stem of the body is hollowed out and allows room for gas.

The composition-ring has three fire escape holes, from which the gas escapes as the composition burns away; and the safety-pin passes through the side of the ring instead of through the dome.

Its diameter is 2·15″; its weight 19·2 oz.; it contains 4·85″ of burning composition; and is marked to 30 half-seconds. It burns when at rest 18 seconds. Great care must be taken when fitting the fuze not to shift the leather washer between the ring and the body; if this is done the fuze would be blind. These fuzes are also marked with the letter N. (naval service), T. (for time safety-pin), P. (for percussion safety-pin), R. ↑ L., date, and Mark.

SHORT TIME AND PERCUSSION.

This fuze is intended to supersede the combination medium in the smaller natures of B.L. guns, and may be relied on to burn with great regularity; to act by time both at very short intervals and at very short ranges, and on graze with certainty.

The principal parts (of the time arrangement) are the body, the composition-ring, the dome, and nut, all made of gun-metal. There are two safety-pins of split copper wire.

The bottom part of the body is threaded with G.S. gauge, and contains the percussion action. Above this the body is of larger diameter, and fits over the head of the shell, a leather washer on

the under side of the fuze making the joint tight. Above this is the stem with a central hole, forming a gas escape, and having three holes communicating with the dome.

Round the enlarged diameter of the body will be found the safety-pin of the percussion action, a hole for the projection of the key by which the fuze is screwed into the shell, and an arrow-head marking the position of a fire-hole communicating with the magazine. A leather washer on the flat part of the body prevents the composition in the ring from exploding.

The composition-ring fits on the top of the central belt of the body; a channel lined with asbestos paper runs nearly all round it, and contains the fuze-composition.

On the upper side of the ring is a small cylinder containing the igniting arrangement, which consists of a gun-metal hammer, having a steel needle suspended by a copper wire ·022″ thick, over ·2 grs. of cap-composition, surrounded with mealed powder.

The composition is indented at the end, and primed with a thread of quick-match to secure its ignition, and the gas escapes into the dome. Round the exterior of the gun-metal ring will be found divisions marked and numbered up to 18, denoting the usual half-seconds of time of burning; the divisions are halved by unnumbered lines, and these again can be bisected by the eye.

The dome fits on the composition-ring, and is retained by the nut. It covers the igniting arrangement of the time-ring, and the space between it and the stem forms a gas chamber, and regulates the burning of the composition.

The safety-pin of the time arrangement passes through the dome, and through the hammer, and when it is withdrawn the hole is closed by a lead pellet in a space in the dome.

The nut is a six-sided cap, with a cylindical projection at the top, through which four fire-escape holes are bored.

The fuze is screwed into the shell by the universal key, the nut loosened, and the dome and ring turned until the required graduation is opposite the arrow-head on the body; the nut is then set up tightly. This is most important, as if it is not done the ring of composition may explode without burning. If required to act as a combined fuze, both safety-pins are withdrawn; if as a time-fuze only, the time safety-pin; if as a percussion fuze, the percussion-pin is taken out and the time safety-pin is left in.

It is not safe to withdraw both pins and set the fuze at zero.

Action of Time Arrangement.—On the shock of discharge, the hammer shears the suspending wire and ignites the detonating composition and the composition-ring, which burns round to the channel communicating with the magazine, fires the percussion arrangement, and the burster of the shell. It burns from 12 to 13 seconds. The gas from the ring escapes into the dome, then through the holes in the stem, and out through the holes in the cap.

The percussion arrangement consists of a body, detonator pellet, safety pellet, and base plug of gun-metal; plain ball, retaining bolt, and spiral spring of brass; a safety-pin of copper, pellet of lead and tin, and a steel needle.

The bottom is closed by a screwed plug, the safety-pin passing through the enlarged part of the body and the safety pellet, which is suspended by a small copper wire.

The steel needle is screwed into the upper part, and is in communication with the time arrangement by eight fire-holes.

The detonator pellet is of brass; and contains a percussion cap and 3 grains of fine-grained powder.

There is a slot down the side for the safety pellet and plain ball to fall into, also a groove down the side in which runs a stud on the body to prevent it from shifting round; the hole in the bottom is closed by a brass disc and shalloon.

The plain ball prevents the detonator pellet moving forward so long as the safety pellet is in its place; when the safety-pin is withdrawn the hole is closed by a small lead pellet and spring.

The retaining bolt is an additional precaution against premature explosion. It passes through the detonator pellet transversely, the head projecting into a recess in the body, and is kept in position by a spiral spring.

The bottom plug is a short cylinder of gun-metal, and is filled with pressed meal powder, covered with a disc of paper and shalloon, secured by a brass washer, the powder being pierced.

Action of Percussion Arrangement.—On the shock of discharge the suspending wire is sheared and the safety pellet sets back into the slot of the detonator pellet, the plain ball follows it on the first movement of rotation.

During flight, the centrifugal force of the heavier end of the retaining bolt overpowers the spring and withdraws the smaller end from the recess in the body, so that the detonator pellet is free to move forward. The lead pellet is also driven outwards by the same force, closing the hole in which the safety pellet works,

thus preventing any grit, dirt, or water entering and drowning the fuze. On impact, the detonator pellet flies forward on the needle and fires the cap, which ignites the fine-grained powder and so passes into the shell.

This fuze is very quick in its action, and weighs 5·8 oz.

PERCUSSION.

PETMAN'S G.S. MARK I.

This fuze differs only from the later pattern, Mark II., in having fewer coverings to the detonating ball.

PETMAN'S G.S. MARK II.

This fuze consists of the following parts:—Body, top plug, plain ball, steady plug, detonating ball, cone plug, lead cup, and suspending wire.

The body, top plug, cone plug, detonating ball, and steady plug are made of gun-metal; the plain ball is made of brass, and the suspending wire of copper.

The body is conical, tapped throughout with a screw, to take the General Service fuze-hole; it is about ·2″ thick, a strong case being essential to resist the shock of heavy discharge. It is slightly hollowed out in the centre of the interior, to allow sufficient play to the detonating ball, and is also hollowed out at the base to allow the lead cup to dovetail into the recess when it is crushed up. It is tapped at the top to receive the top plug. The bottom is solid, with a hole in the centre of the base to allow the cone plug to set back through it.

The top plug is screwed into the fuze, and has two holes in the upper part to enable it to be screwed into the fuze, and a cup-shaped recess in its lower part into which the plain ball fits.

The plain ball is a small solid ball, turned from brass wire.

The steady plug is a disc recessed at the top, and roughened to receive a ring of detonating composition, and having a cup in the centre to receive the plain ball, and three fire-holes to allow the flame to pass down; the bottom of the central hole is enlarged to receive the projection of the detonating ball; detonating composition is pressed into the recess, and is covered over by a thin copper washer and lacquered.

The detonating ball is roughed by a number of vertical grooves, and has a deep horizontal groove near the centre. These grooves retain the composition with which the ball is coated, and also render ignition certain when the ball strikes against the body.

At the top of the ball is a cylindrical projection, which fits into the steady plug, and at the bottom is a smaller rounded-off projection which fits the cone plug. Over the composition is a layer of thin gut, then two thicknesses of thin silk, then two thin copper hemispheres, and finally another thickness of gut and three parts of silk; each layer of silk and gut is varnished.

The object of the two copper hemispheres (or cups), and of the copper washer over the steady plug, is to reduce the sensitiveness of the composition, so that the shock of grazing will not explode it, while the shock of direct impact against a solid body will make it act.

The cone plug is pierced with three fire-holes, the central one being enlarged to support the detonating ball. The bottom of the plug is filled with mealed powder, driven and pierced like a tube; it is recessed near the top to allow the lead cup to dovetail on to it, pierced near the base for the suspending wire, and closed at the bottom by a small cardboard disc.

The lead cup is a hollow cylinder, having a flange on the head to fit the recess on the cone plug.

The fuze is protected from damp by the top plug and bottom disc being covered with cement. It is specially designed to act on impact, not on graze. It will not explode on a shell passing through a wave, but will do so on striking a wooden ship.

Action M.L. Guns.—On the explosion of the charge the wire suspending the cone plug is sheared, the lead cup is crushed up, the lower edges being forced into the undercut portion of the lower part of the body of the fuze, the tube of the cone plug is forced through the fire-hole in the bottom of the fuze, and kept in that position by the crushed lead cup; the steady plug also falls a distance equal to the height of the lead cup before being crushed towards the bottom of the fuze. The rotation of the shell disengages the detonating ball from its supports and it rests in the body of the fuze. On the shell striking a hard substance, the ball is thrown forward with great force, the detonating composition is brought violently into contact with the body of the fuze, is exploded, and the flame passes down through the escape holes in the cone plug, igniting the mealed powder in the tube and the bursting charge of the shell.

Action B.L. Guns.—In B.L. guns, with no windage, owing to the absence of any lateral motion of the shell in the bore, the disengagement of the detonating ball from its supports cannot always be relied upon. It is to obviate this that the small plain

ball and annular groove of detonating composition are placed in the upper part of the steady plug; on impact, the steady plug is driven with great force against the top plug, and the plain ball, which was thrown out of the cup on the explosion of the charge, is driven against the groove of detonating composition, causing it to explode, and the fire passes through the fire-holes in the steady plug and cone plug, and ignites the bursting charge of the shell.

This fuze requires no preparation other than screwing it into the shell, and filled common shell are generally supplied with the fuzes in them.

Each fuze is wrapped in brown paper, and 5 fuzes in a tin box hermetically sealed.

R.L. MARK II.

The body of the fuze is of gun-metal, with a projecting rim, it is tapped outside with the G.S. pitch, and threaded in the interior of the bottom to receive the bottom plug. On the top is a square hole to take the G.S. key.

From the lower surface of the head, and projecting downward, is placed a steel needle. Inside the body is a gun-metal guard, which rests on two projections or feathers of a white metal pellet, and is recessed to take the feather edge at the top.

The pellet is hollowed out for the reception of the detonator, which is a copper cap containing $3\frac{1}{2}$ grains of cap-composition, closed at the top with a thin disc of brass, and at the bottom by a disc of copper with four fire-holes, the lugs of the cap being turned down over it to keep it in place. The cap is secured in the top by the metal of the pellet being spun over it.

A safety-pin is used, which is made of twisted wire, and passes through one side of the head of the fuze, through the metal guard, and between the needle-point and detonator (on one side) into the other side of the head, and is secured by the ends being opened out into a recess, which is closed with a lead plug and brass disc soldered over.

The bottom plug screws into the bottom, and has a fire-hole in the centre, which is closed with a thin brass disc.

When the safety-pin is withdrawn, the hole is closed by a small lead pellet, which moves freely in a recess made in the head of the fuze, and closed by a thin brass disc. When the shell is rammed home the pellet sets back and closes the safety-pin hole and prevents premature explosion.

Action.—On the shock of discharge, the guard sets back and shears the feathers, and the edge of the pellet is forced into the recess in the guard; pellet and guard are locked together, and remain in the bottom of the fuze during flight. On graze or impact they fly forward, the cap strikes the needle-point and ignites the composition, the flash passes through the fire-holes and pellet and blows out the brass disc into the bursting charge of the shell.

The safety-pin is withdrawn with B.L. guns just before entering the shell in the gun, and with M.L. guns after the shell is entered in the gun.

Percussion, Small. Marks I. and II.

This fuze is intended to supersede the R.L. percussion for use with B.L. guns of 4 inch and all below. It consists of a body, detonator pellet, safety pellet, ball, retaining bolt, and spiral spring of brass, safety-pin of copper, closing pellet of lead and tin, steel needle.

The body is threaded to fit the G.S. fuze-hole and has no head; the bottom is closed by a screwed plug. A steel needle is screwed in the top. The top has two slots for the G.S. key and two for the ends of the safety-pin.

The detonator pellet contains the R.L. percussion cap and 3 grs. of F.G. powder. There is a slot down the side for the safety pellet and ball to fall into, and it is prevented from turning by a screw in the body, which projects into a groove down the side of the detonator pellet.

The cap is covered with a brass disc. Mark I. has not this brass disc, and is to be considered obsolete.

The ball prevents the detonator moving forward so long as the safety pellet is in its place.

The safety pellet is suspended in the head of the fuze by a copper suspending wire.

The safety-pin passes through the bridge between the slots in the head, and also through the safety pellet; it is secured by a twisted wire loop.

The retaining bolt is an additional precaution against premature explosions. It passes transversely through the detonator pellet, the head projecting into a recess in the body, where it is kept in position by a spiral spring.

The bottom plug is a cylinder of gun-metal filled with pressed mealed powder, covered with a disc of paper and shalloon, secured by a brass washer.

Action.—On the shock of discharge the suspending wire is sheared and the safety pellet sets back to the bottom of the slot in the detonator pellet; the ball follows it at the first motion of rotation.

During flight, the centrifugal force of the heavier end of the retaining bolt overpowers the spring and withdraws the small end from the recess, so that the detonator pellet is free to move forward. The lead pellet is driven outwards by the same force, closing the top of the hole in which the safety pellet works, preventing any water or grit from entering through the safety pin-hole on graze or the drowning of the fuze.

On impact, the detonator pellet flies forward on the needle-point and fires the cap; the flash ignites the fuze and the burster of the shell.

The fuze is very quick in its action, and is not liable to be fired by an accidental blow unless strong enough to crush in the head of the shell. Weight of the fuze, 5·8 oz.

Mark II. differs from I. by having no ball. It has two retaining bolts with corresponding slots; has no suspending wire, but a spiral spring of copper, which keeps the detonator pellet from the needle-point; the safety-pin passes down through the top of the fuze; the body is longer, and the bottom cup-shaped, and contains a small charge of F.G. powder.

On impact, the pellet is driven forward, overcoming the spiral spring, against the needle-point, which ignites the fuze.

Direct Action. Mark II.

This fuze, which was introduced into the Navy as a temporary measure, in consequence of the failure of Petman's G.S. fuzes at Alexandria, differs from all other descriptions of percussion fuzes, in being intended to fire by a single direct blow.

In all other percussion fuzes the fuze is first "put in action" either by the shock of discharge, the rotation of the shell, or some other cause connected with the firing of the gun; so that, until the gun is actually fired, the fuze is practically more or less safe from accidental ignition; but in the direct-action fuze a single blow on the head is sufficient to ignite it.

It is not probable that this fuze will be long retained in the Navy, but in the meantime the greatest precautions are necessary in dealing with it.

The parts of the fuze are—the body, having a division in the centre through which nine fire-holes convey the flame from the detonator on the top of the division to the blowing-charge underneath.

The needle disc, of thin copper, carrying a steel needle (a striker).

This disc is secured between two screw plugs in the upper part of the body, and is just above the detonator on the division in the centre of the body.

The head of the fuze is covered by a cap, and the bottom closed by a plug with holes in it. The fuze only acts on impact, or on graze at such an angle that the nose of the shell enters the ground, the needle being crushed down on to the detonating composition which fires and ignites the blowing-charge.

Direct Action. Mark III.

This fuze differs from Mark II. in the following particulars. It has no cap, and is threaded its full length, the top being closed by a plug with left-hand thread, and marked with an → and the word "unscrew." The interior parts are the same as Mark II. This fuze can now be screwed its full length into the shell, and may be kept in the shell for which it is used.

Naval Concussion, Large.

This fuze is similar in construction to the smaller naval concussion, except that it is much longer, and has a blowing-chamber filled with fine-grain powder.

Naval Concussion, Small.

This fuze is made of gun-metal; the principal parts are—the body, top plug, needle, guard ball, metal guard and pellet, suspending wire, and safety-pin.

The body is conical, and tapped with a screw to take the G.S. fuze-hole to within half-an-inch of the bottom, which is left plain, with a hole for the safety-pin; it is slightly hollowed out on the inside to allow sufficient play for the guard ball; the bottom is solid, with a fire-hole in the centre primed with mealed powder and pierced and closed with a thin disc of brass.

The top of the fuze is closed with a screw plug, counter-sunk, having a steel needle in the centre projecting downward from the interior, and on top a slot to take the Armstrong key. The

needle is protected by a small brass ball (dome-shaped), hollowed out in the centre, and resting on the metal guard or pellet.

The guard is of gun-metal, and is hollowed out at the lower part to take the pellet, and is recessed in the interior. A small hole is made through both for the suspending wire to keep them in position, the ends of the wire being turned down into grooves on the outside of the guard; the upper part of the guard has a projecting neck, which is cupped out for the reception of the detonator, which is similar to the R.L. fuze, and is primed with mealed powder.

The pellet is also of gun-metal, hollowed out in the centre, and primed with mealed powder; through the side is a hole for the suspending wire, and another through the lower part for the safety-pin. A leaden cup or ring is fitted to the upper part, with a feather edge, which sets up into the recess in the guard, the pellet resting on a paper disc in the bottom of the fuze.

The safety-pin is of brass, and passes through the side of the fuze and through the pellet, and is kept in position by a tape band passing round the fuze, the guard being supported by the safety-pin.

Action.—On the shock of discharge, the suspending wire is sheared, the guard sets back over the pellet, and the leaden cup or ring is forced into the recess of the guard, locking them both together; the guard ball falls off its supports and lays in the body of the fuze, exposing the needle. On graze or impact, the guard and pellet fly forward, and the detonator strikes the needle-point and fires the fuze. The flash ignites the mealed powder in the guard and pellet, and blows out the disc in the bottom of the fuze into the bursting charge of the shell. The safety-pin is removed before screwing the fuze into the shell.

Supply.—Each fuze is in brown paper—20 fuzes in a tin box, painted *drab*, hermetically sealed.

Bolt Percussion Fuze.

The bolt percussion fuze consists of the following parts:—Body, pellet, copper cover, guard, bolt, split-pin, bottom plug, and safety-pin.

The body is of gun-metal, and has a steel needle fixed in the centre of the head, and a slot on one side for the bolt to slide in.

The bolt projects into the interior between the pellet and top of the body, and is kept in that position by the brass split-pin which passes through a hole in it, and on each side of a shearing

wire fixed across the hole. The guard and pellet are both of gun-metal. The copper cover, in form of a tube, fits over the pellet, the upper edge being bent inwards so as to rest on the top of it; the lower edge being cut into wings and bent outwards so as to support the guard. The pellet has a copper cap in the top, the detonating composition being covered with a ·005 in. brass disc, and a powder pellet in the lower part, with a fire-hole connecting them. The bottom of the body is closed by the bottom plug, which screws in, and is filled with pressed gunpowder. The safety-pin passes through the head and split-pin, and prevents the latter bearing on the shearing wire.

The fuze is screwed into the shell, and the safety-pin withdrawn at the moment of loading.

On discharge, the split-pin shears the shearing wire and drops through the bolt into a pocket; the bolt then slides back by centrifugal force.

The guard straightens the wings of the copper cover, and sets down over the pellet, which is then free to move forward against the needle on impact or graze.

Base Percussion Steel and Gun-Metal for 6-pr. Nordenfelt Q.F. Gun.

This fuze is very simple in construction. Its parts are—body, pellet, split-ring, and bottom plug. There are two holes in the body for screwing it into the shell. It is threaded half way; the remainder is plain. A lead washer under the head prevents the entrance of the gas from the charge into the shell. The pellet is solid, having a recess in the end for the detonating composition, which is covered by a brass disc. The exterior of the pellet is turned down to form a shoulder for the split-ring to rest on, which prevents the pellet from going forward until the shock of discharge, when it slips over it and puts the fuze in action. The bottom plug is fitted with a steel needle, and has two holes through it, filled with pressed powder, covered with a paper disc.

Action.—On the shock of discharge, the split-ring is driven over the pellet, and both remain back; on impact, the pellet and ring fly forward on the needle-point and fire the fuze and the burster.

There are two patterns of these fuzes, steel and gun-metal; the latter is used with common shell. The principle is the same, but the body is of gun-metal, and the diameter reduced to suit the thicker walls of the cast-iron shell. These fuzes are, however, interchangeable.

There is a Mark.II. fuze in which the needle is fluted, and the holes in the plug are conical; the ring or guard is rounded at the edges and slightly smaller to prevent the pellet from jamming; but this is not so far supplied (July, '90) to the Victorian Naval Forces.

FITTING AND FIXING FUZES.

Wood Time Fuzes (without detonators).

Wood time fuzes are prepared for any desired range by boring into the required side-hole for the length of fuze-composition. A hook-borer or gimlet-borer is used, and when using it place the fuze in the hook, in the proper position for boring the required hole, enter the bit into the side-hole and screw up until the bit has entered as far as the borer will allow, taking care not to press upon the fuze so as to prevent its bedding in the hook.

Unscrew, and, when the bit is clear, remove the fuze from the hook; the fuze is then screwed into the shell by hand, or a smart blow is given.

Care should be taken when withdrawing the bit to prevent the escape of powder from the channels.

Wood time fuzes may be bored into at any hole irrespective of the projectile in which they are used.

Wood time fuzes are fixed in the fuze-hole by screwing the fuze round by hand until it is held firmly in the fuze-hole, or by a smart blow with a piece of wood, taking care not to split the fuze. The fuze must not be uncapped until the shell is in the muzzle of the gun. These fuzes are "uncapped" by taking hold of the copper band and unwinding it smartly, so as to leave the priming fully exposed.

Wood Time Fuzes (with detonators).

These fuzes are screwed into the fuze-hole by hand, and on no account are they to be struck against anything. The safety-pin is not to be removed until the moment of loading.

Metal Time Fuzes.

These fuzes may be prepared for the desired range after they have been screwed into the shell.

Loosen the nut with the key, so as to free the collar; then move it round until the arrow ↑ points to the required length of fuze; then screw up the nut, steadying the collar at the same time; then tighten the nut with the key.

These fuzes are screwed firmly down with the Armstrong key after the plug is removed, the thimble being screwed in at the moment of loading.

Should the fuze be removed from the shell, the arrow should be set at the blank space before it is returned.

Metal Combination Fuzes.

These fuzes are fitted in a similar manner to metal time fuzes.

Time and Percussion Fuzes.

For time, are fitted as metal time fuzes, except that the time safety-pin is withdrawn. *For percussion*, withdraw the percussion safety-pin. *For both*, withdraw both pins after fitting.

Percussion Fuzes.

G.S. Fuze.—These require no preparation; they are simply screwed firmly into the fuze-hole by means of the key. Should there be any difficulty in extracting a percussion fuze, the shell should be either fired away or thrown overboard.

R.L. Fuze.—These fuzes require no preparation except the removal of the safety-pin; they are screwed firmly into the shell by means of the key. The safety-pin is *not* to be removed until the moment of loading.

Direct Action Fuze.—Remove the cap (or top plug in Mark III.), and screw firmly into the shell with general service or universal key.

Naval Concussion Fuze.—In these fuzes the safety-pin is withdrawn (before the fuze is screwed into the shell) by the tape band round the lower part.

FRICTION-TUBES.

Friction-tubes are used for the ignition of all gun charges, and also for firing rockets.

There are three descriptions, viz.:—Long quill friction-tubes; short quill friction-tubes; and copper friction-tubes with wire loop.

The quill is driven with mealed powder, pierced up the centre with a fine hole (to expose a large surface of the powder to immediate ignition), and a roughened copper friction-bar is passed through it, above the mealed powder (on the top of which the detonating composition is placed); the head is then filled with gunpowder and clay, and closed with shellac-putty, to protect the composition from damp. The head of the tube is kept in place during the pull of the tube-lanyard by a leather loop, which goes over the tube-pin in the gun.

The long tube is 4 inches long, and is formed by cementing two quills together; it is used for guns from the 64-pr. and all above. This tube will strike fire through two thicknesses of serge, when in a vent, at a distance of 21 inches.

The short tube is $2\frac{2}{4}$ inches long, and is used for guns below the 64-pr.; it is also used for the signal-rocket tube, and with life-buoy portfires. It will strike fire, as above, at a distance of 14 inches.

Copper tubes are 3 and 5 inches long, and resemble generally in their manufacture the quill-tube above described, but have no loop for the friction-pin. A wire loop is attached to 5-inch tubes to prevent them from flying about, which has otherwise been found dangerous on the explosion of the gun. They will strike fire, as before mentioned, at a distance of 30 inches.

Tubes are supplied in tin cylinders, each containing 25. The cylinders are hermetically sealed by a strip of tin, the end of which is exposed to facilitate opening when the tubes are required for use.

Quill tubes are packed on their sides, copper tubes on their ends. In the cylinder for copper tubes a loop is formed by a corrugated strip of tin, soldered round the inside, forming a rack for each tube.

All friction-tubes are kept in the gunner's store-room, in a locker lined with metal, under lock and key.

Electric Tubes.

Electric tubes, No. 10, are quill tubes fitted to fire electrically instead of by friction. A platinum wire bridge is fuzed by the passage of the current, and ignites the composition with which it is surrounded.

Electric tubes, No. 11, are a drill imitation of the above.

PRIMERS.

The mechanical primer consists of a body of brass, which is hollowed out for the reception of the priming, and fitted with an anvil carrying a percussion cap. The base of the primer, when struck by the firing needle, comes in contact with the cap and fires the priming, which consists of two pellets of fine-grain powder, with a slight space between them. The anvil contains a little dust gun-cotton, to facilitate ignition.

The electrical primer is similar in outer form to the mechanical, but the priming is fired by the incandescence of a platinum wire, which passes through a small quantity of gun-cotton at the rear of the priming.

Two insulated copper wires are passed through a small channel in the base of the primer-case; and are soldered to two base plugs inserted in a cylinder of ebonite, fitting the interior.

A fine platinum wire is soldered across the heads of these brass plugs, and when the electric current passes through this wire it is heated sufficiently to ignite the gun-cotton surrounding it, and thus fires the priming of gunpowder.

There are several patterns of electrical primers, differing only in detail, being generally on the same principle.

The latest pattern has a metal slide over the base to protect the wires. Further descriptions of these primers will be found in the Victorian Torpedo Manual, 1889.

SIGNAL ROCKETS.

The case is made of thick brown paper, rolled up into a cylinder; the rocket composition is driven by hand over a conical "former," which is afterwards removed. A light paper case is attached to the head, terminating in a cone filled with 28 pellets of composition, which, when ignited, form stars. At the bottom of the pellet-case is a small quantity of mealed powder, which serves to open the case and to scatter them on the rocket attaining its highest position. The star-chamber is separated from the composition by clay driven in on top of it. A hole is pierced through to allow the gas to enter the pellet-case from the composition. The rocket is choked near the base, and has a priming made up of L.G. powder and isinglass. The vent is secured by a paper cap.

A copper socket is seized on to the case of the rocket to take the rocket stick.

Rockets are fired by hand or from a machine, which consists of an oval tube of sheet iron to take the rocket with the portion of the stick at its side, a round tube of sheet-iron being fixed on to it to take the remainder of the stick.

A vent is made in the base of the oval tube opposite to the vent of the rocket to take a quill friction tube, which is prevented from falling out, when the machine is pointed up into the air, by a hinged-piece of gun-metal which shuts in behind its head.

To fire the rocket from the machine.—Force the stick into the copper socket and attach it by pressing the projection into the notch. Tear off the paper cap at the bottom of the rocket, thus exposing the priming, and place the rocket in the machine; enter the friction-tube, see the loop over the stud, hinged-piece put over, and trigger hooked; place the machine in a vertical position, see all clear overhead, and then fire with the tube lanyard.

A short stick, with rope-tail attached, is used when firing rockets by hand.

To fire the rocket by hand.—Attach the stick to the rocket and straighten out the tail; remove the paper cap at the bottom, and ignite the rocket with a piece of slow-match, a light, or a port-fire.

Signal rockets rise to an altitude of about 400 or 500 yards, and can be seen on a clear night at a distance of 30 miles. They are used for signalling at night, and for display when required.

Rocket composition: saltpetre, sulphur, and dogwood-charcoal.

SIGNAL LIGHTS.

The lights used in the Victorian Naval Forces are two—long and short.

The long light consists of a cylinder of brown paper 9·5 inches in length, and 1·78 inches in diameter; the bottom is left open to a depth of 2·2 inches for the reception of the holder. Above this opening is pressed a layer of clay ·2 inches in thickness, which forms the base for the composition, and prevents the holder from being burnt by it. On the top of the clay is pressed, by hydraulic pressure, 6·6 inches of long light composition, the open cavity being smeared with powder paste, and capped with a metallic cap. The top of the case is strengthened by a band of tin. It will burn from five to six minutes.

Long-light composition consists of saltpetre, sulphur, and red orpiment or realgar.

The short light is a cylinder of brown paper, 5·2 inches in length, and 1·78 inches in diameter. It is driven with 2·3 inches of signal-light composition, and in construction is similar to the long light. It will burn one minute.

Short-light composition consists of saltpetre, sulphur, red orpiment, magnesium, and paraffin wax.

The lights, when burning, are held by a hollow wooden holder made of beech, about 10 inches in length, with a screw-knob at one end; it is recessed to contain ten primers; the opposite end fits into the light. The light has two holes to fix it to the holder by means of a wooden peg. At one side of the holder is a groove, as a guide for the entrance of the peg at night.

Lights are ignited by means of a detonating primer, which is placed in a hole at the top side of the light, marked by a black dot; the paper end of the primer is placed in the hole, and is ignited by striking the copper wire of the primer against any moderately hard substance.

The general service primer consists of a cylinder of copper, ·4 inches in length, open at both ends, one of which is fitted with a collar of the same material. A small piece of wire, wedge-shaped at one end and roughened, and smeared with detonating composition, is inserted into the collar of the cylinder; the other end is tightly pinched together on the composition. The flattened end is bound by a few turns of copper wire to increase friction, and is protected by paper shellaced over to exclude moisture.

They are supplied in tin boxes, holding 5 or 10.

If no primers are available, these lights can be ignited by a piece of slow-match, taking off the metallic cap and touching the composition with a spark of fire. They are used for signalling at night and for illuminating.

VERY'S LIGHTS.

There are three descriptions of these lights—"Red," "White," and "Green." They are used for signal purposes, and are painted at the top the colour of the light. They are fired from a hand pistol, and burst on attaining a good height. They are very useful, and all H.M. ships carry them. They are not, however, yet supplied to the Victorian Navy.

PORTFIRES

Are of two descriptions, viz., common and life-buoy portfires.

Common portfire is a paper cylinder, 16 inches long and rather more than half-an-inch in diameter, driven with portfire composition, which consists of saltpetre, sulphur, and mealed powder, the bottom being turned in to form the base for driving. The upper end is primed with mealed powder to make it light easily. They are used for incendiary purposes, and will burn from twelve to fifteen minutes. They are ignited by slow-match.

Life-buoy portfires consist of seven pieces of portfire of different lengths, secured at right angles to each other to a gun-metal plate by means of copper-wire—the first length, and also the last piece but one, is driven with a quicker burning composition, in order to resist the water on immersion of the buoy in falling from the side, and to increase the action of the flame. They will burn from twenty to twenty-four minutes. They serve to indicate the position of the life-buoy at night to the man overboard, and also to the boat's crew who are rescuing him. They are ignited by a friction-tube fixed in position on the plate. A hook, fixed to the metal cover on the ship's side, is hooked to the eye of friction-bar; on the buoy being released from the side, the weight of it falling causes the friction-bar to be withdrawn, which fires the portfire.

Life-buoy portfires are now obsolete, calcium lights being used instead where available.

MATCH.

"SLOW."

Slow-match is pure hemp, slightly twisted, boiled in a solution of water and wood ashes, in the proportion of, water 50 gallons, wood ashes 1 bushel. This serves for 100 lbs. of yarn. It burns at the rate of one yard in eight hours, and serves as a means for incendiary purposes.

"QUICK."

Quick-match is made of cotton wick, boiled with a solution of mealed powder and gum arabic. It is used for the priming of fuzes, and to fire explosives of a dangerous nature which it would be unsafe to approach. It burns, unconfined, one yard in thirteen seconds; confined, instantaneous.

SAFETY FUZE.

Safety-fuze consists of a column of gunpowder enclosed in flax, covered with gutta-percha, and coated with varnished tape. It is used for submarine mining, &c., and can also be used to detonate gun-cotton in connexion with a detonator. It burns one yard a minute.

QUICK-FIRING GUN AMMUNITION.

4·7-INCH QUICK-FIRING GUN.

The cartridge-case is made of brass, and is drawn from the solid metal to shape. It is screwed at the base for the reception of the primer, and its mouth is closed with a combined lubricator and lid soldered on.

Charge	12 lb. S.P.
Projectile	45 lb.
Bursting charge, armour-piercing shell,	1 lb. 13 oz. P. & 9 oz. F.G.
Do. do., practice shell	1 lb. 1 oz. L.G.
Muzzle velocity	1,786 f.s.
Total energy	995-foot tons.
Penetration at muzzle	8·2 inches.

Instructions for filling Shell.—Remove the plug from the fuze-hole, and after seeing that the fuze-hole is clear from dirt, grit, &c., insert the funnel, and pour in the bursting charge. The shell should be first filled with pebble, and the interstices then filled with F.G. powder, well shaken down. Take care that none of the powder is left on the threads of the fuze-hole, then screw in the fuze or plug as required.

The primers (electric) used are termed "double contact primers," having a double bridge, two projections on the outside, and one in the centre. The striker presses against the primer, and is used for electrical or mechanical firing. The primer itself makes earth (E) with the gun. For mechanical firing, an adapter is used, which will take the service primer.

The ammunition is prepared for firing by the primers or adapters being firmly screwed into the cylinders with the spanner supplied for the purpose. A pair of large tongs is used to hold the cylinder whilst screwing in the primer or adapter.

6-PR. NORDENFELT QUICK-FIRING GUN.

AMMUNITION PROPOSED BY THE NORDENFELT GUN COMPANY.

POWDER AND CARTRIDGE.

The powder for these guns is the Nordenfelt hexagon. It is a small pellet-powder of six sides, with indented ends, and of considerable density, viz., 1·82. The service charge, with all descriptions of projectiles, is 1 lb. 15 oz.

The cartridge-case is of brass, solid drawn, the base and body being of one piece. In shape it is slightly conical, to ensure easy extraction. A small brass tube fits into a hole in the centre of the base, and projects into the body of the case about three inches; this tube is primed, and the cap is pressed firmly into its head.

The powder is shaken down into the cartridge-case so as always to occupy the same space; this ensures great uniformity in velocity.

PROJECTILES.

There are two descriptions of projectiles supplied with these guns, viz. :—

Steel shell.
Common shell.

The steel and common shells, weighing 6 lbs., are coated with thin copper, deposited by the electro-chemical process. At a certain distance from the base the deposited copper is much thicker than on the other parts, so as to allow the rotating rings being turned from it. Both descriptions of shell are fitted to receive the base percussion fuze.

SALUTING AMMUNITION.

The saluting ammunition is composed of a cartridge-case, shalloon cartridge, and felt, and paper wads. It is supplied not made up. The case is solid drawn and has a central tube.

When required, the charge is placed in the cartridge-case, the wads placed over it, and secured with shellac. Its weight is 15 oz.

PARTICULARS OF AMMUNITION.

Ammunition.	Marks I. and II.
Charge—description of powder	·45 hexagon.
,, weight	1 lb. 15 oz.
Cartridge case—length	12·072 inches.
,, ,, weight	2 lbs. 7 oz.
Length of cartridge, complete	18·702 inches.
Weight	10·4 lbs.
Common shell—length	8·04 inches.
,, ,, ,, in calibres ...	3·6
,, ,, weight, loaded	6 lbs.
,, ,, bursting charge ...	2 oz. 4 drs.
Steel shell—length	7·9 inches.
,, weight, loaded	6 lbs.
,, bursting charge	2 oz. 12 drs.

MACHINE GUN AMMUNITION.

NORDENFELT 1″-4 BARREL—MARK III.

There is no anvil, but a small boss in the chamber instead.

The powder charge weighs 625 grains, and is pressed into the cartridge case, care being taken that it shall always occupy the same space. The effect of this pressure is to break up the weaker grains, and to form a hard solid mass of dust, with grains interspersed. The bullet weighs $7\frac{1}{4}$ oz., and is of steel, the point being hardened; round the base is a cannelure into which the envelope is choked, and on the base are several radial cuts into which it is set on firing.

The space between the envelope and the inside of the cartridge case is filled with pure beeswax as a lubricator.

The rotation is given by the envelope, which is made of very thin brass, the base being shaped into the form of a gas-check, and the front end carefully turned over the shoulders of the bullet.

The cartridges are packed in bundles containing 12.

The weight of each bundle is about 8 lbs. 9 oz.

These bundles are stowed in an ammunition box, Mark IX. or Mark XI.; either of these boxes contains 8 bundles, that is 96 rounds.

The weight of the box filled is 82 lbs.

When any Nordenfelt ammunition boxes, from which a portion of the ammunition has been removed, are required to be returned into store, or to be moved for any other purpose, the vacant place should be completely filled with wood, tow, or other substance, to prevent danger of explosion by the cartridges moving about and striking against each other.

All hoppers on board are to be kept filled.

Projectile, nature	solid steel	
" weight, including envelope ...	oz.	7·25
" length	cal.	2·675
Envelope, weight of	oz.	·8
Charge, weight of	"	1·43
Cartridge case, weight of	"	2·52
Total weight of cartridge...	"	11·21

NORDENFELT 1″-2 BARREL.

The ammunition for this gun is precisely the same as that for the 4-barrel gun.

SMALL-ARM AMMUNITION.

MARTINI-HENRY RIFLE.

Ball cartridges for the Martini-Henry rifle consist of a case formed of two turns and an overlap of ·004″ brass, lined with tissue paper to prevent the injurious action which would take place if the powder and brass were in contact. Between the folds at the base is a strip of brass of the same thickness as that composing the body, to give additional strength. A small sight-hole is punched in the case to see that this strip is present. The cartridge is made of a bottle-necked shape by crimping in the upper part, so that the whole fits into the shot chamber of the rifle. The base is further strengthened by two base cups of brass (an inner and outer), and the bottom is closed by a carbonized wrought-iron disc. Inside is pressed a paper pellet, having a hole in the centre against the bottom of the cartridge. A cap-chamber pierced passes through the disc, cups, and pellet, and rivets the whole of the parts together, the top of which is bulged out over the paper pellet, the base of this chamber being flanged to fit a countersink in the iron disc. The cap-chamber contains a brass anvil, on the shoulders of which rests the cap, containing ·2 grains of cap-composition, pressed and varnished. On the top of the powder is placed a millboard disc, then a wad of beeswax, cupped out to the front to insure its expanding in cold weather, then two more millboard discs, and lastly the bullet, which is composed of lead hardened with tin, 12 parts lead to 1 part tin.

Weight of bullet, 480 grains; length, 1·27″; diameter increases from ·439″ at the shoulder to ·45″ at base.

Description of powder, R.F.G^2; weight, 85 grains.

The cartridges are packed in bundles of ten, stowed head and tail, in white and brown paper. Weight of each package, about 1 lb. 2 oz.; supplied in quarter metal-lined cases and ammunition boxes.

Solid-drawn cartridges are similar to the above, except that the case is of solid-drawn metal instead of being "built up" or "rolled."

The action is as follows:—On firing, the cap-composition is forced against the point of the anvil and the flash thus produced reaches the charge through the hole in the cap-chamber,

the case expands, and being pressed firmly against the side of the bore prevents the gas from escaping in the direction of the breech; after firing, the cartridge contracts to its original proportions, making extraction easy.

Blank cartridge consists of a brown paper case in lieu of brass, having a bass disc, cap-chamber, cap and anvil, one base cup, and paper-pellet; an additional piece of paper is inserted in the case, forming a head to the cartridge, which is done by turning in the top after the powder is entered.

Description of powder and weight used for blank cartridge:—68 to 72 grains of R.F.G. F.G. and L.G. may also be used.

Blank cartridges are packed in bundles of ten, head and tail, in two coverings of purple paper. On the outside covering is printed the nature of contents, weight of charge, and B.L.; also, the Mark and year of manufacture. They are supplied in metal-lined half-cases.

GATLING GUN.

The cartridge for the ·45 gun consists of a solid brass case, somewhat contracted at the top; the base is formed by pressing out the material of the case, so as to form the projecting rim necessary for extraction. There is no anvil, but the cap strikes against a small boss or nipple in the chamber, which is pierced with two fire-holes. The interior of the case is not lined with paper, but lacquered. The charge, bullet, wads, &c., are identical with those used in the Martini-Henry cartridge.

They are stowed in bundles of ten, head and tail, supplied in ammunition-boxes, each package weighing 1 lb. 2 oz., wrapped in paper similar to the ball cartridge for the Martini-Henry Rifle.

PISTOL (ENFIELD).

The cartridge for the Enfield pistol is made of solid-drawn brass, the centre of the base forming the cap-chamber, in which a cap and anvil are placed. The cap-chamber is pierced as usual.

Weight of bullet, ·265 grains (same alloy as the Martini bullet); length of bullet, ·897 inches; diameter of bullet, ·455 inches; charge, 18 grains pistol or Adams' pistol powder; weight of bundle of 12, about 10 oz.

MARKING OF AMMUNITION BOXES.

In order that the particular kind of ammunition packed in small-arm ammunition boxes may be readily distinguished, all such boxes issued from Woolwich have now labels, with distinguishing marks of various colours. The distinguishing labels are placed on each side and on each end. The following is the detail :—

Contents of Boxes.	Distinguishing Marks. On each side.	Distinguishing Marks. On each end.	Colour of Marks.
Ball Ammunition for—	M.-H. RIFLE.		
Martini-Henry Rifle			Red
	GATLING, 0·45″		
Gatling Gun, 0·45			Black
	NORDENFELT.		
Nordenfelt Gun (service) ..			Green
	NORDENFELT.		
,, ,, (practice) ..			Green
	NORDENFELT.		
,, ,, (dummy drill)			Green
	PISTOL, ADAMS'.		
Adams' Revolver Pistol ..			Brown
	PISTOL ENFIELD.		
Enfield ,, ,, ..			Brown

All wrappers and labels for the ammunition bear, in addition to the other particulars, the distinguishing marks above shown painted upon them in black. Each small-arm ammunition box, in addition to the above distinguishing marks, has upon it a label giving the number and nature of the contents. Stencilled upon it, also, is its gross weight, date of packing, lot, and nature of powder with which the cartridges it contains are made up.

PART IV.

MISCELLANEOUS.

MANNING AND ARMING BOATS.

STORES.

A similar magazine is supplied for all boats armed, and contains the following stores:—

Gunner's Stores.—Rifle ball cartridges, 400; blank, 50; pistol ball cartridges, 120; 1 signal rocket and stick, 1 long light, 1 signal light, 2 holders for lights, 1 portfire, 1 signal book.

Boatswain's Stores.—1 boat's bag, containing—1 lead and line, 1 answering pendant, 1 marlinespike, 1 ball of spunyarn, 1 sewing palm, 1 sewing needle, 1 skein of twine, 1 canvas roll, 1 tallow box.

Carpenter's Stores.—1 hand hammer, 1 fearnaught strip, 1 strip of sheet lead, 1 strip of copper, 12 corks, 1 packet of copper tacks.

Medical Stores.—1 bag or box, containing—1 tourniquet, bandages, and lint.

In addition to the magazine, a quarter-case of rifle ball ammunition, containing 400 rounds, is held in readiness to be sent in each boat, if required.

Each boat carries at least one filled water barricoe when going on service, and an anchor and cable; and at night, a boat's compass and lantern, in addition to the above stores.

JUDGING DISTANCES AT SEA.

(1) *Sir H. Douglas' method*, in which an observer on deck ascertains with a sextant the angle subtended by the enemy's masthead and hammock-netting or waterline.

This method is found very useful for laying out targets and keeping station with the squadron, &c., &c.

(2) *By Sound.*—Sound travels at the rate of about 380 yards a second. If the interval between the flash and the report of a gun in seconds be multiplied by 380, the product will be the distance in yards.

(3) *Admiral Ryder's (or the horizon) method*, namely, to observe from the crosstrees or other convenient place the angle subtended between the horizon and the enemy's waterline or other object, or if on shore from a fort (the higher the better), and is corrected by the dip angle due to the height.

Example (1).—Let the angle subtended between the horizon and the enemy's waterline, ascertained by an observer at a ship's masthead or from a fort (say a height of 205 feet), be 2°. Required the distance.

The dip of the horizon due to a height of 205 feet, see Table II., is 15′ 11″, 2° + 15′ 11″ = 2° 15′, neglecting the seconds.

The distance due to an angle of 2° 15′, if the height had been 20 feet, would have been, from Table I., column 2, 169 yards.

The correction for each foot of additional height, column 3, Table I., is 8·5 yards.

Distance = 169 yards + (205 − 20) 8·5 = 1,741 yards.

This is a sufficiently close approximation to the distance given in Table IV., in Admiral Ryder's work, viz., 1,743 yards, showing that Table I. can be safely used with "horizon" method within the prescribed limits.

Example (2).—Let the angle subtended between the horizon and the enemy's waterline, ascertained by an observer in a ship's top or the upper battery of a fort (say 95 feet above the water) be 9′.

The dip of the horizon due to a height of 95 feet (see Table II.) is 10′ 19″, 9′ × 10′ 19″, neglecting seconds. The distance due to an angle of 19′, if the height had been 20 feet, would have been, from Table I., column 2, 1,204 yards.

The correction for each foot of additional height, column 3, Table I., is 60·3 yards; distance = 1,204 × (95 − 20) 60·3 = 5,726 yards.

On ascertaining the distance for the same height and angle from Table IV., in Admiral Ryder's work, it will be found to be 7,229

yards, showing an error of 1,503 yards, introduced by using Table I. with the "horizon" method beyond the prescribed limits. This example is given to enforce the necessity of confining the use of Table I. for the "horizon" method to the limits laid down above. Of course, if there is any index correction it must be applied, but it will be found more convenient and less embarrassing to the observer aloft to use a sextant that has no index error.

TABLE I.—MASTHEAD ANGLES.

HEIGHT, 20 FEET.

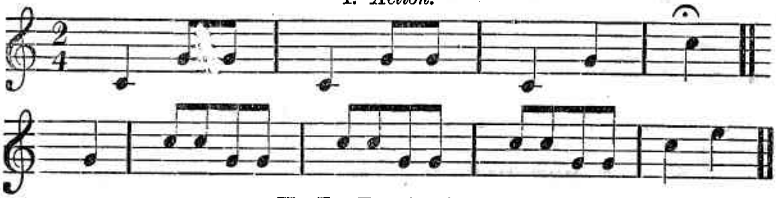
Masthead angle.	Distance in yards.	Correction for 1 foot in height.	Masthead angle.	Distance in yards.	Correction for 1 foot in height.	Masthead angle.	Distance in yards.	Correction for 1 foot in height.	Masthead angle.	Distance in yards.	Correction for 1 foot in height.
° ′	yds.	yds.	° ′	yds.	yds.	° ′	yds.	yds.	° ′	yds.	yds.
5 0	76	3·8	1 52	204	10·2	1 4	358	17·9	0 38	602	30·2
4 30	85	4·2	1 50	208	10·4	1 2	369	18·5	0 37	618	31·0
4 0	95	4·8	1 48	212	10·6	1 0	382	19·1	0 36	636	31·8
3 50	99	5·0	1 46	216	10·8	0 59	388	19·4	0 35	654	32·2
3 40	104	5·2	1 44	220	11·0	0 58	395	19·7	0 34	673	33·7
3 30	109	5·4	1 42	224	11·2	0 57	402	20·1	0 33	694	34·7
3 20	114	5·7	1 40	229	11·4	0 56	409	20·5	0 32	715	35·8
3 10	120	6·0	1 38	234	11·7	0 55	416	20·8	0 31	739	37·0
3 0	127	6·4	1 36	238	11·9	0 54	424	21·2	0 30	763	38·2
2 55	131	6·5	1 34	243	12·2	0 53	432	21·6	0 29	790	39·5
2 50	135	6·7	1 32	249	12·5	0 52	440	22·0	0 28	818	40·9
2 45	139	6·9	1 30	254	12·7	0 51	449	22·5	0 27	848	42·4
2 40	143	7·1	1 28	260	13·0	0 50	458	22·9	0 26	881	44·1
2 35	148	7·4	1 26	266	13·3	0 49	467	23·4	0 25	916	45·8
2 30	152	7·6	1 24	273	13·6	0 48	477	23·9	0 24	954	47·7
2 25	158	7·9	1 22	279	14·0	0 47	487	24·4	0 23	997	49·8
2 20	163	8·2	1 20	286	14·3	0 46	498	25·0	0 22	1041	52·1
2 15	169	8·5	1 18	293	14·7	0 45	509	25·5	0 21	1090	54·6
2 10	176	8·8	1 16	301	15·1	0 44	520	26·0	0 20	1145	57·3
2 5	183	9·2	1 14	309	15·5	0 43	532	26·6	0 19	1204	60·3
2 0	191	9·5	1 12	318	15·6	0 42	545	27·3	0 18	1272	63·6
1 58	194	9·7	1 10	327	16·4	0 41	558	28·0	0 17	1347	67·4
1 56	197	9·9	1 8	337	16·8	0 41	572	28·9	0 16	1431	71·6
1 54	201	10·0	1 6	347	17·4	0 39	587	29·4	0 15	1526	76·4

TABLE II.—A DIP TABLE.

Height of eye above water in feet.	Amount of Dip.	Height of eye above water in feet.	Amount of Dip.	Height of eye above water in feet.	Amount of Dip.
20	4·40	85	9·45	150	13·0
25	5·11	90	10·3	155	13·13
30	5·43	95	10·19	160	13·27
35	6·11	100	10·35	165	13·39
40	6·40	105	10·51	170	13·51
45	7·5	110	11·7	175	14·3
50	7·30	115	11·22	180	14·15
55	7·51	120	11·38	185	14·26
60	8·12	125	11·52	190	14·38
65	8·32	130	12·6	195	14·49
70	8·52	135	12·19	200	15·1
75	9·10	140	12·33	205	15·11
80	9·28	145	12·46	210	15·22

BUGLE CALLS.

I. *Action.*



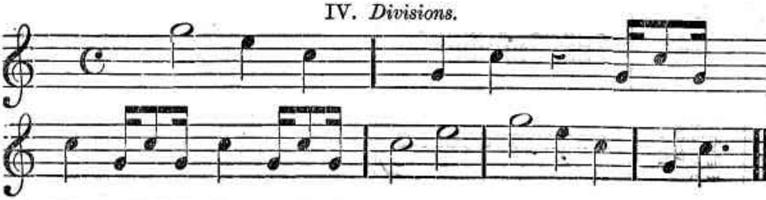
II. *For Exercise Action.*

As for Action, but preceded and followed by one "G."

III. *Quarters for Inspection.*

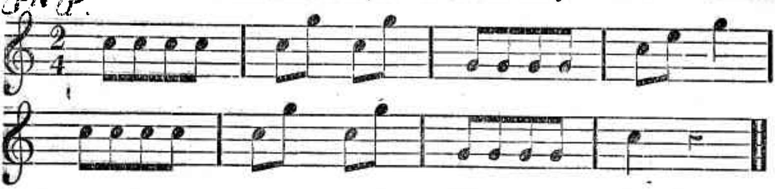
As for Action, but preceded and followed by two "G's."

IV. *Divisions.*



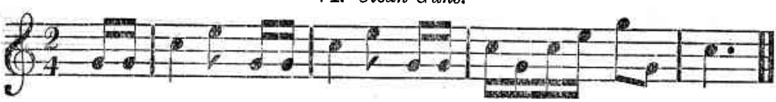
5am 11 Sept 1914

V. *Landing Party Fall in for Landing.*



The same Call, preceded and followed by one "G," refers to the Rifle companies and Field Gun's crews only; to fall in for exercise on board.

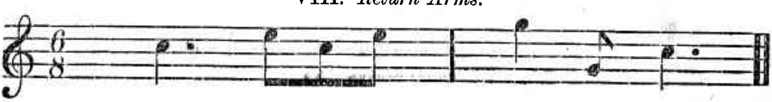
VI. *Clean Guns.*



VII. *Clean Arms.*

The same as Clean Guns, with one "G."

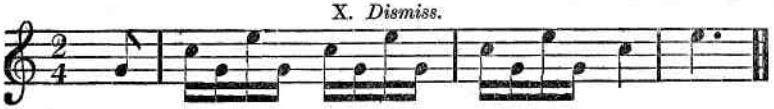
VIII. *Return Arms.*



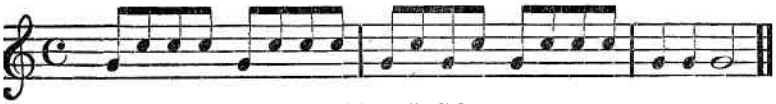
IX. *Secure Guns.*

The same as Return Arms, with one "G."

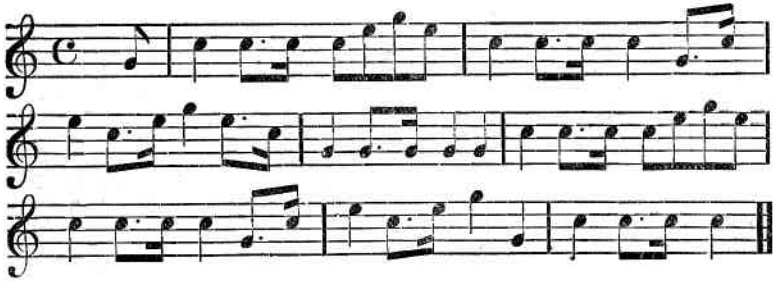
X. *Dismiss.*



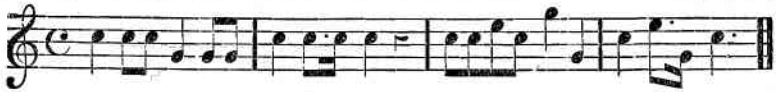
XI. *Advance.*



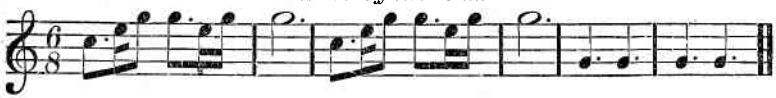
XII. *Admiral's Salute.*



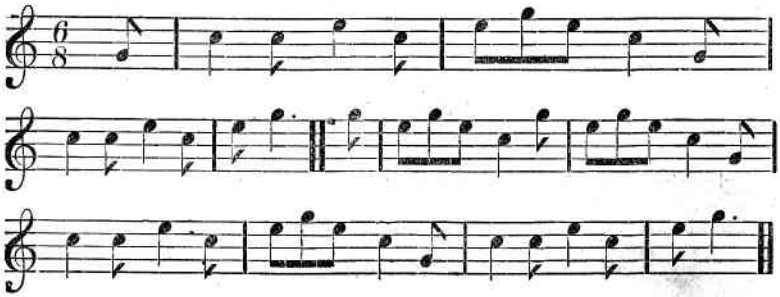
XIII. *Commodore's Salute.*



XIV. *Officers' Call.*

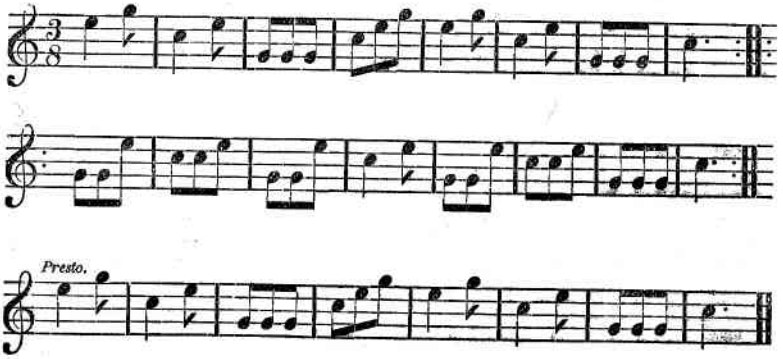


XV. *Officers' Dinner Call.*

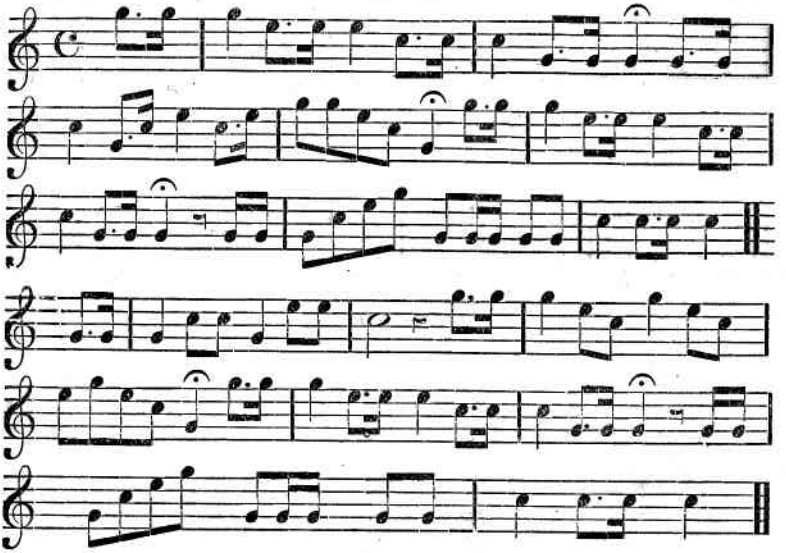


XVI. *Cooks of Messes.*

XVII. *Daylight.*



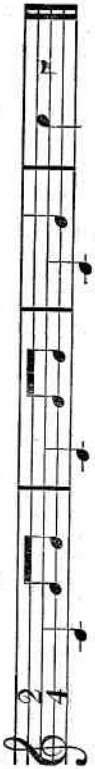
XVIII. *Sunset.*



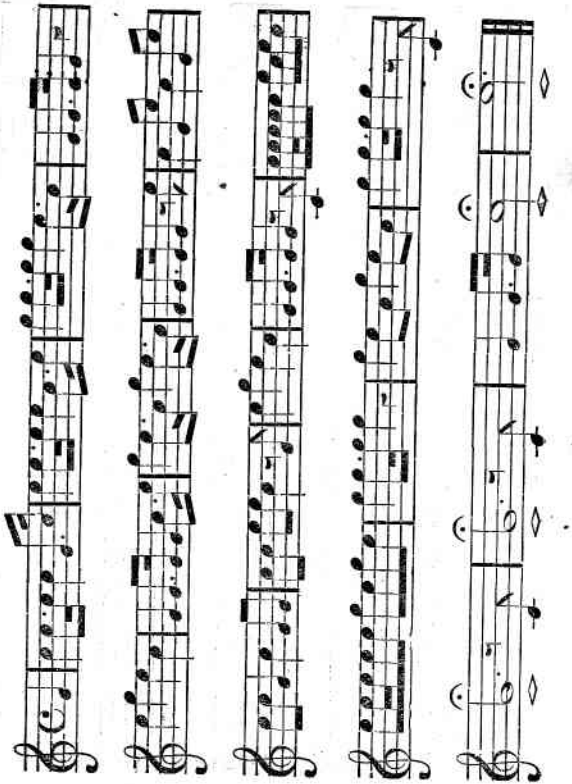
XIX. *Return Stores.*

XX. *Guard Call.*

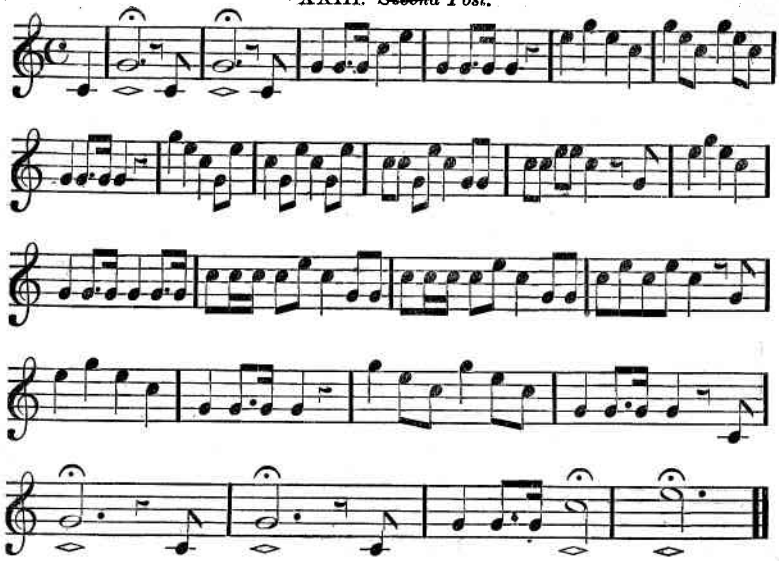
XXI. *Repel Torpedo Attack.*



XXII. *First Post.*



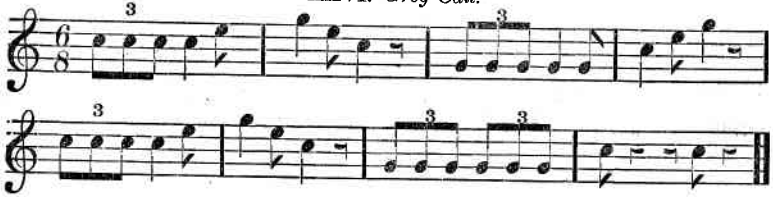
XXIII. ~~Second~~ Last Post.



XXIV. *Stand Easy.*

XXV. *Resume Drill.*

XXVI. *Greg Call.*



NOTE.—When under arms on shore, this Call, preceded and followed by one "G," denotes Permanent Force; preceded and followed by two "G's," denotes Naval Brigade.

Still.

Carry on.

The following Bugle Calls preceded and followed by one "G" refer to the Upper Deck Quarters, or First Division of Boarders.

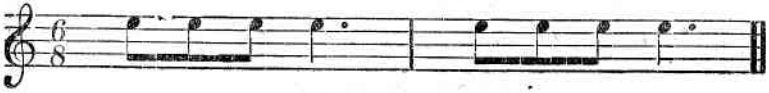
When preceded and followed by two "G's" they refer to the Starboard Battery, Fore Turret, or Second Division of Boarders.

When preceded and followed by three "G's" they refer to the Port Battery, After Turret, or Third Division of Boarders.

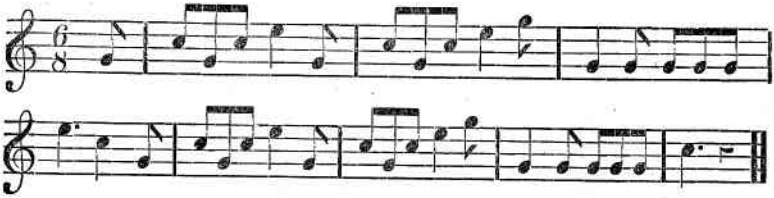
When sounded without "G's" they are general.

I. *Commence Firing.*

II. *Cease Firing.*



III. *Boarders.*



IV. *Boarders return to their Quarters.*

CLOSE WATERTIGHT DOORS.

A succession of "G's" on the Bugle, or short notes on the Foghorn, to be sounded along the decks.

USEFUL RULES AND TABLES.

The Metric Tables are all arranged in rows.

To find the Metric equivalent of any given number, or *vice versâ*, look in the left vertical row for the first figures of the number, and along the top horizontal row for the last figure; the equivalent will be found at the intersection of these two rows.

For example: at page 224, find the equivalent in English inches of 45 millimètres.

Having found the figure 4 in the left vertical row, look along it for its intersection with the row under the figure 5 in the top horizontal row, and find the number 1·77169, which is equivalent in English inches to 45 millimètres.

It is evident that the equivalent of all Metric multiples of 45 will be found by merely shifting the decimal point in the number 1·77169; thus the equivalent of 450 millimètres is 17·7169 inches, and of 4,500 millimètres 177·169 inches, and so on.

As 1 centimètre equals 10 millimètres, and 1 décimètre equals 100 millimètres, the table for the conversion of millimètres into inches is applicable to the conversion of either centimètres or décimètres into inches. Thus 15 centimètres equal 150 millimètres, or 5·906 inches, and 20 décimètres equal 2,000 millimètres, or 78·742 inches.

The Metric measures of length are—

1 millimètre	=	0·039370788 English inches.
10 millimètres	=	1 centimètre.
100 ,,	=	1 décimètre.
1,000 ,,	=	1 mètre.
10 mètres	=	1 décamètre.
100 ,,	=	1 hectomètre.
1,000 ,,	=	1 kilomètre.
10,000 ,,	=	1 myriamètre.

MILLIMETRES TO INCHES.

Examples.

(1.) Find the equivalent number of inches in 0·03, 0·36, 0·97, 1, 20, 36, 360, 3,660, and 7,000 millimètres.

Answer.

0·0012, 0·0142, 0·0382, 0·03937, 0·78742, 1·41735, 14·173, 144·10, and 275·59 inches.

(2.) Find the number of inches in 78·67 millimètres.

Answer.

78	millimètres	=	3·0709 inches.
·67	,,	=	0·0264 ,,
78·67	,,	=	3·0973 ,,

(3.) The 17-centimètre German gun has a calibre of 172·6 millimètres, and a length of bore of 3·784 millimètres; what are the equivalents in English inches?

Answer.

172	millimètres	=	6·771 inches.
·6	,,	=	0·024 ,,
172·6	,,	=	6·795 ,,

3,700	millimètres	=	145·67 inches.
84	,,	=	3·31 ,,
3,784	,,	=	148·98 ,,

MILLIMETRES TO INCHES.

1 millimètre = 0·0393708 inch.

Millimetres.	0	1	2	3	4	5	6	7	8	9
0·0	0·0000	0·0004	0·0008	0·0012	0·0016	0·0020	0·0024	0·0028	0·0032	0·0035
0·1	0·0039	0·0043	0·0047	0·0051	0·0055	0·0059	0·0063	0·0067	0·0071	0·0075
0·2	0·0079	0·0083	0·0087	0·0091	0·0095	0·0098	0·0102	0·0106	0·0110	0·0114
0·3	0·0118	0·0122	0·0126	0·0130	0·0134	0·0138	0·0142	0·0146	0·0150	0·0154
0·4	0·0158	0·0161	0·0165	0·0169	0·0173	0·0177	0·0181	0·0185	0·0189	0·0193
0·5	0·0197	0·0201	0·0205	0·0209	0·0213	0·0217	0·0221	0·0224	0·0228	0·0232
0·6	0·0236	0·0240	0·0244	0·0248	0·0252	0·0256	0·0260	0·0264	0·0268	0·0272
0·7	0·0276	0·0280	0·0284	0·0287	0·0291	0·0295	0·0299	0·0303	0·0307	0·0311
0·8	0·0315	0·0319	0·0323	0·0327	0·0331	0·0335	0·0339	0·0343	0·0347	0·0350
0·9	0·0354	0·0358	0·0362	0·0366	0·0370	0·0374	0·0378	0·0382	0·0386	0·0389
—	—	0·03937	0·07874	0·11811	0·15748	0·19685	0·23622	0·27559	0·31497	0·35434
1	0·39371	0·43308	0·47245	0·51182	0·55119	0·59056	0·62993	0·66930	0·70868	0·74805
2	0·78742	0·82679	0·86616	0·90553	0·94490	0·98427	1·02364	1·06301	1·10239	1·14176
3	1·18112	1·22054	1·25987	1·29924	1·33861	1·37798	1·41735	1·45672	1·49610	1·53547
4	1·57483	1·61421	1·65358	1·69295	1·73232	1·77169	1·81106	1·85043	1·88981	1·92918
5	1·96854	2·00792	2·04729	2·08666	2·12603	2·16540	2·20477	2·24414	2·28352	2·32289
6	2·36225	2·40163	2·44100	2·48037	2·51974	2·56911	2·59848	2·63785	2·67723	2·71660
7	2·75595	2·79534	2·83471	2·87408	2·91345	2·95282	2·99219	3·03156	3·07094	3·11031
8	3·14966	3·18905	3·22842	3·26779	3·30716	3·35653	3·38590	3·42527	3·46465	3·50402
9	3·54337	3·58276	3·62213	3·66150	3·70087	3·74024	3·77961	3·81898	3·85836	3·89773
10	3·93708	3·976	4·016	4·055	4·095	4·134	4·173	4·213	4·252	4·291
11	4·331	4·370	4·409	4·449	4·488	4·528	4·567	4·606	4·646	4·685
12	4·724	4·764	4·803	4·843	4·882	4·921	4·961	5·000	5·039	5·079
13	5·118	5·158	5·197	5·236	5·276	5·315	5·354	5·394	5·433	5·472
14	5·512	5·551	5·591	5·630	5·669	5·709	5·748	5·787	5·827	5·866
15	5·906	5·945	5·984	6·024	6·063	6·102	6·142	6·181	6·221	6·260
16	6·299	6·339	6·378	6·417	6·457	6·496	6·535	6·575	6·614	6·654
17	6·693	6·732	6·771	6·811	6·850	6·890	6·929	6·969	7·008	7·047
18	7·087	7·126	7·165	7·205	7·244	7·284	7·323	7·362	7·402	7·441
19	7·480	7·520	7·559	7·599	7·638	7·677	7·717	7·756	7·795	7·835
20	7·874	7·913	7·953	7·992	8·032	8·071	8·110	8·150	8·189	8·228
21	8·268	8·307	8·347	8·386	8·425	8·465	8·504	8·543	8·583	8·622
22	8·661	8·701	8·740	8·780	8·819	8·858	8·898	8·937	8·976	9·016
23	9·055	9·095	9·134	9·173	9·213	9·252	9·291	9·331	9·370	9·410
24	9·449	9·488	9·528	9·567	9·606	9·646	9·685	9·725	9·764	9·803
25	9·843	9·882	9·921	9·961	10·000	10·039	10·079	10·118	10·158	10·197
26	10·236	10·276	10·315	10·354	10·394	10·433	10·473	10·512	10·551	10·591
27	10·630	10·669	10·709	10·748	10·788	10·827	10·866	10·906	10·945	10·984
28	11·024	11·063	11·103	11·142	11·181	11·221	11·269	11·299	11·339	11·378

MILLIMÈTRES TO INCHES—*continued.*

Millimetres.	0	1	2	3	4	5	6	7	8	9
29	11·417	11·457	11·496	11·536	11·575	11·614	11·654	11·693	11·732	11·772
30	11·811	11·851	11·890	11·929	11·969	12·008	12·047	12·087	12·126	12·166
31	12·205	12·244	12·284	12·323	12·362	12·402	12·441	12·480	12·520	12·559
32	12·599	12·638	12·677	12·717	12·756	12·795	12·835	12·874	12·914	12·953
33	12·992	13·032	13·071	13·110	13·150	13·189	13·229	13·268	13·307	13·347
34	13·386	13·425	13·465	13·504	13·543	13·583	13·622	13·662	13·701	13·740
35	13·783	13·819	13·858	13·898	13·937	13·977	14·016	14·055	14·095	14·134
36	14·173	14·213	14·251	14·292	14·331	14·370	14·410	14·449	14·488	14·528
37	14·567	14·607	14·646	14·685	14·725	14·764	14·803	14·843	14·882	14·921
38	14·961	15·000	15·040	15·079	15·118	15·158	15·197	15·236	15·276	15·315
39	15·355	15·394	15·433	15·473	15·512	15·551	15·591	15·630	15·670	15·709
40	15·748	15·788	15·827	15·866	15·906	15·945	15·984	16·024	16·063	16·103
41	16·142	16·181	16·221	16·260	16·299	16·339	16·378	16·418	16·457	16·496
42	16·536	16·575	16·614	16·654	16·693	16·733	16·772	16·811	16·851	16·890
43	16·929	16·969	17·008	17·047	17·087	17·126	17·166	17·205	17·244	17·284
44	17·323	17·362	17·402	17·441	17·481	17·520	17·559	17·599	17·638	17·677
45	17·717	17·756	17·796	17·835	17·874	17·914	17·953	17·992	18·032	18·071
46	18·111	18·150	18·189	18·229	18·268	18·307	18·347	18·386	18·425	18·465
47	18·504	18·544	18·583	18·622	18·662	18·701	18·740	18·780	18·819	18·859
48	18·898	18·937	18·977	19·016	19·055	19·095	19·134	19·173	19·213	19·252
49	19·292	19·331	19·370	19·410	19·449	19·488	19·528	19·567	19·607	19·646
50	19·685									

The foregoing table will also serve for the conversion of mètres to inches, as 1 mètre = 1,000 millimètres:—

EXAMPLE.

Find the number of inches in 0·02, 0·36, 3·66 mètres.

Answer.

0·787, 14·17, and 144·10 inches.

DECIMETRES TO INCHES.

1 décimètre = 3·937079 inches.

	0	1	2	3	4	5	6	7	8	9
0·1	0·394	0·433	0·472	0·512	0·551	0·591	0·630	0·669	0·709	0·748
0·2	0·787	0·827	0·866	0·905	0·945	0·984	1·024	1·063	1·102	1·142
0·3	1·181	1·220	1·260	1·299	1·339	1·378	1·417	1·457	1·496	1·535
0·4	1·575	1·614	1·654	1·693	1·732	1·772	1·811	1·850	1·890	1·929
0·5	1·968	2·008	2·047	2·087	2·126	2·165	2·205	2·244	2·283	2·323
0·6	2·362	2·402	2·441	2·480	2·520	2·559	2·598	2·638	2·677	2·717
0·7	2·756	2·795	2·835	2·874	2·913	2·953	2·992	3·031	3·071	3·110
0·8	3·150	3·189	3·228	3·268	3·307	3·346	3·386	3·425	3·465	3·504
0·9	3·543	3·583	3·622	3·662	3·701	3·740	3·780	3·819	3·858	3·898
—	—	3·937	7·874	11·811	15·748	19·685	23·622	27·559	31·497	35·434
1	39·371	43·308	47·245	51·182	55·119	59·056	62·993	66·939	70·867	74·804
2	78·742	82·679	86·616	90·553	94·490	98·427	102·364	106·301	110·239	114·176
3	118·112	122·050	125·987	129·924	133·861	137·798	141·735	145·672	149·610	153·547
4	157·483	161·421	165·358	169·295	173·232	177·169	181·106	185·043	188·981	192·918
5	196·854	200·792	204·729	208·666	212·603	216·540	220·477	224·414	228·352	232·289
6	236·225	240·163	244·100	248·037	251·974	255·911	259·848	263·785	267·723	271·660
7	275·595	279·534	283·471	287·408	291·345	295·282	299·219	303·156	307·094	311·031
8	314·966	318·905	322·842	326·779	330·716	335·653	338·590	342·527	346·465	350·402
9	354·337	358·27	362·213	366·150	370·087	374·024	377·961	381·898	385·836	389·773
10	393·708									

EXAMPLES.

(1.) Find the number of inches in 0·22, 1, 6, and 64 décimètres.

Answer.

0·866, 3·937, 23·622, and 251·974.

(2.) The total length of the Russian 24-centimètre gun is 3,367 millimètres; what is this in inches?

Answer.

3,367 millimètres = 33·67 décimètres.

33 décimètres = 129·924 inches

·67 ,, = 2·638

33·67 ,, = 132·562

METRES TO FEET.

EXAMPLES.

(1.) Find the number of feet in 0·05, 0·76, 1, 24, 500, and 550 mètres.

Answer.

0·164, 2,493, 3·281, 78·741, 1,640·45, and 1,804·5 feet.

(2.) Find the number of feet in 68·97 mètres.

Answer.

68 mètres = 223·101 feet.

·97 ,, = 3·182 ,,

68·97 ,, = 226·283 ,,

(3.) The muzzle velocity with the 15-centimètre German gun is 475 mètres; what is the equivalent in English feet?

Answer.

1,558·43 feet.

METRES TO FEET.

1 mètre = 3·2808992 feet.

Met.	0	1	2	3	4	5	6	7	8	9
0·0	0·000	0·033	0·066	0·098	0·131	0·164	0·197	0·230	0·262	0·295
0·1	0·328	0·361	0·394	0·426	0·459	0·492	0·525	0·558	0·590	0·623
0·2	3·656	0·689	0·722	0·754	0·787	0·820	0·853	0·886	0·918	0·951
0·3	0·984	1·017	1·050	1·082	1·115	1·148	1·181	1·214	1·246	1·279
0·4	1·312	1·345	1·378	1·410	1·443	1·476	1·509	1·542	1·574	1·607
0·5	1·640	1·673	1·706	1·738	1·771	1·804	1·837	1·870	1·902	1·935
0·6	1·968	2·001	2·034	2·067	2·100	2·132	2·165	2·198	2·230	2·263
0·7	2·296	2·329	2·362	2·394	2·427	2·460	2·493	2·526	2·558	2·591
0·8	2·624	2·657	2·690	2·722	2·755	2·788	2·821	2·854	2·886	2·919
0·9	2·952	2·985	3·018	3·050	3·083	3·116	3·149	3·182	3·214	3·247
—	—	3·281	6·562	9·843	13·124	16·405	19·685	22·966	26·247	29·528

MÈTRES to FEET—*continued.*

Metres	0	1	2	3	4	5	6	7	8	9
1	32·809	36·090	39·371	42·652	45·933	49·213	52·494	55·775	59·056	62·337
2	65·618	68·899	72·180	75·461	78·741	82·022	85·303	88·584	91·865	95·146
3	98·427	101·708	104·989	108·270	111·550	114·831	118·112	121·393	124·674	127·955
4	131·236	134·517	137·798	141·079	144·360	147·640	150·921	154·202	157·483	160·764
5	164·045	167·326	170·607	173·888	177·169	180·449	183·730	187·011	190·292	193·573
6	196·854	200·135	203·416	206·697	209·978	213·258	216·539	219·820	223·101	226·382
7	229·663	232·944	236·225	239·506	242·787	246·067	249·349	252·629	255·910	259·191
8	262·472	265·753	269·034	272·315	275·595	278·876	282·157	285·438	288·719	292·000
9	295·281	298·562	301·843	305·124	308·405	311·685	314·966	318·247	321·528	324·809
10	320·09	331·37	334·65	337·93	341·21	344·49	347·78	351·06	354·34	357·62
11	360·90	364·18	367·46	370·74	374·02	377·30	380·58	383·87	387·15	390·43
12	393·71	396·99	400·27	403·55	406·83	410·11	413·39	416·67	419·96	423·24
13	426·52	429·80	433·08	436·36	439·64	442·92	446·20	449·48	452·76	456·04
14	459·33	462·61	465·89	469·17	472·45	475·73	479·01	482·29	485·57	488·85
15	492·13	495·42	498·70	501·98	505·26	508·54	511·82	515·10	518·38	521·66
16	524·94	528·22	531·50	534·79	538·07	541·35	544·63	547·91	551·19	554·47
17	557·75	561·03	564·31	567·60	570·88	574·16	577·44	580·72	584·00	587·28
18	590·56	593·84	597·12	600·40	603·69	606·97	610·25	613·53	616·81	620·09
19	623·37	626·65	629·93	633·21	636·49	639·78	643·06	646·34	649·62	652·90
20	656·18	659·46	662·74	666·02	669·30	672·58	675·87	679·15	682·43	685·71
21	688·99	692·27	695·55	698·83	702·11	705·39	708·67	711·96	715·24	718·52
22	721·80	725·08	728·36	731·64	734·92	738·20	741·48	744·76	748·05	751·33
23	754·61	757·89	761·17	764·45	767·73	771·01	774·29	777·57	780·85	784·14
24	787·42	790·70	793·98	797·26	800·54	803·82	807·10	810·38	813·66	816·94
25	820·22	823·51	826·79	830·07	833·35	836·63	839·91	843·19	846·47	849·75
26	853·03	856·32	859·60	862·88	866·16	869·44	872·72	876·00	879·28	882·56
27	885·84	889·12	892·41	895·69	898·97	902·25	905·53	908·81	912·09	915·37
28	918·65	921·93	925·21	928·49	931·78	935·06	938·34	941·62	944·90	948·18
29	951·46	954·74	958·02	961·30	964·58	967·87	971·15	974·43	977·71	980·99
30	984·27	987·55	990·83	994·11	997·39	1000·67	1003·96	1007·24	1010·52	1013·80
31	1017·08	1020·36	1023·64	1026·92	1030·20	1033·48	1036·76	1040·05	1043·33	1046·61
32	1049·89	1053·17	1056·45	1059·73	1063·01	1066·29	1069·57	1072·85	1076·14	1079·42
33	1082·70	1085·98	1089·26	1092·54	1095·82	1099·10	1102·38	1105·66	1108·94	1112·22
34	1115·50	1118·79	1122·07	1125·35	1128·63	1131·91	1135·19	1138·47	1141·75	1145·03
35	1148·31	1151·60	1154·88	1158·16	1161·44	1164·72	1168·00	1171·28	1174·56	1177·84
36	1181·12	1184·40	1187·69	1190·97	1193·25	1196·53	1199·81	1203·09	1206·37	1209·65
37	1213·93	1217·21	1220·49	1223·78	1227·06	1230·34	1233·62	1236·90	1240·18	1243·46
38	1246·74	1250·02	1253·30	1256·58	1259·87	1263·15	1266·43	1269·71	1272·99	1276·27
39	1279·55	1282·83	1286·11	1289·39	1292·67	1295·96	1299·24	1302·52	1305·80	1309·08
40	1312·36	1315·64	1318·92	1322·20	1325·48	1328·76	1332·04	1335·33	1338·61	1341·89
41	1345·17	1348·45	1351·73	1355·01	1358·29	1361·57	1364·85	1368·13	1371·42	1374·70
42	1377·98	1381·26	1384·54	1387·82	1391·10	1394·38	1397·66	1400·94	1404·22	1407·50

MÈTRES to FEET—*continued.*

Metres	0	1	2	3	4	5	6	7	8	9
43	1410·79	1414·07	1417·35	1420·63	1423·91	1427·19	1430·47	1433·75	1437·03	1440·31
44	1443·60	1446·88	1450·16	1453·44	1456·72	1460·00	1463·28	1466·56	1469·84	1473·12
45	1476·40	1479·69	1482·97	1486·25	1489·53	1492·81	1496·09	1499·37	1502·65	1505·93
46	1509·21	1512·49	1515·78	1519·06	1522·34	1525·62	1528·90	1532·18	1535·46	1538·74
47	1542·02	1545·30	1548·58	1551·87	1555·15	1558·43	1561·71	1564·99	1568·27	1571·55
48	1574·83	1578·11	1581·39	1584·67	1587·96	1591·24	1594·52	1597·80	1601·08	1604·36
49	1607·64	1610·92	1614·20	1617·48	1620·76	1624·04	1627·33	1630·61	1633·89	1637·17
50	1640·45	1643·73	1647·01	1650·29	1653·57	1656·85	1660·13	1663·42	1666·70	1669·98
51	1673·26	1676·54	1679·82	1683·10	1686·38	1689·66	1692·94	1695·22	1699·50	1702·79
52	1706·07	1709·35	1712·63	1715·91	1719·19	1722·47	1725·75	1729·03	1732·31	1735·60
53	1738·88	1742·16	1745·44	1748·72	1752·00	1755·28	1758·56	1761·84	1765·12	1768·40
54	1771·69	1774·97	1778·25	1781·53	1784·81	1788·09	1791·37	1794·65	1797·93	1801·21
55	1804·49	1807·78	1811·06	1814·34	1817·62	1820·90	1824·18	1827·46	1830·74	1834·02
56	1837·30	1840·58	1843·87	1847·15	1850·43	1853·71	1856·99	1860·27	1863·55	1866·83
57	1870·11	1873·39	1876·67	1879·96	1883·24	1886·52	1889·80	1893·08	1896·36	1899·64
58	1902·92	1906·20	1909·48	1912·76	1916·04	1919·33	1922·61	1925·89	1929·17	1932·45
59	1935·73	1939·01	1942·29	1945·57	1948·85	1952·13	1955·42	1958·70	1961·98	1965·26
60	1968·54	1971·82	1975·10	1978·38	1981·66	1984·94	1988·22	1991·50	1994·79	1998·07
61	2001·35	2004·63	2007·91	2011·19	2014·47	2017·75	2021·03	2024·31	2027·60	2030·88
62	2034·16	2037·44	2040·72	2044·00	2047·28	2050·56	2053·84	2057·12	2060·40	2063·69
63	2066·97	2070·25	2073·53	2076·81	2080·09	2083·37	2086·65	2089·93	2093·21	2096·49
64	2099·78	2103·06	2106·34	2109·62	2112·90	2116·18	2119·46	2122·74	2126·02	2129·30
65	2132·58	2135·87	2139·15	2142·43	2145·71	2148·99	2152·27	2155·55	2158·83	2162·11
66	2165·39	2168·67	2171·96	2175·24	2178·52	2181·80	2185·08	2188·36	2191·64	2194·92
67	2198·20	2201·48	2204·76	2208·04	2211·33	2214·61	2217·89	2221·17	2224·45	2227·73
68	2231·01	2234·29	2237·57	2240·85	2244·13	2247·42	2250·70	2253·98	2257·26	2260·54
69	2263·82	2267·10	2270·38	2273·66	2276·94	2280·22	2283·50	2286·79	2290·07	2293·35
70	2296·63	2299·91	2303·19	2306·47	2309·75	2313·03	2316·31	2319·60	2322·88	2326·16
71	2329·44	2332·72	2336·00	2339·28	2342·56	2345·84	2349·12	2352·40	2355·69	2358·97
72	2362·25	2365·53	2368·81	2372·09	2375·37	2378·65	2381·93	2385·21	2388·49	2391·78
73	2395·06	2398·34	2401·62	2403·90	2407·18	2410·46	2413·74	2417·02	2420·30	2423·58
74	2427·86	2431·15	2434·43	2437·71	2440·99	2444·27	2447·55	2450·83	2454·11	2457·39
75	2460·67	2463·96	2467·24	2470·52	2473·80	2477·08	2480·36	2483·64	2486·92	2490·20
76	2493·49	2496·76	2500·04	2503·33	2506·61	2509·89	2513·17	2516·45	2519·73	2523·01
77	2526·29	2529·57	2532·85	2536·13	2539·42	2542·70	2545·98	2549·26	2552·54	2555·82
78	2559·10	2562·38	2565·66	2568·94	2572·22	2575·50	2578·79	2582·07	2585·35	2588·63
79	2591·91	2595·19	2598·47	2601·75	2605·03	2608·31	2611·60	2614·88	2618·16	2621·44
80	2624·72	2628·00	2631·28	2634·56	2637·84	2641·12	2644·40	2647·69	2650·97	2654·25

METRES TO YARDS.

1 mètre = 1·0936331 yard.

Metres.	0	1	2	3	4	5	6	7	8	9
0·0	0·000	0·011	0·022	0·033	0·044	0·055	0·066	0·077	0·087	0·098
0·1	0·109	0·120	0·131	0·142	0·153	0·164	0·175	0·186	0·197	0·208
0·2	0·219	0·230	0·241	0·252	0·262	0·273	0·284	0·295	0·306	0·317
0·3	0·328	0·339	0·350	0·361	0·372	0·383	0·394	0·405	0·416	0·427
0·4	0·437	0·448	0·459	0·470	0·481	0·492	0·503	0·514	0·525	0·536
0·5	0·547	0·558	0·569	0·580	0·591	0·602	0·612	0·623	0·634	0·645
0·6	0·656	0·667	0·678	0·689	0·700	0·711	0·722	0·733	0·744	0·755
0·7	0·766	0·776	0·787	0·798	0·809	0·820	0·831	0·842	0·853	0·864
0·8	0·875	0·886	0·897	0·908	0·919	0·930	0·941	0·951	0·962	0·973
0·9	0·984	0·995	1·006	1·017	1·028	1·039	1·050	1·061	1·072	1·083
—	—	1·094	2·187	3·281	4·374	5·468	6·562	7·655	8·749	9·843
1	10·9363	12·0300	13·1236	14·2172	15·3109	16·4045	17·4981	18·5918	19·6854	20·7790
2	21·8727	22·9663	24·0599	25·1536	26·2472	27·3408	28·4345	29·5281	30·6217	31·7154
3	32·8090	33·9026	34·9963	36·0899	37·1835	38·2772	39·3708	40·4644	41·5581	42·6517
4	43·7453	44·8389	45·9326	47·0262	48·1198	49·2135	50·3071	51·4007	52·4944	53·5880
5	54·6816	55·7753	56·8689	57·9625	59·0562	60·1498	61·2434	62·3371	63·4307	64·5243
6	65·6180	66·7116	67·8052	68·8989	69·9925	71·0861	72·1798	73·2734	74·3670	75·4607
7	76·5543	77·6479	78·7416	79·8352	80·9288	82·0225	83·1161	84·2097	85·3034	86·3970
8	87·4906	88·5843	89·6779	90·7715	91·8652	92·9588	94·0524	95·1461	96·2397	97·3333
9	98·4270	99·5206	100·614	101·708	102·802	103·895	104·989	106·082	107·176	108·270
10	109·363									

EXAMPLES.

(1.) Find the number of yards in 0·05, 0·46, 1, 6, 55, 550, and 6,400 mètres.

Answer.

0·055, 0·503, 1·094, 6·562, 60·15, 601·50, and 6,999·25 yards.

(2.) The mean range, mean error in range, and mean error in direction of projectiles fired at 3° elevation from the 15-centimètre German gun are 2,285, 14·66, and 0·85 mètres; what are the equivalents in yards?

Answer.

2,200 mètres = 2,405·99 yards.	14 mètres = 15·31 yards.
85 ,, = 92·96 ,,	·66 ,, = 72 ,,
2,285 ,, = 2,498·95 ,,	14·66 ,, = 16·03 ,,

0·85 mètre = 0·93 yard.

The British measures of length are—

12 inches	=	1 foot.
3 feet	=	1 yard.
5½ yards	=	1 pole or rod.
40 poles	=	1 furlong.
8 furlongs	=	1 mile.

The following tables will facilitate the conversion of British measures of length into corresponding Metric measures:—

INCHES TO MILLIMETRES.

1 inch = 25·3995411 millimètres.

Inches.	0	1	2	3	4	5	6	7	8	9
0·0	0·000	0·254	0·508	0·762	1·016	1·270	1·524	1·778	2·032	2·286
0·1	2·540	2·794	3·048	3·302	3·556	3·810	4·064	4·318	4·572	4·826
0·2	5·080	5·334	5·588	5·842	6·096	6·350	6·604	6·858	7·112	7·366
0·3	7·620	7·874	8·128	8·382	8·636	8·890	9·144	9·398	9·652	9·906
0·4	10·160	10·414	10·668	10·922	11·176	11·430	11·684	11·938	12·192	12·446
0·5	12·700	12·954	13·208	13·462	13·716	13·970	14·224	14·478	14·732	14·986
0·6	15·240	15·494	15·748	16·002	16·256	16·510	16·764	17·018	17·272	17·526
0·7	17·780	18·034	18·288	18·542	18·796	19·050	19·304	19·558	19·812	20·066
0·8	20·320	20·574	20·828	21·082	21·336	21·590	21·844	22·098	22·352	22·606
0·9	22·860	23·114	23·368	23·622	23·876	24·130	24·384	24·638	24·892	25·146
—	—	25·400	50·800	76·199	101·599	127·000	152·399	177·798	203·198	228·598
1	254·0	279·4	304·8	330·2	355·6	381·0	406·4	431·8	457·2	482·6
2	508·0	533·4	558·8	584·2	609·6	635·0	660·4	685·8	711·2	736·6
3	762·0	787·4	812·8	838·2	863·6	889·0	914·4	939·8	965·2	990·6
4	1016·0	1041·4	1066·8	1092·2	1117·6	1143·0	1168·4	1193·8	1219·2	1244·6
5	1272·0	1295·4	1320·8	1346·2	1371·6	1397·0	1422·4	1447·8	1473·2	1498·6
6	1524·0	1549·4	1574·8	1600·2	1625·6	1651·0	1676·4	1701·8	1727·2	1752·6
7	1778·0	1803·4	1828·8	1854·2	1879·6	1905·0	1930·4	1955·8	1981·2	2006·6
8	2032·0	2057·4	2082·8	2108·2	2133·6	2159·0	2184·4	2209·8	2235·2	2260·6
9	2286·0	2311·4	2336·8	2362·2	2387·6	2413·0	2438·4	2463·8	2489·2	2514·6

INCHES TO MILLIMETRES.

EXAMPLES.

(1.) Find the number of millimètres in 0·36, 0·97, 1, 12, and 43 inches.

Answer.

9·144, 24·638, 25·400, 304·80, and 1,092·2 millimètres.

(2.) Find the number of millimètres in 3·1 inches.

Answer.

3	inches	= 76·199	millimètres.
·1	,,	= 2·540	,,
3·1	,,	= 78·739	,,

(3.) The British 64-pr. gun has a calibre of 6·3 inches, and a length of bore 97·5 inches; what are the equivalents of these numbers in millimètres?

Answer.

6	inches	= 152·399	millimètres.
·3	,,	= 7·620	,,
6·3	,,	= 160·019	,,

97	inches	= 2,463·8	millimètres.
·5	,,	= 12·7	,,
97·5	,,	= 2,476·5	,,

FEET TO METRES.

1 foot = 0·3047945 mètre.

Feet.	0	1	2	3	4	5	6	7	8	9
0·0	0·000	0·003	0·006	0·009	0·012	0·015	0·018	0·021	0·024	0·027
0·1	0·030	0·034	0·037	0·040	0·043	0·046	0·049	0·052	0·055	0·058
0·2	0·061	0·064	0·067	0·070	0·073	0·076	0·079	0·082	0·085	0·088
0·3	0·091	0·094	0·097	0·100	0·104	0·107	0·110	0·113	0·116	0·119
0·4	0·122	0·125	0·128	0·131	0·134	0·137	0·140	0·143	0·146	0·149
0·5	0·152	0·155	0·158	0·161	0·164	0·168	0·171	0·174	0·177	0·180
0·6	0·183	0·186	0·189	0·192	0·195	0·198	0·201	0·204	0·207	0·210
0·7	0·213	0·216	0·219	0·222	0·226	0·229	0·232	0·235	0·238	0·241
0·8	0·244	0·247	0·250	0·253	0·256	0·250	0·262	0·265	0·268	0·271
0·9	0·274	0·277	0·280	0·283	0·286	0·289	0·293	0·296	0·299	0·302
—	—	0·305	0·610	0·914	1·219	1·524	1·829	2·134	2·438	2·743
1	3·048	3·353	3·657	3·962	4·267	4·572	4·877	5·181	5·486	5·791
2	6·096	6·401	6·705	7·010	7·315	7·620	7·925	8·229	8·534	8·839
3	9·144	9·449	9·753	10·058	10·363	10·668	10·973	11·277	11·582	11·887
4	12·192	12·497	12·801	13·106	13·411	13·716	14·020	14·325	14·630	14·935
5	15·240	15·544	15·849	16·154	16·459	16·764	17·068	17·373	17·678	17·983
6	18·288	18·592	18·897	19·202	19·507	19·812	20·116	20·421	20·726	21·031
7	21·336	21·640	21·946	22·250	22·555	22·860	23·164	23·469	23·774	24·079
8	24·384	24·688	24·993	25·298	25·603	25·907	26·212	26·517	26·822	27·127
9	27·431	27·736	28·041	28·346	28·651	28·955	29·260	29·565	29·870	30·175
10	30·479									
20	60·959									
30	91·438									
40	121·918									
50	152·397									
60	182·877									
70	213·356									
80	243·836									
90	274·315									
100	304·79									
200	609·59									
300	914·38									
400	1219·18									
500	1523·97									
600	1828·77									
700	2133·56									
800	2438·36									
900	2743·15									
1000	3047·94									

FOR CONVERTING FEET TO METRES.

EXAMPLES.

(1.) Find the number of mètres in 0·08, 0·36, 1, 39, and 78 feet.

Answer.

0·024, 0·110, 0·305, 11·887, and 23·774 mètres.

(2.) Find the number of mètres in 57·62 feet.

Answer.

57	feet	=	17·373	mètres.
·62	,,	=	0·189	,,
57·62	,,	=	17·562	,,

(3.) The muzzle velocity with the British 7-inch M.L. gun 1,561 feet; what is the equivalent in mètres?

Answer.

1,000	feet	=	304·79	mètres.
500	,,	=	152·387	,,
61	,,	=	18·592	,,
1,561	,,	=	475·779	,,

YARDS TO METRES.—1 yard = 0·9143834 mètres.

Yds.	0	1	2	3	4	5	6	7	8	9
0·0	0·000	0·009	0·018	0·027	0·037	0·046	0·055	0·064	0·073	0·082
0·1	0·091	0·101	0·110	0·119	0·128	0·137	0·146	0·155	0·164	0·174
0·2	0·138	0·192	0·201	0·210	0·219	0·229	0·238	0·247	0·256	0·265
0·3	0·274	0·283	0·293	0·302	0·311	0·320	0·329	0·338	0·347	0·357
0·4	0·366	0·375	0·384	0·393	0·402	0·411	0·420	0·430	0·439	0·448
0·5	0·457	0·466	0·475	0·485	0·494	0·503	0·512	0·521	0·530	0·539
0·6	0·549	0·558	0·567	0·576	0·585	0·594	0·603	0·613	0·622	0·631
0·7	0·640	0·649	0·658	0·668	0·677	0·686	0·695	0·704	0·713	0·722
0·8	0·732	0·741	0·750	0·759	0·768	0·777	0·786	0·796	0·805	0·814
0·9	0·823	0·832	0·841	0·850	0·860	0·869	0·878	0·887	0·896	0·905
—	—	0·914	1·829	2·743	3·657	4·572	5·486	6·401	7·315	8·229
1	9·144	10·058	10·973	11·887	12·801	13·716	14·630	15·544	16·459	17·373
2	18·288	19·202	20·116	21·031	21·945	22·860	23·774	24·688	25·603	26·517
3	27·431	28·346	29·260	30·175	31·089	32·003	32·918	33·832	34·747	35·661
4	36·575	37·490	38·404	39·318	40·233	41·147	42·062	42·976	43·890	44·805
5	45·719	46·634	47·548	48·462	49·377	50·291	51·205	52·120	53·034	53·949
6	54·863	55·777	56·692	57·606	58·520	59·435	60·349	61·264	62·178	63·092
7	64·007	64·920	65·836	66·750	67·664	68·579	69·493	70·407	71·322	72·236
8	73·151	74·065	74·979	75·894	76·808	77·723	78·637	79·551	80·466	81·380
9	82·294	83·209	84·123	85·038	85·952	86·866	87·781	88·695	89·610	90·524
10	91·438									
20	182·88									
30	274·32									
40	365·75									
50	457·19									
60	548·63									
70	640·07									
80	731·51									
90	822·95									
100	914·38									
200	1828·77									
300	2743·15									
400	3657·53									
500	4571·92									
600	5486·30									
700	6400·68									
800	7315·07									
900	8229·45									
1000	9143·84									
2000	18287·67									
2500	22859·59									
3000	27431·50									
3500	32003·43									
4000	36575·34									
5000	45719·17									

RANGE TABLES.

Full

10-INCH M.L.R. GUN.

Charge: 70 lbs. P. Projectile: Palliser Shot, with Gas-check, Mark II., 400 lbs. Muzzle Velocity: 1,379 f.s.

Range.	Elevation.	To hit an object 10 ft. high, Range must be known within—	Time of Flight.	Fuze Scale. Fifteen Seconds Wood M.L., (based on practice of various dates proof of Fuzes).	
Yards.	° ′	Yards.	Seconds.	Yards.	Tenths.
0					
100	0 3	636	0·22	245	1·0
200	0 12	318	0·44	330	1·5
300	0 21	212	0·66	415	2·0
400	0 30	156	0·89	500	2·5
500	0 39	122	1·12	585	3·0
600	0 48	101	1·35	670	3·5
700	0 58	84	1·58	755	4·0
800	1 8	73	1·82	840	4·5
900	1 18	64	2·06	920	5·0
1,000	1 28	56	2·30	1,005	5·5
1,100	1 38	50	2·54	1,085	6·0
1,200	1 48	45	2·78	1,170	6·5
1,300	1 58	41	3·03	1,250	7·0
1,400	2 9	38	3·28	1,335	7·5
1,500	2 20	35	3·53	1,415	8·0
1,600	2 31	32	3·78	1,500	8·5
1,700	2 42	30	4·04	1,580	9·0
1,800	2 53	28	4·30	1,665	9·5
1,900	3 4	26	4·56	1,745	10·0
2,000	3 15	25	4·82	1,830	10·5
2,100	3 27	24	5·09	1,910	11·0
2,200	3 39	22	5·36	1,990	11·5
2,300	3 51	21	5·63	2,070	12·0
2,400	4 3	20	5·90	2,150	12·5
2,500	4 15	19	6·18	2,225	13·0
2,600	4 27	18	6·46	2,300	13·5
2,700	4 40	17	6·74	2,370	14·0

Full

10-INCH M.L.R. GUN—*continued.*

Charge: 70 lbs. Palliser Shot, 400 lbs. M.V.: 1.379 f.s.

Range.	Elevation.	To hit an object 10 ft. high, Range must be known within—	Time of Flight.	Fuze Scale. Fifteen Seconds Wood M.L., (based on practice of various dates proof of Fuzes).	
Yards.	° ′	Yards.	Seconds.	Yards.	Tenths.
2,800	4 53	16	7·02	2,440	14·5
2,900	5 6	15	7·30	2,510	15·0
3,000	5 19	15	7·59	2,580	15·5
3,100	5 32	14	7·88	2,650	16·0
3,200	5 45	13	8·17	2,720	16·5
3,300	5 59	13	8·46	2,790	17·0
3,400	6 13	12	8·75	2,860	17·5
3,500	6 27	12	9·04	2,935	18·0
3,600	6 41	11	9·34	3,005	18·5
3,700	6 55	11	9·64	3,075	19·0
3,800	7 9	11	9·94	3,150	19·5
3,900	7 24	10	10·24	3,220	20·0
4,000	7 39	10	10·54	3,290	20·5
4,100	7 54	10	10·84	3,360	21·0
4,200	8 9	9	11·14	3,430	21·5
4,300	8 24	9	11·45	3,500	22·0
4,400	8 40	9	11·76	3,570	22·5
4,500	8 56	8	12·07	3,635	23·0
4,600	9 12	8	12·4	3,705	23·5
4,700	9 28	8	12·7	3,770	24·0
4,800	9 44	8	13·0	3,840	24·5
4,900	10 0	7	13·3	3,905	25·0
5,000	10 17	7	13·7	3,970	25·5
5,100	10 34	7	14·0	4,035	26·0
5,200	10 51	7	14·3	4,105	26·5
5,300	11 8	7	14·7	4,170	27·0
5,400	11 26	6	15·0	4,235	27·5
5,500	11 43	6	15·3	4,300	28·0
5,600	12 0	6	15·6	4,370	28·5
5,700	12 18	6	16·0	4,435	29·0
5,800	12 36	6	16·3	4,500	29·5
5,900	12 54	5	16·6	4,565	30·0
6,000	13 12	5	17·0		

Reduced

10-INCH M.L.R. GUN.

Charge: 44 lbs. P. Projectile: Common Shell, with Gas-check Mark II., weight 400 lbs. Muzzle Velocity: 1,028 f.s.

Range.	Elevation.	To hit an object 10 ft. high, Range must be known within—	Time of Flight.	Fuze Scale, 15 Seconds. M.L. Wood Time Fuze.	
Yards.	° ′	Yards.	Seconds.	Yards.	Tenths.
0				240	1·0
100	0 13	355	0·29	320	1·5
				390	2·0
200	0 29	179	0·58	455	2·5
				520	3·0
300	0 45	117	0·88	585	3·5
400	1 1	87	1·18	650	4·0
				720	4·5
500	1 17	70	1·48	790	5·0
600	1 33	58	1·77	855	5·5
				920	6·0
700	1 49	49	2·08	985	6·5
800	2 6	43	2·39	1,050	7·0
900	2 23	38	2·70	1,115	7·5
				1,180	8·0
1,000	2 40	33	3·01	1,250	8·5
				1,315	9·0
1,100	2 57	30	3·32	1,385	9·5
1,200	3 14	28	3·63	1,450	10·0
				1,515	10·5
1,300	3 31	25	3·95	1,580	11·0
1,400	3 48	23	4·27	1,645	11·5
1,500	4 6	22	4·59	1,710	12·0
				1,775	12·5
1,600	4 24	20	4·91	1,840	13·0
1,700	4 42	19	5·23	1,905	13·5
1,800	5 0	18	5.56	1,970	14·0
				2,035	14·5
1,900	5 18	17	5·89	2,100	15·0
2,000	5 36	16	6·22	2,165	15·5
				2,225	16·0
2,100	5 54	15	6·55	2,290	16·5
				2,355	17·0
2,200	6 12	14	6·88	2,420	17·5
2,300	6 31	13	7·22	2,480	18·0
2,400	6 50	13	7·56	2,545	18·5

Reduced

10-INCH M.L.R. GUN—*continued.*

Charge: 44 lbs. Common Shell, 400 lbs. M. V.: 1,028 f.s.

Range.	Elevation.	To hit an object 10 ft. high, Range must be known within—	Time of Flight.	Fuze Scale, 15 Seconds. M.L. Wood Time Fuze.	
Yards.	° ′	Yards.	Seconds.	Yards.	Tenths.
2,500	7 9	12	7·90	2,605	19·0
				2,670	19·5
2,600	7 28	12	8·24	2,730	20·0
2,700	7 47	11	8·58	2,795	20·5
2,800	8 6	11	8·93	2,855	21·0
				2,920	21·5
2,900	8 25	10	9·28	2,980	22·0
				3,040	22·5
3,000	8 45	10	9·63	3,100	23·0
				3,165	23·5
3,100	9 5	9	10·0	3,225	24·0
3,200	9 25	9	10·3	3,290	24·5
3,300	9 45	9	10·7	3,335	25·0
				3,420	25·5
3,400	10 5	8	11·1	3,480	26·0
3,500	10 25	8	11·4	3,545	26·5
3,600	10 46	8	11·8	3,605	27·0
				3,670	27·5
3,700	11 7	7	12·2	3,730	28·0
3,800	11 28	7	12·5	3,795	28·5
3,900	11 49	7	12·9	3,850	29·0
				3,910	29·5
4,000	12 10	7	13·2	3,970	30·0

10-INCH M.L.R. GUN OF 18 TONS

Full Charge, 70 lbs. P. Powder. Projectile: Common Shell, without Gas-check.

Range.	Elevation.	Fuze Scale.	Range.	Elevation.	Fuze Scale.
Yards.	° ′		Yards.	° ′	
170	0 15	1	2,570	4 42	16
260	0 23	1·5	2,640	4 52	16·5
340	0 31	2	2,710	5 2	17
430	0 39	2·5	2,780	5 12	17·5
510	0 47	3	2,850	5 22	18
600	0 55	3·5	2,920	5 32	18·5
680	1 3	4	2,990	5 42	19
770	1 12	4·5	3,060	5 52	19·5
850	1 21	5	3,130	6 2	20
940	1 30	5·5	3,200	6 12	20·5
1,020	1 39	6	3,260	6 22	21
1,110	1 48	6·5	3,330	6 32	21·5
1,190	1 57	7	3,400	6 42	22
1,270	2 6	7·5	3,460	6 51	22·5
1,350	2 15	8	3,530	7 1	23
1,430	2 24	8·5	3,590	7 10	23·5
1,510	2 33	9	3,660	7 21	24
1,590	2 42	9·5	3,720	7 31	24·5
1,670	2 52	10	3,780	7 41	25
1,750	3 2	10·5	3,850	7 52	25·5
1,820	3 11	11	3,910	8 1	26
1,900	3 20	11·5	3,970	8 11	26·5
1,970	3 29	12	4,030	8 20	27
2,050	3 38	12·5	4,090	8 30	27·5
2,120	3 47	13	4,150	8 40	28
2,200	3 56	13·5	4,210	8 50	28·5
2,270	4 5	14	4,270	9 0	29
2,350	4 14	14·5	4,330	9 10	29·5
2,420	4 23	15	4,380	9 18	30
2,500	4 32	15·5			

10-INCH M.L.R. GUN OF 18 TONS.

Reduced Charge, 44 lbs. P. Powder. Projectile: Common Shell, without Gas-checks.

Range.	Elevation.	Fuze Scale.	Range.	Elevation.	Fuze Scale.
Yards.	° ′		Yards.	° ′	
160	0 19	1	2,330	5 36	16
240	0 28	1·5	2,400	5 47	16·5
320	0 38	2	2,460	5 58	17
400	0 48	2·5	2,530	6 10	17·5
480	0 58	3	2,590	6 21	18
560	1 8	3·5	2,660	6 34	18·5
630	1 18	4	2,720	6 46	19
710	1 28	4·5	2,790	6 59	19·5
780	1 38	5	2,850	7 11	20
860	1 49	5·5	2,910	7 23	20·5
930	1 59	6	2,970	7 35	21
1,000	2 9	6·5	3,030	7 47	21·5
1,080	2 20	7	3,090	7 59	22
1,150	2 30	7·5	3,150	8 11	22·5
1,220	2 40	8	3,210	8 23	23
1,300	2 51	8·5	3,270	8 35	23·5
1,370	3 1	9	3,330	8 48	24
1,440	3 12	9·5	3,390	9 0	24·5
1,510	3 22	10	3,440	9 12	25
1,580	3 33	10·5	3,500	9 25	25·5
1,650	3 43	11	3,570	9 38	26
1,720	3 54	11·5	3,620	9 51	26·5
1,790	4 5	12	3,670	10 2	27
1,860	4 16	12·5	3,730	10 15	27·5
1,930	4 27	13	3,798	10 29	28
2,000	4 39	13·5	3,840	10 42	28·5
2,070	4 50	14	3,900	10 56	29
2,140	5 2	14·5	3,950	11 8	29·5
2,200	5 13	15	4,010	11 23	30
2,270	5 25	15·5			

8-INCH B.L. GUN.

Full Charge: 100 lbs. Projectile: 180 lbs.

Range.	Elevation.	Time of Flight.	Length of Fuze.	Range.	Elevation.	Time of Flight.	Length of Fuze.
Yards.	° ′	″	Inches.	Yards.	° ′	″	Inches.
100	0 1	.08	·01	4,000	4 16	8·11	3·21
200	0 3	·18	·07	4,100	4 26	8·38	3·31
300	0 5	·33	·14	4,200	4 36	8·65	3·41
400	0 7	·50	·21	4,300	4 46	8·93	3·51
500	0 9	·68	·28	4,400	4 56	9·21	3·61
600	0 12	·88	·35	4,500	5 6	9·49	3·71
700	0 15	1·06	·42	4,600	5 17	9·77	3·81
800	0 19	1·24	·50	4,700	5 28	10·06	3·92
900	0 23	1·42	·57	4,800	5 39	10·35	4·03
1,000	0 27	1·61	·65	4,900	5 50	10·65	4·14
1,100	0 32	1·79	·73	5,000	6 1	10·95	4·25
1,200	0 37	1·97	·80	5,100	6 13	11·26	4·36
1,300	0 42	2·15	·87	5,200	6 25	11·57	4·47
1,400	0 48	2·34	·95	5,300	6 37	11·88	4·58
1,500	0 54	2·53	1·02	5,400	6 49	12·19	4·69
1,600	1 0	2·72	1·10	5,500	7 1	12·50	4·80
1,700	1 6	2·91	1·17	5,600	7 13	12·81	4·91
1,800	1 13	3·10	1·25	5,700	7 26	13·13	5·02
1,900	1 20	3·30	1·33	5,800	7 39	13·46	5·13
2,000	1 27	3·50	1·41	5,900	7 52	13·79	5·25
2,100	1 33	3·70	1·49	6,000	8 5	14·12	5·37
2,200	1 40	3·90	1·57	6,100	8 18	14·45	5·49
2,300	1 47	4·11	1·66	6,200	8 31	14·78	5·61
2,400	1 54	4·32	1·75	6,300	8 45	15·11	5·73
2,500	2 2	4·54	1·84	6,400	8 59	15·44	5·85
2,600	2 10	4·76	1·92	6,500	9 13	15·77	
2,700	2 18	4·98	2·00	6,600	9 27	16·10	
2,800	2 26	5·20	2·09	6,700	9 41	16·43	
2,900	2 34	5·42	2·18	6,800	9 55	16·77	
3,000	2 42	5·65	2·27	6,900	10 9	17·11	
3,100	2 51	5·88	2·37	7,000	10 23	17·45	
3,200	3 0	6·11	2·46	7,100	10 37	17·79	
3,300	3 9	6·35	2·55	7,200	10 51	18·13	
3,400	3 18	6·59	2·64	7,300	11 5	18·47	
3,500	3 27	6·84	2·73	7,400	11 19	18·81	
3,600	3 36	7·09	2·83	7,500	11 33	19·15	
3,700	3 46	7·34	2·92	7,600	11 47	19·49	
3,800	3 56	7·59	3·02	7,700	12 1	19·83	
3,900	4 6	7·85	3·11				

8-INCH B.L. GUN.

Reduced Charge: 65 lbs. Projectile: 180 lbs.

Range.	Elevation.	Time of Flight.	Length of Fuze.	Range.	Elevation.	Time of Flight.	Length of Fuze.
Yards.	° ′	″	Inches.	Yards.	° ′	″	Inches.
100	0 1	·12	·04	3,600	5 22	8·51	3·36
200	0 3	·27	·10	3,700	5 35	8·80	3·46
300	0 6	·45	·18	3,800	5 48	9·09	3·57
400	0 9	·65	·26	3,900	6 1	9·39	3·68
500	0 12	·86	·34	4,000	6 14	9·69	3·79
600	0 16	1·07	·42	4,100	6 27	10·00	3·89
700	0 21	1·29	·51	4,200	6 41	10·31	4·00
800	0 27	1·51	·60	4,300	6 55	10·62	4·11
900	0 34	1·73	·69	4,400	7 9	10·93	4·22
1,000	0 41	1·95	·78	4,500	7 23	11·25	4·34
1,100	0 48	2·17	·87	4,600	7 37	11·57	4·46
1,200	0 55	2·39	·96	4,700	7 51	11·90	4·58
1,300	1 3	2·61	1·05	4,800	8 5	12·23	4·70
1,400	1 11	2·83	1·14	4,900	8 19	12·56	4·82
1,500	1 20	3·05	1·23	5,000	8 33	12·89	4·94
1,600	1 29	3·27	1·32	5,100	8 47	13·22	5·05
1,700	1 39	3·49	1·42	5,200	9 1	13·55	5·17
1,800	1 49	3·72	1·51	5,300	9 15	13·88	5·29
1,900	1 59	3·96	1·61	5,400	9 30	14·22	5·41
2,000	2 9	4·21	1·71	5,500	9 45	14·57	5·53
2,100	2 20	4·46	1·80	5,600	10 0	14·92	5·65
2,200	2 31	4·71	1·90	5,700	10 15	15·27	5·77
2,300	2 42	4·96	2·00	5,800	10 29	15·62	5·89
2,400	2 53	5·22	2·10	5,900	10 44	15·97	
2,500	3 4	5·48	2·20	6,000	10 58	16·32	
2,600	3 16	5·74	2·30	6,100	11 13	16·67	
2,700	3 28	6·01	2·40	6,200	11 27	17·03	
2,800	3 40	6·28	2·51	6,300	11 42	17·39	
2,900	3 52	6·55	2·62	6,400	11 57	17·75	
3,000	4 4	6·82	2·73	6,500	12 12	18·12	
3,100	4 17	7·09	2·83	6,600	12 28	18·50	
3,200	4 30	7·37	2·93	6,700	12 44	18·88	
3,300	4 43	7·65	3·03	6,800	13 0	19·26	
3,400	4 56	7·93	3·14	6,900	13 16	19·64	
3,500	5 9	8·22	3·25	7,000	13 32	20·02	

8-INCH B.L. GUN.

Charge, 65 lbs. Projectile: 210 lbs. Muzzle velocity: 1,575 f.s.

Range.	Elevation.	Time of Flight.	Length of Fuze. Large.	Length of Fuze. Small.
Yards.	° ′	″	Inches.	Inches.
100	0 3	·20		
200	0 10	·40		
300	0 17	·60		
400	0 24	·80		·37
500	0 32	1·00	·38	·49
600	0 39	1·20	·46	·61
700	0 46	1·40	·54	·74
800	0 53	1·60	·62	·86
900	1 0	1·80	·70	·98
1,000	1 7	2·01	·78	1·11
1,100	1 15	2·22	·87	1·24
1,200	1 23	2·45	·95	1·37
1,300	1 31	2·68	1·04	1·50
1,400	1 39	2·91	1·13	1·64
1,500	1 48	3·14	1·22	1·77
1,600	1 57	3·37	1·31	1·90
1,700	2 6	3·61	1·41	2·03
1,800	2 15	3·85	1·50	2·16
1,900	2 24	4·09	1·59	2·29
2,000	2 33	4·33	1·69	2·41
2,100	2 42	4·57	1·78	2·53
2,200	2 52	4·82	1·88	2·66
2,300	3 2	5·07	1·98	2·78
2,400	3 12	5·32	2·07	2·90
2,500	3 22	5·57	2·17	3·02
2,600	3 32	5·83	2·27	3·14
2,700	3 42	6·09	2·37	3·27
2,800	3 53	6·35	2·48	3·39
2,900	4 4	6·61	2·58	3·51
3,000	4 15	6·87	2·69	3·64
3,100	4 26	7·14	2·80	3·77
3,200	4 37	7·41	2·90	3·90
3,300	4 48	7·68	3·01	4·03
3,400	4 59	7·95	3·12	4·16
3,500	5 10	8·22	3·23	
3,600	5 22	8·50	3·34	
3,700	5 34	8·78	3·45	

Range.	Elevation.	Time of Flight.	Length of Fuze. Large.
Yards.	° ′	″	Inches.
3,800	5 46	9·07	3·56
3,900	5 59	9·36	3·68
4,000	6 12	9·65	3·79
4,100	6 25	9·94	3·91
4,200	6 38	10·23	4·02
4,300	6 51	10·53	4·14
4,400	7 4	10·83	4·25
4,500	7 18	11·13	4·37
4,600	7 32	11·43	4·49
4,700	7 46	11·74	4·61
4,800	8 0	12·05	4·73
4,900	8 15	12·36	4·85
5,000	8 30	12·67	4·97
5,100	8 45	12·98	5·09
5,200	9 0	13·29	5·21
5,300	9 16	13·60	5·33
5,400	9 32	13·92	5·45
5,500	9 48	14·24	5·57
5,600	10 4	14·56	5·69
5,700	10 20	14·88	
5,800	10 36	15·20	
5,900	10 53	15·53	
6,000	11 10	15·87	
6,100	11 27	16·21	
6,200	11 44	16·55	
6,300	12 1	16·89	
6,400	12 18	17·23	
6,500	12 36	17·57	
6,600	12 54	17·91	
6,700	13 12	18·25	
6,800	13 30	18·60	
6,900	13 48	18·95	
7,000	14 6	19·30	
7,100	14 25	19·66	
7,200	14 44	20·03	
7,300	15 3	20·40	
7,400	15 23	20·77	

6-INCH B.L. GUN.*

Full Charge: 42 lbs. Projectile: 80 lbs.

Range.	Elevation.	Time of Flight.	Length of Fuze.
Yards.	° ′	″	Inches.
100	0 2	·03	·00
200	0 7	·07	·02
300	0 2	·14	·04
400	0 3	·24	·08
500	0 5	·38	·14
600	0 8	·54	·21
700	0 12	·72	·28
800	0 17	·90	·35
900	0 23	1·12	·44
1,000	0 30	1·34	·53
1,100	0 37	1·58	·62
1,200	0 44	1·82	·72
1,300	0 52	2·06	·82
1,400	1 0	2·30	·92
1,500	1 8	2·54	1·02
1,600	1 16	2·78	1·12
1,700	1 24	3·02	1·22
1,800	1 32	3·26	1·32
1,900	1 40	3·50	1·42
2,000	1 48	3·74	1·52
2,100	1 56	3·98	1·62
2,200	2 4	4·22	1·72
2,300	2 12	4·46	1·82
2,400	2 21	4·72	1·92
2,500	2 30	4·98	2·02
2,600	2 39	5·24	2·12
2,700	2 48	5·50	2·23
2,800	2 57	5·76	2·33
2,900	3 6	6·02	2·43
3,000	3 16	6·28	2·53
3,100	3 26	6·54	2·63
3,200	3 36	6·80	2·73
3,300	3 46	7·06	2·83
3,400	3 56	7·32	2·93
3,500	4 7	7·60	3·03
3,600	4 18	7·88	3·13

Range.	Elevation.	Time of Flight.	Length of Fuze.
Yards.	° ′	″	Inches.
3,700	4 29	8·16	3·23
3,800	4 41	8·44	3·34
3,900	4 53	8·72	3·44
4,000	5 5	9·00	3·54
4,100	5 17	9·28	3·64
4,200	5 30	9·56	3·74
4,300	5 43	9·86	3·84
4,400	5 56	10·16	3·95
4,500	6 10	10·46	4·06
4,600	6 24	10·76	4·17
4,700	6 38	11·06	4·28
4,800	6 52	11·36	4·39
4,900	7 6	11·66	4·50
5,000	7 20	11·96	4·61
5,100	7 35	12·27	4·71
5,200	7 50	12·57	4·82
5,300	8 5	12·88	4·93
5,400	8 20	13·18	5·04
5,500	8 35	13·49	5·15
5,600	8 50	13·80	5·26
5,700	9 5	14·10	5·37
5,800	9 20	14·41	5·48
5,900	9 35	14·71	5·59
6,000	9 50	15·02	5·70
6,100	10 5	15·34	
6,200	10 20	15·66	
6,300	10 35	16·00	
6,400	10 51	16·30	
6,500	11 7	16·62	
6,600	11 23	16·94	
6,700	11 40	17·26	
6,800	11 57	17·58	
6,900	12 14	17·90	
7,000	12 31	18·23	
7,100	12 48	18·56	
7,200	13 5	18·89	

* NOTE.—This is the spare gun at the Williamstown Drill-room.

6-INCH B.L. GUN.*

Reduced Charge: 30 lbs. Projectile: 80 lbs.

Range.	Elevation.	Time of Flight.	Length of Fuze.	Range.	Elevation.	Time of Flight.	Length of Fuze.
Yards.	° ′	″	Inches.	Yards.	° ′	″	Inches.
100	0 0	·14	·05	3,100	5 11	7·90	3·14
200	0 1	·28	·10	3,200	5 26	8·20	3·25
300	0 3	·43	·16	3,300	5 41	8·50	3·36
400	0 6	·59	·22	3,400	5 57	8·82	3·47
500	0 11	·77	·30	3,500	6 13	9·14	3·59
600	0 17	·97	·38	3,600	6 29	9·46	3·70
700	0 24	1·19	·47	3,700	6 45	9·78	3·82
800	0 32	1·42	·56	3,800	7 1	10·10	3·93
900	0 41	1·66	·66	3,900	7 17	10·43	4·05
1,000	0 51	1·90	·76	4,000	7 33	10·76	4·17
1,100	1 2	2·16	·86	4,100	7 59	11·09	4·29
1,200	1 13	2·42	·97	4,200	8 5	11·42	4·41
1,300	1 24	2·68	1·08	4,300	8 21	11·75	4·52
1,400	1 35	2·94	1·19	4,400	8 38	12·08	4·64
1,500	1 46	3·20	1·29	4,500	8 55	12·42	4·76
1,600	1 57	3·48	1·41	4,600	9 12	12·75	4·88
1,700	2 8	3·76	1·53	4,700	9 29	13·10	5·00
1,800	2 19	4·04	1·64	4,800	9 46	13·44	5·12
1,900	2 31	4·42	1·76	4,900	10 4	13·78	5·25
2,000	2 43	4·60	1·88	5,000	10 22	14·12	5·37
2,100	2 55	4·90	2·00	5,100	10 40	14·46	5·50
2,200	3 8	5·20	2·11	5,200	10 58	14·80	5·62
2,300	3 21	5·50	2·22	5,300	11 16	15·14	5·75
2,400	3 34	5·80	2·33	5,400	11 34	15·48	
2,500	3 47	6·10	2·44	5,500	11 51	15·82	
2,600	4 0	6·40	2·56	5,600	12 8	16·16	
2,700	4 14	6·70	2·68	5,700	12 25	16·50	
2,800	4 28	7·00	2·80	5,800	12 42	16·83	
2,900	4 42	7·30	2·92	5,900	12 59	17·16	
3,000	4 56	7·60	3·03	6,000	13 17	17·48	

* NOTE.—This is the spare gun at the Williamstown Drill-room.

6-INCH B.L. GUNS.*

Reduced Charge: 30 lbs. Projectile: 80 lbs.

Range.	Elevation.	Time of Flight	Length of Fuze.		Range.	Elevation.	Time of Flight.	Length of Fuze.
			Large.	Small.				Large.
Yards.	° ′	″	In.	In.	Yards.	° ′	″	In.
100	0 0	·14			3,100	5 11	7·90	3·14
200	0 1	·28			3,200	5 26	8·20	3·25
300	0 3	·43			3,300	5 41	8·50	3·36
400	0 6	·59			3,400	5 57	8·82	3·47
500	0 11	·77	..	0·36	3,500	6 13	9·14	3·59
600	0 17	·97	0·38	0·48	3,600	6 29	9·46	3·70
700	0 24	1·19	0·47	0·61	3,700	6 45	9·78	3·82
800	0 32	1·42	0·56	0·75	3,800	7 1	10·10	3·93
900	0 41	1·66	0·66	0·90	3,900	7 17	10·43	4·05
1,000	0 51	1·90	0·76	1·05	4,000	7 33	10·76	4·17
1,100	1 2	2·16	0·86	1·20	4,100	7 59	11·09	4·29
1,200	1 13	2·42	0·97	1·35	4,200	8 5	11·42	4·41
1,300	1 24	2·68	1·08	1·50	4,300	8 21	11·75	4·52
1,400	1 35	2·94	1·19	1·65	4,400	8 38	12·08	4·64
1,500	1 46	3·20	1·29	1·80	4,500	8 55	12·42	4·76
1,600	1 57	3·48	1·41	1·95	4,600	9 12	12·75	4·88
1,700	2 8	3·76	1·53	2·10	4,700	9 29	13·10	5·00
1,800	2 19	4·04	1·64	2·25	4,800	9 46	13·44	5·12
1,900	2 31	4·32	1·76	2·40	4,900	10 4	13·78	5·25
2,000	2 43	4·60	1·88	2·55	5,000	10 22	14·12	5·37
2,100	2 55	4·90	2·00	2·70	5,100	10 40	14·46	5·50
2,200	3 8	5·20	2·11	2·85	5,200	10 58	14·80	5·62
2,300	3 21	5·50	2·22	3·00	5,300	11 16	15·14	5·75
2,400	3 34	5·80	2·33	3·14	5,400	11 34	15·48	
2,500	3 47	6·10	2·44	3·28	5,500	11 51	15·82	
2,600	4 0	6·40	2·56	3·42	5,600	12 8	16·16	
2,700	4 14	6·70	2·68	3·56	5,700	12 25	16·50	
2,800	4 28	7·00	2·80	3·70	5,800	12 42	16·83	
2,900	4 42	7·30	2·92	3·85	5,900	12 59	17·16	
3,000	4 56	7·60	3·03	4·00	6,000	13 17	17·48	

Small Fuze used up to 3,000 yards.

* NOTE.—These guns are mounted in *Victoria*, *Albert*, and Hopper Barges.

6-INCH B.L. GUNS.*

Full Charge: 42 lbs. Projectile: 80 lbs.

Range.	Elevation.	Time of Flight	Length of Fuze.		Range.	Elevation.	Time of Flight.	Length of Fuze.
			Large.	Small.				Large.
Yards.	° ′	″	In.	In.	Yards.	° ′	″	In.
100	0 3	·16			3,800	4 33	8·63	3·38
200	0 7	·32			3,900	4 44	8·93	3·50
300	0 11	·48			4,000	4 56	9·24	3·62
400	0 15	·64			4,100	5 8	9·55	3·74
500	0 19	·81	..	·37	4,200	5 20	9·86	3·86
600	0 23	·98	·37	·48	4,300	5 32	10·17	3·99
700	0 28	1·16	·44	·59	4,400	5 44	10·49	4·12
800	0 33	1·34	·51	·70	4,500	5 57	10·81	4·24
900	0 38	1·53	·58	·82	4,600	6 10	11·14	4·37
1,000	0 43	1·72	·66	·94	4,700	6 23	11·47	4·50
1,100	0 48	1·91	·73	1·06	4,800	6 36	11·80	4·63
1,200	0 54	2·11	·81	1·18	4,900	6 50	12·13	4·75
1,300	1 0	2·32	·89	1·30	5,000	7 4	12·47	4·88
1,400	1 6	2·53	·97	1·42	5,100	7 18	12·81	5·01
1,500	1 12	2·74	1·06	1·54	5,200	7 32	13·15	5·14
1,600	1 18	2·95	1·15	1·66	5,300	7 46	13·50	5·27
1,700	1 25	3·17	1·23	1·79	5,400	8 1	13·85	5·41
1,800	1 32	3·39	1·32	1·91	5,500	8 16	14·21	5·55
1,900	1 39	3·61	1·41	2·04	5,600	8 31	14·57	5·69
2,000	1 46	3·84	1·50	2·16	5,700	8 46	14·93	
2,100	1 53	4·08	1·59	2·29	5,800	9 1	15·30	
2,200	2 1	4·32	1·68	2·41	5,900	9 16	15·67	
2,300	2 9	4·56	1·77	2·53	6,000	9 31	16·04	
2,400	2 17	4·80	1·87	2·65	6,100	9 47	16·42	
2,500	2 25	5·05	1·97	2·78	6,200	10 3	16·80	
2,600	2 34	5·30	2·07	2·90	6,300	10 19	17·19	
2,700	2 43	5·56	2·17	3·02	6,400	10 35	17·58	
2,800	2 52	5·82	2·27	3·13	6,500	10 51	17·97	
2,900	3 1	6·08	2·38	3·26	6,600	11 8	18·37	
3,000	3 10	6·35	2·49	3·39	6,700	11 25	18·77	
3,100	3 20	6·62	2·60	3·51	6,800	11 42	19·18	
3,200	3 30	6·90	2·71	3·64	6,900	11 59	19·59	
3,300	3 40	7·18	2·82	3·78	7,000	12 17	20·00	
3,400	3 50	7·47	2·93	3·92	7,100	12 35	20·42	
3,500	4 0	7·76	3·04	4·06	7,200	12 53	20·84	
3,600	4 11	8·05	3·15		7,300	13 11	21·26	
3,700	4 22	8·34	3·26		7,400	13 29	21·68	

Small Fuze used up to 3,500 yards.

* NOTE.—These guns are mounted in *Victoria*, *Albert*, and Hopper Barges.

6-INCH B.L. GUN.*

Charge: 30 lbs. Projectile: 100 lbs. Muzzle velocity: 1,450 f.s.

Range.	Elevation.	Time of Flight	Length of Fuze		Range.	Elevation.	Time of Flight.	Length of Fuze.
			Large.	Small.				Large.
Yards.	° ′	″	In.	In.	Yards.	° ′	″	In.
100	0 4	·21			3,300	5 56	8·50	3·34
200	0 12	·42			3,400	6 10	8·80	3·46
300	0 20	·63			3,500	6 25	9·11	3·58
400	0 28	·84		·39	3,600	6 40	9·42	3·70
500	0 36	1·06	·40	·53	3,700	6 55	9·73	3·82
600	0 45	1·28	·49	·66	3,800	7 10	10·05	3·95
700	0 54	1·50	·58	·80	3,900	7 25	10·37	4·07
800	1 3	1·73	·67	·94	4,000	7 41	10·69	4·20
900	1 12	1·96	·76	1·08	4,100	7 57	11·01	4·32
1,000	1 21	2·20	·86	1·22	4,200	8 13	11·33	4·45
1,100	1 31	2·44	·95	1·36	4,300	8 29	11·65	4·57
1,200	1 41	2·69	1·05	1·51	4,400	8 45	11·97	4·70
1,300	1 51	2·94	1·15	1·65	4,500	9 2	12·30	4·82
1,400	2 1	3·19	1·24	1·80	4,600	9 19	12·63	4·95
1,500	2 11	3·44	1·34	1·94	4,700	9 36	12·96	5·08
1,600	2 22	3·70	1·44	2·08	4,800	9 53	13·29	5·21
1,700	2 33	3·96	1·54	2·22	4,900	10 11	13·63	5·34
1,800	2 44	4·22	1·64	2·35	5,000	10 29	13·97	5·47
1,900	2 55	4·49	1·75	2·49	5,100	10 47	14·31	5·60
2,000	3 6	4·76	1·86	2·63	5,200	11 5	14·65	5·73
2,100	3 18	5·03	1·96	2·76	5,300	11 24	15·00	
2,200	3 30	5·30	2·07	2·90	5,400	11 43	15·35	
2,300	3 42	5·58	2·17	3·03	5,500	12 2	15·70	
2,400	3 55	5·86	2·28	3·16	5,600	12 21	16·05	
2,500	4 8	6·14	2·39	3·29	5,700	12 40	16·40	
2,600	4 21	6·43	2·51	3·43	5,800	12 59	16·75	
2,700	4 34	6·72	2·63	3·56	5,900	13 19	17·10	
2,800	4 47	7·01	2·74	3·70	6,000	13 39	17·46	
2,900	5 0	7·30	2·86	3·84	6,100	13 59	17·82	
3,000	5 14	7·60	2·98	3·99	6,200	14 19	18·18	
3,100	5 28	7·90	3·10	4·13	6,300	14 39	18·54	
3,200	5 42	8·20	3·22		6,400	15 0	18·91	

* NOTE.—These guns are mounted in *Victoria*, *Albert*, and Hopper Barges.

12½-PR. B.L. GUNS.

Charge: 3¾ lbs. R.L.G². Projectile: 12½ lbs.

Muzzle velocity: 1,650 f.s.

Range.	Elevation.	Time.	Length of Fuze.		Range.	Elevation.	Time.	Length of Fuze.
			Small.	Medium.				Medium.
Yards.	° ′	″	In.	In.	Yards.	° ′	″	In.
100	0 0	·18	·08	·00	3,100	6 2	9·19	3·93
200	0 0	·37	·15	·01	3,200	6 21	9·61	4·13
300	0 4	·78	·37	·04	3,300	6 40	10·03	4·33
400	0 10	1·03	·54	·08	3,400	6 59	10·45	4·53
500	0 16	1·28	·71	·12	3,500	7 19	10·87	4·73
600	0 23	1·53	·90	·17	3,600	7 39	11·30	4·94
700	0 31	1·78	1·06	·22	3,700	7 59	11·75	
800	0 40	2·04	1·21	·29	3,800	8 20	12·20	
900	0 50	2·30	1·36	·37	3,900	8 41	12·65	
1,000	1 0	2·56	1·50	·46	4,000	9 2	13·10	
1,100	1 10	2·82	1·64	·56	4,100	9 23	13·55	
1,200	1 21	3·08	1·77	·68	4,200	9 45	14·00	
1,300	1 32	3·34	1·88	·80	4,300	10 7	14·45	
1,400	1 43	3·60	2·01	·95	4,400	10 29	14·90	
1,500	1 55	3·87	2·14	1·12	4,500	10 52	15·40	
1,600	2 7	4·14	2·27	1·30	4,600	11 15	15·90	
1,700	2 20	4·42	2·41	1·50	4,700	11 40	16·40	
1,800	2 33	4·71	2·55	1·69	4,800	12 6	16·90	
1,900	2 47	5·00	2·70	1·87	4,900	12 33	17·40	
2,000	3 1	5·30	2·85	2·04	5,000	13 1	17·92	
2,100	3 15	5·60	3·00	2·20	5,100	13 30	18·44	
2,200	3 30	5·91	3·15	2·34	5,200	14 0	18·96	
2,300	3 45	6·23	3·31	2·50	5,300	14 31	19·50	
2,400	4 1	6·56	3·48	2·67	5,400	15 3	20·04	
2,500	4 17	6·90	3·65	2·84	5,500	15 36	20·60	
2,600	4 34	7·25	3·83	3·01	5,600	16 12	21·16	
2,700	4 51	7·61	4·01	3·18	5,700	16 51	21·76	
2,800	5 8	7·99	4·20	3·36	5,800	17 33	22·36	
2,900	5 26	8·38	..	3·55	5,900	18 18	23·00	
3,000	5 44	8·78	..	3·74	6,000	19 6	23·70	

Small Fuze used up to 2,900 yards.

9-PR. B.L. GUNS.

Charge: 2·5 lbs. Projectile: 9 lbs.

Range.	Elevation.	Time.	Length of Fuze.		Range.	Elevation.	Time.	Length of Fuze.
			Medium.	Small				Medium.
Yards.	° ′	″	In.	In.	Yards.	° ′	″	In.
100	0 4	·25	·00	·10	2,900	5 45	8·26	3·50
200	0 8	·46	·02	·18	3,000	6 2	8·64	3·68
300	0 13	·68	·03	·31	3,100	6 21	9·02	3·86
400	0 19	·89	·06	·45	3,200	6 40	9·40	4·04
500	0 26	1·11	·09	·61	3,300	7 0	9·80	4·24
600	0 33	1·35	·13	·78	3,400	7 20	10·20	4·43
700	0 41	1·60	·18	·96	3,500	7 40	10·60	4·63
800	0 49	1·86	·24	1·13	3,600	8 0	11·04	4·84
900	0 58	2·12	·30	1·29	3,700	8 20	11·48	5·04
1,000	1 7	2·38	·39	1·44	3,800	8 42	11·92	
1,100	1 16	2·66	·49	1·58	3,900	9 4	12·36	
1,200	1 26	2·94	·61	1·70	4,000	9 26	12·08	
1,300	1 38	3·22	·73	1·83	4,100	9 50	13·24	
1,400	1 50	3·50	·89	1·97	4,200	10 14	13·70	
1,500	2 4	3·78	1·06	2·11	4,300	10 38	14·16	
1,600	2 18	4·08	1·27	2·25	4,400	11 3	14·64	
1,700	2 32	4·38	1·48	2·40	4,500	11 28	15·12	
1,800	2 46	4·68	1·68	2·54	4,600	11 54	15·60	
1,900	3 0	4·98	1·88	2·69	4,700	12 20	16·08	
2,000	3 16	5·28	2·05	2·84	4,800	12 47	16·56	
2,100	3 32	5·58	2·19	2·99	4,900	13 15	17·04	
2,200	3 48	5·90	2·35	3·15	5,000	13 44	17·52	
2,300	4 4	6·22	2·50	3·31	5,100	14 14	18·00	
2,400	4 20	6·54	2·65	3·47	5,200	14 45	18·50	
2,500	4 37	6·86	2·80	3·63	5,300	15 17	19·00	
2,600	4 54	7·20	2·97	3·80	5,400	15 50	19·50	
2,700	5 11	7·54	3·14	3·97	5,500	16 28	20·00	
2,800	5 28	7·90	3·33		5,600	17 10	20·50	

Small Fuze used up to 2,800 yards.

4·7 INCH Q.F. GUNS.

Charge: 12 lbs. S.P. Projectile: 45 lbs. Muzzle velocity: 1,786 f.s. Jump: 2′.

Range	Elevation.	5 minutes elevation increases or decreases the range by	5 minutes will alter point of impact vertically or laterally at each range.	Remaining Velocity.	Time of Flight.	Angle of Descent.	Length of Fuze.	
							Medium.	Small.
Yards.	° ′	Yards.	Yards.	f. s.	″	° ′	Inches.	
100	0 4	92	0·14	1,748	0·21	0 6		
200	0 10	90	0·29	1,710	0·42	0 12		
300	0 16	88	0·43	1,673	0·63	0 18		
400	0 23	86	0·58	1,637	0·85	0 25		·40
500	0 29	84	0·72	1,602	1·06	0 31		·53
600	0 36	83	0·87	1,568	1·28	0 37		·66
700	0 42	81	1·01	1,535	1·49	0 45		·79
800	0 49	79	1·16	1,503	1·71	0 52		·93
900	0 56	77	1·31	1,471	1·93	0 59		1·07
1,000	1 3	76	1·45	1,440	2·15	1 6		1·20
1,100	1 9	74	1·60	1,409	2·37	1 14	·42	1·32
1,200	1 16	73	1·74	1,378	2·59	1 22	·49	1·45
1,300	1 23	71	1·89	1,348	2·81	1 31	·58	1·58
1,400	1 30	70	2·03	1,319	3·04	1 40	·68	1·71
1,500	1 37	68	2·18	1,291	3·26	1 49	·79	1·84
1,600	1 45	67	2·32	1,263	3·49	1 59	·91	1·96
1,700	1 52	65	2·47	1,237	3·71	2 9	1·04	2·08
1,800	2 0	64	2·61	1,213	3·94	2 20	1·17	2·21
1,900	2 8	62	2·76	1,190	4·17	2 31	1·32	2·33
2,000	2 16	61	2·91	1,168	4·40	2 43	1·48	2·44
2,100	2 24	59	3·05	1,148	4·63	2 55	1·63	2·56
2,200	2 33	58	3·21	1,129	4·86	3 8	1·78	2·68
2,300	2 41	57	3·34	1,111	5·09	3 21	1·92	2·79
2,400	2 50	56	3·49	1,094	5·33	3 35	2·05	2·91
2,500	2 59	54	3·63	1,077	5·57	3 49	2·19	3·02
2,600	3 8	53	3·78	1,061	5·81	4 4	2·31	3·14
2,700	3 17	52	3·92	1,045	6·05	4 19	2·44	3·25
2,800	3 27	51	4·07	1,030	6·30	4 34	2·57	3·37

4·7 INCH Q.F. GUN.

Charge: 12 lbs. S.P. Projectile: 45 lbs. Muzzle velocity: 1786 f.s. Jump: 2′—*continued.*

Range	Elevation.	5 minutes elevation increases or decreases the range by	5 minutes will alter point of impact vertically or laterally at each range.	Remaining Velocity.	Time of Flight.	Angle of Descent.	Length of Fuze.	
							Medium.	Small.
Yards.	° ′	Yards.	Yards.	f.s.	″	° ′	Inches.	
2,900	3 37	50	4·21	1016	6·55	4 49	2·70	3·48
3,000	3 47	49	4·36	1003	6·81	5 5	2·82	3·61
3,100	3 57	48	4·51	991	7·07	5 21	2·94	3·73
3,200	4 8	47	4·65	980	7·33	5 38	3·06	3·86
3,300	4 19	46	4·80	970	7·60	5 55	3·19	3·99
3,400	4 30	45	4·94	960	7·87	6 12	3·32	4·12
3,500	4 41	44	5·09	950	8·14	6 29	3·45	
3,600	4 53	43	5·23	940	8·42	6 47	3·58	
3,700	5 5	42	5·38	930	8·70	7 5	3·72	
3,800	5 17	41	5·52	920	8·98	7 24	3·85	
3,900	5 29	40	5·67	911	9·26	7 43	3·97	
4,000	5 41	40	5·81	902	9·55	8 2	4·10	
4,100	5 53	39	5.96	893	9·83	8 21	4·24	
4,200	6 6	39	6·11	885	10·12	8 41	4·38	
4,300	6 19	38	6·25	876	10·41	9 1	4·52	
4,400	6 32	38	6·40	867	10·70	9 21	4·66	
4,500	6 45	38	6·54	858	11·00	9 41	4·80	
4,600	6 58	37	6·69	850	11·30	10 2		
4,700	7 11	37	6·83	842	11·61	10 23		
4,800	7 25	36	6·98	834	11·92	10 44		
4,900	7 39	36	7·13	826	12·23	11 5		
5,000	7 53	36	7·27	818	12·55	11 26		
5,100	8 7	35	7·42	811	12·87	11 47		
5,200	8 21	35	7·56	804	13·19	12 9		
5,300	8 35	35	7·71	797	13·51	12 31		
5,400	8 50	35	7·85	790	13·83	12 53		
5,500	9 4	34	8·00	783	14·15	13 15		
5,600	9 19	34	8·14	776	14·48	13 38		

Small fuze used up to 3,400 yards.

4·7 INCH Q.F. GUN.

Charge: 12 lbs. S.P. Projectile: 45 lbs. Muzzle velocity: 1786 f.s. Jump: 2′—*continued.*

Range	Elevation.	5 minutes elevation increases or decreases the range by	5 minutes will alter point of impact vertically or laterally at each range.	Remaining Velocity.	Time of Flight.	Angle of Descent.	Length of Fuze.	
							Medium.	Small.
Yards.	° ′	Yards.	Yards.	f.s.	″	° ′	Inches.	
5,700	9 34	34	8·29	769	14·81	14 1		
5,800	9 49	34	8·43	762	15·14	14 24		
5,900	10 4	33	8·58	755	15·47	14 47		
6,000	10 19	33	8·73	748	15·80	15 11		
6,100	10 36	33	8·87	742	16·14	15 33		
6,200	10 52	33	9·01	736	16·48	15 57		
6,300	11 9	32	9·16	730	16.83	16 20		
6,400	11 26	32	9·30	724	17·18	16 44		
6,500	11 43	32	9·45	718	17·54	17 8		
6,600	12 1	32	9·60	712	17·90	17 32		
6,700	12 19	31	9·74	706	18·27	17 56		
6,800	12 38	31	9·89	700	18·64	18 20		
6,900	12 57	31	10·03	694	19.02	18 44		
7,000	13 17	31	10·18	689	19·40	19 9		
7,100	13 37	31	10·32	683	19·79	19 34		
7,200	13 58	30	10·46	678	20·18	19 59		
7,300	14 19	30	10·60	673	20·58	20 24		
7,400	14 41	30	10·75	668	20·99	20 50		
7,500	15 4	30	10·89	663	21·41	21 16		
7,600	15 27	30	11·04	658	21·84	21 42		

Small fuze used up to 3,400 yards.

NORDENFELT 6-PR. Q.F. GUNS, MARKS I AND II.

Charge: 1lb. 15oz. Weight of Projectile: 6 lbs. Muzzle velocity: 1870 f.s.

Yards.	Elevation.	Angle of Descent.	Increase or Decrease of Range due to 5′	Time of Flight.	Dangerous Zone for a 6′ object.	Remaining Velocity.
	° ′	° ′	yards.	″	yards.	f.s.
100	0 5	0 6	100	·18	——	1804
200	0 10	0 12	100	·35	——	1741
300	0 15	0 18	100	·52	——	1680
400	0 20	0 24	100	·70	——	1620
500	0 26	0 31	83	·88	222	1561
600	0 32	0 38	83	1·07	182	1504
700	0 39	0 48	71	1·26	143	1448
800	0 46	0 58	71	1·46	118	1395
900	0 53	1 9	71	1·66	100	1345
1000	1 0	1 21	71	1·88	87	1296
1100	1 7	1 33	71	2·10	74	1251
1200	1 15	1 48	62	2·33	64	1208
1300	1 23	2 6	62	2·57	54	1169
1400	1 31	2 24	62	2·83	47	1132
1500	1 39	2 42	62	3·10	42	1097
1600	1 48	3 0	55	3·38	38	1066
1700	1 57	3 18	55	3·67	35	1038
1800	2 8	3 37	46	3·97	31	1014
1900	2 19	3 56	46	4·27	29	995
2000	2 31	4 17	42	4·57	27	979
2100	2 43	4 38	42	4·88	24	966
2200	2 55	5 0	42	5·19	23	954
2300	3 8	5 23	38	5·50	21	942
2400	3 21	5 46	38	5·82	19	930
2500	3 34	6 10	38	6·14	18	918
2600	3 47	6 37	38	6·46	17	904
2700	4 0	7 4	38	6·78	16	890
2800	4 14	7 32	36	7·02	15	876
2900	4 28	8 0	36	7·46	14	862
3000	4 43	8 30	33	7·80	13	848
3100	4 58	9 2	33	8·15	13	834
3200	5 13	9 36	33	8·50	11	821
3300	5 28	10 11	33	8·85	11	808
3400	5 44	10 47	31	9·20	10	796
3500	6 0	11 23	31	9·58	10	784
3600	6 16	12 0	31	9·98	9	773
3700	6 33	12 37	29	10.38	8	762
3800	6 50	13 15	29	10.80	8	752
3900	7 8	13 54	27	11.22	8	743
4000	7 27	14 36	26	11.64	7	735

PART V.

NAVIGATION.

SECTION 1.—INSTRUMENTS USED IN NAVIGATION.

(A).—AZIMUTH COMPASS.

There are three patterns of compasses in use in the Victorian Navy.

Cerberus has the ordinary ship's azimuth compass.

Victoria has Sir Wm. Thompson's.

Albert has Sir Wm. Thompson's.

There is a slight difference in those of the last two named ships the *Victoria* using a mirror reflector for taking bearings. Both *Cerberus* and *Albert's* compasses are fitted with the direct means, that is a prism and vein.

Both kind of cards are marked in points, degrees, and twenty minutes; used either for steering purposes or taking bearings.

The azimuth ring, which is shipped on the compass bowl, is marked to minutes for taking horizontal angles in observations on shore.

The card of the ordinary ship's compass, as used in *Cerberus* consists of ordinary paper cemented on a plate of mica (a mineral liable to the minimum expansion or contraction through change of temperature).

Sir W. Thompson's card is marked on tissue paper.

Compass bowls are made of copper, freely suspended, and are marked on the fore and aft line of the ship with what is called the lubber's point.

The lubber's point indicates the position of the ship's head, and where it shows on the compass card is the direction in which the ship is heading.

The ordinary ship's compass is supplied with two cards, known as the A and J cards.

The A card is generally used. It is centred with an agate cap, working on a sharp pointed pivot of native alloy.

In heavy weather, when card A is found to be too unsteady, card J is used. It is a heavier card, centred with a ruby cap, and works on a hardened steel pivot. All compasses have a locking arrangement, by which the card is lifted off the pivot-head.

A compass is locked for transporting, or in the case of the ordinary ship's compass when the ship is firing her heavy guns.

Every ship's compass card has a system of magnets suspended on to, and under it.

To maintain the card in a horizontal position, small sliding brass weights are attached to each magnet, and these have to be regulated for any material change of latitude.

The magnets act in keeping the north end of the card pointed in the direction of the magnetic north, and it is they that are affected by the presence of the local attraction of the iron or steel on board ship, causing what is called deviation.

Variation is defined as the angle between the true and magnetic meridians, or it is the declination of the compass from the true meridian.

It is the same quantity whatever the ship's head may be, but varies in different parts of the earth.

The variation of a place, as well as its yearly increase or decrease, is marked on every chart or plan, either by variation curves or at the foot of the title, and on all attached compasses.

It is always given in degrees and minutes, and marked E. or W., according as the compass is deflected to the left or right of the "true" direction.

Deviation, on the other hand, is due to local attraction, and varies according to the direction of the ship's head (owing to the different angles of attraction of the local iron and compass magnet when the ship swings the circle) and the proximity of the local force.

It has been found necessary now to have recourse to various contrivances to neutralize the effect of deviation, but no compass is totally devoid of it; hence one of the reasons of seamen

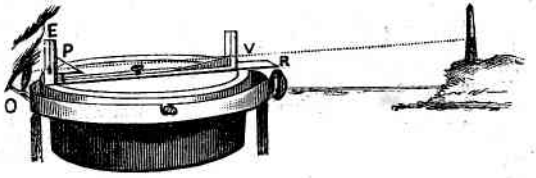
removing their knives, when taking their trick at the wheel, is to prevent its undue and unallowed-for action affecting the compass.

Deviation is always given in degrees and minutes, and usually separately tabulated, and marked E. or W. for each point of the compass, according as the card is deflected to the left or right of the magnetic meridian.

There are several methods for finding the deviation of the compass; but "swinging a ship" on every point, and taking the bearing of another compass on shore, who, by a simultaneously preconcerted signal, takes the bearing of the ship's compass, is the simplest and most accurate. It is called "deviation by simultaneous bearings"—the difference between the two bearings is the deviation, E. or W., according as the ship's observation is to the left or right of the shore-bearing inverted. Of other methods, swinging by a distant object (either the sun or a shore object) are the most often used. In the former, special tables are required; and in the latter charts do not always contain an object sufficiently far distant. It should not be less than seven miles, unless the ship is swung round a special "swinging" buoy, when half that distance would be ample; such is the manner the swinging buoy in Hobson's Bay is used. For any one point of the compass, it is often convenient to take a "rising or setting amplitude," that is at the time that the sun is its own diameter above the horizon, but the solution of this also requires tables.

To take a Bearing.

The following sketch will help to illustrate the description of the use of the azimuth circle:—



An observer, O, by looking through a slit, E, gets the vane, V, in ine with an object on shore (the compass being freely suspended). Then looking through the little hole at the bottom of the slit, E,

follows the line of the vane to the markings on the card seen through the prism, P, and read off the degrees and minutes. In giving the direction of the bearing, look over the compass and see between what quadrantal points V lies. All bearings are read from N. and S. towards E. and W. Thus, for example, the reading is 20° 40′—the vane, V, lies between S. and E.; the bearing, then, is S. 20° 40′ E.

The vane, V, has a reflector, R, attached. This is used when the top of the vane does not reach high enough to the object. This is principally in the case of the sun when above a certain altitude, and this is when shades are used. In taking a bearing of the sun, the object is reflected through the shades to the eye, bisected by the vane, and read off as in the case of the direct object.

It is often found difficult to give the direction of a bearing when it is near quadrantal points. In that case, after reading off, move the azimuth ring to the right and left; if, in moving to the right, the vane passes over 90°, the bearing must be in the left quadrant, and *vice versâ*.

Definitions.

True Meridian, or True North, or True Bearing.—True meridian is that great circle of the earth's surface passing through the poles and the position of the observer. All charts are constructed and printed on the true meridian, that is, true N. and S. A true bearing is a bearing reduced to that true N. and S.

Magnetic Meridian or Bearing.—A magnetic meridian is a meridian or great circle of the earth passing through the magnetic poles and the position of the observer.

All bearings taken by compass, and corrected for deviation of the ship's head, are magnetic, as dependent on the magnetic north or meridian. Hence the difference between a true bearing or course and a magnetic bearing or course is the variation at the position of the observer. Except in charts on a very small scale, all attached compass figures are magnetic. In all sailing directions, or bearings given of any dangers, &c., &c., the bearings or courses are magnetic.

Compass-course or Bearing.

When a compass-course is given it is that course as absolutely steered by the compass, and in such cases, for plotting or steering purposes, has to be corrected for deviation to bring it to its equivalent as a magnetic course. A compass-bearing is that bearing

as absolutely read off the compass. Before it can be applied it must be corrected for the deviation of the ship's head at the time of observation, and referred to the compass diagram on the chart. Should there be no compass diagram, it must be corrected for variation also, and referred to the true meridian on which the chart is constructed.

A compass is divided into four (4) quadrants, enclosing 90° each, and each quadrant enclosing 8 points, they in turn being divided into quarter points.

¼ Point	= 2° 49′	4 Points	= 45° 00′
½ ,,	= 5° 37′	5 ,,	= 56° 15′
¾ ,,	= 8° 26′	6 ,,	= 67° 30′
1 ,,	= 11° 15′	7 ,,	= 78° 15′
2 ,,	= 22° 30′	8 ,,	= 90° 00′
3 ,,	= 33° 45′		

To Shape and Correct a Course.

Given a pair of parallel rulers and a pair of dividers, prick off the distance which it is intended to pass clear of the nearest approaching danger, taking into consideration the set of the tide or current, if any. Connect the point of departure with this point. Slide the parallel rulers on to the centre of the compass diagram on the chart. This will give the magnetic course from one point to the other. To adjust this to the compass, deviation must be applied in the following way:—

Magnetic to find compass, E. deviation apply to the left, and W. deviation to the right.

In the case of a chart not being marked with a magnetic compass, the following are the steps to be taken:—

Correct the true course for variation and deviation in the same way as above. The application is reversed in the cases of—given a compass-course or bearing, find the true or magnetic course or bearing, so that—

Compass to find magnetic or true, E. variation and deviation, apply to the right; W. variation and deviation, apply to the left.

In the cases of bearings they are always observed by compass; and to transfer them to a chart deviation or variation must either both be applied (the former for the direction of the ship's head), according as a chart is designed with a magnetic compass diagram or not, before it can be used.

Fixing the Position of a Ship by Compass Bearings.—The definition of fixing is to ascertain a ship's position by compass bearings or sextant angles taken at the same instant.

1. Objects to be used for accurate fixing by compass at anchor.
2. The further distant an object is the more an error is magnified to the length of line. At the same time, if all the objects are very close, the position is ambiguous, no error will show. A combination of the two has a good result, and a line of 6 inches length should seldom be exceeded if possible. Principal and well-defined objects should be chosen. By principal is meant those the least likely to have been or become shifted, and which will have been the best fixed in the original survey, such as lighthouses, leading marks, conspicuous and well-defined hillocks, churches, &c. In fixing at sea along a coast, and using tangents, be careful to get the high-water mark.

No two objects should be less than 20 degrees apart, and the nearer a right-angle the better, and no less than three bearings is a dependable fix. Along the coast, take what you can get; but the value will be according to the points used, their relative positions, and the value of the check which may be either the ship's course or a sounding.

To apply: Correct each bearing for the deviation of the ship's head at the instant of observation.

Plot from the chart's compass, drawing a line through each object observed; the intersections of these lines will give a position.

Owing to an usual inaccuracy of bearing, &c., the result is invariably that the three lines do not intersect, but form what is called a "cocked hat;" besides inaccuracy, this is due also to the use of objects improperly situated. (See objects to be used.) To obviate this, and for further accuracy, see section on "fixing by sextant."

(B).—THE HAND LOG.

The hand log is a triangular piece of wood, sector shape, weighted with lead on its rounded side; this is to keep the apex up, and forms a means of resistance.

The line is fitted, at the log end, with three spans, two of which are secured through the log ship; the other span is shorter and has a bone peg—bone, because in its contact with wet wood it is

not so likely to jam too tightly. For use, this short leg is pegged into a hole in a corner of the log ship, so that when in the water the log ship stands upright and is towed from its centre of gravity.

The log line is marked with—

1. A piece of bunting, up to which for a distance of about twenty fathoms is spare line; it is from this mark that time is taken, and up to it the line should be allowed to run without assistance; it gives it a chance of being taut before counting time.
2. After the bunting there are half knots and knot marks in succession. After the bunting has passed the hand, every assistance should be given to the line to run out, to minimize the action of friction.

Each knot mark is 47·3 feet apart. This is obtained from the simple proportion of 3,600 (seconds in a hour) : 28 (seconds of glass) : : 6,080 (feet in a knot) : length of knot = 47·3 feet. A 28-seconds glass is used simply for convenience. A longer glass would be too tedious, and a shorter one introduces an error in the result (47·3 feet), which would make repetition very inaccurate.

When the speed exceeds 5 knots, the 14-seconds glass is used; in other words, half the glass-time is allowed to run through. In that case the speed is twice the number of knots shown as having run out.

The hand log should be invariably hove the lee side, or that side which is opposite to that on which the patent log is towing. The lee side because it is the less liable to foul the ship's side when thrown, and the wind will blow the line clear.

(C).—THE PATENT LOG.

The patent log is used for "running down distances," and also for ascertaining at any moment the distance run from a port or between any observations.

It should be invariably put over when a ship shapes her departure course.

It is towed from the end of a spar from the weather quarter, with an in-haul attached to the line, and sufficiently far astern to be clear of the action of the screw or the capillary attracted water from the ship.

The weather quarter because it is clear of anything thrown from the shoot which would be liable to be caught by the fans. It has an iron guard for that purpose, but this is often found to be inadequate to protect the fans of the log.

It works on a system of cogs, and its indicator shows hundreds, tens, units, and fractions.

It should be hauled in every few hours to see that it is clear, and is not usually re-set before every 24 hours, and only then when a correct error is known for the distance run in that time.

It is invariably found that patent logs have a constant error, due either to original make or damage to fans or cogs.

The error is found by running a certain distance between two accurate fixes of the ship at slack water, or at sea by accurate observations—compare distance run by observation with patent log. This error may vary according to speed, so that generally for a certain speed the patent log will have a certain error per cent.

(D).—THE HAND LEAD.

The uses of the hand lead in navigation are to give indications of the depth of water a ship is in, and consequently whether she is deepening or shoaling her water.

It is invariably to be used in approaching land, or in cases of the slightest doubt as to position owing to fog or darkness.

Usually hove from the lee chains, to prevent it being blown on to the ship's side.

Every seaman must know how a lead line is fitted, and care should also be taken to know the drift between the water's edge and the portion held in the hand—this is applicable for use in the dark.

In ground where there is not much water to spare under foot, it is essential to know the state and fall of the tide, with a view to comparing it to the soundings as stated on the chart at the supposed position.

Soundings in a chart are always reduced to a low-water standard (not necessarily ordinary low-water springs).

A knowledge of the use of the lead is most invaluable to a navigator.

A positive sounding (that is a sounding where bottom has been obtained), correctly reduced, is of assistance as to a ship's position, and the soundings taken before or after will give indication as to whether a ship is running into shallower or deeper water.

A sounding marked thus $\underline{3}$ indicates the sounding obtained over mud flats at high water.

Below the title of a chart it is stated whether a chart is sounded in feet or fathoms.

(E).—DEEP-SEA LEAD.

The ordinary deep-sea lead is only useful for positive soundings obtained.

In well-sounded or surveyed waters, a deep-sea cast acts as a check to a doubtful fix. A ship must not be going more than 5 knots to obtain an up and down deep-sea cast up to 30 fathoms, with a 28-lb. lead, and at a gradually less speed than that for deeper soundings; but to obtain a correct up and down sounding at 100 fathoms a ship-way must be stopped.

It is easier to keep a steamer stern to wind, and heave over the stern for any sounding of 100 fathoms and above, but up to that drop in the usual way over the bows and pick up the sounding astern.

A deep sea line is marked from 20 fathoms, having 2 knots, to 100 fathoms, having 10 knots; intermediate 5 fathoms are marked with 1 knot.

Ordinary deep-sea leads have a brass indicator which can be attached. It is screwed in the upper part of the lead. A small fan works this indicator, which should be carefully set at zero. As the lead touches the ground a guard comes down by its own weight and checks the further action of the fan. In hauling up, the pressure of the water keeps the guard down. The reading on the indicator is the correct depth.

SECTION II.—TIDES.

Every chart contains in the title the time of high water at full moon or change of the moon, marked High Water, Full and Change. It is the time of high water at the place named on the days that the moon is either at its full or when the moon is at its change (*i.e.*, new).

It is from this time given that the state of the tide on any day at that place can be determined.

The moon rises on an average roughly 50 minutes later every day; that is, passes over the meridian of the place also 50 minutes later. The tide acts in conjunction with the moon, so that the tide also is 50 minutes later every day. Thus, suppose it is high water, Williamstown, at 1 o'clock a.m. on the 1st of the month,* on the 2nd it will be high water 50 minutes later, that is at 1.50; on the 3rd it will be high water 100 minutes (*i.e.*, 1 hour and 40 minutes) later, or at 2.40, and so on; so that *multiply the number of days past full or new moon by 50, and add to the time given of High Water at Full and Change*, the result is time of high water on the day required; 6 hours before and after that hour, of course, gives time of low water.

Note.—This is only a rough method, but sufficiently near for practical purposes.

The time of High Water, Full and Change, at Williamstown, and of Queenscliff is 1 hour apart. At the entrance to the Channels from the Bay, it will probably be half-an-hour earlier than at Williamstown; but up to the vicinity of the Western Channel, starting from the Bay, the time of High Water, Full and Change, may be regarded as the same as that at Williamstown.

The High Water, Full and Change, of a port is also called the "Establishment of the Port."

Spring tides are those which take place at about the day of full or of new moon; sometimes at places on the day; sometimes before or after: those occur, roughly speaking, once a fortnight (14 days).

Neaps occur during the intervals of Full and Change.

In the former case the tides rise higher and fall lower than in the latter.

Every chart or plan gives the rise of spring tides and of neap tides above a *lower water standard*. The range of the tide is the greatest amount, under ordinary circumstances of springs, that the tide rises and falls; so that having found the "state of the tide" at any hour, by applying its fall as given (corrected for the state of the moon), any sounding obtained can be compared with that on the chart. See section 1 (*d*) on soundings; or

* The day of Full and Change (F. and C.) of the moon is given in the nautical almanac.

knowing the "state of the tide," and observing on the chart the direction given to the tide arrows (——> direction of ebb, ~~~~——> direction of flood), its influence on the course of the ship will be known.

These tide arrows must not be confused with the direction of a current marked thus ~~~~——

(A).—READING A CHART OR PLAN.

Every chart or plan is constructed on the true meridian.

Anything under half-inch scale is usually constructed as a chart; over that is a plan.

The difference between a chart and a plan is that in the former the true meridians are put in, and the scale is in the side of the margin. In a plan there are no true meridians, and the scale is a separate construction, placed where most convenient.

Every chart or plan has a title, in which will be found the name of the surveyor, and the month and year in which the work was done. Then follows latitude and longitude of some specified point—this is for correcting chronometers; High Water, Full and Change; rise of springs and range of tide, explained under the heading of Tides, &c.; soundings in feet or fathoms; and data of reduction, that is, the standard to which all the soundings are reduced.

~~~~——> indicates direction of current.

~~~~——> indicates direction of flood tide.

——> indicates direction of ebb tide.

~~~~~~ indicates tide race.

——•—— means no bottom at 115 fathoms.
115

3 means that there is 3 feet at high water when the sand or mud bank is covered.

Abbreviation *m.* under a sounding gives the nature of the bottom as mud.

Abbreviation *s.* under a sounding gives the nature of the bottom as sand.

Abbreviation *sh.* under a sounding gives the nature of the bottom as shell.

Abbreviation *f.* indicates fine.

Abbreviation *c.* indicates coarse.

Where the bottom is very varied, necessitating a number of abbreviations, their interpretation will be found in the title.

Single dots, thus . . . . . represent the 1-fathom contour line; all soundings of 1 fathom and under are enclosed by this line.

Similarly double dots .. .. .. is the 2-fathom contour line.

Similarly treble dots ... ... is the 3-fathom contour line.
&c., &c., &c.

•——•—— is the 10-fathom line

••——••—— is the 20-fathom line, and so on.

These contour lines are useful towards a knowledge of the shape of the bottom.

+ is a rock under water with less than 1 fathom on it.

⁜ is a rock which covers and uncovers.

⚓ points out the anchorage.

necessary to moor.

✠ is a church.

(B).—TIDES IN THE BAY.

No definite rule can be given of the relative state of the tide of Willliamstown and the Channels and Heads. The tides at the Heads are so much influenced by both local causes, winds and freshets, and effects of the surface current outside the Heads, which may have been pushed up by disturbances far from land that it is impossible to lay down any rule of the state of the tide, at any place inside the Heads, knowing what its state is at the place of departure inside the Heads. Under ordinary circumstances, the time of high water, Williamstown, is approximately 1 hour later than at the Heads.

Strong northerly winds will retard the flood tide for 1 hour and decrease the height of the tide.
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Strong S. or S.S.Wly. winds considerably increase the height of tides.

Generally.—The flood comes from southward and eastward, and after entering the Heads sets up against Shortland's Bluff, when it spreads through the various Channels, following their banks.

The ebb sets out of Hobson's Bay to the southward and across the Channels in an oblique direction, until the water on the banks is very low, when this tide will then follow the direction of the Channels, and curving round Point Lonsdale Bight, sweeps across towards Point Nepean, and thence down the coast towards Cape Schanck.

SECTION III.—LIGHTS AND BUOYS.

(A).—LIGHTS AND BUOYS IN PORT PHILLIP BAY.

GELLIBRAND.

Gellibrand Lightship is in 5 fathoms.

White Light, Revolving, showing a bright flash every 30 secs., visible 10 miles.

In foggy weather, a gong is sounded every 10 minutes, and a rocket fired every 5 minutes.

NOTE.—Should the Lightship break away, two Red Lights will be substituted, and a flare-up shown every quarter of an hour.

GEELONG.

Geelong Lightship is in 12 feet of water.

White Light, Fixed, visible 9 miles.

A gong is sounded every 10 minutes in foggy weather.

Tidal signals are hoisted by day.

NOTE.—In the event of Lightship breaking adrift, two Red Lights will be substituted, and a flare-up shown every quarter of an hour.

South Channel.—Jetty type of light from two Beacons in north bank at the east and west entrance to South Channel, visible 6 miles. From east entrance a Red Light is shown towards Point Henry and Bird Rock, with a sector of White Light marking a clear passage off the Point Wilson and Wilson Spit Buoys.

At west entrance, a Green Light is exhibited, visible between W. $\frac{3}{4}$ S. round northerly to S. $\frac{1}{4}$ W.

Old Channel.—One White Light on first Red Dolphin and inshore of Lightship. One Red Light on westernmost Red Dolphin on west side of channel.

PORTARLINGTON.

Lighthouse—Painted White, situated on north side of town.

Light—Fixed Red (150 feet), visible 7 miles.

The light is visible between W.S.W. and S.E. by E., and is cut so as to clear Prince George bank to the eastward and the shoal off Point Richards to the westward.

POINT LONSDALE.

Lighthouse—Painted Red and White.

Light—Fixed Red and Green, 80 feet; visible 10 miles.

The Green light is visible, bearing about N. by W. to N.W. $\frac{1}{2}$ W.

The Red Light is visible, bearing N.W. $\frac{1}{2}$ W. to W. by S.

In foggy weather, a fog-horn will be sounded every 2 minutes, or a signal rocket will be fired every 5 minutes.

QUEENSCLIFF LIGHTS.

The High Lighthouse is situated on Shortland's bluff—colour of bluestone.

Light—Fixed White, 130 feet; visible 17 miles.

The Light is visible between E. by N. and N.

Within the Heads, the Light is visible between N.E. by E., round N. and W., to S.W. by W.

Low Lighthouse is painted White.

Light—Fixed Red and White, 90 feet; visible 14 miles (White), and Red Light; visible 10 miles.

The White Light is visible between N.E. by E. and N.E. $\frac{1}{2}$ N.

The Red Light is visible between N.E. $\frac{1}{2}$ N. and N.N.E., and White again from N.N.E. to W.

A sector of Red is exhibited from the Low Light; visible between S.W. by W. $\frac{1}{4}$ W. and S.W. by W. $\frac{3}{4}$ W., or from Black Buoy No. 1 to Perch Buoy No. 2 at entrance to West Channel.

Swanspit Lightship.

A Circular Hull, painted Red, surmounted by a White Iron Tower.

Light—Fixed Red, 38 feet high. Visible 8 miles.

The light is visible all round.

During thick or foggy weather warning signals will be given every five minutes, *i.e.*, alternately sounding a gong and a bell.

South Channel Lights.

The Lighthouse is immediately under Arthur's Seat, and painted White.

Light—Fixed Red and White, 100 feet. Visible 13 miles.

The Red Light is visible between S. by W. ½ W., and S.E. ¼ E.

The White Light is visible between S.E. ¼ E. and E. by N. ½ N.

The Pile Light is at eastern end of South Channel, in 27 feet of water.

Light—Fixed Red and White, 27 feet high. Visible 10 miles.

The Red Light shows from W. ½ S. round N. to N.E. ¼ N.

The White Light shows between N.E. ¼ N. and S.S.E.

Between the bearings of S.S.E. to W. ½ S. this light is obscured.

A ray of White Light shows over No. 15 Buoy, and is visible between W. by S. ¼ S. and W. ½ S., established for the purpose of ascertaining the position of the Pile Lighthouse in ships making the Channel from either Hobson's Bay or Geelong.

Schnapper Point.

Lighthouse is erected on Schnapper Point, and painted White.

Light—Fixed White, 50 feet high. Visible 10 miles.

The Light is visible all round to seaward.

West Channel Pile Light.

West Channel Pile Light is in 15 feet of water.

Light is fixed Red and White, 38 feet high. Visible 11 miles.

The Light shows Red between N.E. by N. and S. by E. ¼ E.

The Light shows White between N.E. by N. and S. by E. ¼ E. (round westerly).

The Red Light is cut to mark the Black Buoy off Prince George's Bank and No. 5 Buoy in West Channel.

Minor Lights.

West Channel Gas Buoy (No. 12), White. Visible 5 miles.
South Channel Gas Buoy (No. 15), White. Visible 3 miles.
Geelong, Lamp on foreshore of Snipe hill, Light-Green. Visible 3 miles.

Pier Head Lights.

GREEN LIGHTS.

Queenscliff, New Pier (2),
St. Leonard's,
Portarlington,
Ann-street Pier, Williamstown,
Port Melbourne Railway Pier,
St. Kilda,
Frankston,
Dromana,
Sorrento,
Quarantine Station,
Griffith's Point,
Rosebud.
All visible 3 miles.

RED LIGHTS.

Queenscliff, Old Pier,
Portsea,
New Pier, Brighton,
Schnapper Point,
Port Melbourne Town Pier,
Williamstown Town Pier,
Williamstown Breakwater Pier,
Geelong, Moorabool-street,
Mordialloc,
Brighton, Park-street Jetty.
Visible 3 miles.

WHITE LIGHT.

Geelong.—Yarra-street Pier. Visible 5 miles.

RED AND GREEN LIGHT.

Picnic Point Jetty.—The Red Light marks the shoal water on west side of jetty.

(B).—BUOYS AND PILOTAGE.

Buoyage in Hobson's Bay.

A Gas Buoy at the entrance of the river is for ships proceeding up the river.

Five Red Buoys, in 16 feet water, in Fisherman's Bend, for swinging ships.

One Red Buoy, off Nelson, in 24 feet water, for swinging ships.

Three St. Kilda Bank Buoys—the outer one of which is in 26 feet, the White Perch of which is in 28 feet, and an inner one of which is in 18 feet.

Approaches to, and Geelong Harbour.

Point Cook Buoy is Black, situated 1 mile off Point Cook in $4\frac{3}{4}$ fathoms.

Arthur the Great Buoy, striped Red and Black, lies off Point Wilson in 3 fathoms, and marks a rocky knoll stretching about 2 miles off shore.

Point Wilson Steamboat Buoy, Red Perch, is in the middle of Point Wilson Spit in 12 feet, and is used as a turning buoy for small craft in or out of Geelong harbour.

Wilson Spit Buoy.—White Perch in 24 feet, marks the south extension of Wilson's shoal, and is the turning buoy for the deep draught vessels in and out of Geelong. A small chequered Cask Buoy marks a 20 feet knoll off it. Two Black Buoys, called the East and West Bellarine Buoys, about 1 mile off shore, mark the south side of the passage. Two Black and two White Buoys in 18 feet mark the outer cut.

The "New" Ship Channel is marked on its north side by five (5) White Dolphins and three White Piles. The East and West Dolphins are distinguished with Lights. (See Table of Lights.) On the south side of the Channel there are three Piles, the East and West Entrance being marked with Black Buoys. The tide sets across the Channel $2\frac{1}{2}$ knots. The Point Henry Channel is marked on its northern side by four built Pile Beacons and six single Piles.

Following the South Coast via Portarlington to Cole's Channel.

Buoys and Beacons.—Geelong to Cole's Channel, and Sailing Directions for Ditto.—Leaving the outer cut, Wilson Spit White Buoy bears S.E. by E., distant $3\frac{1}{4}$ miles—turn close round it. Wilson Spit Red Buoy bears E. $\frac{3}{4}$ N. distant $3\frac{1}{4}$ miles. A Black Buoy, 1 mile off Point Richards, marking the end of the shoal off that Point, and in $4\frac{1}{2}$ fathoms, bears from the Wilson Spit White Buoy N.E. by E. distant $6\frac{3}{4}$ miles, and from the Wilson Spit Red Buoy E. by N. $\frac{1}{2}$ N. 5 miles.

To pick this Buoy up at night, it is arranged that the cutting of the arc of Red Light from Portarlington, visible 5 miles, starts over it—a course of E. $\frac{1}{2}$ N. for $5\frac{1}{2}$ miles—puts you abreast of Prince George's Bank Buoy. This Buoy is about 2 miles off shore in 6 fathoms, and marks the N.E. corner of the bank.

The West Channel Pile Light (White Sector) cuts over this Buoy, and in a steam-boat, by running along the edge of the light, the Buoy should be easily picked up. From thence the Governor Reef Buoys bear S. by E. $\frac{1}{4}$ E. distant 3 miles. These buoys, which are in 3 fathoms, mark the edge of the shoal off the North Red Bluff; $\frac{1}{2}$ mile in shore of them is the Governor Reef Beacon; St. Leonard's Light will then be visible, bearing about S.W. by S.

Gellibrand to Swan Island Pile Light through Cole's Channel.

Except for steam-boats of not more than 7 feet draught, this Channel should only be used by day.

By night steam-boats are recommended to close the shore ahead of South Red Bluff, and keeping Swan Island Light ahead and St. Leonard's Pier Light astern will clear all dangers. Cole's Channel is about 7 miles long. By day, from Gellibrand Lightship, a course of S. by W. $\frac{3}{4}$ W. for about 19 miles, picking up Swan Beacon right ahead, will pass about $\frac{1}{2}$ mile off the Governor Reef Buoys, when alter course 1 point to port, keeping the Red Bluff on the starboard bow, until Indented Head is just open off St. Leonard's Pier. A course midway between Swan Spit Light and the tangent of Swan Island, picking up the two Red Buoys in the Channel until ahead of the Wreck Buoy (Green), will keep a ship in no less than 13 feet. After passing the Wreck Buoy, steer for Lightship.

Should there be any difficulty in making the Governor Reef Buoys, a hillock (176 feet) over Quarantine Ground, in line with Swan Spit Lightship, will prevent a ship getting too far to the eastward, and that line cuts over the Buoys.

From Swan Spit Lightship.—The Wreck Buoy bears north, after passing which keep the houses on Quarantine Ground right astern, and pick up the Channel Buoys (Red). When the South Red Bluff is a little abaft the beam, a course of N. by E. ¼ E. will bring the Newport Works chimney nearly ahead.

From Gellibrand to the Heads through West Channel.

From Gellibrand to West Channel Pile Light is S. by W. ½ W., distant 20⅔ miles. West Channel is marked with two Lights and fourteen Buoys, No. 12 being a Gas Buoy. There are five Black Buoys on the starboard with odd numbers, and eight White on the port hand with even numbers (looking seawards).

The draught of water for ships navigating West Channel should be limited to 17 feet. Vessels should pass ½ cable to the eastward of the Pile Light.

Steer between the Buoys—keeping the starboard side of the Channel. When abreast of No. 6, steer towards No. 4 White, so as to give the Swan Spit Lightship a wide berth, owing to the shoal on the N.E. of it; Swan Spit Lightship abeam, steer a course between No. 1 Black and No. 2 White (the Royal George Buoy). This shoal is marked on its east ridge with a White Cask Buoy in 21 feet.

By Night.—Going down West Channel.—After rounding Pile Light about ½ cable, bring the Gas Buoy (No. 12) a point on the port bow, taking care to keep within the White Sector of the Pile Light. When clear of No. 12, alter course so as to bring the Swan Spit Lightship about 1 point on starboard bow, continuing this course until the Red ray from Queenscliff is opened, when steer with it about a point on starboard bow.

Coming up the West Channel.—After rounding Lightship, keep Pile Light about a point on starboard bow until abreast of Gas Buoy (No. 12), gradually rounding so as to bring the Pile Light on port bow and Swan Spit Lightship on starboard quarter.

Gellibrand to Heads through South Channel.

From Gellibrand Lightship to abreast of easternmost Black Buoy of South Channel is S. ⅜ E. 27 miles, and from there to the Pile Light is W. ½ S. 2¼ miles. The South Channel is 9 miles long. Soundings varying from 7 fathoms at the western end to 12 and 20 fathoms off Point King, and decreasing to 4 and 5 fathoms at its eastern end. The Channel is marked by three leading lights, the two eastern being immediately under Arthur's Seat, and the western shown from a Pile Lighthouse, besides which there are twelve Buoys—eight Black on starboard hand and four White on port hand (looking seawards). The Black Buoys are marked with odd numbers and the White with even numbers, commencing from seawards. The first and last Black Buoys are surmounted by a staff and ball.

Steer about S. by E., making Arthur's Seat Lighthouse ahead, until the easternmost Black Buoy is a little before the beam, when alter course round it and No. 13; steer for Lightship, passing it on port hand, and thence between the Buoys. In deep draught ships the line of South Channel Pile and Arthur's Seat Lighthouse clears all dangers.

At Night.—A course of S. by E. will make Arthur's Seat Light ahead and the White ray from South Channel Pile Light on the starboard bow; maintain this course until the Red Sector of the Pile Light is open on a bearing of W. by S., when steer for it, passing to the northward close to the Pile, and gradually bring that light in line with Arthur's Seat Light. This course will lead a ship up to the Queenscliff leading lights.

From Seaward by Night.—After entering the Heads, pick up the South Channel Pile Light (White) in transit with Arthur's Seat (White) on an E. ⅜ S. bearing. Pass to the northward of the Pile Light and steer about East, taking care to get sight of its Red Light again until Arthur's Seat Light shows Red, when shape course for anchorage.

From Seaward by Day.—The same disrections as by night. After passing the South Channel Pile, follow the Buoys on the port hand, and when clear of No. 15 shape course. South Channel Pile Light exhibits tide signals.

Through Capel Sound.—Capel Sound is only navigable for ships or boats of not more than 10 feet draught. From any direction steer for Arthur's Seat and make Arthur's Seat Lighthouse.

By Day.—Pick up No. 15 Buoy and alter course for a prominent White Cliff on the south shore (bearing about S.W. by W.) for about 4 miles, when steer for the Black Buoy at the entrance of the Sound, and thence from Buoy to Buoy alternately placed White and Black. After passing the last White Buoy on port hand, there is a small Black Buoy abreast of this one marking a 6-feet patch; keep No. 2 White South Channel Buoy well on the port bow until Point King is abeam, and this will clear the 8 feet sounding off Point King.

By Night.—Having made Arthur's Seat Red Light, keep on the edge of the White Sector with this Light ahead, bearing S. E.$\frac{1}{4}$ E. Pass through the South Channel White Sector, getting into its Red, when alter course to about W.S.W. for about 5 miles (taking care to keep within the White Sector from Arthur's Seat Light), when the White Sector from Pile Light will be opened. Continue the W.S.W. course for about 1 mile, when the Black Buoy at the entrance to the Sound should be picked up. (N.B.—The Rye Jetty Red Light, visible 3 miles, kept on port bow after sighting will be of great service in case of strong tides to prevent getting drifted either way.) Turning this Buoy, keep Point King Light ahead (Rye Light will then be nearly astern and Sorrento Green Light a little on port bow), and after passing the next White Buoy steer for Sorrento Light. Off the end of Sorrento Pier is a Red Buoy, which pass on the the port hand, and bringing Sorrento Light astern for 1 mile will clear all dangers.

From Seaward by Night.—Make Sorrento Green Light on about S. by E. bearing; run down on that course, passing the outer White and next Black Buoy until abreast of the Pier, when bring the Light astern on a bearing about W. by N. Pass close to the White Buoy. Rye Light is just visible after passing this Buoy, and by keeping that Light nearly ahead (a little on port bow) for about 1½ miles, the next Black Buoy will be easily distinguished, when alter course to about N.N.E. for 6 miles, striking the Red Sector from Arthur's Seat, and then shape course for any anchorage.

(C).—COURSES AND DISTANCES FROM PLACE TO PLACE.

From.	To.	Course (mag.)	Distance.
Gellibrand Lightship	Point Wilson Inner Buoy	S.W. ½ S.	22¾
Gellibrand Lightship	Point Wilson Outer Buoy	S.W.	25½
Gellibrand Lightship	Governor's-reef Buoy	S. by W. ¾ W.	19
Gellibrand Lightship	West Channel Lightship	S. by W. ½ W.	20½
Gellibrand Lightship	No. 15 Buoy, South Channel	... ...	27
Gellibrand Lightship	Arthur's Seat Lighthouse	S. by E.	28
Point Wilson Inner Buoy	East Entrance Outer Cut	W. ¾ S.	3½
Point Wilson Inner Buoy	Point Richards Buoy, Geelong	E. by N. ½ N.	5½
Point Richards Buoy	Point George Buoy	E. ¼ N.	5½
Point George Buoy	Governor's-reef Buoys	S. ½ E.	3
Point George Buoy	West Channel Pile	S. by E.	5½
Point George Buoy	No. 15 Buoy, South Channel	S.E. ½ S.	15
No. 15 Bouy, South Channel	Capel Sound Buoy	S.W. by W. ¾ W.	5½
West Channel Pile	Queenscliff	... ...	7
South Channel Pile	Queenscliff	... ...	9½
West Channel Pile	South Channel Pile	... ...	13½
West Channel Pile	Swan Spit	... ...	4½

Geelong Outer Harbour.—Off Point Henry the best anchorage is with the Gasworks clear of the Point and Geelong Lightship well open to the westward of the east Pile Light to Ship Channel.

It is not advisable in bad weather to anchor in either the South or West channels, on account of the tide and loose nature of the bottom, but in S.W. gales small vessels will find good shelter under Swan Spit in 3½ fathoms, the upper Lighthouse just shut in with Swan Point, about ½ mile off shore.

Bound up and caught in South Channel with a northerly or north-westerly gale, anchorage can be found in Capel Sound off the White Cliff, bearing S.W., in about 5 to 7 fathoms, about 1 mile, or with No. 8 White or No. 9 Black in line and Arthur's Seat bearing about E. will afford good shelter.

Off Queenscliff.—The High Light bearing about W., distant 1½ miles, in 6 to 7 fathoms, or No. 1 Black Buoy in transit with West Channel Pile Light and the Red Beacon in Queenscliff bight just closed by the Cliff.

For Gunboats.—Swan Spit Light in transit with No. 1 Black Buoy and Point Lonsdale Staff just open of the Cliff and Queenscliff jetty, bearing about N.W., in 3 fathoms.

By Night.—In the Red Sector of Queenscliff Low Light with Queenscliff Jetty Green Light bearing N.W.

Off Quarantine Ground.—About ½ mile to the westward of Nicholson's Knoll (Chequered Buoys) with Quarantine Station or Pier Light bearing about South, distant about ½ mile, in 7½ fathoms.

Anchorage for Gunboats, off Swan Island.

By Day.—Swanspit Light in transit with No. 4 White; No. 8 White in transit with Cask over 11 feet shoal. The end of the Torpedo Pier should then be just open of the tangent of the land, and the Outer Pile of the Torpedo Boats Channel should be distant about 1 cable—depth 12 to 15 feet.

By Night.—Queenscliff Light just open of the tangent of Swan Island and Swan Spit Light, bearing about S. by E.

If approaching anchorage through Cole's Channel, steer for Swan Light until the transit is open.

If from West Channel, round the Cask Buoy, steer for right tangent of Swan Island until the transit is open.

From Seaward, round Swan Light, steer N. by W. until transit is open.

NOTE.—The positions of the Buoys cannot be depended upon for very accurate navigation.

(C).—NAVIGATING IN THE CHANNELS.

For a Boat of 9 feet Draught.—From Swan Island to South Channel, starting from No. 6 White West Channel, and keeping No. 1 Black (Perch, South Channel) in line with either Portsea Hotel or Nicholson's Knoll Buoys, will keep a boat in 10 feet or over; or Swan Spit Light astern and Point King ahead will clear the shoals at high water, passing over an 8 feet (low water shoal) close to No. 4 White.

From West Channel Pile Light to South Channel or Capel Sound.—Pass No. 16 White at starboard hand, and thence steer for Pile at entrance to Symond's Channel, S.E. by E. ½ E., giving it a berth of about 1 cable on starboard hand, when steer for South Channel Fort S. ¼ E. until Sorrento Hotel is just open to the westward of No. 5 Black Buoy, bearing S.W. by S., or in transit with No. 4 White pass No. 5 Black about 2 cables on port hand.

For Capel Sound.—Make for No. 6 West, and thence in a straight line to Rye Jetty, or the left end of the township, when the Capel Sound Buoys can be picked up. This direction will keep a boat in no less than 12 feet low water springs.

From Capel Sound to West Channel.—No. 6 ahead and Rye astern will keep a boat in no less than 11 feet, when steer for No. 5 Black, turn that Buoy, keeping Sorrento astern, until South Channel Fort is in transit with Rye. A course of north will pick up Symond's Channel Pile ahead, which gives a berth of 1 cable on port hand. A straight course to the West Channel Light will clear all dangers.

	Miles.
Distance from No. 16 White to Symond's Buoy ...	2½
Symond's Buoy to position for altering course ...	4
Thence to No. 5 Black	1¼
To No. 6 White, a little over	1
To entrance Capel Sound	2
To Capel Sound Buoy	1
Total	12

Round by No. 15 Black is 16 miles.

The above are the best possible fixes, probably never found in practice, but they give the idea of what is to be attained. It is when the objects are of necessity in a bad position that the extra angle has to be taken for a check. Avoid objects which, if joined, would rest in the circumference of the same circle. Three objects in a straight line is good and safe. Three objects forming a triangle, inside of which the observer is, is a good fix.

Protracting.—Having observed the angles, lay them off, either on a station pointer, or protract them on a semicircular horn protractor, or tracing paper, and, placing either on the chart, move it so that the legs or lines pass through the three or more objects observed. The centre of the instrument is the position of the observer.

In picking up a particular anchorage or position—given the position—protract the angle between the objects intended to be used, and place the least "sensitive" angle on the sextant, pick up the position obtained by this angle, then place the most sensitive angle on the sextant, and gradually work into that, remembering that, to increase the angle, go towards a position about midway between the objects.

A "sensitive" angle is that in which the least change of position will show the greatest change in angle; usually the larger angle is the more sensitive, or the objects which are being approached in the most direct manner, *i.e.*, in a course nearest the perpendicular to the line joining them, will contain the most sensitive angle.

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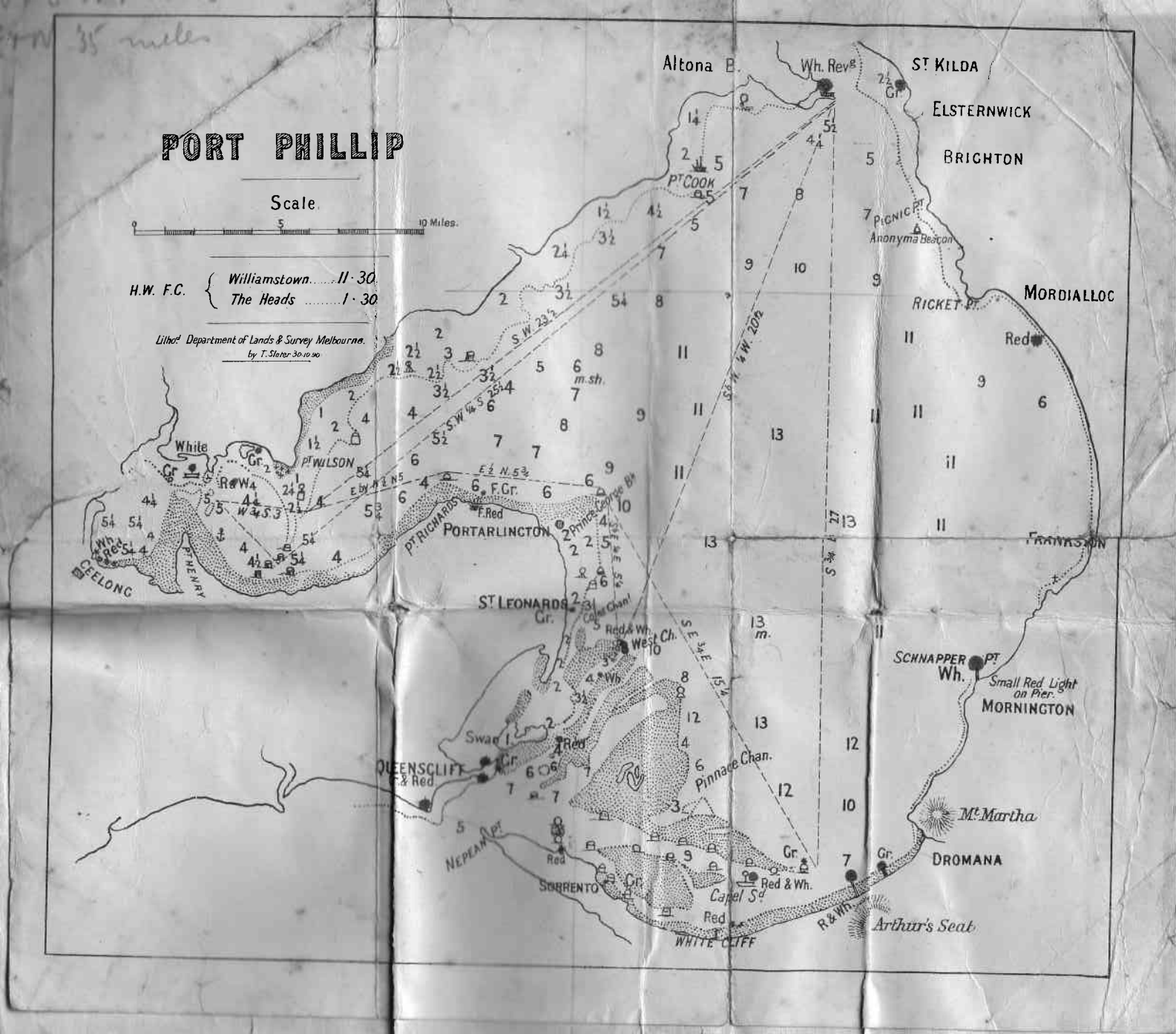
PORT PHILLIP
Scale
0 5 10 Miles.
H.W. F.C. { Williamstown.....11·30
The Heads .....1·30
Lithod Department of Lands & Survey Melbourne.
by T. Slater 30.10.90
Altona B.
Wh. Revs
St KILDA
Gr.
ELSTERNWICK
BRIGHTON
Pt COOK
PICNIC PT
Anonyma Beacon
MORDIALLOC
RICKET PT.
Red
S.W. ¼ W. 20m
S.W. 23½
S.W. ¼ S.
E.W. ¼ N.
E½ N. 5¾
S.E. ¼ E.
S. ¾ E.
m.sh.
White
Gr.
Pt WILSON
R & W
F. Gr.
F. Red
PORTARLINGTON
Pt RICHARDS
Pt HENRY
CEELONG
Wh.
Red
ST LEONARDS
Gr.
Cable Chan.
Red & Wh.
West Ch.
S.E. ¾ E. 15¼
SCHNAPPER Pt
Wh.
Small Red Light on Pier
MORNINGTON
Swan I.
Red
QUEENSCLIFF
& Red
Pinnace Chan.
Mt Martha
NEPEAN Pt
Red
SORRENTO
Gr.
Red & Wh.
Capel Sd
DROMANA
R & Wh.
Arthur's Seat
Red
WHITE CLIFF