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HANDBOOK

FOR

6-INCH, B.L., MARK XXIII GUNS

ON

TRIPLE, MARK XXII MOUNTING

BOOK I—TEXT

1937

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Amendment No.	Authority. A.F.O.	Pages amended.	Date inserted.	Initial.
1.	P. 723/41.			
2.	P. 57/42	p. 22.	7 · 2 · 42.	W.E.
3.	P. 113/43.	para. 753.	19. 3 · 43	"
4.	P. 741/43	p. 13.	27 · 4 · 44	"
5.	P. 35/44	p. 13.	"	"
6	P 274/48.	P. 14.	6. 9. 48	[illegible]
7	P 408/48		24. 11. 48	[illegible]
8	P 360/49	P. 9. Page 61.	18. 10. 49.	B.
9	P 197/51.	Para 248.	22. 5. 51.	B.
10	P 579/51.	P 550.	14. 12. 51.	

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Attention is called to the penalties attaching to any infraction of the Official Secrets Acts.

~~C.B. 1973 A~~
O.U. 6359 A.

HANDBOOK

FOR

6-INCH, B.L., MARK XXIII GUNS

ON

TRIPLE, MARK XXII MOUNTING

BOOK I—TEXT

(FOR PLATES *see* ~~C.B. 1973 B~~) O.U. 6359B.

1937

Admiralty, S.W.1,

6th January, 1938.

G.04564/37.

The " Handbook for 6-inch, B.L., Mark XXIII Guns on Triple, Mark XXII Mounting, Book I, Text, and Book II, Plates," having been approved by My Lords Commissioners of the Admiralty, is hereby promulgated for information and guidance.

By Command of Their Lordships,

R. H. A. Carter

To the Flag Officers and Commanding Officers of H.M. Ships and Vessels concerned.

HANDBOOK FOR 6-INCH, B.L., MARK XXIII GUNS ON TRIPLE, MARK XXII MOUNTING (BOOK I), 1937

CONTENTS

INDEX TO PLATES (C.B. 1973B)

CHAPTER I

SECTION I.—GENERAL DESCRIPTION. (Plate 1.)

1. This Handbook is designed to assist officers and ratings to understand the 6-inch, Mark XXII, Triple mounting, and the 6-inch, B.L., Mark XXIII guns mounted therein.

2. Certain details are included to assist those responsible for its maintenance, but the plates, although prepared from working drawings, are only diagrammatic, and, until a thorough knowledge of the mounting has been obtained, stripping should on no account be undertaken without reference to the relevant working drawings, a complete set of which is supplied to each ship. Certain drawings, a list of which is given in Appendix II, contain full stripping instructions.

3. Four 6-inch, Triple, Mark XXII mountings are fitted in each of H.M. Ships "Southampton," "Newcastle," "Sheffield," "Glasgow," "Birmingham," "Liverpool," "Gloucester" and "Manchester."

4. All magazines and shell rooms are on the level of the hold. All revolving structures are identical in construction, the differences in heights of turrets in the ship being allowed for by differences in the lengths of the hoists in the fixed structure.

Revolving Structure

5. For the first five ships of the "Southampton" class, the gunhouse consists of a floor of ¾-inch N.C. plate, in which is carried a 1-inch splinter proof N.C. armour plate shield. For the last three of the class, the gunhouse consists of a floor of 1½-inch "D" quality plate, on which is carried a shield with side, rear and roof plates of 2-inch N.C. plate, and front plate of 4-inch N.C. plate. The trunnion brackets are built up from the floor of the gunhouse, and a 6-inch, Mark XXIII gun is mounted between each pair of brackets. The trunnions of the centre guns are set back 2 feet 6 inches abaft the trunnions of the wing guns.

6. Beneath the gunhouse is the turntable compartment, to the outside of which, on the underside, is secured the upper roller path. The turntable compartment contains the elevating engines, training engines, training worms and wormwheel, and cordite hand-up scuttles. Most of the remainder of the space is occupied by the gunwells, make-up feed tank, and shell hoist casings.

7. Beneath the turntable compartment is the working chamber containing the power pump and motor, oil cooler, pressure stack and the duplex oil strainer, and shell hoist engines, which are bolted to the roof.

8. The power pump provides hydraulic power for all machinery in the revolving structure, the pressure medium being special mineral oil.

9. The three shell hoists project through the deck of the working chamber into the shell handing room, which compartment is part of the fixed structure of the ship. The shell handing room contains a revolving platform attached to the bottom of the shell hoists, on which stand the men who load the hoists, and also the air bottles for the turret which are mounted at the back of the shell hoists. Six spring guide rollers bear against the edge of this revolving platform, and steady the revolving structure in the fixed structure.

Fixed Structure

10. There is one shell room to each turret, and duplex electrically-driven endless chain hoists deliver the shell direct from the shell room to the shell handing room, where they are slid round a circular chute until they are opposite the bottom of the shell hoists in the revolving structure. The electric hoist motor is fitted in the shell handing room.

11. There is one magazine to each turret, with the lower cordite handing room built in to form a pocket in the magazine. Cordite is passed from magazine to handing room through two vertical revolving scuttles. Duplex electrically-driven chain hoists deliver cordite from the lower handing room direct to the upper cordite handing room, which is situated on the next deck below the level of the gunhouse (*i.e.*, on a level with the working chamber, and one deck above the shell handing room). The hoist motor is in the upper handing room.

12. From the upper handing room, the cordite is passed out through an arched opening into the cordite gallery, which is part of the fixed structure of the ship and runs right round the turret outside the working chamber.

13. The cordite pockets in the turntable compartment open directly into the cordite gallery, the bottoms of the pockets being some 5 feet above the deck of the gallery, and contain the hand-up scuttles through which charges are passed to the gunhouse. The charges are therefore carried by hand round the gallery, passed to the men in the cordite pockets (who are on the revolving structure), and thence sent up to the gunhouse through the hand-up scuttles.

14. The oil purifying and settling tank is fitted in the space which is directly above the magazine or handing room.

Capabilities

15. The mounting is designed for an elevation of 45°. The extreme range, corresponding to 44° elevation, is 24,800 yards, with 112-lb. shell. Elevating is by power and hand.

16. The mounting can train 145° either side of the centre line. Both training engines are normally clutched in to their common training shaft, giving a rate of training of 5° per second. One training engine can train the turret alone, giving a higher training speed of 7° per second, but better control is obtained if both engines are clutched in. Hand training, by handles in the working chamber, is also fitted.

17. The mounting as a whole is designed to be able to fire up to 8 rounds per gun per minute under favourable conditions. The shell and cordite hoists in the fixed structure can supply 32 rounds per minute, *i.e.*, 16 rounds per minute from each hoist of a pair.

18. On the revolving structure there is one shell hoist to each gun, which will deliver 10 rounds/minute, so that if one hoist breaks down, the other two can supply all three guns at a reasonable rate. A rate of supply of 8 rounds per gun per minute of cordite can be obtained through the cordite hand-up scuttles.

19. Hand ramming is employed and the breech is also hand-worked.

20–30.

SECTION 2.—GENERAL ARRANGEMENT

The Gunhouse. (Plates 2, 3 and 4.)

31. The gunhouse consists of a floor of ¾-inch N.C. plate (except in H.M. Ships "Liverpool," "Gloucester" and "Manchester," in which 1½-inch "D" quality plate is used) on which is carried the shield forming the sides and roof of the gunhouse. About 3 feet below the gunhouse floor is the turntable floor, underneath the outside edge of which is bolted the upper roller path, which rests on the rollers of the live roller ring.

32. The trunnion brackets are built up from the floor of the gunhouse, and in them the trunnions secured to the cradles of the guns are mounted.

33. In the front of the turret, between the left and centre guns, is a cabinet containing the local director sight, the training control position and training receiver.

34. The shell hoists for the right and left guns come up on the inner side of the gun about 4 feet forward of the trunnions. The hoist for the centre gun comes up on the left of the gun (i.e., close to the hoist for the left gun) and rather farther forward of the trunnions than at the other guns.

35. The centre gun is fitted as a right gun, and is mounted 2 feet 6 inches to the rear of the other two guns to allow sufficient working space for the guns' crew.

36. The tops of the cordite hand-ups are about 10 feet in rear of the trunnions, the left and centre hand-ups being close together between these guns.

37. In the rear of each gun well is the rammer tank, which holds 25 gallons of fresh water for the hand sponge and rammer.

38. There are two access doors in the rear of the turret behind the right and left guns, each having a hole at the bottom and a chute attachment for disposal of the cordite containers. The chute for the centre gun is fitted to the left of the centre line of the turret, in the rear plate.

39. A vent plate is fitted in the rear plate on the centre line of the mounting.

40. At the rear of the turret, slightly to the right of the centre line, is the O.O.T's position. This is provided with a periscope projecting through the roof of the turret. At the O.O.T's position also are fitted a turret training indicator, a lever for working the cordite drenching system, the emergency stop-push for the pump, an electro-megaphone and voicepipes to the local sight cabinet, working chamber, and shell handing room. In rear of the periscope is a hole in the turret roof, covered with a sliding door which can be worked from inside the turret. There is a platform in rear of the O.O.T's seat, and by standing on this the O.O.T. can look out of the hole in the turret roof.

41. In front of the O.O.T's position is the telephone standard, with a seat for the operator. The standard carries telaupads to the T.S., a Gunnery Exchange telephone and the direct telephone to the adjacent turret. No rangefinders, or fire control instruments for local control, other than the local director sight, are fitted.

42. The elevating control positions and receivers are placed abreast the trunnions of the guns, on the right at right and centre guns and on the left at the left gun, and are arranged so that the gunlayer can easily see the breech.

43. Tube lockers and racks are fitted close to the breech workers' positions.

44. Ready use shell racks and stowages for the sub-calibre gun and rammers, are fitted on the sides of the gunhouse.

45. Access from the gunhouse to the working chamber is arranged by a ladder leading down from a position between the left and centre guns.

The Guns

46. The guns are 6-inch, B.L., Mark XXIII, and are of all-steel construction. The weight of the projectile is 112 lb., and of the charge, 30 lb.

47. The guns can be elevated independently between 5° depression and 45° elevation. The cradle can be locked at 5° elevation by a hand-operated locking bolt.

48. The gun can be loaded at any angle between 5° depression and 12½° elevation, this being the limit of travel of the intermediate tray. At greater elevations, the breech cannot be opened, as it will foul the gun well

49. The usual air-blast arrangements are fitted.

The Turntable Compartment

50. The elevating engines for the right and left guns are in the right and left pockets of the turntable compartment.

51. The centre elevating engine and the right training engine are in the right centre pocket, and the left training engine in the left centre pocket. The training worm and wormwheels are in the front of the compartment.

The Working Chamber. (Plates 2 and 3.)

52. The working chamber is immediately below the turntable compartment floor. It contains the power unit on the right-hand side and the oil cooler on the left forward side. The shell hoist engines (3) and the double oil strainer are bolted to the roof. The shell hoist and auxiliary shell hoist casings pass through into the shell handing room. The hand gear for the shell hoists, and the hand training gear, is situated in the working chamber.

53. The starter for the pump, and the switchboard, are fitted on the right and left sides, and the cordite hand-up pockets project into the working chamber at the left and right rear.

Shell Handing Room

54. The lower sections of the shell hoists and auxiliary shell hoists project into the shell handing room. The lower buckets of the shell hoists are at the front, and at the back are the air-bottles for the turret air blast, and the panel with the air blast reducing valve. The reserve oil tank, oil drain tanks, and the gun well drain tank, are mounted close to the air bottles.

55. The motor for the fixed structure shell hoist is in the shell handing room.

56. At the rear of the shell handing room on the ring bulkhead about 3 feet above the floor are six boxes containing the two batteries for the local control circuits.

Elevating Arrangements

57. Each gun can be elevated independently by hand or power. Power should be used for following large movements of the pointers, and for laying the gun to load and laying to the firing elevation. Hand elevating should normally be used for following the director pointers when at the firing elevation.

58. The layer sits facing the gun abreast the trunnions, and inclined towards the breech, except at the centre gun, where he is directly facing the breech, this being necessary to allow him more working space. In front of the layer is the director elevation receiver, between the layer and the gun is the lever operating the power elevating control valve, and the pedal of the hand-power clutch. This clutch is normally kept in the " Hand " position by a spring embodied in the clutch. In order to use power, the gunlayer presses down on the pedal, thus overcoming the spring and engaging the power drive. He can then work his power control lever as required.

59. When elevating by power, elevation and depression control arrangements are fitted which force the control lever into the central position when approaching the limits of elevation or depression.

60. A separate depression control arrangement is fitted which comes into action when depressing by hand.

Training Arrangements

61. The seating for the lower roller path is built on top of the ring bulkhead surrounding the cordite gallery, the seating being machined when in place in the ship. Resting on the lower roller path is the live roller ring containing 60 double flanged rollers, and on this in turn rests the upper roller path which carries the weight of the revolving structure.

62. The training rack is bolted to the lower roller path, and it is inside the ring bulkhead of the cordite gallery. Two training pinions, on opposite sides of the turret, engage with the rack.

63. Both training pinions are driven by a common shaft through worm, wormwheel and frictional gear. Either or both training engines can be clutched to this shaft, but both cannot be unclutched simultaneously.

64. The hand training gear drives a sprocket wheel on the shaft which can be clutched in when required, the clutch being in the working chamber.

Ammunition Supply

Magazines

65. The charges, in their cardboard containers, are withdrawn by hand from the rectangular cases in the magazine and passed through vertical flashtight revolving scuttles (two per magazine) into the lower handing room.

Handing Rooms

66. In the lower handing room the charges are fed, through vertical flashtight revolving scuttles, into the bottom of a duplex endless chain hoist, which raises them to the upper handing room, on a level with the working chamber. The motor for the twin hoists is in the upper handing room, and both hoists are operated from this position by means of a clutch pedal. The two hoists revolve their scuttles, and deliver, independently when the doors in the lower handing room are closed.

67. The charges are caught, or tipped out on to a table, in the upper handing room, and from there are passed out by hand through an arched opening into the cordite gallery. They are carried by hand round the gallery and passed to the men stationed in the cordite pockets, who load them into the flashtight hand-up scuttles. When the lower door of the hand-up scuttle is closed, the upper door in the gunhouse will open, and the charge can be lifted out. When the upper door is closed the lower door opens automatically.

Shell Rooms

68. The shell are lifted from the bins by hand, and placed on their bases on portable dumping trays, from which they are slid into the vertical flashtight revolving scuttles of a duplex endless chain hoist, which raises them direct to the shell handing room. The hoists are driven by an electric motor in the shell handing room, a clutch pedal in this position operating both hoists. Each hoist, however, revolves its scuttle and delivers independently when the scuttle lever in the shell room is placed horizontal.

69. At the top of the hoist the shell arrive in buckets which are tilted horizontally, and the shell are rammed automatically out of the buckets into the circular chute. The chute slopes downwards from the buckets and forms a complete ring round the bottom of the revolving structure.

70. Between the ends of the chute, just below the fixed hoist, is a short bye-pass chute, by means of which shell from one of the fixed structure hoists can be diverted down the other side of the ring chute. This is necessary in order to equalize the supply of shell to the bottoms of the hoists in the revolving structure, as the shortest route of supply to these latter hoists depends on the bearing of the turret.

71. The shell are slid round the ring chute by hand (the slope of the ring assists this) and up-ended opposite the bottoms of the hoists in the revolving structure.

Shell Hoists in the Revolving Structure

72. The shell are placed base first on a sloping tray door, which is tilted by hand to a vertical position, so closing the lower door of the hoist. If the tilting bucket at the top of the hoist is vertical, *i.e.*, the lever there has been put to "start," the hoist will make one cycle, and on completion the top bucket will tilt horizontal and the lower door fall open again.

73. When the shell arrive in the gunhouse they are pushed out of the tilting bucket by hand into the intermediate tray.

Auxiliary Hoist

74. Two auxiliary hoists are fitted in each turret. These are plain tubes between the gunhouse and shell handing room, and can be used either for shell or cordite, hand whips being used for hoisting to the gunhouse. The bottom end of the tube is closed by a sliding door and the top end by Millers flaps.

Loading Arrangements in Gunhouse—Shell

75. In rear of the tilting bucket and fixed tray at the top of the shell hoists in the gunhouse is an intermediate tray which can be moved up and down on curved rails, the centre of curvature being the axis of the trunnions. This enables it to receive a shell from the tilting bucket and fixed tray, and then deliver it to the gun loading tray (which is pivoted on an arm on the cradle) at any position between extreme depression and 12½° elevation.

76. When empty, the intermediate tray is normally kept in line with the fixed tray by a balance weight. When loaded, and the locking stop withdrawn by hand, the tray falls either to the level of the gun loading tray, or to a stop corresponding to 12½° elevation, if the gun is at a greater elevation. When the intermediate tray and gun loading tray come into line with each other, the shell automatically slides into the gun loading tray. As the breech is opened the loading tray is swung forward into line with the bore and the shell rammed home.

77. At the centre gun, an extra fixed tray is fitted between the tilting bucket and the intermediate tray. The centre gun is set back relative to the wing guns, but the tops of the shell hoists are in line, so that an extra length of fixed tray is necessary.

Cordite

78. The charge in its cardboard container is removed from the top of the hand-up scuttle, the upper door being then closed by treading on the foot pedal, this action opening the lower door at the same time, so that another charge can be loaded from the cordite pocket. The lid of the container is removed and the charge is then tipped from its case and loaded via the loading tray into the gun.

79. The empty case is ejected through the ports fitted in the rear doors of the turret.

Loading Procedure

80. Loading procedure in the gunhouse is as follows :—

81. As soon as the gun has fired, the gunlayer lays to a convenient elevation for loading (5°–7°), if it is not already there ; the breech worker opens the breech, inserts a fresh tube, and masks the vent by pushing over on the lock hand lever.

82. As the breech opens, the tray worker (5) slides back the guard, swings the tray into line with the bore and in the same motion partially enters the shell into the chamber. The shell is rammed home by (3) and (4). The cordite number (6) tips a charge from the container, which he is holding on his shoulder with the open end covered by his hand, into the hands of (5), who loads it over the tray into the gun. (5) then withdraws the tray, the breechworker closes the breech and the gunlayer lays to the firing elevation.

83. As soon as the loading tray is withdrawn, the intermediate tray, which by that time should be reloaded with a shell, is released, and as it comes down the shell slides into the loading tray.

Anti-Flash Arrangements

84. Each charge of cordite is stowed in its own flashproof cardboard case inside the rectangular metal case in the magazine. It is not removed from the cardboard container until reaching the gunhouse and immediately before loading into the gun.

85. Both doors of the cordite hand-up scuttles in the gunhouse are flashtight, so that the scuttle is flashproof whichever door is closed.

86. The shell hoist casings are flashproof and the lifting heads are a flashtight fit in the hoists.

87. Thus the cordite gallery and shell handing room are flashproof from the gunhouse and gun wells.

88. The lower cordite handing rooms are flashproof from the magazines, charges being passed from one to the other by flashtight revolving scuttles. The bottom of both shell and cordite hoists in the fixed structure are flashproof, as the shell and charges are fed into the hoists by flashtight revolving scuttles. All the fixed structure hoists have an upper section of such a length as to ensure that at least one of the lifting heads is always in it, and the lifting heads are a flashtight fit in this section.

89. The cordite hoists can vent into the danger space, if a charge ignites in the hoist.

90. Cordite drenching arrangements are described in Chapter 8, Section 5.

Turret Heating Arrangements

91. Eight electric convectors (radiators) are fitted in the revolving structure, five distributed round the gunhouse and three in the working chamber. Of the latter, one is close to the power pump, between the pump and the right shell hoist, and the other two close to the bottom of the right and left shell hoist.

92. In addition, a steam pipe is fitted in the fixed structure which makes a complete circuit of the turret at the level of the working chamber.

Turret Ventilating Arrangements

93. Ventilation is provided by two fans at rear of gunhouse, which draw air either through holes in the rear shield (as in H.M. Ships "Newcastle" and "Southampton") or through holes in the floorplate, as in later cruisers.

94. A two-way inlet valve is provided in order that air may be drawn either from outside the turret or from inside for circulating only.

Note.—An alternative suction in the gunhouse is provided.

Sighting Arrangements

95. A local director sight is fitted in the cabinet between the left and centre guns. The trainer trains the turret to keep his crosswires on, and the local director layer lays his crosswire on, so transmitting elevation to the receivers at the guns. Range and deflection are applied by the local R. and E. unit at the local director.

96. In director firing, the turret trainer follows the director pointer in the training receiver, while the elevation receivers at the guns are controlled by the R. and E. unit at the director control tower or in the T.S.

97. The O.O.T. has a periscope for local control, but no other instruments. A voicepipe is fitted between the O.O.T. and the cabinet.

98. Two change-over switches are fitted for the director elevation and firing circuits, and the fire control circuits. One of these is situated in the local cabinet close to the trainer's position, and one at the O.O.T. position. These switches have the following functions :—

Position.	Switch to Director.	Switch to Quarters.
Near Turret Trainer	Firing Circuits and Elevation Receiver Red Pointers. } Controlled by Main Director.	Firing Circuits and Elevation Receiver Red Pointers. } Controlled by Local Director.
Near O.O.T. ..	Fire Gong—from T.S. Gun Ready Lamps—to T.S. and O.O.T. Range for M.V. correction in Elevation Receivers. } from T.S. Supply from L.P. Main.	Fire Gong—OFF. Gun Ready Lamps—to Local Cabinet and O.O.T. Range for M.V. correction in Elevation Receivers. } OFF. Supply from Local Battery.

"Shipping Sub-Calibre Guns

99. The overhead rails and lifting gear are being removed, and three tapped holes in the gunhouse roof to take 1-in. diameter eyebolts, provided in lieu. The sub-calibre guns are shipped by means of rope tackles hooked to the eyebolts; the eyebolt holes are provided with preserving screws."

100–120.

(This amendment embodies A.F.O. 4569/43.)

(G. 6351/43.—A.F.O. P.35/44.)

CHAPTER II

SECTION I.—THE GUN

Page 14. Paragraphs 121 and 122. *Cancel* and *substitute* :—

" 121. The gun is of steel, and consists of an ' A ' tube, jacket, breech ring and breech bush. The guns are interchangeable for use in right or left positions.

Inspection

122. Particulars regarding the probable life, inspection series, condemning limits, breech mechanism clearances, etc., are given in the relevant tables in B.R. 291."

(*G. 3010/48.—A.F.O. P.274/48.*)

~~122. The " series " after which the gun must be inspected, ... the provisional limit for wear at 1 inch from C.R., at which the gun is condemned, is 0·33 inches.~~

" A " Tube

123. The " A " tube extends from the seat of obturation to the muzzle. It is slightly tapered externally, and has a deep shoulder immediately in front of the shot seating, which engages with a corresponding shoulder on the interior of the jacket. It is shaped internally to form the chamber and obturator seating.

Rifling

124. The " A " tube is rifled on the polygroove system, having 36 grooves of plain section, with a uniform right-handed twist of one turn in 30 calibres.

Jacket

125. The jacket extends for approximately two-thirds of the length of the " A " tube, on which it is shrunk. It is stepped internally to correspond with the shoulder on the " A " tube, and threaded internally to receive the breech bush. The breech bush, in conjunction with the shoulder inside the jacket, secures the " A " tube in position longitudinally. Collars are formed on the exterior of the jacket at the rear for securing the balance ring to the gun.

Breech Ring

126. The breech ring is formed with two lugs on one side to receive the breech mechanism. It is threaded internally at its front end, and has two steps at the rear, which engage with corresponding threads and steps on the exterior of the jacket. Clinometer planes are prepared on both the upper and lower sides of the breech ring.

Breech Bush

127. The breech bush is screwed into the jacket, securing screws being fitted on the breech face to prevent the breech bush and breech ring from turning, when they are in position. The breech bush is prepared internally for the reception of the breech screw.

Weight

128. The weight of the bare gun is 6 tons 14 cwt. 1 qr. 5 lb., and with the mechanism in position is 6 tons 18 cwt. 19 lb. The centre of gravity of the gun unloaded, but with mechanism in place, is 101·93 inches from the breech face, and of the bare gun 104·88 inches from the breech face.

129. Reference should be made to the range tables for weights of projectiles and charges, and the corresponding muzzle velocities.

130–140.

SECTION 2.—THE BREECH MECHANISM. (Plates 5, 6 and 7.)

General

141. The reference numbers used in the following description are those given in the official schedule of component parts. Certain parts are not interchangeable between right and left guns, and the numbers of such parts have the suffix R or L to indicate the fact. This is shown in Appendix I, which gives the official schedule, but these suffixes are not used in the description of the mechanism.

142. The parts of the lock and box slide, for which there is no official schedule, have been given arbitrary numbers over 100.

143. The centre gun of the mounting has a right-hand breech mechanism.

144. The principal differences between the right and left breech mechanisms are that the **left**-hand mechanism has :—

(i) A thicker carrier, involving a longer vent stalk.

(ii) The half-cock push in the lower part of the carrier, instead of the upper.

(iii) The lock and box slide mounted the other way up.

These differences can be seen by comparing Plates 5 and 6.

145. The breech mechanism is of the Asbury type. The breech is closed by a Welin breech screw (73), mounted on a carrier (1) in the usual manner. A de Bange obturating pad (83) seals the mouth of the chamber. It has outer and inner rear rings (80, 81), a front ring (82) and a protecting disc (84). The vent at the front face of the mushroom head is shaped so as to form a water baffle, so preventing water from the sponge and rammer from choking the vent.

Actuating Gear. (Plates 5 and 7.)

146. A right-hand breech mechanism will be described. The breech is first assumed to be closed.

147. It is not possible to start the movement of the B.M. lever (27), until the catch, B.M. lever (21), is pressed down, bringing the toe (21A) clear of a catch plate (22) on the carrier, behind which the toe engages when in the fully closed position.

148. The breech cannot be opened unless the latch of the hangfire safety mechanism is either tripped or set to " Drill." This mechanism is described below under safety arrangements.

149. The breech screw is rotated through an angle of 30° by means of the crank pin (28A), which is part of the crankshaft (28). The crankshaft is revolved by the arm, B.M. lever (27), which is keyed to it. The crank pin (28A) fits into the crosshead (59), which is made of bronze, and which slides in a cylindrical hole in the breech screw in a direction parallel to the bore of the gun.

150. As the unscrewing part of the motion of the breech screw is completed, the roller (77), revolving on an axis pin (76) secured to the breech screw, engages in the cam, rotating breech screw, secured to the rear face of the gun. This causes the breech to commence the second part of its motion, *i.e.*, swinging out of the gun. By the time the roller is clear of the cam, a toe (27A) on the lever B.M. engages in the control arc (93) and prevents the lever B.M. from rising, and consequently the breech screw from revolving.

151. As the breech becomes fully open, the toe (27A) comes opposite a cut-away portion of the control arc, and a spring (95) behind plunger (96) forces the toe of the lever B.M. outwards and the lever itself slightly upwards. A flat on the toe (27A) takes behind a flat (93A) on the control arc and so the breech is held in the fully open position.

Carrier Hinge Pin. (Plates 5 and 6.)

152. The carrier swings on the hinge bolt (31). The hinge bolt revolves in two-hinge bolt bushes (33) which are made of steel, and are secured in the carrier by check screws (34). These bushes have keys cut inside them which take in the keyway on the hinge bolt.

153. The weight of the carrier is taken by the lower hinge bolt bush (33) resting on the lower hinge lug bush (58). The hinge lug bushes (58) are screwed into the lugs on the breech ring of the gun. They can be adjusted vertically up or down by screwing them round with a tommy bar, and they are locked in position by a check screw (55) and a collar with split pin (56). The distance between the holes for the check screw represents a vertical movement of 1/96 inch of the hinge lug bush.

Lock Actuating Gear. (Plates 5 and 7.)

154. Keyed to the crankshaft (28) is the cam, actuating lock (15) in which engages a plunger catch (68). This plunger is secured in the arm (65) of the lever, hand, lock, and can be partially withdrawn to the rear by pressing in on the catch lever (70) on the arm, thus lifting the cap (69) and the plunger catch (68) against the catch plunger spring (71).

155. The arm (65) is connected to the lock by the link, actuating lock (61) and the slide, actuating lock (60) in which takes the lock guide bolt (101). Thus the lock is moved to and fro to mask or unmask the vent, either by means of the lever, hand, lock, or by the action of the cam (15) when the crankshaft is revolved.

156. There are three grooves in the cam in which the catch plunger (68) may travel. The left-hand groove is that in which it will travel if, with the breech open, the vent has been masked by the hand lever, and the breech is then closed, *i.e.*, no movement is imparted to the lock.

158. The right-hand groove is that in which the plunger, catch (68) will travel if, with the breech closed, the vent has been unmasked and the breech is then opened, *i.e.*, no movement is imparted to the lock on opening the breech.

159. The groove in which the plunger normally travels when the breech is opened, is the diagonal one between the other two.

160. The left-hand groove is shallower than the others, so that unless the lever, catch (70) is pressed, so partly withdrawing the plunger, catch (68) the latter will always travel in the diagonal groove when the cam (15) rotates as the breech is opened, and so the vent will be unmasked. When the breech is closed, the plunger (68) will again travel in the left-hand groove if the normal procedure of masking the vent by the lever, hand, lock (65), while the breech is open has been carried out. If the vent is left unmasked and the breech is then closed, the plunger catch (68) will travel in the right-hand groove. A short straight groove connects the ends of the right and left-hand grooves, and it is in this that the plunger catch (68) travels when the vent is masked or unmasked by the lock hand lever alone.

161. The needle (102) of the lock is fitted with a spring (103) which tends always to press it inwards towards the vent axial. Secured to the needle is a withdrawing sleeve (104), which is actuated by an elbow lever (105) pivoted on the box slide. The other arm of this lever (105) can only be actuated by a toe on the retracting bar (5), which in turn is worked by the lever actuating retracting bar (2) pivoted on its axis pin (14). The retracting bar (5) has a spring (6) tending to keep it over to the right.

162. The movement of the lever actuating retracting bar (2) is governed by two factors. Firstly, it can be moved over by the safety stop (10) (generally known as the half-cock push). To do this the safety stop is pushed in and twisted, being held in this position by a guide screw (13) working in a groove. On releasing the safety stop, a spring (11) helps to return it to the Out position. Secondly, it can be moved over by the cam actuating lock (15), the left-hand side of which bears

against a roller (4) on the lever actuating retracting bar (2). On the left side of the cam is a recess (15A) which only comes into line with the roller (4) when the breech is fully closed. Hence, unless the breech is fully closed, the retracting bar (5) is pushed over to the left and the needle is withdrawn from contact with the tube.

163. The distance that the needle is withdrawn, by means of the retracting bar, is sufficient to allow the lugs on the withdrawing sleeve (104) to clear the raised cams (106) on the lock, which hold the sleeve and needle to the rear while the lock is being moved over to unmask the vent. But until the sleeve is clear of these cams the lock cannot be moved over; hence, with the breech closed, it is impossible to unmask the vent by means of the lock hand lever unless the sleeve is withdrawn first, and this can only be done by pushing in on the safety stop (10) or by partially opening the breech.

Airblast Cam

164. The cam (35) which operates the air blast admission valve is secured to the upper end of the hinge bolt by a fixing screw (37) and belleville washers (36), and is prevented from turning by serrations. It has indicating marks to show its normal assembly position for a right and left gun, but it can be adjusted as required.

Safety Arrangements. (Plates 6 and 7.)

165. (1) When the breech has been closed, it cannot be reopened until the gun has recoiled.

This is effected by means of the hangfire safety mechanism (Plate 6). This consists of a pendulum weight, called the hangfire latch (51) hanging on a pivot on a bracket (43) secured to the carrier. When the breech is fully closed, a corner (51A) on the hangfire latch takes in a corresponding niche (27B) in the boss of the B.M. lever, and prevents it being moved to open the breech.

As the gun recoils, the hangfire latch lags behind, due to inertia, and so revolves about its axis. This pulls the pawl (52) down until a step (52A) takes behind a corresponding stop (43A) on the bracket (43), the pawl being forced into this position by a spring and plunger (45). With the pawl in this position, the hangfire latch (51) is held forward, so freeing (51A) from the B.M. lever and allowing the latter to be moved.

As the breech is opened, the enlarged part (27C) on the boss of the B.M. lever forces in on pawl (52) so disengaging the step (52A) from (43A), and allowing the hangfire latch to fall, assisted by the spring plunger (45) until its corner (51A) bears against the boss of the B.M. lever. As the breech is closed, (51A) will again engage in (27B), so locking the B.M. lever as before. If the gun does not recoil, (51A) will not disengage from (27B) and the breech cannot be opened.

For drill purposes, the hangfire latch (51) can be pushed forward and held in that position by the retainer, hangfire latch (53), which is put over to the position marked " DRILL " for the purpose.

166. (2) Gun cannot fire unless the breech is fully closed.

Contact between the tube and the needle (102) of the lock is not made till the breech screw is fully closed, and is broken again before the breech begins to unscrew.

The first movement of the crankshaft withdraws the needle (102) by forcing roller (4) out of the recess (15A) on the side of the cam (15). While this is taking place, the crank pin is passing over the dead centre (this is commonly called the " idle movement ") and therefore the breech does not begin to unscrew until contact has been broken. Similarly, until the final movement of closing the breech, roller (4) cannot get back into the notch (15A) and so allow the needle to make contact with the tube.

A safety cam (74) is also fitted to the rear face of the breech screw, engaging with a toe on the retracting bar (5). This cam prevents the retracting bar from moving over to the position where the needle makes contact, until the breech screw has been rotated to the locked position.

An additional safeguard is provided by the breech safety contacts, which also incorporate the change-over switch for the main and auxiliary firing circuits. (Only the holes (122) for these contacts are shown in Plate 5.)

(3) The breech cannot unscrew due to firing, or any forces other than those exerted by the B.M. lever, if the latter is fully closed.

When the breech is fully closed, the crank pin (28A) is on the near side of its dead centre, and the breech screw will not begin to revolve until the pin is the same distance past on the far side. Consequently, any force tending to revolve the breech screw on firing, must, if the B.M. lever is fully closed, tend to close it still further.

Interchangeability of Mechanisms

167. Breech mechanisms are not as a whole interchangeable between right and left guns. Due to the fact that both the breech screws are right-handed, whilst the final movement of the B.M. lever is upwards in both cases, the movements of the crank, breech screw, etc., are different relative to the carrier; thus the majority of important parts are not interchangeable, though many of the small parts are.

168. The schedule of component parts given in Appendix I shows which parts are interchangeable and which are not. The letter R against the number of a part indicates that the part is different for right and left guns, whereas the interchangeable parts have plain numbers.

169. The breech bushes in the guns are identical and therefore the guns themselves are interchangeable.

Stripping

170. The most convenient sequence of stripping the breech mechanism is as follows :—

Remove lock and box slide.
Open the breech.
Unscrew vent axial nut (87), and remove the vent axial (85) sleeve (86), and rebound spring (88).
Close the breech.
Unscrew hinge bolt nut (32) and remove loading tray safety cam (57).
Remove the control arc (93).
Open the breech.
House the B.M. lever.
Remove the split pin and unscrew the crankshaft nut (29).
Withdraw the B.M. lever. Care is necessary in getting it past the hangfire latch gear, but it is not necessary to remove this.
Unscrew the nut (18), securing the lock hand lever.
Remove the lock hand lever guide (12) and the lever (65) complete with plunger.
Note the position of the adjustable bolt (62) and remove it.
Remove the link actuating lock (61) and the slide actuating lock (60).
Remove the bolt (30) securing the crankshaft bearing.
Revolve the breech screw through a small angle till the crank pin is on its dead centre.
Withdraw the crankshaft (28), crankshaft bearing (42) and cam actuating lock (15) complete as one unit.
Remove the breech screw (73).
Withdraw the hinge bolt (31) and airblast cam (35) as a unit.
Ease off the upper adjustable hinge lug bush (58) about half a turn.
Remove the carrier.
If the lower adjustable hinge lug bush is to be removed, first note carefully its position.

Note.—The weight of the breech screw is approximately 1 cwt.

The weight of the carrier is $1\frac{1}{2}$ cwt.

Assembling Breech Mechanisms

171. The sequence is the reverse of that for stripping.

172. As soon as the carrier is in position, tighten up the upper adjustable hinge lug bush (58) as much as possible, at the same time partially taking the weight of the carrier, as this will facilitate insertion of the hinge bolt. When the hinge bolt is in position, ease off the upper bush to the nearest position for insertion of the check screw (55).

173. The only parts that can possibly be assembled wrongly are the guide (12) for the lock hand lever, and the cam actuating lock (15). The guide should be assembled so as to give the lock hand lever the longest travel. If screwed in position the wrong way round, the lever will have insufficient travel to operate the lock correctly.

174. The cam actuating lock must be assembled on the crankshaft so that the notch (15A), in which roller (4) rests, is facing the crank pin.

175–180.

SECTION 3.—THE BOX SLIDE

181. A box slide, Z, Mark I, and a lock, electric, E.K., Mark I, are provided. No arrangements are fitted for percussion firing. Both lock and box slide are interchangeable between right and left guns.

The Box Slide. (Plate 7.)

182. The body (107) of the box slide is secured to the vent axial (85) by interrupted threads, and is prevented from turning by the ~~plunger (97) on the~~ catch retaining box slide, which is secured to the carrier. P36 of 49.

183. The box slide has in it two vertical axis pins (108) and (109). The lever withdrawing sleeve (105) is pivoted on axis (108) and the extractor (110) on pin (109).

184–190.

SECTION 4.—THE LOCK

191. The body of the lock (111) slides horizontally in the box slide, being moved by the lock guide bolt (101) which passes through the lock. Screwed into the body is the bush (112), within which are the needle (102), insulating bush (113), insulating washer (114), sliding bush (115) and spring (103). The withdrawing sleeve (104) is secured to the needle by nuts. Pivoted on the lock body are the tumblers (116), which cause the final movement of the extractor.

Operation

192. The withdrawing sleeve (104) is moved to the rear by the spring plunger (117), which in turn is worked by the lever operating sleeve (105) as the latter is moved by the retracting bar (5). This movement is sufficient to clear the horns of the withdrawing sleeve (104) from the cams (106). The lock is moved over to mask or unmask the vent by the lock guide bolt (101), which takes in the slide actuating lock (60). The operation of the retracting bar, and slide actuating lock, has already been described under " Lock Actuating Gear."

Extraction

193. As the lock moves over, two bevelled faces (118) on the lock bush take against two corresponding faces (119) on the extractor, providing a gradual primary extracting movement. As the lock is moved further over, the faces (120) of the tumblers take against corresponding toes (121) on the extractor and give it a sharp movement which ejects the tube. Final movement of the lock takes the faces of the tumbler past clear of the toes. (View 2.)

Masking the Vent

194. When a tube is inserted, it presses the extractor in with it, and the toes (121) press the tumbler over so that the tube can enter till the extractor is in the primary extraction position. As the lock is moved over to mask the vent, an inclined surface (112A) on the lock bush pushes the tube and extractor right home. Just before the vent is fully masked, the inclined surface on each tumbler meets a corresponding surface on the extractor (110A) which returns the tumblers to their previous position.

195. When the vent is fully masked, and the breech fully closed, the needle moves forward under the action of its spring and makes contact with the tube.

196–200.

CHAPTER III

SECTION 1.—THE CRADLE. (Plates 8 and 9.)

201. The gun is carried in a cradle (1) of cast steel into which the two trunnion pins (2 and 2A) of forged steel are screwed and shrunk. One pin (2A) is made with a projection, by which pressure for air blast is taken from the trunnion bracket to the cradle.

202. Secured to the bottom of the cradle, by fitted bolts, is the elevating arc (3) which is machined from a forged billet of nickel steel. A separate arc (11) is fitted for working the black pointers of the director elevation receiver.

203. A hand locking bolt (68) is mounted on the trunnion bracket. It takes into a socket on the cradle and locks the cradle at 5° elevation.

204. Five manganese bronze rings (10) are riveted into either end of the cradle, and it is on these that the gun bears during recoil and run-out. Stauffer grease lubricators are fitted to force grease in between these rings and the gun.

205. The balance ring (4) is secured rigidly to the gun, and carries the recoil cylinder (6) and the controlling plunger (7).

206. The piston rod of the recoil cylinder is secured to a lug on the cradle by nuts (33). In the top of the balance ring is a small filling tank (42).

207. The run-out cylinder (recuperator) (54) is secured to the cradle. The run-out ram (55) is secured to the balance ring by two rods (58) and a crosshead (57).

208. Mounted on the cradle in connection with the run-out cylinder are the charging connection and valve (60), pressure gauge (61), intensifier (62), and intensifier charging pump (64).

209. Air blast is led from the trunnion bracket into the trunnion (2A) through its extension, and thence to the cradle sliding pipe (9), outside which is the recoiling sliding pipe (8) secured in the balance ring. Thence the air is led to the air blast admission valve on the carrier.

210. The loading tray (69) swings on an arm (70) pivoted on the loading arm (71). The latter is bolted to the cradle, in a fitted socket, by four bolts (74).

211. The recoiling portion (13) of the interceptor is secured to the balance ring. The non-recoiling portion (14) is hinged on a bar (15) secured to the cradle by a bolt (16). The bar slides in a groove on the balance ring.

The Balance Ring. (Plate 9.)

212. The balance ring is secured round the breech end of the gun, and is fitted to allow the trunnions to be placed close to the breech end. This simplifies design as a whole in a mounting capable of 45° elevation.

213. Each gun and cradle, with all weights, including recoil liquid, etc., in place, or allowed for, is carefully balanced about the trunnions, and lead is added to the balance ring as requisite for this purpose.

214. The balance ring is made in two halves fitted round the breech end of the gun and secured by 12 horizontal bolts.

215. Collars (5) on the gun engage in corresponding recesses in the balance ring, and two longitudinal keys pass through these collars and prevent the gun turning in the ring. The run-out cylinder, which is secured to the cradle, works in a recess in the balance ring. Flats are machined on either side of the run-out cylinder, and two bronze bearing plates are secured in the balance ring, and take

against these flats. Thus the balance ring, and hence the gun, is prevented from turning in the cradle on firing. The recoil piston rod is made a loose fit in the lug on the cradle to which it is secured, so allowing for the wear of the bearing rings in the cradle, and for the tendency of the gun to twist, without the strain being taken by the sides of the piston rod against the recoil cylinder glands.

Splinter Protection Plate. (Plate 8.)

216. The splinter protection plate (17), made in two halves, is secured to a bush (18) bolted on to the front end of the cradle, and to two supporting pieces (19) above and below the cradle. The plate is of semi-circular section and concentric with the trunnions. Bearing on the plates are leather strips (20), whose degree of tightness is adjustable by bolts (21). This renders the gunhouse blast proof and practically waterproof.

217. ~~C... front of the bush supporting the splinter protection plate is secured a g... of salt wat... rings durin... the gun pr...~~

Page 22, **Splinter Protection Plate.** *Delete* paragraph 217 and *substitute* :—
"217. To protect the chase of the gun when fully run-out, a canvas cover is fitted which satisfactorily excludes water and is easily removed for purposes of cleaning the chase : this replaces the steel gun protection tube originally fitted (*see* fly to plate 8 in O.U. 6359B)."

(G. 07698/41.—A.F.O. P.57/42.)

Wiper Rin...

218. ~~... the bush ...~~

Wiper Ring. *Delete* paragraphs 218 and 219 and "220-225" and *substitute* :—
"218. A wiper ring, which is a close spring fit round the gun, and is sprung into the bush, is held in position by a junk ring, which is in turn screwed into the front of the bush."

(G. 07698/41.—A.F.O. P.57/42.)

(Amendment No. 1, A.F.O. P.723/41.)

~~219. ... to transfe... elevation comes into play.~~

~~220-225.~~

SECTION 2.—THE TRUNNIONS. (Pl...)

226. The weight of the gun and cradle is taken by the trunnion pins in their bearings, which are supported on trunnion brackets built up from the floor of the gunhouse.

227. The trunnion bearings are in two parts, the part nearest the gun being a plain gunmetal bearing, and the outer part a roller bearing. The gunmetal bearing is supported directly on the trunnion bracket, and is held in place by the trunnion cap (25). The roller bearing (26) is supported by a steel segment (27), which can move up and down through a limited distance in the trunnion bracket. This segment is mounted on wedge-pieces (28) and Belleville spring washers (29), which are supported in the trunnion bracket.

228. Through the upper wedge-piece passes a screwed adjusting bolt, which is fitted with a ball-bearing at the front end. When this bolt is rotated, the upper wedge-piece is moved across the lower wedge-piece, and causes the steel segment and the roller bearing to move up or down in the vertical plane.

229. The wedge-pieces of the trunnion bearing are adjusted in the erecting shop, and marked, so that 90 per cent. of the weight of the gun and cradle is taken by the roller bearings and Belleville spring washers, thus keeping the elevating effort low. When the gun is fired, however, the additional pressure set up compresses the Belleville spring washers, and the majority of the load is then taken on the greater area of the plain gunmetal bearings.

230. The adjusting bolt is prevented from slacking back by a keep plate bolted to the trunnion bracket.

231. The trunnion bracket bearings are lubricated by two Stauffer grease cups, which force grease through channel ways in the gunmetal bearings.

232–235.

SECTION 3.—RECOIL ARRANGEMENTS. (Plate 9.)

236. The energy of the recoil of the gun is absorbed mainly by the recoil cylinder and piston, but partly also by the compression of the air in the run-out cylinder.

237. The recoil cylinder is rigidly secured in the underside of the balance ring by a shoulder at the rear end and a nut (30) at the front end. Within the cylinder is the hollow piston rod and piston (31), into which is screwed the throttling bush (32).

238. The front end of the piston rod is secured by nuts (33) to a lug on the cradle (34). It is not a close fit in the lug, and this permits the rod to "drop" the very small amount required to allow for "drop" of the gun, due to wear in the bearing rings in the cradle.

239. The control plunger (7) fits inside the hollow piston rod, and is secured at the rear end to the cylinder closing plug (50), and therefore moves in recoil with the gun.

Action during Recoil

240. When the gun recoils, the recoil cylinder and control plunger are carried to the rear with the gun, the piston and piston rod remaining fixed.

241. As the cylinder travels to the rear, the liquid in it is forced through the ports (35) in the piston, and through the annular space (32A) between the throttling bush (32) and the control plunger (7), to the rear of the cylinder. This annular space becomes gradually smaller during the recoil because the control plunger is tapered, having its maximum diameter at the front end. The shape of the taper is designed to effect an approximately uniform retardation throughout the recoil and to govern the length of recoil.

242. The pressure set up in the cylinder also forces a certain amount of liquid into the space between the piston rod and the control plunger. The front end of the control plunger is fitted with a sleeve non-return valve (36), the travel of which is limited by the fixed control valve (37) and the washer (38).

243. During recoil, the sleeve valve is forced by the pressure of liquid towards the front, thus allowing liquid to pass through the ports (39) into the increasing space (40) which, at the end of recoil, will be completely filled.

Action during Run-out

244. On completion of recoil, the gun is returned to the firing position by the pressure of the air in the run-out cylinder.

245. The speed of run-out is governed by the control groove (41), which is cut in the inside wall of the piston rod. This groove is of varying cross-sectional area and is largest at the rear end, gradually diminishing in depth towards the front.

246. When the run-out commences, the control plunger begins to travel to the front with the recoil cylinder. Sufficient pressure is now set up in the space (40) to force the sleeve valve (36) hard over to the rear, thus completely closing port (39). The only passage now available for the escape of liquid from the space (40) is over the sleeve valve and through the gradually diminishing groove (41). This groove is of sufficient depth to allow the gun to run out quickly. Just as the gun reaches the fully run-out position the groove (41) terminates, thus stopping the escape of liquid from the space (40) and bringing the gun gently to rest. Liquid can pass from left to right of the recoil piston through the annular space (32A) during the run-out, but this flow takes no part in the run-out control.

247.

Filling Tank

248. Owing to the varying volume of the liquid spaces during recoil and run-out, the total quantity of liquid required in the system alters. A filling tank (42) situated in the top of the balance ring, allows liquid to enter the non-pressure end of the recoil cylinder, as requisite, through a pipe (44). The tank is fitted with a filling plug (43, Plate 8), and the lid of the tank can be removed when it is desired to clean out the inside. A drain plug (45) is fitted at the bottom rear end of the recoil cylinder. Two air plugs (46 and 47) are fitted at the top front end of the cylinder and piston respectively, to remove all air when filling the system. An instruction plate is fitted near the filling tank, giving instructions for filling the recoil system. The liquid used for the recoil cylinders is OIL, O.M. 13 (Pattern No. KK22) P 194/51.

Construction of the Glands in the Recoil Cylinder

249. The front end of the recoil cylinder is sealed by a "U" leather (48) and cotton packing (49). Pressure reaches the "U" leather through channels during recoil, and expands it round the neck of the piston rod.

250. The rear end of the cylinder is closed by a plug (50), which is forced home on to a copper ring (51) by a nut (52) which screws into the cylinder. The section of the copper ring is such that it is expanded readily by the pressure of the plug, thus ensuring an effective seal.

251. The control plunger is entered into the cylinder closing plug from the front end and is secured by a nut and split pin. The joint is sealed by a white metal ring (53) between a collar on the plunger and a recessed seating on the cylinder closing plug.

252. A stop bracket (73) is fitted on the cradle just clear of the run-out cross-head when the gun is in the fully run-out position. Its object is to allow the recoil cylinder gland to be repacked without releasing the pressure in the run-out cylinder. This can be done by easing back the nuts on the forward side of the run-out cross-head, and slightly elevating the gun. The gun will then run back under its own weight, the recuperator ram being retained in position by the stop bracket (73). The tie rods are long enough to allow the gun to be run back as far as is necessary for the glands at the front end of the recoil cylinder to be repacked.

253. When run back, the gun will be out of balance, and as both hand and power elevating work through similar friction clutches, it is improbable that the gun can be depressed to run it out. It must therefore be hauled out by screwing up the nuts on the tie rods.

254–260.

SECTION 4.—RUN-OUT ARRANGEMENTS

261. The gun is run out by compressed air, and the arrangement of the run-out cylinder is shown on Plate 9.

262. The run-out cylinder (54) is rigidly secured to the cradle above the gun and does not move when the gun recoils or runs out. Within the cylinder works a hollow ram (55), secured to the crosshead (57) by a nut (56). The crosshead is connected to the balance ring on the gun by two tie rods (58) and thus the movement of the gun during recoil is imparted to the hollow ram. A machined surface (12) is provided on the top of the cradle, acting as a guide for the crosshead.

263. The run-out cylinder is connected by a pipe (59) to the intensifier (62). A pressure gauge (61) is fitted in the pipe with a stop valve on either side. A charging connection (60) is fitted in the pipe close to the point of entry into the run-out cylinder, so that the cylinder can be charged through a flexible hose from a connection at the base of the trunnion bracket. The pressure in the run-out cylinder should be 1,000 lb./square inch.

Action of Run-Out cylinder

264. When the gun recoils, the ram is carried to the rear into the run-out cylinder, further compressing the air therein. This increase of pressure assists to bring the gun to rest. When the recoil of the gun is overcome, the air pressure in the run-out cylinder asserts itself and forces the ram to the front, and returning the gun back to the firing position.

265. The gland of the run-out cylinder is formed by two " U " leathers (63), between which oil is forced, at a greater pressure than the air in the cylinder, by the intensifier (62), which is connected direct to the end of the run-out cylinder. Outside the " U " leather gland is another gland of cotton packing.

The Intensifier

266. The object of the intensifier is to ensure that the pressure of air inside the run-out cylinder is always maintained, by preventing any leakage of air round the run-out ram.

267. The intensifier (62) consists of a cylinder within which works a piston. The run-out cylinder is connected by an air-pipe to the rear side of this piston, which is therefore always subjected to the existing air pressure in the cylinder. The front end of the intensifier is filled with liquid and connected by a pipe to the run-out cylinder gland, between the " U " leathers.

268. The piston is fitted with a piston rod which projects through the front end of the intensifier, the joint being kept tight by a gland.

269. The effective area on the air side of the piston is therefore greater than that on the liquid side by the amount of the area of the piston rod. The pressure of the liquid is consequently greater than the air pressure in the run-out cylinder, and therefore the " U " leathers are forced against the run-out ram by a pressure greater than that of the air in the run-out cylinder, which is trying to escape. An indicator is fitted in the piston rod whereby the amount of liquid remaining in the intensifier can be checked.

270. The liquid used for the intensifier consists of a mixture of one part potash soft soap, Grade I, to two parts heavy torpoyl.

Intensifier Charging Pump

271. The liquid of the intensifier can be recharged by a small hand-worked pump (64) mounted on the cradle and connected to the intensifier through a pipe (65) and a stop valve (66). The pump handle is normally unshipped and stowed in a position on the trunnion bracket.

Arrangements for Charging Intensifier in Mountings for H.M. Ships "Sheffield," "Glasgow," "Birmingham," "Liverpool," "Gloucester," and "Manchester." (*See* inset on Plate 8.)

272. The liquid end of the intensifier is charged by a hand pump (75) mounted on the cradle and connected to the intensifier through a stop valve (77) and pipe (76). The portable ratchet handle (78) can normally be lifted off and stowed in clips on the structure supporting the trunnion bracket.

273. The dome shaped cap (79) can be unscrewed to enable the pump to be filled by hand with the torpoyl/soft soap mixture.

Breast Shore

274. A breast shore (72) is supplied which can be shipped between the run-out crosshead and that part of the cradle in which the run-out cylinder is fitted. This keeps the gun fully out if it is required to release the pressure in the run-out cylinder temporarily for any reason, such as repacking a gland. It is naturally **imperative** that the breast shore should be removed before firing.

275–280.

CHAPTER IV

SECTION 1.—THE POWER SYSTEM

PRESSURE SIDE. (Plate 10.)

281. Hydraulic power for laying, training, and shell supply, is provided by a variable swash-plate pump in the working chamber. Special mineral oil is the pressure medium used.

282. The pump, which is driven by a 103-h.p. electric motor, draws its suction through a duplex strainer from the make-up feed tank, which is on the turntable floor. It delivers pressure to a stack in the working chamber, from which there is a separate stop valve and pressure pipe to each of the seven control valves.

283. There is a pressure gauge at the stack, and another in the gunhouse. There are eight motors requiring hydraulic power, *i.e.*, three for shell hoists, three for elevating, and two for training, but one control valve controls both training engines.

284. A locked drain cock is provided at the bottom of the main suction pipe (*See* Plate 11 and description thereof.)

285. Exhaust pipes from the control valves of the elevating engines, and the shell hoist engines are led down to N.R.Vs. on the exhaust manifold in the working chamber, and thence to the cooler bye-pass valve. The exhaust pipe from the control valve of the training engine is led down to a N.R.V. in the turntable, and thence to a connection on the pipe joining the exhaust manifold to the cooler bye-pass valve. The normal course of the oil, then, is through the cooler and back to the make-up feed tank, and it may also be bye-passed direct to the make-up feed tank.

286. A pressure gauge is fitted to the exhaust manifold. In the pipe between the exhaust manifold and the cooler bye-pass valve there is a relief valve—loaded to 50 lb./square inch, which allows any excess pressure to escape direct to the make-up feed tank without passing through the cooler.

287. On the platform in the shell handing room, there is a reserve feed tank of 38 gallons capacity, from which a semi-rotary pump can deliver oil to the make-up feed tank. This reserve tank is filled through a portable funnel and a pipe, the latter being situated beneath a screwed plug fitting flush in the gunhouse floor.

288–300.

SECTION 2.—OIL COOLING SYSTEM. (Plate 13.)

301. A Serck oil cooler is fitted in the working chamber and the exhaust oil can be passed through it before being returned to the make-up feed tank.

302. The cooler consists of a cylindrical main casing with top and bottom casings, the top casing being divided longitudinally. Salt water from a pump on the fixed structure comes into one side of the top casing, passes down through tubes in the main casing, through the bottom casing, and up through tubes to the outlet pipe on the other side of the top casing.

303. Oil from the exhaust system enters at the bottom of the main casing, passes round the outside of the water-cooled tubes—its passage being lengthened by baffles—and emerges at the top of the main casing. The casing joint rings are made of oil-resisting rubber.

304. Pressure gauges are fitted to the cooler to show the inlet and outlet pressures of the oil, and also the inlet and outlet pressures of the salt water.

305. Thermometers are fitted to show oil inlet and outlet temperatures, and salt water inlet and outlet temperatures.

Oil Circulation System for Power Pump. (Plate 13.)

306. An oil circulating pump (Malcolm-Feuerheerd) is fitted for the lubrication and cooling of the pressure pump. It is driven by gearing off the pressure pump, and draws its suction from the top of the pressure pump casing, thus ensuring that the latter is kept full. It delivers the oil to the exhaust manifold. The supply of fresh oil to the pump casing is by gravity from the make-up feed tank, through a sluice valve and duplex strainer. A switch cock is fitted on the suction side of the circulating pump, so that in the event of this pump being out of action, pump casing circulation can be obtained on the thermo-syphonic principle, by switching the cock over.

Drain System from the Hydraulic Engines. (Plate 11.)

307. The hydraulic engines are lubricated internally by seepage of oil from the pressure side. To prevent pressure accumulating in the casings, a drain pipe is fitted to each engine which allows surplus oil to escape. On the L.H. side the drain pipes from the elevating, shell hoist and training engines are joined up into one pipe; on the R.H. side the drain pipes from the R.H. and centre elevating, shell hoist and training engines are also joined up into one pipe and these two pipes unite with the drain pipe from the centre shell hoist engine at the side of the make-up feed tank. The combined drain is then led into the make-up feed tank above the working oil level. This drain system is a closed system throughout.

Air Cock Drain System. (Plate 11.)

308. There are 18 air cocks in the revolving structure, one on each pressure and exhaust pipe from each elevating control valve to its elevating engine (1) (Total, 6), one at the highest practical point of the pressure line to each shell hoist control valve (2) (Total, 3), one on each pressure and exhaust pipe between the training control valve and training engine (3) (Total, 2), one on the control cylinder of the pump (4), three near the top of the Serck oil cooler, for the oil outlet and water inlet and outlet (5), one on the highest point of the main pressure supply pipe from the pump to the pressure stack (6), and two for the 3·75-inch bore Duplex Strainer on the underside of the make-up feed tank which drain into the save-all under the strainer (7); the cock on the underside of the save-all enables it to be emptied by hand. In addition, there are save-alls beneath all the control valves, and a drain cock on the bottom of the main suction pipe from the make-up feed tank to the pumps, all of which drain into one or other of the funnels. The drain cock on the main suction pipe is fitted for emptying this pipe and the strainer, when it is desired to remove the pump (or its rotary valve) for overhauling purposes.

309. With the exception of the drains from the Serck oil cooler and the 3·75-inch bore Duplex Strainer, all the drains lead into covered funnels (there being holes cut to suit in the covers to allow for admittance of pipes) and thence through non-return valves into the oil drain tank on the platform in the shell handing room; this tank has an air vent pipe leading up to the underside of the gunhouse floor.

310. A semi-rotary hand-pump, conveniently situated, sucks the oil from the bottom of the tank and discharges it to the 2-inch bore flexible hose connection for the purifier system on the underside of the working chamber floor, whence it may be led, by connecting the flexible hose, to the settling tank (*see* Plate 12).

311. The drains from the air cocks, as well as the drain cocks, on the Serck oil cooler lead into their respective save-alls for oil or water. These are situated under the cooler, and have to be emptied by hand.

312. There is also a cock on the underside of the reserve oil tank to enable this tank to be drained.

313. An open drain on the casing of the control cylinder allows seepage of oil from the piston to escape to the pump bedplate, which is fitted with a plug for draining.

Oil Purifying System. (Plate 12.)

214. Two systems are fitted, one serving " A " and " B " turrets and the other " X " and " Y " turrets, each consisting of a 90-gallon settling tank and a " Vickcen " centrifugal oil separator of 50 gallons per hour capacity. The forward system is situated in the space above " A " magazine and the after one in " Y " shell handing room.

315. A 1·9-inch bore drain from the make-up feed tank leads through stop valves (1) and (2) to a flexible hose connection beneath the working chamber floor. Thence, a flexible hose is connected to the corresponding connection with stop valve (3) on the fixed structure in the shell handing room. The latter pipe leads through valve (4) to the settling tank.

316. The separator is fed by gravity from the settling tank, and a gear pump (5), incorporated in the separator, delivers the clean oil back through a ·75-inch bore pipe and stop valves (6) and (7), through a flexible hose in the shell handing room, to stop valve (8) on the revolving structure, and thence to the top of the make-up feed tank.

317. Funnel (9), situated at the top of the settling tank, is for the reception of any waste oil, whilst stop valve (10), situated on the drain connection beneath the working chamber floor, receives the discharge from the air cock drain tank. (*See* Plate 11.)

318–320.

SECTION 3.—THE POWER UNIT.

(Plate 14.)

General Arrangement

321. One power pump is installed in the centre of the working chamber for supplying hydraulic (oil) pressure to the machinery in the revolving structure.

322. The pump, which is of the usual variable delivery swashplate type, is driven through a flexible coupling (1) by a 103-B.H.P. electric motor at a constant speed of 300 revs./min. and is capable of delivering 36,000 cub. in./min.

323. It is mounted on a common bedplate with the motor. The unit provides sufficient power to work simultaneously three shell hoists, three elevating engines at full speed and both training engines at half-speed.

324. The pump consists of a steel casing (2), the left-hand end of which is open. At this end are fitted the cast iron cylinder casing (3), the rotary valve (4) and valve cover (5). The right-hand end is closed except for a hole through which the pump shaft (6) passes and small holes (7) through which the oil passes to the gearing driving the Malcolm-Feuerheerd pump.

325. The cylinder casing, pump casing and gear casing are held together by four bolts (8).

326. Running on ball bearings in the casing is the pump shaft (6). This shaft has a wedge-shaped boss (9) forged on it and fitting over the large end of this boss is the swashplate swivel piece (10).

327. The revolving swashplate (11) rests on two cam blocks (12), one on either side of the boss (9), and is kept up against the face of the swivel piece by a spherical bearing (13) and spring (14).

328. Rollers (15), shown dotted, are fitted between the cam blocks and the swivel piece. The revolving swashplate is thus free to pivot in the swivel piece about the spherical bearing, and its position is governed by guide blocks, which work in grooves in the cam blocks.

329. The fixed swashplate (16) rests on the revolving swashplate, the longitudinal thrust being taken on a double ball race (17). The radial bearing consists of a roller race (18) and a ball race (19).

330. The fixed swashplate (16) is prevented from revolving with the shaft by two trunnions (20), forged solid with it, which pivot in trunnion blocks (21). When the swashplate angle changes, the trunnion blocks are free to move longitudinally in gunmetal bearing strips (22) secured to the pump casing.

331. The cylinder casing (3) has nine cylinders bored in it, each with a port (23) connecting with face of the casing. This face is a machined surface on which the valve face bears.

332. The pistons (24) which work in the cylinders are connected to the fixed swashplate by connecting rods (25), both ends of which are spherical and work in sockets.

333. Clutched to the left-hand end of the shaft and located by the pin (26) is the eccentric (27) which operates the rotary valve.

The Pump Casing

334. The pump casing is made of cast steel and is secured to the bedplate by four bolts. On the inner side of the right-hand end is fitted a double ball race (28) to take the thrust of the swivel piece (10). The shaft bearing, where it passes through the end of the pump casing, consists of a double ball race (29).

The Cylinder Casing

335. The cylinder casing is made of tough, close grained cast iron and is bolted to the pump casing by four bolts (8).

The Valve

336. The valve is of the wheel type with two concentric bearing surfaces, the two surfaces being connected by vanes or spokes which themselves do not form any bearing surface.

337. The back of the valve being open to the suction inlet, the same condition applies to the space between the concentric surfaces forming the valve space. The space round the outside of the valve is a belt with a discharge outlet at the top of the cylinder casing through which the pump delivers pressure.

338. The bearing surfaces on the valve are kept up against the machined face on the cylinder casing by a bearing ring (30) and a belleville spring washer (31). The bearing ring is prevented from turning by pins (32). The back of the bearing ring is in contact with the inside face of the valve cover (5), so that when the latter is bolted into place, it presses against the bearing ring, thus compressing the belleville washer which holds the valve up against the port face of the cylinder casing with an even pressure. Oil is prevented from escaping between the back of the valve and the bearing ring by a flat leather ring (33) supported by a spring ring. These are held on the back of the valve by a nut (34) screwed on to the back of the valve. A retaining screw prevents the nut from slacking back.

339. Within the inner surface of the valve is a ball race and eccentric (27), which causes the valve (4) to rotate with an eccentric movement, so opening the ports (23) of the cylinders in rotation through the valve to suction, and, alternatively, past the outer edge of the valve face to delivery. The action of the valve is illustrated in Figs. I to IV.

The Valve Cover

340. The valve cover is made of tough, close grained cast iron and is bolted to the cylinder casing by 12 bolts.

341. Leakage from the pressure port in the cylinder casing is prevented by a " U " leather joint (35).

342. The suction inlet is in the lower part of the cover. The centre of the cover is taken up by a sleeve (36) connected to the control shaft (37) operating the swashplate.

343. The sleeve is provided with a gland (38) to prevent leakage of oil.

The Gear Casing

344. The gear case (39) for the Malcolm-Feuerheerd pump, secured to the pump casing by the same four long bolts as the cylinder casing, contains a gear wheel (40) keyed to the main shaft (6).

345. The outer end of the gear case is provided with a gland (41) to prevent the oil leaking along the shaft.

The Main Shaft, Swivel Piece, Cam Blocks and Revolving Swashplate

346. The main shaft is of forged steel and is hollow for the full length. In one end is fitted the shaft for the eccentric operating the valve, and on the other end is fitted one-half of the flexible coupling (1), the hole at this end of the shaft being plugged. The sides of the wedge-shaped boss (9), previously mentioned, are fitted with hard gunmetal bearing surfaces. The swivel piece (10), fitted over the large end of the wedge-shaped boss, revolves with the shaft and is provided with two radial faces for taking the thrust from the swashplate.

347. The cam blocks (12) have two corresponding radial faces and the thrust from them is transmitted to the radial faces on the swivel piece (10) by means of seven rollers (15) on either side, fitted in cages. The thrust on the swivel piece (10) is transmitted through the ball thrust bearing (28) to the pump casing.

348. A cam groove is machined in the inner face of each cam block (12) in which guide blocks are fitted.

349. The two guide blocks are connected by a pin (42) which passes through two elongated slots in the hollow shaft (6) and also through a connection piece secured to the end of the control shaft (37). The guide blocks in cam blocks (12) being constrained to move longitudinally only, any movement of the control shaft (37) forces the swashplate to a different angle.

350. The position of the thrust rollers (15) is controlled by two links (43), shown dotted. One end of each link is pivoted on a pin attached to a collar on the main shaft, the other end being controlled by a stud in the cam block.

351. Each link has an elongated slot into which fits a pin on the side of the cage containing the rollers (15), the roller cage therefore rising or falling with the movement of the link.

352. The revolving swashplate is maintained in contact with the cam blocks (12) by the spherical bearing piece (13) and spring (14). The spring is enclosed in a cover which is kept up against the spherical bearing piece by a nut (44) on the valve end of the shaft, which also holds the two ball races forming the main shaft bearing and the distance piece (45) in position. The thrust between the fixed and revolving swashplates is taken on a double ball race (17) and the radial load is taken on a roller bearing (18). A double purpose ball race (19) holds the fixed swashplate on to the revolving swashplate and also assists the roller bearing (18) in taking the radial load. The roller bearing (18) and ball bearing (19), together with a distance piece, are held in position by a nut (46), screwed on to the boss of the moving swashplate, which prevents the swashplates moving apart.

The Fixed Swashplate

353. Over the fixed swashplate trunnions (20) are fitted trunnion guide blocks (21) which slide in guides (22) in the pump casing. The guide blocks are fitted with phosphor bronze bushes which are held in position by pins (47).

354. The nine connecting rods are secured in holes in the fixed swashplate by gunmetal bushes (48) made in halves, and steel securing rings screwed into the swashplate. The securing rings are slotted, and between each pair is a locking plate which engages in the slots, the locking plates being secured, by split pins, to studs (49) in the fixed swashplate. The thrust is taken on hard bronze sockets at the bottom of the holes.

355. The other end of each connecting rod is held in the piston (24) by a phosphor bronze socket, which takes the thrust, screwed into the back of the piston. The connecting rod end is held by this socket against a phosphor bronze hemi-spherical bearing ring, which is supported by a collar in the skirt of the piston. The screwed socket is secured in position by a locking washer. No leathers are fitted, but the pistons are a ground fit, and an annular groove on the piston helps to reduce any leakage between the piston and the cylinder walls. An oilway is drilled through the centre of the screwed socket in each piston and an oil hole runs through the centre of the connecting rod to the bearing socket in the fixed swashplate.

356. The maximum angle to which the swashplate can be set is 18° and the minimum is zero. In the former case the stroke of the piston will be 3·2 inches, when the pump will be delivering 36,000 cubic inches per minute, and in the latter case nil.

The Control Cylinder

357. The control cylinder is fitted to regulate the rate of discharge of oil by the pump, according to the amount being used, and so maintain a constant pressure in the system. This is done by varying the angle of the swashplate. A pressure lead is taken from the discharge side of the pump to the control cylinder (50). Working in this cylinder is a solid piston (51) fitted with two " U " leathers. Screwed on to the end of the cylinder is the spring case (52), in the other end of which is screwed an end piece (53) through which passes the control rod (54).

358. Two springs, separated by a distance piece (55) are kept in a state of compression by the compression nut (56) being screwed up against a distance piece (57), which also acts as a stop on coming into contact with the end piece (53). The end of the spring bears against a ring (56A) which bears against the compression nut. The piston is in contact with, but not secured to, the compression nut.

Action of the Control Cylinder

359. The delivery from the pump is dependent upon the oil pressure in the system.

360. Rise of pressure forces the piston (51) and control rod (54) to the left against the spring load, and moves the control shaft (37) to the right.

361. As previously explained, this decreases the angle of the swashplate, thus reducing the stroke of the pistons and therefore the volume of oil delivered.

362. Fall of pressure allows the spring to move the control in the opposite direction to the above, thus increasing the angle of swashplate and the volume of oil delivered.

363–365.

SECTION 4.—THE MALCOLM FEUERHEERD CIRCULATING PUMP

366. This pump is for circulating the oil in the main pump casing, taking suction from the top of the casing and discharging into the main exhaust pipe between the exhaust manifold and the cooler by-pass switch cock.

367. The power pump casing is kept flooded with cool oil by gravity from the make-up feed tank.

368. The pump is driven by gear wheels (40 and 58) off the main pump shaft, the circulating pump shaft being connected to the gear wheel (58) by shearing pins (59).

369. The pump has a delivery of 14·5 gallons per minute at a speed of 439 revs./min.

Construction

370. The pump is of the rotary type working on the displacement principle. The casing (60) is circular in internal section, but eccentric with the shaft (61). Keyed to the shaft are two discs (62) connected by five pins (63) on each of which are pivoted two links (64). The other ends of each pair of links are connected by a pin (65) on which revolves the roller (66).

371. Revolving between the discs (62) and around the shaft (61) is a loose ring (67) having such an external diameter that the five rollers are pressed against the internal diameter of the pump casing, thereby making a tight working fit between the loose ring and the casing.

372–375.

Notes on Stripping and Adjustment of Power Unit

Examination of Valve

376. Drain oil from pump casing and remove suction pipe and control lever. Remove four short studs and ship two withdrawing bars. Take off nuts securing cover and ease off cover on to bars. Fit eyebolt in hole provided, sling up and remove.

377. Take off valve retaining ring and Belleville washer. Remove control sleeve by unscrewing back nut with special spanner and then take off thrust bearing. Valve will stick to cylinder block by oil film and care must be taken in removing it. Ball race is a push fit on eccentric.

378. When facing up valve, dermatine washer, etc., and retaining nut must be assembled as tightening this up tends to distort the valve. If it is necessary to remove more than say 0·01 inch from the two faces of the valve, shims must be inserted under the Belleville washer to maintain the correct compression (approximately 0·06 inch).

379. This can be carried out with the pump in place in the working chamber. For details of valve, *see* Drawing N.8588.

Examination of Control Cylinder, Piston, etc. (*See* Fig. 1.)

380. Take off control lever and pressure pipe to cylinder. Unscrew cylinder from spring casing (grub screws secure) and piston can be withdrawn.

Note.—Load of spring is on piston shoulder for first 0·05 inch until collar on spindle takes against end of casing. This can be carried out without moving the pump. (*See* Drawing N.8594 for details of control gear.)

Adjustment of Control Spring. (*See* Fig. 2.)

381. Start up pump and throttle down on bye-pass valve until control piston moves. This should occur at about 975 lb./sq. in. and maximum stroke of piston, *i.e.*, bye-pass shut should correspond to about 1,200 lb./sq. in. If power is not available, hand pump may be connected to cylinder and control lever removed. If adjustment is required, spring, casing and cylinder complete must be removed to workshop and packing washers inserted to increase compression of spring. Thickness of washer required can be ascertained by noting distance moved by piston for a given pressure difference (approximately 0·5 inch — 0·7 inch = 50 lb./sq. in.) while throttling on bye-pass or pumping by hand.

382. To remove spring for insertion of washers, take off cylinder (grub screw securing) and place spring and casing in jig provided, with flats on end of rod preventing turning (Drawing N.11762). Remove two grub screws securing screwed sleeve to rod and unscrew.

Note.—When operating piston by hand pump, friction of leathers, etc., causes a lag equivalent to about 15 lb./sq. in. compared with pump running condition.

383. For general arrangement of spring, casing and cylinder, etc., *see* Drawing N.8594.

Examination of Malcolm-Feuerheerd Pump

384. Break join at main pump casing and remove pipes to Malcolm Feuerheerd pump. Remove the latter complete. (Sufficient clearance is provided to do this without disturbing main pump). Take off Malcolm Feuerheerd pump cover and roller assembly can be withdrawn for examination.

385. For general arrangement and details of Malcolm Feuerheerd pump, *see* Drawing N.8596.

Stripping Main Pump

386. Drain oil from pump casing and remove suction pipe and control lever. Remove hand training gear stanchion, discharge and oil circulating pipes and pump holding down bolts. Unship control cylinder complete. Cant up at valve end to clear lugs on feet and slide pump off coupling. At this stage the whole pump should be removed to workshop. *See* Drawing N.8879 for method of removal. (For general arrangement of pump, *see* Drawing N.8597). Take off main coupling. Proceed as for examination of valve. Remove gear casing and large gear wheel (grub screws) by forcing screws supplied.

387. Take out two top casing bolts and insert long withdrawing bars, then take off two lower casing bolts. Pull cylinder block on to bars until clear of shaft and pistons, and take off.

388. Slip withdrawing sleeve on to coupling end of shaft, hard up against ball race 11/N.8590 (Drawing N.8597) and pull shaft out from valve end far enough to sling and remove complete with swash assembly. (The most convenient position to work now is with shaft vertical, coupling end projecting through hole in bench.)

389. Remove grub screw and withdraw eccentric. Take off ball races, distance piece, spring and cover, spherical bearing, fixed swash retaining nut and trunnion blocks.

390. Fixed swash can now be removed complete with pistons, ball races and roller races. *Note.*—Upper row of balls are loose. Spherical ends of connecting rods, etc., can now be examined.

391. Remove pins engaging links and lift off rotating swash. Take off cam pieces, rollers and cam blocks, push out control pins and withdraw control rod. Take off swivel piece and remove links.

Assembly of Pump

392. Fit solid ball race on back of swivel piece and secure with two clamps. Put links on pins in shaft and place swivel piece in position on shaft, and bump on. Assemble control rod, place in position in shaft and insert pin. Place roller cages in position on swivel piece, engaging with links. Replace cam blocks on control pin.

393. Fit cam pieces, engaging with links and cam blocks. Assemble rotating swash on cam pieces—dowel pin on shaft indicates which way round—and fit pins engaging with cam pieces and links. Secure pins with washers and split pin.

394. Replace ball races and roller bearings and spherical bearing.

395. Assemble pistons and connecting rods in fixed swash.

Note.—After refitting connecting rod ends and reassembling pistons the latter should be tried in their respective bores as they may be distorted. New locking washers should be used, as old ones may fracture with repeated bending.

396. Replace fixed swash complete and assemble ball bearing and retaining nut, spring holding spherical bearing and casing, two ball bearings and sleeve on shaft, securing nut and trunnion blocks.

397. Insert eccentric and secure by dowel pin through nut and shaft.

398. Place ball races and cages in position in casing.

399. Fit assembling sleeve on shaft, sling up and place in position in casing.

400. Fit cylinder block joint.

401. Gauge pistons to make sure there are no burrs.

402. Insert long assembling bars and replace cylinder block, with internal assembly at full swash, inserting each piston in turn.

403. Fit lower bolts, withdraw bars and fit upper bolts and pull up.

404. Assemble valve in position and replace control thrust bearing. Insert " U " leather cover joint.

405. Replace cover and repack control rod gland.

406. Replace gear wheel and secure, and assemble gear casing.

Note.—When pump is stripped, the spherical bearing should always be examined for wear. This is done in the following manner. (*See* Figs. 3 and 4.)

407. When the shaft and swash assembly is withdrawn, pistons, connecting rods and trunnion blocks are removed and it is mounted on two of its ball-bearings on " V " blocks. (A sleeve must be made to slip over the smaller bearing to bring the diameter up to that of the larger, so that the shaft will lie horizontally.)

408. Place the swash in the neutral position (perpendicular to shaft) and support one trunnion pin on parallel strips (which incidentally, must be long enough to allow for the swash to oscillate over its full range), so that its axis is level with the axis of the shaft.

409. Rig a clock gauge on the top of the other pin. Rotate the shaft and, holding one pin on the parallel strips, gauge the other. No movement should be observed. Turn the fixed swash through 180° and rest the opposite pin on the parallel strip ; repeat the operation. (If any movement is observed during either test, it indicates that wear has taken place in the radial roller bearing between the fixed and rotating swashes, or the spherical bearing itself is worn. The latter can be checked later on. If this movement exceeds 0·003 inch, the bearings must be refitted and replaced.)

6 INCH TRIPLE Mk XXII MOUNTING.

DIAGRAMS OF POWER PUMP ADJUSTMENTS.

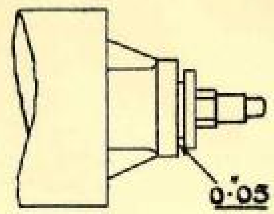

FIG. 1

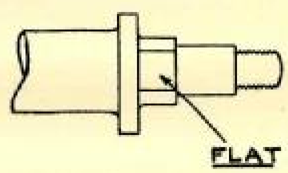

FIG. 2

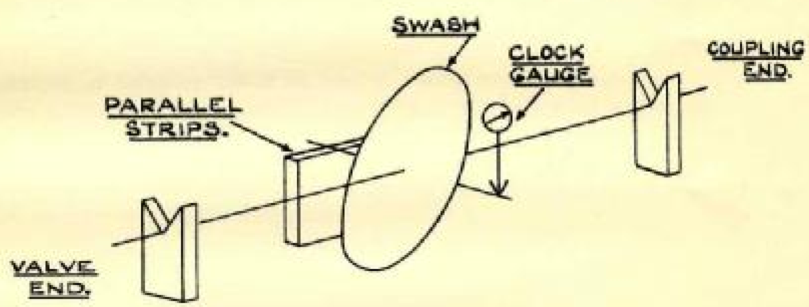

FIG 3

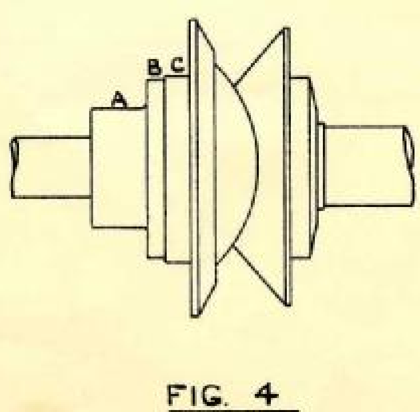

FIG. 4

410. If above tests are correct, tilt the swash to its maximum angle and, allowing one pin to slide to and fro on the parallel strips, gauge the height of the other for every 90° rotation of the shaft. Height should remain constant within the same limits.

411. If it does not, error may be identified by the following observation. If in the position shown in the diagram the gauged pin is in its lowest position, the thrust bearing between fixed and rotating swashes is worn and must be packed out or renewed. If it is in its highest position the bearing is holding the fixed swash too far out and its thickness must be reduced.

To Check for Wear in Spherical Bearing. (*See* Fig. 4.)

412. Dismantle fixed swash and its thrust bearing. Support shaft on "V" blocks as before with rotating swash in neutral position. Gauge faces A, B, C while revolving the shaft. If bearing is worn these will be eccentric.

413. Finally, dismantle the rotating swash, reassemble ball races on shaft and gauge spherical bearing.

Note.—When fitting new parts or refitting old ones, above tests should be carried out in reverse order, making sure spherical bearing and rotating swash are correct before assembling fixed swash.

414–500.

SECTION 5.—CONTROL VALVES. (Plate 15.)

501. This plate shows a control valve typical of all those used for the hydraulic engines on the revolving structure. In the case of the shell hoists, one pipe will always be controlled pressure and the other pipe always controlled exhaust. It is not, in theory, necessary to control the exhaust, but in practice it provides a more positive control.

502. The method of forming ports on the valve by bevelling off a portion of the cylindrical boss provides a very good "creep" control when oil is the pressure medium.

503. The small screw holes in the metal packing pieces of the gland are only provided to assist in removal when stripping.

504–505.

CHAPTER V

SECTION I.—ELEVATING ARRANGEMENTS

506. The guns can be elevated, either by hand or power, between 45° elevation and 5° depression. A two-way friction clutch is fitted in the elevating drive, which is normally kept in the position for "Hand" elevating by a spring. There is a foot pedal close to the gunlayer's seat, and when this is depressed the drive from the handwheel is disconnected and the swash-plate elevating motor is connected to the elevating drive instead. The elevating speed is 10° per second in power and 2° per second in hand.

507. From the clutch the drive passes through a worm and wormwheel to the elevating pinion shaft to which the wormwheel is connected by the usual type of frictional gear. The elevating pinion meshes with the elevating arc, which is bolted to the cradle.

Hand Elevating. (Plate 18.)

508. The drive from the hand elevating wheel is taken by bevel wheels, at the top of the casing carrying the wheel, to a vertical shaft which, through another pair of bevel wheels, drives one side of the friction clutch. The other side of the clutch is driven direct by the elevating swash-plate motor.

Power Elevating

509. The elevating motor is controlled by a valve (3) worked by a hand lever (1) pivoted on the trunnion bracket. A double-acting spring box and dashpot (4) returns the hand lever to the neutral position as soon as it is released. The cut-off gear for full elevation and depression, and the safety depression gear, are also connected to the lever which works the control valve through pivoted lever (5).

The Clutch. (Plate 16.)

510. The clutch has two end members, one of which (2) is driven by the handwheel and the other (3) by the elevating motor. In each end member, carried on three pins (4) is a disc (5) lined on both sides with ferodo. Springs (6) on these pins tend to push the ferodo-lined disc towards the centre of the clutch.

511. The drive from the end member (2 or 3) to its disc (5) is not through the pins (4) but by four keys (not shown in the plate) machined in the end member, which are a sliding fit in corresponding keyways cut in the disc.

512. The elevating shaft (7) has keyed to it a sleeve (8) and two disc-wheels (9), one at each end. They are secured on the shaft by a nut (13), under which is a ball race (14). Sliding on keys (10) on sleeve (8) is the central member of the clutch (11), normally kept over to the right by a spring (12). The central member (11) can be pushed over to the left by the foot pedal working through levers (15) and a collar (16), which slides, but does not revolve.

513. Whether the central member (11) is pushed over to the left by the foot pedal, or to the right by the spring, the ferodo-lined disc at the appropriate end is gripped between the disc wheel (9) and the central member (11) of the clutch. Thus, the drive is transmitted from the end member (2 or 3) through the keys to the ferodo-lined disc; then, by friction on one side of the disc, to the central member (11) and thence to the sleeve (8) and the elevating shaft; and, by friction on the other side of the disc, to the disc-wheel (9) and thence to the elevating shaft.

514. The function of the springs (6) is to push the disc (5) clear of one of the disc-wheels (9), when the clutch is engaged with the opposite side.

515. The weight of the elevating shaft is taken at the right-hand end on a ball race (17) and, at the left-hand end, through a ball race (18), by the bearings of the elevating motor shaft.

516. A ball race (19) in the centre takes the radial thrust between the elevating shaft and the drive from the hand elevating wheel in which it works. The driving shaft from the handwheel is supported by a large ball race (20).

517. When the hand elevating wheel is engaged by the spring, there is no longitudinal thrust in the elevating shaft, but when the drive is put over to "power" the tendency is to force the shaft over to the left. This thrust is taken by the ball thrust-race (21).

518. Both sides of all ball races are fitted with felt washers, to prevent dirt getting in and grease getting out.

Elevating Drive. (Plate 17.)

519. To the further end of the clutch shaft is connected the wormshaft (1) by a keyed coupling (16).

520. The clutch shaft has a removable length in the middle for convenience of assembly and stripping. The worm (2) engages with a wormwheel (3). The worm shaft is carried in two sets of ball bearings, and the thrust of the worm is taken by a double thrust ball race (4).

521. The teeth of the wormwheel (3) are cut on a casting to which are keyed eight brass friction discs (5), which bear against corresponding steel discs (6) keyed to the pinion shaft (7). The wormwheel casting is carried on a sleeve (10) keyed on the pinion shaft, which bears against the ball race, through the pressure of the nut (14). The pressure is communicated through a sleeve (11) and inner roller race to the shoulder of a larger part of the shaft to which the elevating pinion (9) is keyed.

522. Pressure on the friction discs is maintained by a plate (19), three belleville washers (8), a bush (15) and a nut with check nut.

523. The pinion shaft is supported by a ball bearing (12) close to the wormwheel and by roller bearings (13) on either side of the elevating pinion.

524. Thus, if any excessive load is placed on the elevating gear the pinion shaft (7) and sleeve (10) will turn inside the wormwheel casting (3), the steel friction plates (6) rendering against the brass plates.

525. For instructions for adjusting pressure by nut (14), *see* Drawing No. N.8876.

Elevating Control, Clutch Control and Hand Safety Depression Gear. (Plate 18.)

526. The elevation control lever (1) operates the control valve (3) through a control rod (2). Acting on the control lever is a double acting re-centring spring and dashpot (4), which returns the control lever to its neutral position when it is released.

527. By means of a lever (5) working in a slot in the control rod (2), connection is made with a floating lever, one end of which is connected through a series of levers to a striking arm (6), which is actuated by the elevation striker (7) or the depression striker (8) on the elevating arc. The other end of the floating lever is connected to the safety depression control gear. Due to the slot in the control rod (2) having a certain amount of longitudinal clearance, movement of the elevating control lever will not move the striking arm (6), when elevation or depression cut off is not in action.

Safety Depression Gear when using Hand Elevating

528. A rod (9) working in a bracket secured outside the front of the turret, has at its base a roller (11), which runs on a cam rail (12) secured to the fixed structure. A spring buffer (10) at the top of the rod prevents the gun from being layed to more than 5° depression on any bearing, or to less depression on certain bearings where the cam (12) comes into play raising the rod (9) and buffer (10).

529. If, when in hand elevating, with the gun at full depression, the turret is trained by power on to a dangerous bearing, the roller (11) will ride up on the cam and force the gun to a higher elevation. This is only possible, due to the friction gear (13) rendering.

Elevation Cut-off. (Plate No. 19.)

530. As the gun approaches maximum elevation, the rear striker (1) on the elevating arc comes into contact with the striking arm (2). The action of the elevation striker moves the striking arm forward, which in turn, through a series of levers, pulls the upper end of the floating lever (3) forward, bringing the lower end against a stop (4), thus operating the lever (5) in the slot of the valve connecting rod, which puts the elevating control valve (6) into a neutral position, bringing the gun to rest.

531. When the gun is depressed, the return spring (9A) moves the striker arm (2) and levers back to the normal position.

Depression Cut-off

532. As the gun approaches full depression the forward striker (7) on the elevating arc comes into contact with the striking arm (2), which pushes the upper end of the floating lever back, and, as the lower end of the floating lever is on a stop (8), the connecting rod (9) at the centre of the floating lever is pushed back, operating the lever (5) in the slot of the valve connecting rod, which puts the control valve into neutral position, and brings the gun to rest.

533. Return spring (9A) acts as above.

Safety Depression Control Gear

534. If after bringing the gun to rest at full depression the turret is trained on to a bearing that brings the power cam (10) into operation, the roller (11) will ride up on the cam and operating the various levers, move the lower end of the floating lever (3) to the rear and (providing the striking arm (2) is against the depression striker (7)), will operate the lever (5) in the slot of the valve connecting rod, and put the valve (6) and control lever to elevate. As the gun elevates the depression striker moves away from the striking arm, the latter being free moves into normal position, which in turn puts the control valve to neutral, and brings the gun to rest. If while the safety depression control gear is in operation, the depression striker is away from the striking arm, the floating lever will move idly, taking up any stroke due to the cam rail.

535. The power cam rail is arranged so as to give sufficient stroke to the control valve to stop or elevate the gun, providing the striking arm is against the depression striker. When power elevating, the gun is kept clear of the hand safety depression buffer, by the power cam rail.

536. It will be realised that the depression cams for the power and hand depression control gear, are quite separate. The depression cams for power are inside the danger space, and the cam for hand is outside the turret.

Arrangement of Elevation Receiver Drive from Elevating Arc, including Tilt-Corrector Drive from Training Rack. (Plate No. 31.)

For Centre Gun

537. The director elevating arc (1), carried by the cradle, drives a spring split pinion (2), keyed to a horizontal shaft (3). This shaft is carried in a bracket (4) which houses the pair of bevel wheels (5) and (6). Wheel (6) is keyed to the vertical shaft (7), which carries at its upper end a vernier coupling (8) for alignment of the black pointer of the elevation receiver (9). The vernier coupling (8) engages with the inner of two concentric shafts (10) which in turn engages at its upper end with the clutch driving the black pointer of the elevation receiver (9).

538. The tilt-corrector drive is taken from the training rack (11) by pinion (12), and is transmitted through bevel gears (13) and (14), to shaft (15), which is universally jointed at each end. The upper universal joint couples up to the shaft (16) which drives, through gears (17), the outer of the two concentric shafts (18), which engages with the clutch of the tilt drive of the elevation receiver (9).

Right- and Left-hand Guns

539. The drives to the elevation receivers for these guns are similar to that for the centre gun, but it has been possible to arrange them more directly. The drive for the right-hand gun is shown, that for the left being similar, but left-handed.

540. The reference numbers are shown as for the centre gun, but, owing to the more direct drive, bevel gears (13) and (14) are not required for the side positions.

541–545.

SECTION 2.—TRAINING ARRANGEMENTS. (Plate 20.)

546. The training rack is bolted to the fixed roller path. Pinions on either side of the revolving structure engage in this rack. These pinions gear with similar pinions which are mounted on vertical shafts, at the upper ends of which worm-wheels and friction gears are fitted. The pinions, vertical shafts, worm wheels, and worms are mounted in rigid castings secured to the revolving structure. The worms driving the wormwheels are cross-connected from side to side of the mounting by a common shaft with four flexible couplings, one close to each worm and one on either side of the clutch gear. Keyed to the wormshaft between the two centre couplings is a sliding dog clutch, which can be connected either to a sprocket wheel driven through a chain by the hand training gear, or to a pinion driven by power. Neither sprocket wheel nor pinion are keyed to the shaft. The pinion on the training worm shaft is driven by an intermediate pinion, which in turn gears with a similar pinion on the shaft to which the training engines are clutched. It is not possible to have both engines unclutched from this shaft simultaneously.

547. Both training engines are governed by the same control valve, but either can be isolated by valves in the connecting pipes. Better control is obtained if both training engines are used, and maximum speed of training of about 5° per second will be obtained and a creep of 1° per minute.

548. With one training engine in use, maximum speed of training is about 7° per second. A voicepipe is fitted between the trainer and the hand training position in the working chamber.

549. The training control valve is operated by the training handwheel at the local director sight through gearing consisting of worm and sector rods, etc.

The Worms, Wormwheels and Friction Gear. (Plate 21.)

550. The worms, of irreversible type, are carried by a ball bearing on either side. The thrust is taken by two thrust ball races. The frictional gear is of the usual type and adjusted to give sufficient resistance to prevent throw-off of the turret when one gun fires at a time. Details are given in Drawings N.8497 and N.8498. The weight of the training pinion shaft is taken by a double thrust ball race

on D

Page 40. Paragraph 550. *Add* :—

"On re-assembly of the training pinion shaft (Plate **21**), care should be taken that the nut securing the double thrust bearing is effectively tightened against the sleeve of the bearing. If necessary, the locking grub screw should be re-positioned".

(G. 09479/51.—A.F.O. P.579/51.)

Clutc

551. The hand or power clutch (1) slides in keyways on wormshaft (2), and can be engaged either with the sprocket wheel (3), driven by a chain from the hand training standard, or with the pinion sleeve (4) which is not keyed to the wormshaft. This pinion is always in mesh with an intermediate pinion which is geared with another pinion (5) keyed to a shaft (6) to which can be clutched either or both training engines.

552. There is an operating wheel (7) for each training engine clutch, and the wheel can be locked at each revolution by a spring bolt (8). The upper view in Plate 21 shows the right training engine clutch engaged and the left disengaged. If the left handwheel is now turned through five revolutions the left clutch will also be engaged. If the dogs on the clutch do not at once correspond with those on the training engine shaft, the clutch arm (9) will cease to pivot about the pin (10) as it usually does but will pivot about the clutch pin (11) and the pin (10) and rod (12) will move to the right against the action of the spring (13). As soon as the training engines move, the dogs will come into line and the spring (13) will assert itself and engage the clutch.

553. It is not possible to disengage both training engine clutches simultaneously due to the screwed rods (14) and (15), inside the handwheels, butting against one another.

Hand Securing Bolt. (Plate 22.)

554. The turret can be locked in the fore and aft position, by a hand securing bolt. The bolt is worked by an arm in which a removable hand lever is fitted.

555. A continuation of the arm has two projections labelled L. (locked) and F. (free).

556. A circular deck plate with instructions engraved on it, screws down over the locking bolt, and a small hole in the plate fits over one of these projections, holding the bolt in either the locked or free position and showing in which position the bolt is.

Training Buffers and Buffer Stops. (Plate 22.)

557. The training buffers are designed to bring the turret gently to rest by bearing against the buffer stops, at the extreme limits of training in either direction.

558. The buffers are attached to the fixed structure and the buffer stop is attached to the revolving structure, being incorporated with the turret locking bolt casting.

559. The buffer consists of an oil filled cylinder fitted with piston and piston rod, which normally projects due to the action of a spring in the cylinder.

560. When the buffer stop strikes the piston rod, the piston is forced over and oil is forced to pass from one side of the piston to the other.

561. The only passage for the oil, with the exception of a small hole in the piston head, is a groove at the bottom of the cylinder.

562. The groove is of varying depth, becoming gradually shallower towards the closed end, so that the resistance of the buffer is gradually increased the further it is forced into the cylinder.

563. The spring, in addition to assisting the retarding force of the buffer, returns the piston to its normal position when the turret is trained off the stop.

564. The oil used in the buffer cylinder is the same as that used in the power system of the turret, *i.e.*, special mineral. The cylinder is fitted with air, filling and drain plugs.

565. Access for filling the buffers is obtained through two holes in the forward left-hand side of the gunhouse floorplate. The turret must be trained until these holes line up with Plugs "A" and "B."

566. Instructions for filling the buffers are engraved on the cover plates for the above access holes.

Black Pointer Drive to Turret Training Receiver. (Plate No. 32.)

567. A large spring split pinion (1) gears into the Training Rack, and is keyed to a shaft which passes through the gunhouse floor to bevel gears (2), carried in a housing in the Local Director Sight Pedestal. From these the drive passes, by means of shaft (3), to two pairs of bevel gears (4) and (5) respectively.

568. Gears (4) convey the drive to the Local Director Sight Tilt Corrector, while gears (5) drive spindle (6), which carries the coupling engaging the gearing to the black pointer of the Training Receiver.

569. A vernier adjustment for alignment of the black pointer is provided at (8).

Clips and Rollers

570. There are eleven training clips, five large ones being fitted on the front half of the mounting and six small ones on the rear half. The clip clearance should be 20 thousandths of an inch.

571. Four gaps are provided in the upper roller path, for the removal and examination of rollers. One gap is under the muzzles of the guns, the centre being 18° to the left of the centre line of the turret. The other three gaps are spaced 90° apart round the upper roller path.

572. To remove a roller, train the turret so that the roller to be removed is under one of the gaps. Take off the roller spindle nut, which is accessible from the cordite gallery, and withdraw the spindle and roller into the danger space.

573–580.

CHAPTER VI

SECTION 1.—SHELL HOISTS IN FIXED STRUCTURE

GENERAL ARRANGEMENT. (Plate 37.)

581. For each turret a duplex shell hoist is fitted from the shell room to the shell handing room. The length of the hoist depends on the height of the turret, and consequently the shell handing room in the ship.

582. A duplex hoist consists of two separate hoists of the endless chain type which are driven by one motor. Each hoist can be worked independently and is capable of delivering 16 rounds per minute, *i.e.*, 32 rounds per duplex hoist.

583. Two chains pass over sprocket wheels at the top and bottom of a hoist and the lifting heads, spaced 68 inches apart, are supported between them. The upper sprocket wheel shafts are connected, through bevels, to a main driving shaft, which is driven by an 8-h.p. electric motor through a flexible coupling, a friction clutch, and a worm and wormwheel. The worm and wormwheel can be disengaged from either of the sprocket wheel shafts, by means of dog clutches and the respective hand drive engaged. The friction clutch is engaged by a control pedal when shell are required. The lower sprocket wheel shafts, which are adjustable vertically to take up slackness in the chains, drive cam wheels which work the flashtight loading scuttles.

Operation

584. Shell are loaded into the bottom of the hoists by means of vertical flashtight revolving scuttles. A shell is loaded into a scuttle past two spring pawls which prevent it from falling back again, and the operating lever is put over to the " operative " position, in which it blocks the entrance to the scuttle. The scuttle, worked by timing gear off the shaft of the lower sprocket wheels, is turned through 180°. The movement is timed to take place whilst the lifting heads are clear of the scuttle. As the scuttle revolves, the operating handle flies back to its original position, and another shell can then be loaded into the scuttle.

585. As a lifting head comes up, its edge takes the shell with it, and due to an inclined inner surface of the hoist, the shell is moved over to a central position on the lifting head as the latter rises.

586. As the shell reaches the top of the hoist it enters a tilting bucket, which is tilted and the shell rammed into the loading trough in the shell handing room. The tilting and ramming are done automatically by levers worked by separate cams on a wheel driven through gearing by the upper sprocket wheel shaft.

Mechanism at the Bottom of a Hoist. (Plate 37.)

587. A small pinion (1) keyed to the lower sprocket wheel shaft drives a cam wheel (2) to which are fitted two cams (3) set at 180° apart.

588. A roller (4) working in these cams moves a rack (5) and clutch pinion (6) to and fro, the gearing and assembly being so arranged that one movement either to or fro takes place between the passage of successive lifting heads. But no movement of the scuttle will take place unless the clutch pinion (6) is engaged with the clutch drum (7) which is keyed to the shaft (8) of the scuttle.

589. Scuttle control lever (9) is put over, its last movement withdrawing bolt (56) which allows the clutch pinion to engage if the rack (5) is fully over in one direction or the other. Bolt (56) holds the clutch out until it is withdrawn by the control lever when fully over. The direction in which the scuttle revolves depends on which cam (3) happens to come into play next after the scuttle control lever is put over.

590. It will be assumed in the first place that the dogs on the clutch pinion (6) are in line with their corresponding recesses in the clutch drum (7). Then, as the scuttle control lever is put over, the rod (10) is raised and the sleeve (11) moved over to the left against the action of a spring (12).

591. The sleeve (11) takes with it the retaining bolt (13) whose casing is part of the sleeve, and also the locking bolt (14) through the medium of another spring (15). Movement of the locking bolt (14) works the bell-crank lever (16) so engaging the clutch pinion (6) with the drum (7). The lateral movement of the retaining bolt (13) allows it to spring up into one of two cavities (17) on the circumference of the clutch drum (7) so holding the sleeve (11) over to the left, and the operating lever in the " operative " position.

592. The next cam (3) on the drum, moves the roller (4), the rack (5), and the clutch pinion and drum, and consequently the shell scuttle is revolved. With the clutch drum revolving, the bolt (13) is pushed down as the cavity (17) diminishes until it is flush with the bottom of the drum. This allows the sleeve (11) to move over towards the drum under the action of the spring (12), forcing the locking bolt (14) against the side of the drum. When the drum and scuttle have revolved through 180°, the bolt enters one of the sockets (18), locking the drum and scuttle, and by means of the bell-crank lever (16) withdraws the clutch pinion (6) from the drum. At the same time this movement of the sleeve returns the scuttle operating lever (9) to its original position.

593. If, on the other hand, the scuttle operating lever is put over to the " operative " position whilst the rack and clutch pinion are in motion the clutch pinion will be unable to engage in the clutch drum, and the locking bolt (14) will only be able to move outwards until the dogs on the clutch pinion come into contact with the surface of the drum.

594. Spring (15) then comes into play, being compressed, so allowing the locking bolt to remain engaged whilst the sleeve (11) is withdrawn and held up by the retaining bolt (13). As the rack reaches the end of its stroke and the dogs on the clutch pinion come into line with their corresponding recesses on the drum, the spring (15) asserts itself, engages the clutch pinion in the drum and withdraws the locking bolt fully, allowing the action already described above to take place.

595. The spring boxes (19) connecting the two arms of the bell-crank lever are provided to give resilience.

596. Spring bolt (23) prevents hand lever (9) being operated until a shell has completely entered the scuttle (21). As a shell is pushed from the waiting tray (22) into the scuttle it depresses pawls (20), which through levers, force bolt (23) to come in the way of hand lever (9), thus preventing its operation. When the shell is completely in the scuttle, pawls (20) can rise and the spring withdraws bolt (23), leaving the hand lever free to be operated.

Scuttle yielding Device. (Plate 37.)

597. Clutch drum shaft (8) is connected to scuttle (21) by means of sleeve clutch (51), spindle (52) and spring (53). If the scuttle becomes jammed in the scuttle casing, during its rotation, sleeve clutch (51) is forced clear of shaft (8) against spring (53) thus preventing damage to the operating gear. When the scuttle is freed it is easily returned to its normal position and automatically re-engages with shaft (8) by means of spring (53).

At the Top of the Hoist. (Plates 37 and 38.)

598. With the power clutch (24) to power and the motor running, the hoist will start as soon as the friction clutch (25) is engaged by treading on the control pedal (26).

599. A spring actuated pawl (55) is fitted which prevents the lifting heads from running back if power fails, and a shell from falling down the hoist should the bucket fail to tilt, but which is forced aside as the lifting heads pass in an upward direction.

Power Drive. (Plates 37 and 38.)

600. The motor shaft is connected to the friction clutch (25) through a flexible coupling (27). The shaft (28) on the other side of the coupling has a sleeve (29) secured to it, and sliding on keyways on this sleeve is a disc (30) both sides of which are faced with ferodo. The travel of this disc on the sleeve is limited by a nut (31) and a shoulder on the sleeve (29). A number of small springs keep the disc pressed towards nut (31) when the clutch is free. As the control pedal is depressed, the non-revolving portion of the clutch (32) moves over to the left, and the sleeve (33) moves over, making contact with one side of the ferodo-faced disc, and forces it against the clutch drum (25). A spring box (34) is fitted in the mechanism between the control pedal and the clutch, to ensure gradual and even application of pressure to the latter. The clutch drum is keyed to the worm shaft (35). The sleeve (33) has keys working in keyways in the clutch drum (25) so that the two revolve together with the ferodo-faced disc (30) gripped between them. The hoist is driven from the worm shaft by a worm (36), worm wheel (37), shafts (38) and (50) with bevels, and sprocket wheels to the chains. When the control pedal is released, a spring (49) reasserts itself and throws the clutch out and returns the pedal to the " clutch free " position. The clutch drive is designed so that the clutch can be stripped without removing the driving motor.

601. An automatic brake (54) operates on friction clutch (25) and prevents the hoists running back if stopped when fully loaded.

Tilting and Ramming. (Plates 37 and 38.)

602. On the outer end of each sprocket wheel shaft is a pinion (39) gearing with the large pinion wheel (40). The ratio is so arranged that large pinion wheel (40) makes one revolution while the chain moves a distance equal to that between the lifting heads. On the outer side of this wheel a cam is cut, in which works a roller (41). The roller works the tilting bucket through a bell crank (42), rod (43), and rack (44).

603. On the inner side of the wheel is another cam (45) and roller (46) which, by a bell crank, rod, and bell crank work the rammer (47). The cutting of the cams is so arranged that the rammer stroke commences as soon as the bucket completes its tilting movement, and the bucket commences to return as soon as the rammer is fully withdrawn again.

604. The shell is rammed out on to a receiving ledge, whence it is slid by hand round a chute which encircles the lower ends of the revolving structure hoists.

Hoist Casing

605. The hoist (excluding the driving gear, scuttle and its operating gear) is enclosed in a tube. (1933 and 1934 Programme, 1-inch steel, D1 quality; 1935 Programme, 2-inch NC armour.)

606. The upper end of the hoist can be closed by W.T. doors (48) which work on hinges.

607. The entrance to the loading scuttles can be closed by W.T. doors, which have a stowage position at the side of the hoist. Thus, the hoist as a whole can be made W.T. and when assembled in place on board it is tested to an air pressure of 20 lb./square inch.

608. When all doors are open the hoist is flashtight at the lower end, due to the construction of the loading scuttles, and at the upper end due to the flashtight fit of the working head in that hoist section.

Chains and Lifting Heads

609. The chains are of 2-inch pitch and the lifting heads are secured to them at intervals of 68 inches. As each lifting head has to take up the shell moving at a speed of 18 inches per second, they are made with a ½-inch rubber ring between the upper and lower parts, the upper part (56) being secured by a nut.

Instructions for Setting of Interlocks at Top of Hoist

610. (Ref. Drawing No. N.8777—Diagrammatic arrangement of Control Gear at Top of Hoist which is included in Ship's Officers' Sets of Drawings.)

No. 1 Hoist

(1) Set forked lever actuating power clutch " M " vertical and cross-over link square with hoist. Adjust connecting rod and couple up.

(2) Fully engage power clutch "M" and adjust rod between power interlock "A" and cross-over link to free hand-gear interlock " B."

(3) Set forked lever actuating power clutch vertical as in Operation 1 and adjust rod between interlock bolt "A" and power clutch hand lever (H. No. 1) to bring the latter vertical.

(4) Put hand-gear clutch lever " OUT " and power clutch lever H " IN " and adjust on rod between hand-gear clutch lever and bell crank lever to free the vertical bolt G.I.

(5) Put hand-gear clutch lever " IN " and adjust rod between bell crank lever and interlocking bolt " B " to free interlocking bolt "A."

No. 2 Hoist

(1) Set forked lever actuating power clutch " M " vertical and adjust rod between lever actuating clutch and power clutch hand lever to bring the latter vertical.

(2) Fully engage power clutch and adjust rod between forked lever actuating clutch and power interlocking bolt "A" to free hand interlocking bolt " B."

(3) Put hand-gear " OUT " and adjust rod between bell crank lever and hand-gear clutch lever " E " to free the vertical interlocking bolt " G."

(4) Put hand-gear " IN " and by means of adjustment on interlocking bolt " B " free power interlock "A."

Setting of Watertight Door Interlocks

611. (1) Shut the watertight doors and by means of adjustment on rods " R " bring the red lines on the side faces of interlocking blocks " S " flush with top faces of interlock casting.

(2) Shut watertight doors and adjust rod between link actuating block " T " and crank to cross-shaft " D " until cross-shaft " D " is inoperative when starting pedal is depressed.

612–615.

SECTION 2.—CORDITE HOIST IN FIXED STRUCTURE

H.M. Ships " Southampton," " Newcastle," " Sheffield," " Glasgow " and " Birmingham "

General Arrangement

616. A duplex cordite hoist is fitted from the lower cordite to the upper cordite handing room for all turrets and is of the endless chain type. The lifting heads are 70 inches apart.

Plate No. 39

617. The upper sprocket wheel shafts are connected through bevels to a main driving shaft which is driven by an 8-h.p. electric motor through a flexible coupling and friction clutch (1), worm and wormwheel (2). The friction clutch (1) is operated by a foot pedal and is used for starting and stopping the hoist.

618. The worm and wormwheel (2) can be disengaged from either of the sprocket wheel shafts (3) by means of dog clutches (4), and the respective hand drives connected up by further clutches.

Operation

619. Charges are loaded into the bottom of the hoists by means of vertical flashtight revolving scuttles, past two spring actuated flaps (11) which prevent the charge from falling back again.

620. As the door is closed by handle (5) it operates spring catch (6) which withdraws spring bolt (7) and allows clutch pinion (8) to engage clutch drum (9).

621. The scuttle (10) is worked by a continually rotating cam drum on the lower sprocket wheel shaft through rack and clutch pinion (8), and is revolved through 180° at a time when it is clear of the lifting heads. As the heads rise, they take beneath the edge of a charge and raise it. The inside of the hoist is inclined so that as the lifting head rises, the charge is gradually moved over to a central position on it.

622. As the lifting head and charge reach the top of the hoist, the charge is caught by the rating tending the hoist (or, if not caught, it falls on to a table formed by the door of the top of the hoist) and is transferred by hand to the cordite gallery.

Mechanism at Bottom of Hoist. (Plate Nos. 39 and 40.)

623. The scuttle operating gear is identical in design and operation with that of the bottom of the fixed shell hoist. (*See* page 42.)

624. The charges are loaded in, past two spring actuated flaps (11) which prevent the charge from falling back.

625. The door is then closed by handle (5).

626. When the door is fully closed it is locked by spring actuated catch (6) and the clutch pinion (8) is allowed to engage with clutch drum (9). Spring bolt (24) rises into a cavity (25) on the circumference of the clutch drum and prevents the door being reopened.

627. When the scuttle has revolved through 60°, one of the four toe-pieces (12) rides over a stop (13) momentarily releasing the catch (6). The door under the action of return spring (14) will open about 3°, allowing the scuttle locking bolt (15) to bear against the side of the clutch drum. As the bolt enters its socket in the drum, the door opens fully and the clutch pinion is withdrawn.

628. The spring box (16) fitted in the operating rod, only comes into action as the locking bolt is being withdrawn. It prevents any possibility of a jar if the door has operated catch (6) and comes back on to the safety catch. When the scuttle revolves it throws the bolt out (due to its bevelled end) and tends to close the door further ; the spring box absorbs the shock.

629. The tension of the hoist chains is adjustable. This is carried out by adjusting the height of the lower sprocket wheel shaft (17) by means of the nut and check nut provided. The shaft has a travel of $\frac{3}{4}$ inch above or below the centre line of the shaft of the cam drum. This small amount of travel does not appreciably affect the meshing of the spur wheels (18) and (19). The weight of the revolving scuttle is taken on the spindle (20) of the clutch drum. This in turn is supported on a thrust ball-bearing (21) secured by a castellated nut (22). Great care is needed in the adjustment of this nut as it governs the height of the clutch drum, the holes in which must correspond with the position of the scuttle locking bolts. Lubrication of the conical cam roller (23) and its shaft, is effected by an aluminium segmental trough (14) which will receive the oil from the small pipe above it, whatever the position of the roller.

630. There is an instruction plate inside the bottom of the hoist giving details for assembly of mechanism. When these have been carried out, the lifting head just rising, will be 16½ inches above the centre line of the cam drum when the scuttle has just completed a stroke, assuming the lower sprocket wheel shaft to be in its highest position.

631. Both ends of the hoist can be closed by watertight doors.

632. When the doors are open, the hoist is flashtight at the lower end, due to the construction of the scuttles and the lifting heads are a flashtight fit in the hoists.

633–635

SECTION 3.—CORDITE " HAND-UP " IN FIXED STRUCTURE

(Plate 41.)

636. In the lower cordite handing room of each turret, hand-up scuttles are fitted in the deck overhead, through which cordite can be passed to the space over the handing room, if the cordite hoists break down. There are two hand-ups to each handing room.

637. The hand-up consists of a tube, 43 inches long internally, which is bolted to the deck between the handing room and the space above.

638. A door is fitted at the top and bottom, and the top one can be made watertight by seven butterfly nuts, a special nut being fitted on the hinge. Both doors are flashtight, and are opened or closed by rotating about a vertical hinge. A pair of spring-loaded pawls at the bottom of the tube hold the charge in place when it is loaded, thus making it easy to close the bottom door. These pawls are in no way connected to the door.

639. An interlock is fitted which prevents both doors being open simultaneously. This ensures that the tube is always flashtight. The interlock is combined with two tell-tales, one in the handing room and one on the deck above, which show " Loaded " or " Unloaded."

Operation of the Hand-up

640. It is assumed that both doors are closed, and the tube is empty. If the tube is empty, the rating above will have closed the upper door, and lifted the tell-tale rod (10) by its handle (11), causing both tell-tales to show " Unloaded." The tell-tale rod will be held in this position by a spring plunger (9) taking under a shoulder on the rod. When the tell-tale rod is in the " up " position, its lower end is clear of the socket (7) in the lower door (1) (so leaving the lower door free to be opened) and its upper end engages in the socket (17), and locks the upper door closed.

641. When the tell-tale shows " Unloaded," the rating in the handing room opens the lower door (1).

642. As the bottom door is opened, the cam plate (2) is revolved. This clears roller (3), and its attached lever (4) (which are forced against the cam plate by a spring box (5)) and the toe (6) springs over the bevelled edge of a spring catch (8) on the plunger (9), which is holding the tell-tale rod in the " up " position.

643. The charge is inserted and held in position by the pawls (12), the lever (13) which works the pawls being pinned in the locked position. The spring loaded bush to which both the pawls are connected has 45° play in the keyways on the lever shaft (14), which gives the pawls, and the spring plunger (15) which works them, sufficient movement on the shaft to allow the charge to pass.

644. As the lower door is closed again, the cam (2) forces the roller (3) to the right, and the toe (6) engages with the catch (8), withdrawing the locking bolt (9) against the action of its spring. This leaves the tell-tale rod (10) free to drop, under the action of its spring (16), into the socket (7) on the lower door. The rod cannot drop fully until the socket is in line, and this only occurs when the lower door is fully closed. Thus the rod locks the lower door closed. At the same time, the upper end of the rod (10) clears the socket (17) in the upper door, leaving it free to be opened. Both tell-tales show "Loaded."

645. With the final movement of the roller (3) the toe (6) clears the catch (8) and the plunger (9) is free to move in again under the action of its spring. By this time, however, the shoulder on the tell-tale rod (10) has passed the top of plunger (9).

646. The upper door is opened when the tell-tale shows "Loaded," and the charge removed.

647. As soon as the upper door is moved, the socket (17) is put out of line with the upper end of rod (10), and consequently the lower door is positively locked closed. As the upper door is closed again, socket (17) comes into line with the rod, allowing the latter to be lifted by its handle. This unlocks the lower door once more and puts the tell-tale to "Unloaded."

648. It will be seen, therefore, that—

(1) Only one door can be open at one time.

(2) When the lower door is closed, both tell-tales are put to "Loaded," and the door cannot be opened again till the tell-tale rod is put to "Unloaded." This can only be done by the handle on the deck above, and the handle cannot be moved unless the upper door is fully closed.

(3) When the upper door has been closed and the tell-tale rod put to "Unloaded" the door cannot be opened again until the tell-tale shows "Loaded." This cannot occur till the lower door has been opened and fully closed again.

649. The hand-up can be used for passing charges back to the handing room from the space above. To do this, the pawl lever (13) must be unpinned. The tell-tales will have the reverse meaning to that shown. When the lower door is opened, the rating in the handing room takes the weight of the charge, and pulls down on the lever (13), allowing the charge to be lowered into the handing room.

650. When passing charges back by this method, they must **not** be dropped on to the pawls, but must be lowered down gently. The pawls are easily bent by the weight of a charge dropped on to them, and, if bent, will jam and prevent the hand-up being used.

651–655.

CHAPTER VII

SECTION 1.—SHELL HOIST ON REVOLVING STRUCTURE

General

656. One shell hoist is fitted for each gun. The lower end projects into the ammunition lobby, and the upper end is close to the gun. The left-hand and right-hand hoists are on the inner side of their respective guns, 3 feet 3 inches behind the trunnions. The centre hoist is on the left-hand side of the centre gun, 9 inches behind the trunnions.

657. The hoist is of the endless chain type with two chains, between which are secured the 12 lifting heads at 44-inch intervals.

658. The chains pass over sprocket wheels at top and bottom. The hoist is driven through the top sprocket wheels by a swashplate engine. The shaft of the bottom sprocket wheels works in adjustable bushes, so that slackness, due to wear in the chains can be taken up.

659. The hoist starts as soon as (*a*) the lower door is closed, and (*b*) the lever at the top is pushed over to "START." The hoist will not move unless both these conditions obtain, and it is immaterial which occurs first. The hoist moves through one cycle (corrresponding to a movement of 44 inches of the chain) and then stops automatically. As the chain is of 2-inch pitch and there are 20 teeth in each sprocket wheel, both sprocket wheel shafts make 1·1 revolutions per cycle. During this movement one shell arrives in the vertical tilting bucket at the top, the bucket tilts automatically, and the hand-lever moves to "STOP." At the same time the door at the bottom of the hoist is opened automatically.

660. The shell is pushed by hand, out of the tilting bucket, through the fixed tray, into the intermediate tray and then lever is pushed back to "START." At the bottom of the hoist, a shell is loaded on to the door tray, and the door is closed. The hoist then moves through another cycle.

Operation. (Plates 23 and 24.)

661. *Note.*—The operation of the hoist as a whole is most easily understood by reference to Plates 23 and 24. On Plates 26 and 27, which show the mechanisms as they actually appear, the items have been numbered in the same way as in Plates 23 and 24.

662. The hoist is assumed to be in the "stopped" position as shown in Fig. 2, Plate 23, *i.e.*, the bucket (1) at the top is tilted, the handle (2) is over to "STOP," the cam (24) is locked by the stop lever (11) and is held there, since a bleeding port in the control valve is always open and tending to raise the hoist. The door (17) at the bottom of the hoist is open.

663. Rod (4) can be worked by levers (5) and (7). Lever (5) can be pushed up by rod (8), but not pulled down.

664. Lever (7), which is pivoted in rod (4), works in a long slot in rod (3), and has its other end in rod (25) which tends to remain up due to the spring on rod (9) acting through lever (6).

665. *Case* 1.—If the bottom door is closed first, rod (8) comes up, which through lever (5) will lower rod (4). Lever (7), with one end held in rod (25), will have its pivot lowered and its other end will travel down the slot in rod (3). When the shell is pushed out of the tilting bucket, handle (2) is put over to "**Start,**" and this raises rod (3). This will raise lever (7), whose pivot is held in rod (4), and hence lower rod (25) against the action of the spring on rod (9). The moving of rod (9) will open the control valve (23) through lever (10) and rod (12).

666. *Case* 2.—If the handle (2) is put to "**Start**" first, rod (3) is raised, which will raise lever (7). As the other end of lever (7) is held in rod (25), rod (4) will be raised. This will raise one end of lever (5), and lower the other. When the lower door is closed, rod (8) will be raised, and with it lever (5). Rod (4) will be lowered, and with it the pivot of lever (7). As rod (3) is holding one end of lever (7) rod (25) will be lowered against the action of the spring on rod (9). The moving of rod (9) will work valve (23) as before.

667. Hence the combination of these two actions opens the valve and starts the hoist.

668. At the same time rod (9) withdraws stop lever (11) from cam lever (24A). The control rod also raises lever (16) and puts the roller in lever (15), in contact with the lowest point of the cam (24). Cam (24) does one revolution for each cycle of the hoist.

669. When the hoist has moved through half a cycle (this is the position illustrated in Fig. 1, Plate 23), the cam (24) is pressing against the roller in lever (15), gradually forcing it over, lowering control rod (3) and putting the hand lever (2) over to "STOP." The first part of this movement of the control rod tilts the bucket into the shell discharging position. The upward movement of lever (15) also closes the valve by means of lever (14) and rod (12). As soon as the bucket begins to tilt, the fulcrum for the floating lever (7) in control rod (3) is lost and a spring, acting on rod (9), raises lever (6) and allows locking lever (11) to advance to "locked" position. An elongated slot in rod (9) allows this movement to occur without moving lever (10) and hence the valve.

670. At the same time, at the bottom of the hoist, a cam (21) which is driven by spur gearing from the lower sprocket wheel shaft, engaging with a roller, withdraws the spring locking bolt (19), by a system of levers. This allows the door (17) to fall open. A buffer (32) takes the shock, as the door comes to rest. The locking bolt is only released momentarily, springing up again before the hoist comes to rest.

Hand Operating Gear

671. The clutch lever is put to "Hand," thereby disconnecting the engine and connecting up the hand gear.

672. Worked by a rod from lever (6A) is a tell-tale near the hand gear in the working chamber. This shows "READY" when both rods (4) and (25) are in the down position, *i.e.*, when the bottom door is closed and the lever (2) is over to "START." At the end of each cycle, rod (25) is raised and "READY" is withdrawn from the tell-tale. Thus the men on the hand gear are informed automatically when to operate the hoist and when to stop.

Safety Arrangements

673. (1) The hoist cannot be set in motion until the door at the bottom has been closed and the lever at the top has been put to "START." This is due to the action of floating lever (7) as before described.

"3. In order to enable fire to be opened whilst the lower quarters are being manned, the loading tray can be held in the closed position by the catch lever (Plate 26A) and thus provide continuous motion of the Shell hoists, without the ma[illegible] [illegible]peration of the loading tray."

(G.05213/48—A.F.O. P.408/48.)

Mechanical Details. (Plates 26 and 27.)

674. The hoist casing consists of fiv[illegible] [illegible]op two and the bottom one are castings, and the other two [illegible] [illegible]ions. The casings are all bolted together and are supported at the work[illegible]g chamber floor, and the gunhouse floor.

675. The two top casings are flashtight, the clearance round the working heads and rollers being ·01 inch. The working heads have a clearance of ·06 inch in the remainder of the hoist.

676. The bearings of the lower sprocket wheel shaft are carried in plates (26), adjustable by a lever (29) and bolt (28) to take up slackness in the chain. The plates (26) work in guides, secured by tap bolts (27).

677. The upper surfaces of the lifting heads have a groove (31) cut in them to ensure that no weight is at any time taken on the base fuze or its protecting plate.

678. The lifting heads are secured to either chain by two bolts and special nuts (30). To remove a length of chain the split pin, inside the lifting head, is withdrawn and then the bolt unscrewed and withdrawn, so freeing one end of a length.

679–680.

SECTION 2.—GENERAL LOADING ARRANGEMENTS FOR SHELL

681. The loading arrangements consist of a fixed tray at the top of the hoist, a loading tray, which pivots on a loading arm bolted to the gun cradle and which can be swung in to load the gun, and an intermediate tray which works between the two.

682. As already explained, a shell arrives at the top of the hoist and is tilted automatically by the tilting bucket and comes to rest, still in the bucket, with its base in the fixed tray. A stop in the fixed tray prevents the shell being pushed into the intermediate tray, unless the latter is both up in line with the fixed tray and empty.

683. The intermediate tray, which is balanced by a balance weight, works on rollers running on guide rails concentric with the trunnions. When empty, it locks itself in the top position in line with the fixed tray and when loaded and released it comes down and rests on a buffer on the loading arm (unless the gun is at more than $12\frac{1}{2}°$ elevation, when it comes on to another buffer on the guide rails). There is a stop in the intermediate tray which prevents a shell in it from sliding into the loading tray unless the intermediate tray is resting on the loading arm and the loading tray is back in line with the intermediate tray. When both these conditions obtain, the shell will slide into the loading tray, in which it can be swung into line with the breech to be rammed home. It cannot be so swung in, unless the gun is fully run out and the breech is open.

The Fixed Tray. (Plate 25.)

684. As the tilting bucket (7) tilts in an anti-clockwise direction, the base of the shell rides up the trough and over two spring pawls (2) and its base then rests in the fixed tray (1). A stop (4) held in the " up " position by levers and a spring bolt (11), prevents the shell being pushed out of the bucket if the intermediate tray is " down " or loaded. The pawls (2) prevent the rating at the top of the hoist putting his lever over to " START " and so tilting the bucket back and dropping the shell down the hoist, if he has omitted to push it out of the bucket.

685. The stop (4) can only be withdrawn by a roller (13) on rod (12) working on the intermediate tray. This can only occur if the intermediate tray is up and empty. If it is up and has a shell in it, the shell will rest on the roller (14), so withdrawing rod (12) and roller (13), and allowing the spring (11) to assert itself and raise the stop.

Note.—At the centre gun, an extension tray is fitted to the fixed tray owing to the gun being set further to the rear of the mounting than the right and left guns.

In order that stop (4) shall come up while the shell is on its way to the intermediate tray, the extension tray has a lever (14A) over which the shell slides. Depressing this lever raises stop (4).

The Intermediate Tray

686. As a shell is pushed into the intermediate tray it rides over the roller (14), allowing the stop (4) in the fixed tray to rise and prevent another shell from being pushed in.

687. The intermediate tray is balanced with a balance weight over a pulley. The weight is heavier than the tray by about half the weight of a shell, so that when the tray is free it will automatically go down if loaded and rise if empty. In its top position the tray is locked automatically by a spring locking bolt (5). This is released when the loading number pulls down on a handle (6), and the tray goes down until buffer (15) takes against the loading arm. If the gun is at more than $12\frac{1}{2}^\circ$ elevation a buffer on the guide rails brings it to rest until the gun "picks it up" on being brought up to load.

688. The stop (3), holding the shell in the tray, is kept up by a spring bolt (16), and is only withdrawn by means of a lever and roller (9) engaging with a cam (8) on the arm of the loading tray. This occurs just before the buffer (15) comes on to the loading arm, and will only occur then if the loading tray is in its fully back position, as otherwise the high portion of the cam (8) will not be in line with the roller (9).

The Loading Tray

689. In Plate 25, the intermediate tray is shown in line with the fixed tray and the loading tray in line with the intermediate tray. This position of the loading tray corresponds to the gun being at 5° depression. At any normal loading angle, the shell will slide by its own weight from the intermediate to the loading tray as soon as the stop (3) is withdrawn.

690. The loading tray is pivoted on its arm (10) which is pivoted on the loading arm (23). Fixed to the latter is a sprocket wheel (22 teeth) connected by a chain (17) to another sprocket wheel (19 teeth) on the shaft of the loading tray. This causes the loading tray as it swings over to turn through a small angle, so that it is parallel to the bore of the gun when in position for ramming the shell.

691. Two spring stops, worked by a handle (18), lock the loading tray either in the ramming or waiting position. Pushing in on the handle releases the waiting position stop and leaves the ramming position stop free to enter its socket under the action of a spring as soon as the tray reaches the ramming position. Pulling on the handle works the stops in the opposite way.

692. The cam (8) on the arm of the loading tray has a slope so that, if the intermediate tray is already down on the loading arm, the action of withdrawing the tray withdraws the stop (3) and lets the shell slide in at once.

693. Further safety arrangements prevent the loading tray being swung into the ramming position unless the gun is fully out and the breech open. A stop (19) on the loading tray arm engages with one toe of the lever (20) actuating the breech interlock. The other toe of this lever is held by a casing (21) secured to the breech ring of the gun, if the gun is not fully run out, and by the end of a bar (22) if the gun is fully out, but breech closed. The bar (22) is worked by a cam keyed to the bottom of the breech hinge pin. Hence the lever (20) and, consequently, the loading tray is only free when the gun is out and breech fully open. Conversely, the breech cannot be closed until the loading tray has been withdrawn.

Shell Loading Gear in Gunhouse. (Plate No. 28.)

694. The trays in elevation and plan view are shown on Plate 28, which also illustrates the relation of the trays to the gun and to the top of the shell hoist. The gun is shown at 5° depression and the distinguishing numbers used correspond to those used on Plate 25.

695–700.

SECTION 3.—CORDITE HAND-UP. (Plate 29.)

701. In this design of mounting the cordite hand-up takes the place of cordite hoists in the revolving structure. There is one hand-up for each gun.

702. A cordite charge enclosed in its cardboard container is passed by hand from the top of the duplex cordite hoist via the cordite gallery, within the ring bulkhead, to an elevated platform at the rear of the working chamber. From there it is passed up through the hand-up to the gunhouse above.

703. The elevated platforms for the cordite handing numbers are recessed into the rear of, and partitioned from, the working chamber at the right- and left-hand side, these recesses being called the " cordite pockets."

704. The cordite hand-ups for the left and centre guns are operated from the left-hand platform and the hand-up for the right gun is operated from the right-hand platform.

705. The hand-up consists of a tube of sufficient size to accommodate a charge complete with cardboard container.

706. It is set at an angle and bolted to the gunhouse floor. Flashtight doors are provided one at each end, one door opening into the gunhouse and the other into the cordite pocket. The doors are interlocked to prevent both being open at the same time.

Operation of Cordite Hand-up

707. The cordite hand-up is shown with the top door open and the bottom door closed.

708. The number in the gunhouse removes the charge and depresses the pedal (1) which actuates the top cam (2) and, through the rod (3), the bottom cam (4). The first half movement of the pedal closes the top door by means of the top cam (2) and the door actuating lever (5), the bottom door remaining closed because the bottom door actuating lever (6) remains in the straight portion of the bottom cam (4). Further movement of the pedal opens the bottom door, the top door remaining closed because the top door actuating lever (5) remains in the straight portion of the top cam (2). On completion of the pedal stroke and after release the pedal is returned, by spring plunger (7), the actuating rod (3) and cams remaining in the up position, with the top door closed and the bottom door open.

709. In opening the bottom door the cam on the door actuating shaft (8) rides past bolt (9) which is spring returned, locking the bottom door in the open position. The hand-up is now ready for loading.

710. The charge is inserted and remains held in position by the pawls (15), the lever (16) actuating them being locked in the stowage position. Both pawls have about 45° play on their pivot shafts (17) which permits the pawls and spring plunger (18) which actuates them sufficient movement to allow the charge to pass them.

711. After loading the reverse movement of the doors takes place, the man on the hand-up platform operating hand lever (10). The first operation necessary is to free bolt (9) and unlock the bottom door from the open position. This is done through the trigger release in hand-lever grip rod (11) and levers (12) and (13).

712. The first half movement of hand lever (10) closes the bottom door, the top door remaining closed. Continuation of the hand lever movement opens the top door, the bottom door remaining closed. On completion of the stroke, and after release, the hand lever is returned by the spring loaded plunger (14).

713. In order to enable charges to be returned from the gunhouse, the pawls (15) can be housed clear by means of lever (16).

714–715.

SECTION 2.—FIRING, NIGHT SIGHT, AND LOCAL CONTROL SUPPLY CIRCUITS. (Plate 36.)

741. Two batteries of 65 ampere hour capacity, each consisting of 18 nickel iron cells " Nife " type D6, and each battery fitted in 3 boxes, are accommodated in the shell handing room.

742. The battery charging resistance is carried in an adjacent position on the ship's structure.

743. The distribution panel, placed in the working chamber, has five principal switches. Switches I and II feed the bus-bars supplied by the respective batteries, or, in second position, connect the batteries to the charging circuit.

744. Switch No. III supplies the earth circuits for quarters firing and night sights.

745. From this switch the circuit is led to the Quarters Firing C.O.S., thence to fuze panel in gunhouse ; whence, split into main and auxiliary circuits, it goes to the double contact firing pistol at the local director sight, while separate circuits from the bus-bar in fuze panel supply current for night sights at the L.D.S. and officer's periscope.

746. From the pistol the firing circuits go through the non-inductive resistance and Quarters Firing C.O.S. to interceptors at the guns, and through breech safety change-over contacts to lock contacts.

747. Switch No. 4 feeds the fuze panel for local control circuits ; the particular circuits served by each pair of fuzes for fire control being as follows :—

For " A," " X " and " Y " turrets :—
- Gun Range (Local).
- Gun Elevation (Local).
- Gun Ready Lamp.
- Turret Training.
- Illumination.
- Telephone A.D.
- M/A for Local Control.

For " B " Turret :—
- Gun Range (Local).
- Gun Elevation (Local).
- Gun Ready Lamp.
- Turret Training.
- Illumination.
- M/A for Local Control.

Switch No. 5 supplies the Emergency Lighting Circuits.

Wiring at Local Director Sight Position. (Plate 36A.)

748. A terminal box is carried in local director sight pedestal and from this all the local director sight services are led, as shown in detail on diagram.

749–750.

SECTION 3.—THE COMPRESSED AIR SYSTEM. (Plate 33.)

751. Air is required in the turret either for air blast or for charging the run-out cylinder. It can be supplied from the ship's mains or from a reservoir of two air bottles stowed on the revolving platform in the shell handing room.

752. The ship's mains supply air at 3,500 lb. per square inch pressure, which is led into the turret through a central pivot, and swivel connection to the air blast panel carried on the revolving platform. There is also a connection from the panel to the air bottles.

753. Air, either from the bottles or mains, passes through the reducing valve, which reduces the pressure to 1,250 lb. per square inch, and then the pipe divides, and one lead goes to each gun, to a four-way connection near the outer trunnion bracket in the case of the side guns, and on the right-hand trunnion bracket of the centre gun. From here one pipe takes air through the trunnion and sliding pipes (for details, *see* Plate 9) to the admission valve on the breech ring ; one pipe ... alve and ... charged.

Paragraph 753, *add* :—

"*Note.*—In order to reduce the amount of air used for air blast, the reducing valve is to be kept set to 750 lb. per square inch, being only set to 1,250 lb. per square inch when charging the run-out cylinder".

(*This amendment embodies A.F.O. 4381/42.*)

(*G. 01329/43.—A.F.O. P.113/43.*)

(*Amendment No. 2, A.F.O. P.57/42.*)

... anel are ... opened, ... e into a ... whence it runs into the gun-well drain tank.

755. For sub-calibre firing, the elbow piece on the outlet side of the automatic air-blast valve is disconnected and swivelled round, and a flexible hose connected. This hose is stowed on the left-hand side of the structure supporting the centre gun trunnion bracket.

756–760.

SECTION 4.—THE RAMMER TANKS AND GUN-WELL DRAIN SYSTEM

(Plate 11.)

761. The three rammer tanks of 25 gallons each are filled with fresh water by hose from outside the turret.

762. On the underside of each tank is fitted a short pipe and cock for draining the tank. This cock is situated under the step in each gun-well.

763. The gun-well drain tank, of 60 gallons capacity, into which the gun-wells and air cylinders drain, is fitted with a lead to a semi-rotary hand-pump by means of which, through a flexible hose stowed in the centre gun-well, any rammer tank may be refilled.

764. The gun-well drain tank is fitted with a valve, to which may be connected a flexible hose for draining the tank.

765.

SECTION 5.—CORDITE DRENCHING SYSTEM IN REVOLVING STRUCTURE. (Plate 30.)

766. Cordite can be drenched in each of the cordite hand-ups and also whilst being handled on either cordite hand-up platform.

767. Salt water for spraying is taken off the supply pipe to the cooler through a non-return valve (1) to the drenching valve (2), mounted on the gunhouse roof support, and thence to the spraying system.

768. The drenching valve (2) can be worked by a handle (3) at the valve or by the Officer of Turret's handle (4) at the rear of the gunhouse. An Aren's control wire (5) worked off the drenching valve handle, simultaneously closes a quick closing sluice valve (6) on the cooler supply pipe, so reserving the whole of the flow for the drenching system.

769. Three flexible hoses and fittings are provided, by which charges in the chamber of each gun can be drenched if required.

770. The drenching valve is kept closed normally by the pressure of water on top of it and a spring and plunger (7). When opened a spring (8) forces out the catch (9) which engages in a notch (10) and so holds the valve open until released by pressing up on the handle (11).

771. The quick-closing sluice valve has a spindle (12) worked by a handwheel (13) which moves the spindle up or down by a bridge (14). The bridge is supported on two pillars (15) which pass through guide holes in the valve box and are held in the " open " position by catches (16). The springs (17) always tend to close the valve by forcing the pillars and bridge down but cannot do so until the catches (16) are released by the Arens control wire (5), which works against the action of the spring (18).

772. If the valve has been closed by this means it can only be reopened by first revolving the handwheel (13) as if to close the valve. As the valve is then seated, this has the effect of raising the bridge and pillars against the springs until the catches (16) engage again under the action of the spring (18). The bridge is then held in the open position and the valve can be opened by revolving the handwheel in the opposite direction.

773. The non-return valves are fitted in the system to ensure it remaining full when it has once been used and so obtaining an immediate jet of water when the drenching valve is opened, instead of a preliminary rush of air. The non-return valves between the drenching valve and the sprayers are spring loaded to keep them shut and so hold the head of water above them when the drenching valve is closed.

774–775.

SECTION 6.—LEAD OF SALT WATER SUPPLY FOR COOLING AND DRENCHING FROM FIXED TO REVOLVING STRUCTURE

776. A pipe is led off the 50-ton pump or alternatively the fire main to a connection on a pedestal on the deck immediately below the platform in the shell handing room. A flexible, internal armoured, rubber and canvas hose takes the salt water to another connection under the underside of the working chamber floor, whence it passes to the cooling and drenching systems. The return pipe is arranged in a similar manner alongside the supply pipe.

SECTION 7.—VENTILATION, COOLING, FLOODING AND SPRAYING

(Plate 42.)

Ventilation

777. Air is drawn through a mushroom vent on the weather deck and passes down the supply trunk, through a gastight flap to the supply fan. Air is forced by the fan through a W.T. sluice valve " A " (which must be open) on the platform deck, into the magazine.

778. Exhaust air from the magazine leaves by the exhaust trunk, passes through a W.T. sluice valve " B " (which must be open) on the platform deck, then through a W.T. trunk discharging through a flashtight fitting between the upper deck beams.

Spraying

779. Spraying is done by spray pipes fitted over the cases in the magazines; water can be admitted to these through a pipe connecting with the firemain system of the ship. A valve is fitted outside the magazine for controlling the supply of water to the spray pipes, operated by rod gearing from inside the magazine itself, or from the handing room or the flooding locker on the weather deck. A hose connection with valve is fitted to the supply pipe inside the magazine.

Flooding

780. Flooding can be carried out through the usual 7-inch flood pipe connected to sea by a flood valve and a sea-cock, operated by rod gearing from a flooding locker on the weather deck, and a convenient position near the escape from magazine.

781–785.

APPENDIX I

Schedule of Component Parts of Breech Mechanism

Note.—Those parts which are **different** for Right and Left guns have the letter R after the item number. Those parts which are interchangeable are given plain numbers.
Taken from N.O.D. 2196/19.

Description.

Item No.	Carrier
1R	Carrier body.
2R	Lever, actuating retracting bar, with split keep pin.
3R	Pin, axis, roller.
4	Roller, retracting bar actuating lever.
5R	Bar, retracting.
6	Spring, retracting bar.
7	Screw, retaining retracting bar.
8	Plug, retracting bar.
9	Screw, fixing, lock hand lever guide (2 in No.).
10R	Safety stop.
11R	Spring, safety stop.
12	Guide, lock hand lever.
13R	Screw, guide, safety stop.
14	Pin, axis, retracting bar, actuating lever, with split keep pin.
15R	Cam actuating lock.
16	Screw, check, lock hand lever axis stud.
17	Stud, axis, lock hand lever, with split keep pin.
18	Nut, lock hand lever axis stud.
19	Stud, stop, slide box.
20	Screw, check, stop stud.
21	Catch, breech mechanism lever.
22R	Plate, catch, B.M. lever.
23	Block, retaining spring, B.M. lever catch.
24	Spring, B.M. lever catch.
25	Pin, securing spring retaining block.
26	Screw, fixing, B.M. lever catch plate.
27R	Arm, breech mechanism lever.
28	Crankshaft.
29	Nut, crankshaft, with split keep pin.
30	Bolt, securing crankshaft bearing, with split keep pin.
31	Bolt, hinge, with split keep pin.
32	Nut, hinge bolt.
33	Bush, hinge bolt (2 in No.).
34	Screw, check, hinge bolt bush.
35	Cam, air blast.
36	Washer, spring, air blast cam fixing screw.
37	Screw, fixing, air blast cam.
38	Lubricator, Tucker.
39	Plunger.
40	Nut, retaining.
41	Spring, plunger.
42	Bearing, crankshaft.
43R	Bracket, hang-fire latch.
44	Spring, hangfire latch, Mark II.
45	Plunger, hangfire latch.
46	Detent, hangfire latch retainer, with split keep pin.
47	Spring, detent.
48	Screw, fixing, hangfire latch bracket (2 in No.).
49	Plate, locking (2 in No.).
50	Screw, fixing, locking plate (2 in No.).
51R	Latch, hangfire.
52R	Pawl, hangfire latch.
53R	Retainer, hangfire latch.
54R	Plate, bearing, hangfire latch.
55	Screw, check, hinge lug bush (2 in No.).
56	Collar, locking, with split keep pin (2 in No.).
57	Cam, safety, loading tray.
58	Bush, hinge lug (2 in No.).
59	Crosshead.
60	Slide, actuating lock.
61R	Link, actuating lock.
62	Bolt, adjustable.
63	Plate, locking adjustable bolt.
64	Screw, fixing locking plate.

Item No.	Description.
	Lever, Hand, Lock
65R	Arm, with split keep pin.
66	Stud, guide, catch lever spring.
67	Pin, axis, catch lever.
68	Plunger, catch.
69	Cap, catch plunger, with split keep pin.
70	Lever, catch.
71	Spring, catch plunger.
72	Spring, catch lever.
	Screw, Breech
73R	Body.
74R	Cam safety.
75	Screw, fixing safety cam (2 in No.).
76R	Pin, axis, roller.
77	Roller.
78	Pin, securing roller axis pin, with split keep pin.
79	Screw, lubricating (short).
	Obturator
80	Ring, rear, outer.
81	Ring, rear, inner.
82	Ring, front.
83	Pad.
84	Disc, protecting, front.
	Axial Vent
85R	Bolt.
86R	Sleeve.
87	Nut.
88	Spring.
	Cam, Rotating Breech Screw
89R	Body.
90	Screw, fixing (2 in No.).
91	Plate, locking fixing screw (2 in No.).
92	Screw, fixing, locking plate (2 in No.).
	Arc Control
93R	Body, with split keep pin.
94	Screw, fixing.
95	Spring.
96	Plunger.
	Catch **~~Screw,~~ Retaining, Box Slide** P36/49.
97	Plunger.
98	Spring.

APPENDIX II

LIST OF NUMBERS AND TITLES OF THE "WORKING DRAWINGS" CONTAINING STRIPPING INSTRUCTIONS AS SUPPLIED TO THE SHIP

Roller No.	Admiralty No.	V/A Drawing No.	Description.
4	17	N.8481	Arrangement of Friction Clutch and Worm Drive for Training Gear.
6	23	N.12018	Details of Dismantling Gear for Training Gear Brackets, Sheaves, etc.
6	24	N.12019	Details of Dismantling Gear for Training Gear Brackets, Sheaves, etc.
6	25	N.11427	Details of Dismantling and Assembling Gear for Training Pinions.
7	26	N.9601	Arrangement of Cradle.
10	35	N.8535	Arrangement of Brackets for Dismantling Splinter Protection Plates and Method of Removing Gun from Gunhouse.
10	37	N.11445	Details of Brackets for Dismantling Splinter Protection Plates on Gun Cradle.
13	52	N.8876	Arrangement showing Method of Dismantling Elevating Gear.
13	53	N.11791	Dismantling Gear for Hand and Power Clutch Coupling Shaft.
19	82	N.8879	Arrangement of Lifting Gear for the Removal of Pump and Motor.
19	83	N.8880	Details of Lifting Gear for the Removal of Pump and Motor.
19	84	N.12020	Dismantling Gear for Air Bottles, Cooler, Pump, Motor, etc.
21	88	N.8791	Arrangement of Shell Hoist on Revolving Structure, showing Method of Assembling Chains, etc.
39	165	N.12045	Diagram of Settings for Control and Operating Valves.
47	206	N.11449	Arrangement of Dismantling Gear for Local Director Sight.
47	207	N.11450	Details of Dismantling Gear for Local Director Sight.
55	241	N.9120 and Fly.	General Arrangement of Sighting Mechanism.
57	246	N.10726 and Fly.	General Arrangement of Training Receiver, Type D, Mark V.
58	249	N.10732 and Fly.	General Arrangement of Elevation Receiver, Type E, Mark II—Sectional Views.
59	252	N.9938 and Fly.	General Arrangement of Gyro Director Sight, Type T, Mark I*—Longitudinal Section.
61	259	N.9207 and Fly.	Range to Elevation Unit, Mark III—Sectional Arrangement through Centre Line of Unit.

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