CONTENTS

Danger sector switch. The danger sector warning and cutout switch (page 15-37) has two contacts normally open and two contacts normally closed. The normally closed contacts are part of circuit 1PA. Six of these switches are utilized, one for each gun in elevation and one for each gun in train. They serve to open their respective gun layer's firing key circuits when gun elevation or turret train movement causes the line of fire to closely approach own ship structure.

Gun captain's ready switch. The gun captain's ready switch (page 15-19), when positioned to SAFE, opens Gun Firing Circuit Mk 2 Mod 0, and, if the gun is in AUTOMATIC or LOCAL control, it closes a load control circuit that brings the gun to the load position and holds it there. When positioned to READY, the switch restores its portion of the gun firing circuit, and, at the same time, energizes a control circuit which returns the gun to its firing position while in AUTOMATIC or LOCAL control. Other functions of the ready switch are described in the ready light system text below.

Main battery ready light circuit (1R). Circuit 1R is a system of visual indicators and safety interlocks of the fire control system. The ready light (1R) circuit includes an arrangement of indicator dials located at turret control stations, as well as a system of relays, solenoids, and limit switches at various locations. These are interconnected with operating switches of the guns at the gun captain's, gun layer's, and gun trainer's stations so that the electric lamps of the indicators light up to show completion of the actions. In addition, the safety interlocking feature of the circuit serves to avoid accidents by preventing crew actions for the loading and firing sequence from being performed at a wrong or unsafe time. Figure 15-34 identifies the terminal connections of all elements of the circuit.

Circuit description. Circuit 1R components comprise the following elements, which are described as to character, location, and electrical hook-up function in the following paragraphs. (See also chapter 12 for location and purpose.)

- Turret officer's selective switch
- Turret officer's indicator panel
- Turret officer's recoil indicators
- Turret captain's indicator panel
- Gun elevation ready, gun ready, and load indicators
- Breech closed, recoil, and bore clear indicators
- Gun elevation and train ready indicators
- Train ready indicators
- Gun captain's ready switches
- Foot-operated ready switches
- Action cutout switch
- Safety interlock arrangement composed of:
  - Bore clear switch
  - Bore clear relay, recoil relay, and rammer relay
  - Rammer switch
  - Cradle control solenoid and powder hoist door control solenoid
  - Recoil switch
  - Drill switch
  - Breech closed switch
  - Slide contacts
  - Unlocking solenoid of gun captain's ready switch

Power supply for the circuit is 120 volts, 60 cycles, derived from the forward or after main battery control switchboard. An additional power supply of 117 volts, 60 cycles, for the operation of the powder hoist door control solenoid and cradle control solenoid, is derived from a 440/117-volt transformer on the upper projectile flat.

Turret officer's selective switch. Circuit 1R utilizes the lower switch assembly of the turret officer's selective switch (fig. 15-20), in common with circuit 1PA. The switch provides a continuous 120-volt, 60-cycle supply, whether positioned at A. C. SUPPLY or BATTERY. A separate bank of contacts provides battery supply to the firing circuit, when the switch is in the BATTERY position.

Turret officer's indicator panel. The top three dials on the turret officer's indicator panel (fig. 15-21) are colored yellow and marked 1, 2, and 3. They indicate the state of readiness of the three turrets. The second row of three dials, colored red, clear, and green, are marked L, C, and R. These dials are lighted when the gun captains' ready switches are turned to READY. The third row of three dials, marked L, C, and R and colored yellow, are actuated by the foot-operated ready switches at the gun layers' stations. The three clear glass dials in the fourth row, marked AUTO ELEV. L. GUN, AUTO ELEV. C. GUN, and AUTO ELEV. R. GUN, are illuminated when the elevation transfer valve switches are closed, and indicate that the guns are functioning automatically in elevation. The three clear glass dials of the bottom row are marked AUTO TRAIN, TRAIN READY, and PLOT READY. The AUTO TRAIN dial is lighted when the train transfer valve switch is closed, indicating that the turret is in automatic train operation. The TRAIN READY dial is actuated by the foot-operated ready switches at the left and right sight trainers' and the train operator's station. The PLOT READY light is actuated from the forward or after main battery plotting room.

Turret officer's recoil indicators. Mounted horizontally above the turret officer's indicator panel is a three-dial indicator panel with three amber-colored indicator dials, each marked RECOIL, for the left, center, and right guns, respectively. Each dial is illuminated during the time when the gun is in recoil and counterrecoil, and remains illuminated throughout the first portion of the loading cycle until the bore clear switch is pressed by the gun captain.

Turret captain's indicator panel. The turret captain's indicator panel (page 15-18) is connected in parallel with the turret officer's indicator panel. Its indicating dials present the same information to the turret captain as that presented to the turret officer by his indicating panel. However, the turret captain's panel has no recoil indicators.

Gun elevation ready, gun captain ready, and load indicators. These three-dial indicators (fig. 15-23) are located at each gun captain's station and each gun layer's station. The bottom (LOAD) dial is illuminated when the gun captain's ready switch is positioned at SAFE or when the recoil relay is energized. The LOAD light indicates to the gun captain that this part of his ready light circuit is in operation and indicates to the gun layer that the gun is to be moved to, or should remain at, the loading angle. The upper (red) dial is illuminated when the gun captain's ready switch is at READY. The middle (blue) dial is illuminated by the gun layer, through his foot-operated ready switch (page 12-13) when the gun elevation is matched with the gun order.

Breech closed, recoil, and bore clear indicators. Located at each gun captain's station, the lights in this three-dial indicator are arranged in the ready light circuit to signal when the actions they identify occur during the loading and firing cycle. The breech closed indicator (upper, white) is illuminated when the gun is in battery and the breech is closed, through the contacts of the breech closed switch, the slide contacts on the yoke and slide of the gun, and the recoil switch in the open position. The recoil indicator (middle, amber) is illuminated while the gun is in recoil, through the closed contacts of the recoil switch and the bore clear relay. It remains illuminated through the contacts of the recoil relay as soon as that relay becomes energized, and goes OFF when the contacts of the recoil relay open, as a result of the gun captain closing the bore clear switch momentarily. Other recoil lights located at turret officer's station are arranged in parallel with, to go ON and OFF with, the recoil light at each gun captain's station. The bore clear light (lower, green) is illuminated when the gun captain presses the bore clear switch, through the SAFE contacts of the gun captain's ready switch. It remains illuminated through the SAFE contacts of the ready switch and contacts of the bore clear relay, as soon as that relay becomes energized, and goes OFF when the gun captain's ready switch is positioned to READY.

Gun elevation and train ready indicators. These four-dial indicators, located at the left sight pointer's and right sight pointer's stations, and at the train operator's station, are arranged in the circuit so that each of the upper three dials is illuminated when the respective left, center, or right gun layer depresses his foot switch, as the gun elevation is matched with the gun order. Similarly, the lower "TRAIN READY" dial is illuminated by closing one of the foot-operated switches at the right and left sight trainers' stations and at the train operator's station. These three switches are connected in parallel so that the dial is illuminated by closing any one of them.

The upper dials indicate to the sight pointers and train operator that the guns are ready in elevation. The lower dial indicates to the train operator that his ready light circuit is working and indicates to the sight pointers that the guns are in train.

Train ready indicators. The single-dial train ready indicators (fig. 15-26), located at the left and right sight trainers' stations, are also illuminated by the foot-operated ready switches at the left and right sight trainers' stations and at the train operator's station. These switches are connected in parallel so that the closing of any one of them energizes the indicator dials.

Gun captain's ready switches. Located at each gun captain's station is a gun captain's ready switch (fig. 15-22). This switch is arranged in the 1R circuit with the gun elevation ready, gun ready, and load indicator lights, the turret officer's indicator panel, and the turret captain's indicator panel. The unlocking solenoid of the switch is arranged in the safety interlock portion of the circuit with the slide contacts, breech closed switch, and recoil switch so that it is energized only when the gun is in battery and the breech is closed, thereby permitting the switch lever to be shifted to the opposite position only in proper sequence in the loading operation.

Foot-operated ready switches. Foot-operated ready switches (fig. 15-27), located at the gun layers', sight trainers', and train operator's stations, are arranged to illuminate the appropriate dials on the gun elevation ready, gun ready and load indicators, gun elevation and train ready indicators, train ready indicators, the turret officer's panel, and the turret captain's indicator panel.

Action cutout switch. The action cutout switch, located at each gun captain's station, is arranged in the 1R circuit to turn off the 120-volt alternating-current power supply of the major portion of the 1R circuit. The only portion of the 1R circuit which is not controlled by the action cutout switch is the TRAIN READY indicator light circuit. Although the 117-volt alternating-current power for the cradle control solenoid and powder hoist door control solenoid is not controlled directly by the action cutout switch, the relays, through whose contacts the power must be carried, are controlled; therefore, the action cutout switch serves indirectly to control these solenoids also.

Bore clear switch. The bore clear switch, located at the gun captain's station, is arranged in the 1R circuit to energize the bore clear relay through the SAFE contacts of the gun captain's ready switch, and also to illuminate the bore clear indicator light.

Bore clear relay, recoil relay, and rammer relay. These relays, located together in boxes mounted at each gun captain's station, are arranged in the 1R circuit to initiate the closing of certain contacts only with the proper prerequisite conditions existing in the circuit, thereby opening the proper ports in the hydraulic lines so that the powder hoist doors and the projectile cradles can be moved only when it is safe to do so.

The bore clear relay has three sets of contacts, two of which are normally open, and the middle one of which is normally closed. The first set of contacts serves in this relay's own holding circuit, through the SAFE contacts of the gun captain's ready

switch. The second (normally closed) contacts are in the holding circuit of the recoil relay, and serve to open that holding circuit as the bore clear relay becomes energized. The third set of contacts energizes the cradle control solenoid, and are also arranged in the rammer relay circuit with the rammer switch and with the powder hoist door control solenoid. The bore clear relay becomes energized when the bore clear switch is momentarily depressed.

The recoil relay uses two sets of contacts, both normally open. The first set of contacts serves as the recoil relay's own holding circuit, through the normally closed contacts of the bore clear relay. The second set of contacts serves to illuminate the LOAD lights in the gun elevation ready, gun ready, and load indicators. The recoil relay becomes energized when the recoil switch is momentarily closed during recoil, or when the drill switch is closed.

The rammer relay uses two sets of contacts, both normally open. The first set of contacts serves to energize the powder hoist door control solenoid by a circuit through the rammer switch (rammer retracted) and the third contacts of the bore clear relay. The second set of contacts of the rammer relay serves as its own holding circuit through the third contacts of the bore clear relay. The rammer relay becomes energized when the rammer is extended to ram the projectile while the bore clear relay is energized.

Rammer switch. The rammer switch (fig. 15-34) is a single-pole, double-throw limit switch, mounted adjacent to the rammer by means of a bracket on the turret officer's bulkhead, and in such a way that the rammer switch's normally open contacts close whenever the rammer head is extended 4.0 inches or more from the fully retracted position (figs. 10-8 and 10-20). It is arranged in the 1R circuit to energize the rammer relay when its normally open contacts are closed (rammer extended) and to energize the powder hoist door control solenoid, through the first contacts of the rammer relay, when its normally closed contacts are closed (rammer retracted). This arrangement of the contacts on the rammer switch prevents the powder hoist door from being opened as long as the rammer head is extended beyond 4.0 inches from the fully retracted position.

Cradle control solenoid and powder hoist door control solenoid. These solenoids are integral parts of solenoid-controlled pilot-operated four-way valves located in the cradle operating hydraulic line and the powder hoist door operating hydraulic line, respectively. These valves are so constructed that continuous energization of the solenoids directs the flow of the hydraulic oil one way, and a spring actuates the valve for reverse flow. The cradle control solenoid is arranged in the 1R circuit so that it is energized (through the third contacts of the bore clear relay) to port the hydraulic oil to the cradle operating cylinder only when the bore clear relay is energized.

The powder hoist door control solenoid is arranged in the 1R circuit so that it becomes energized, through the first contacts of the rammer relay, the rammer switch (rammer retracted) and the third contacts of the bore clear relay, to port the hydraulic oil to the door operating cylinder only if the rammer relay is energized (after ramming projectile) and if the bore clear relay is energized.

Recoil switch. The recoil switch is a limit switch mounted on the rear face of the gun slide so as to be actuated by a cam on the front face of the yoke as the gun recoils (fig. 4-13). During recoil, the contacts of the recoil switch close, and reopen again as the gun counterrecoils back to battery position. The recoil switch is arranged in the 1R circuit to energize the recoil relay and to illuminate the recoil indicator lights when it is in the closed position and to complete the circuit through the slide contacts and the breech closed switch when it is in the open position.

Drill switch. The drill switch, located at the gun captain's station, is a plug and receptacle type unit which is arranged in the 1R circuit to bypass the recoil switch when the plug is inserted in the receptacle, thereby energizing the recoil relay.

Breech closed switch. The breech closed switch is a limit switch mounted on the breech face of the gun, and is operated by the breech operating lever (see chapter 3) when that lever is latched. This switch actuates the unlocking solenoid at the gun captain's ready switch and is arranged in the circuit in series with the slide contacts and the recoil switch to illuminate the BREECH CLOSED light when the switch is closed and the gun is in battery position.

Slide contacts. The slide contacts (fig. 4-13) are two sets of knife and prong type contacts. The knife-blade portions are mounted on the front face of the yoke and make contact by mating with the prongs mounted on the slide in such a way that the blades and prongs mesh only when the gun is in battery. These contacts are arranged in the 1R circuit, in series with the breech closed switch, so that they prevent the solenoid of the gun captain's ready switch from unlocking when the gun is not in battery.

Unlocking solenoid of gun captain's ready switch. The unlocking solenoid (fig. 15-22) is an integral part of the gun captain's ready switch. This solenoid is controlled by the breech closed switch, and it, in turn, prevents the ready switch from being shifted into the opposite position unless the gun is in battery and the breech is closed.

Safety interlock arrangement

The safety interlock arrangement* of the ready light circuit is illustrated schematically in figures 15-35A through 15-35L for one complete cycle of the gun loading and firing sequence. The purpose of this interlock arrangement is to prevent movement of the gun captain's ready switch lever, movement of the cradle, or opening of the powder hoist door until certain required conditions of safety have been met.

Action of safety interlock components. Gun in battery. Figure 15-35A illustrates the conditions of

* Added by NAVORD ORDALT 3255 and SHIPALT 819.

the safety interlock circuit after the gun has fired, recoiled, and counterrecoiled to battery position. The gun captain's ready switch has not yet spring-returned to SAFE and the breech is still closed. The recoil lights, the breech closed light, the LOAD lights, and the gun captain's ready lights are all ON. The recoil relay has become energized when the recoil switch closed and opened during recoil, and the unlocking solenoid of the gun captain's ready switch is energized through contacts of the recoil relay.

Figure 15-35B illustrates the change which occurs in the safety interlock circuit components as the gun captain's ready switch lever spring-returns to SAFE. The gun captain ready lights go OFF, but the LOAD lights, RECOIL lights, and BREECH CLOSED lights remain ON. Through other contacts of the gun captain's ready switch (refer to fig. 15-34) the gun automatically assumes the five-degree loading angle.

Action of safety interlock components. Breech opening action. Figure 15-35C shows the safety interlock circuit action as the gun captain opens the breech. The breech closed switch opens and breaks the circuit to the unlocking solenoid of the gun captain's ready switch, thereby locking the switch lever in the SAFE position. The BREECH CLOSED light goes OFF, but the RECOIL and LOAD lights remain ON, and the recoil relay remains energized. The salvo latch (see chapter 3) is actuated mechanically to the lock condition.

Action of safety interlock components. Bore clear examination. With the conditions existing after the opening of the breech, the gun captain ascertains that the bore is clear, wipes the mushroom, and then depresses the bore clear switch momentarily. The primerman, using a special tool, inserts a primer into the receiver of the firing lock. Figure 15-35D shows the circuit action which takes place. The bore clear relay becomes energized and held by its own holding circuit through the SAFE contacts of the gun captain's ready switch. The bore clear light goes ON and remains on as long as the bore clear relay remains energized. The recoil relay becomes de-energized as soon as the bore clear relay becomes energized, since the normally closed contacts of the bore clear relay, when they open, break the recoil relay holding circuit. The recoil lights go OFF. The cradle control solenoid becomes energized as soon as the bore clear relay is energized and remains energized as long as the bore clear relay is so held (namely, until the gun captain's ready switch is positioned to READY). The cradle control valve is opened by the solenoid, opening the port in the cradle operating hydraulic line. The cradle hydraulic control valve is then manually shifted to permit hydraulic oil to flow into the cradle cylinder, thereby lowering the cradle with its projectile to the spanning position for loading. The bore clear and LOAD lights still remain ON.

Action of safety interlock components. Projectile ramming action. Before the projectile is rammed, the conditions existing are: the breech is still open, and therefore the breech switch is open; the bore clear relay is energized, the bore clear and LOAD lights are ON, the gun captain's ready switch is locked at SAFE, and the cradle is down in spanning position.

Figure 15-35E illustrates the change which occurs in the 1R circuit as the rammer operator shifts the hand lever (in the rammer hydraulic circuit) to RAM. As the rammer head moves to an extended position 4.0 inches away from the fully retracted position, it actuates the rammer switch to energize the rammer relay, which then closes its own holding circuit through contacts of the bore clear relay. The rammer operator then shifts the hand lever back to RETRACT. The rammer head returns to the fully retracted position. In doing so, the rammer closes the other contacts of the rammer limit switch (see fig. 15-35F), thereby energizing the powder hoist solenoid valve, so the door can then be opened hydraulically.

Action of safety interlock components. Ramming powder bags. Before the powder bags are rammed, the conditions existing are: the breech is still open, and therefore the breech switch is open; the bore clear relay is still energized, the bore clear and LOAD lights are ON, the rammer relay is still energized, the gun captain's ready switch is locked at SAFE, and the cradle is down in spanning position. As the powder hoist door is opened hydraulically, the powder bags are dumped on the tray.

The rammer operator again shifts the hand lever to RAM (fig. 15-35G). Then, as the rammer head passes the point 4.0 inches out from the fully retracted position, the powder hoist door control solenoid becomes de-energized so that the powder hoist door cannot be moved hydraulically until the rammer head is again retracted out of the way. The rammer operator then shifts the hydraulic hand lever to RETRACT. The powder hoist door can then be closed by manual hydraulic lever, and the cradle is raised by manual hydraulic lever.

Action of safety interlock components. Breech closing action. Figure 15-35H shows the conditions existing in the 1R circuit prior to closing the breech. The breech closed switch is still open and the breech closed light is OFF. The bore clear relay is still energized; the bore clear light and LOAD lights are ON. The rammer relay is still energized, the gun captain's ready switch is locked at SAFE, the rammer is fully retracted, the powder hoist door solenoid and cradle control solenoid are both still energized, the powder hoist door is closed, and the cradle is raised.

Figure 15-35I shows the action of the circuit components as the gun captain closes the breech. The breech switch closes, the breech closed light goes ON, and the unlocking solenoid in the gun captain's ready switch becomes energized, retracting the leverlock. The salvo latch locks mechanically (see chapter 3) so that the breech cannot be reopened until after firing and recoil.

Action of safety interlock components. Gun captain ready. The conditions of the circuit 1R, before the gun captain repositions his switch to ready, are:

the breech is closed and the BREECH CLOSED light is ON. The bore clear relay is still energized (while the ready switch remains at SAFE). The bore clear light is still ON (while the bore clear relay remains energized). The LOAD lights are still ON (while the ready switch remains at SAFE), and although the gun captain's ready switch lever is at SAFE, the unlocking solenoid is energized and the locking lever is retracted.

Figure 15-35J illustrates the changes which occur in the circuit when the gun captain turns his ready switch lever to READY. The unlocking solenoid becomes de-energized, locking the lever in the READY position. The GUN CAPTAIN READY lights go ON; the LOAD lights go OFF. The bore clear relay becomes de-energized, and when its contacts open the bore clear light goes OFF, the rammer relay becomes de-energized, the cradle control solenoid becomes de-energized so the cradle cannot be lowered, and the powder hoist door control solenoid becomes de-energized so that the door cannot be opened. With the gun captain's ready switch at READY, also, the gun automatic laying and turret train control circuit is closed and the gun elevates to the firing angle. When the gun is elevated to the elevation order, the gun layer steps on his foot switch to light the gun layer ready lights. Meanwhile the gun trainer does the same for train.

Action of safety interlock components. Gun ready to fire. Figure 15-35J shows the conditions existing in the circuit when the gun is ready to fire. The breech closed light is ON; the bore clear relay, recoil relay, and rammer relay are all de-energized; the gun captain's ready switch is locked at READY with its unlocking solenoid de-energized. The gun captain ready lights are ON; the gun elevation ready and TRAIN READY lights are ON. The rammer is retracted, and the door and cradle control solenoids are both de-energized.

Figure 15-35K shows the conditions existing during firing and recoil. The gun is fired from plot, and as it recoils the recoil switch closes and the slide contacts open until the gun returns to battery. The RECOIL lights go ON, the recoil relay becomes energized, and is held through its own holding circuit, through the normally closed contacts of the bore clear relay. The gun captain's ready switch remains locked in the ready position until the gun returns to battery.

Action of safety interlock components. Counterrecoil to battery position. Figure 15-35L illustrates the action of the circuit during counterrecoil. As the gun returns to battery position the slide contacts close, closing the circuit to the unlocking solenoid of the gun captain's ready switch through the contacts of the recoil relay. The LOAD lights go ON by the circuit through the contacts of the recoil relay. Conditions shown in figure 15-35A then exist again.

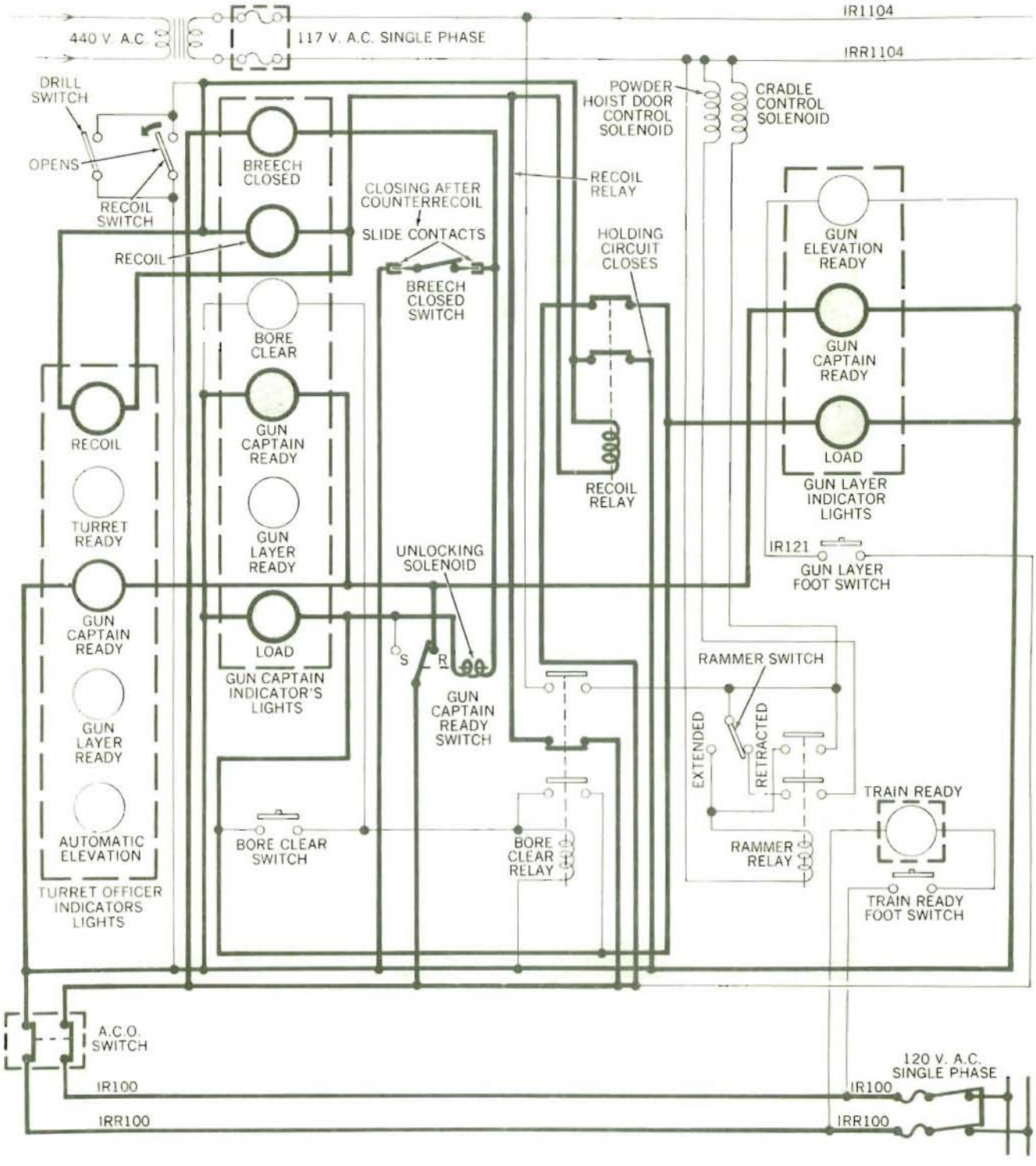

Figure 15-35A. Gun in Battery After Recoil

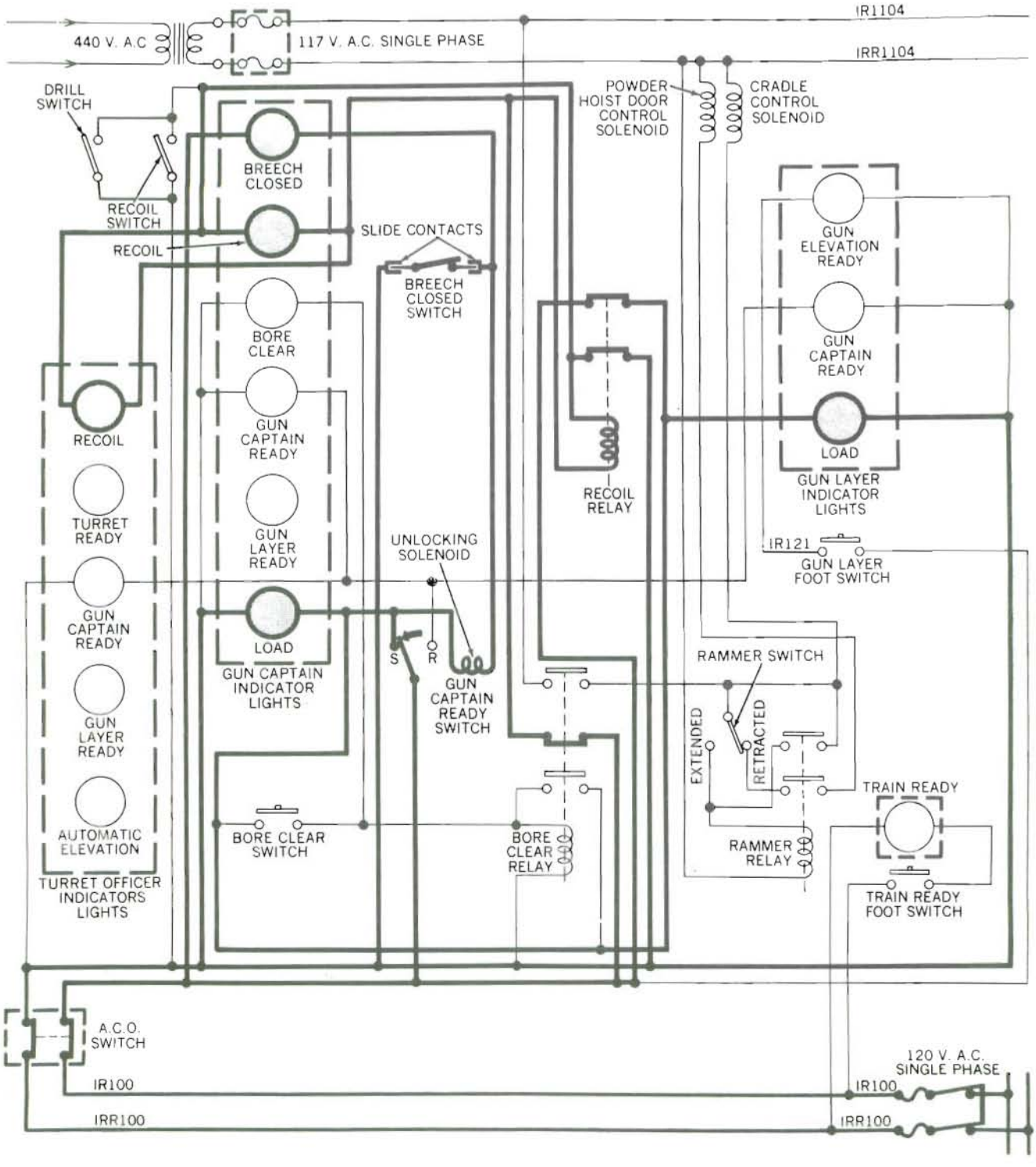

Figure 15-35B. Gun Captain's Ready-Switch Spring Returns to "Safe." Gun Moves to Loading Angle (not shown)

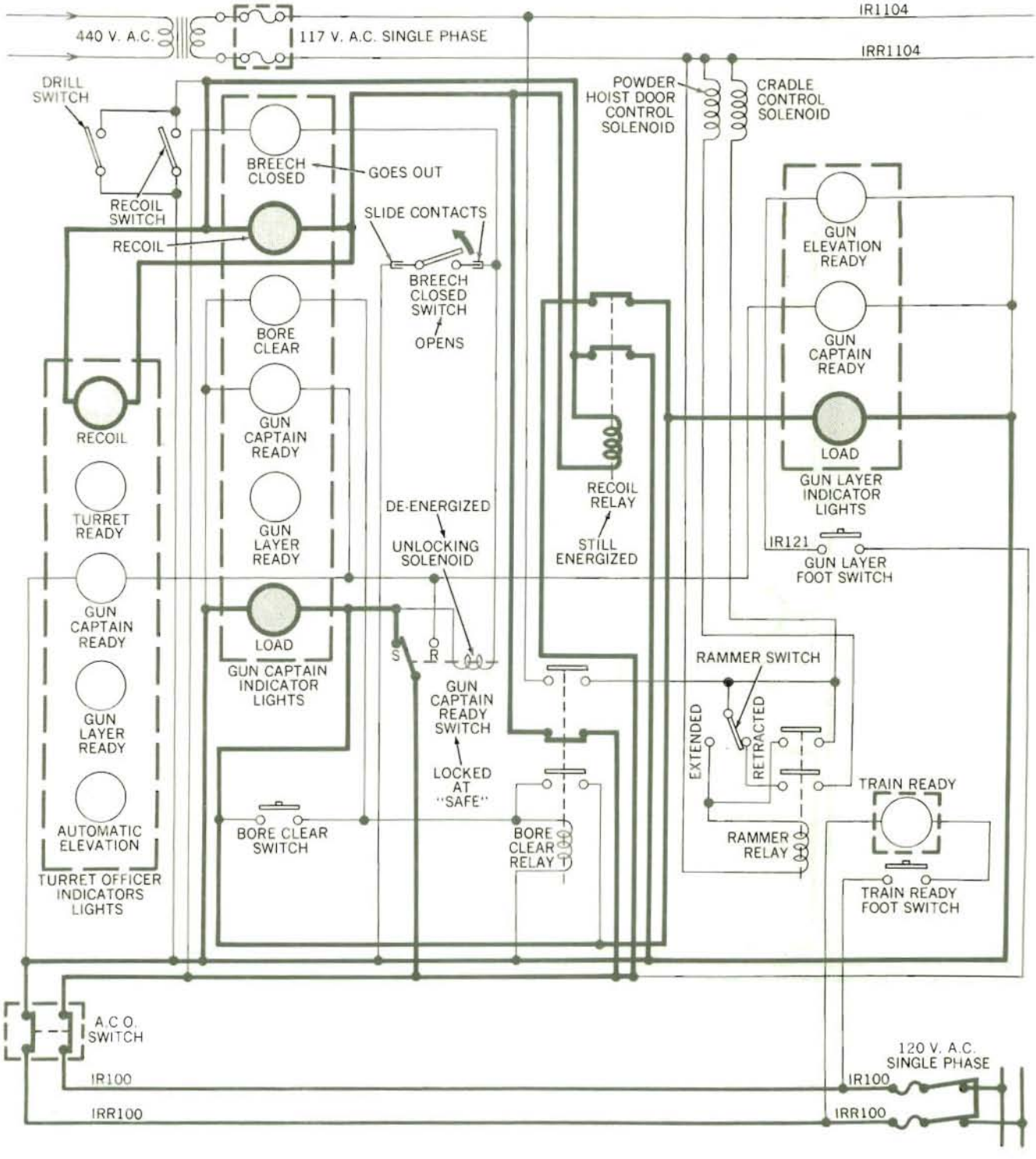

Figure 15-35C. Opening the Breech

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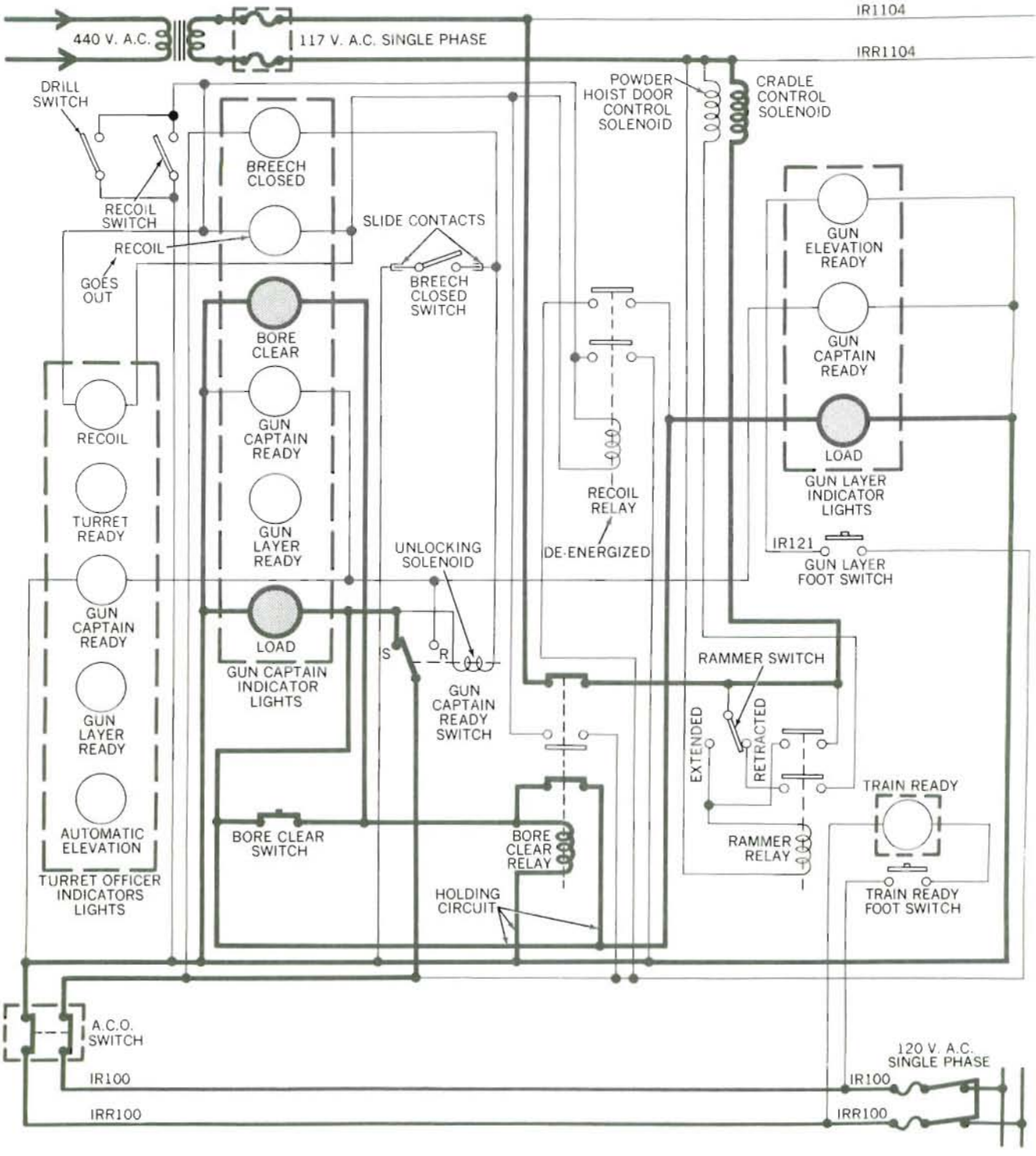

Figure 15-35D. Bore Clear Switch Button Pressed

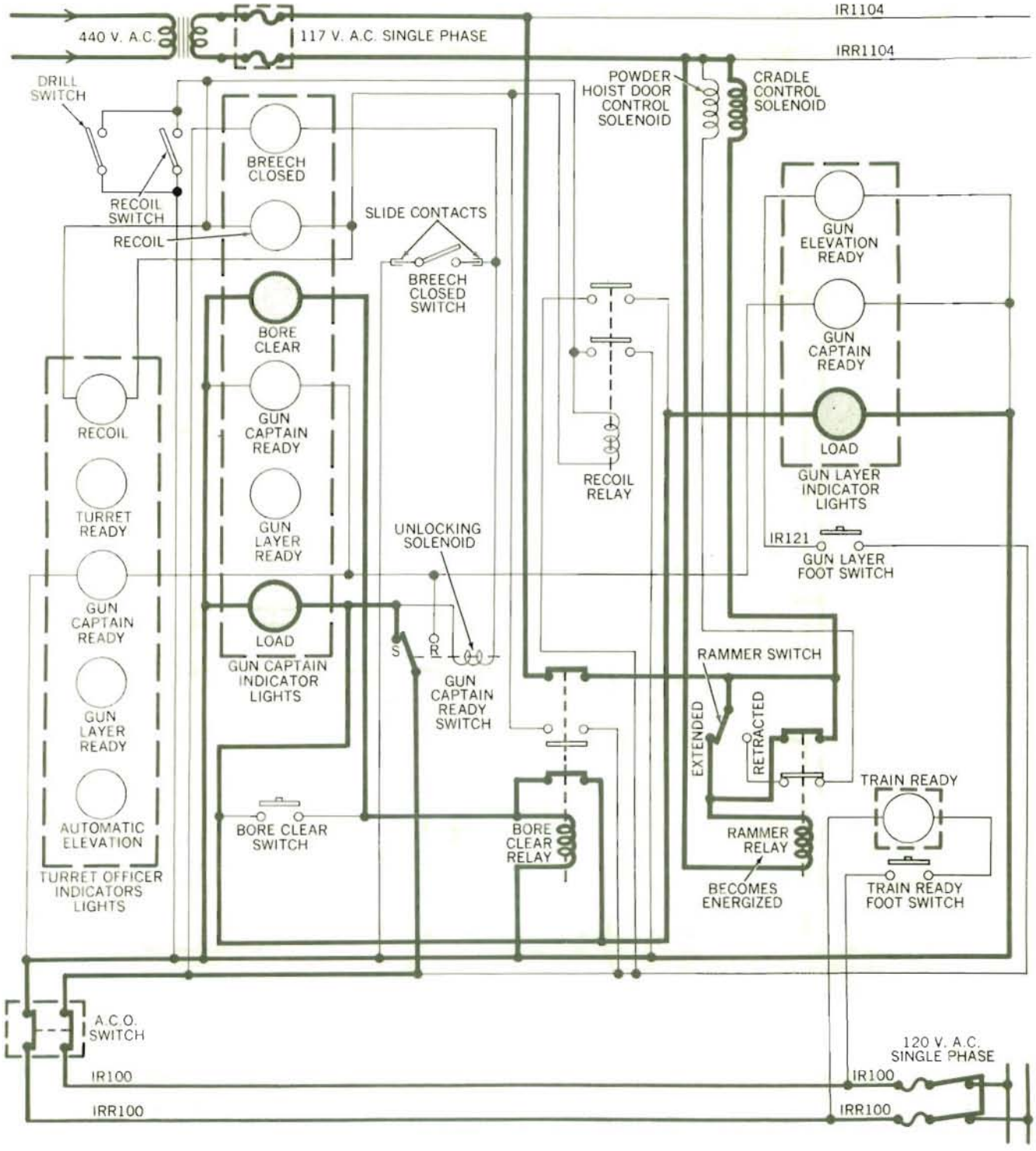

Figure 15-35E. **Rammer Extended to Ram** Projectile

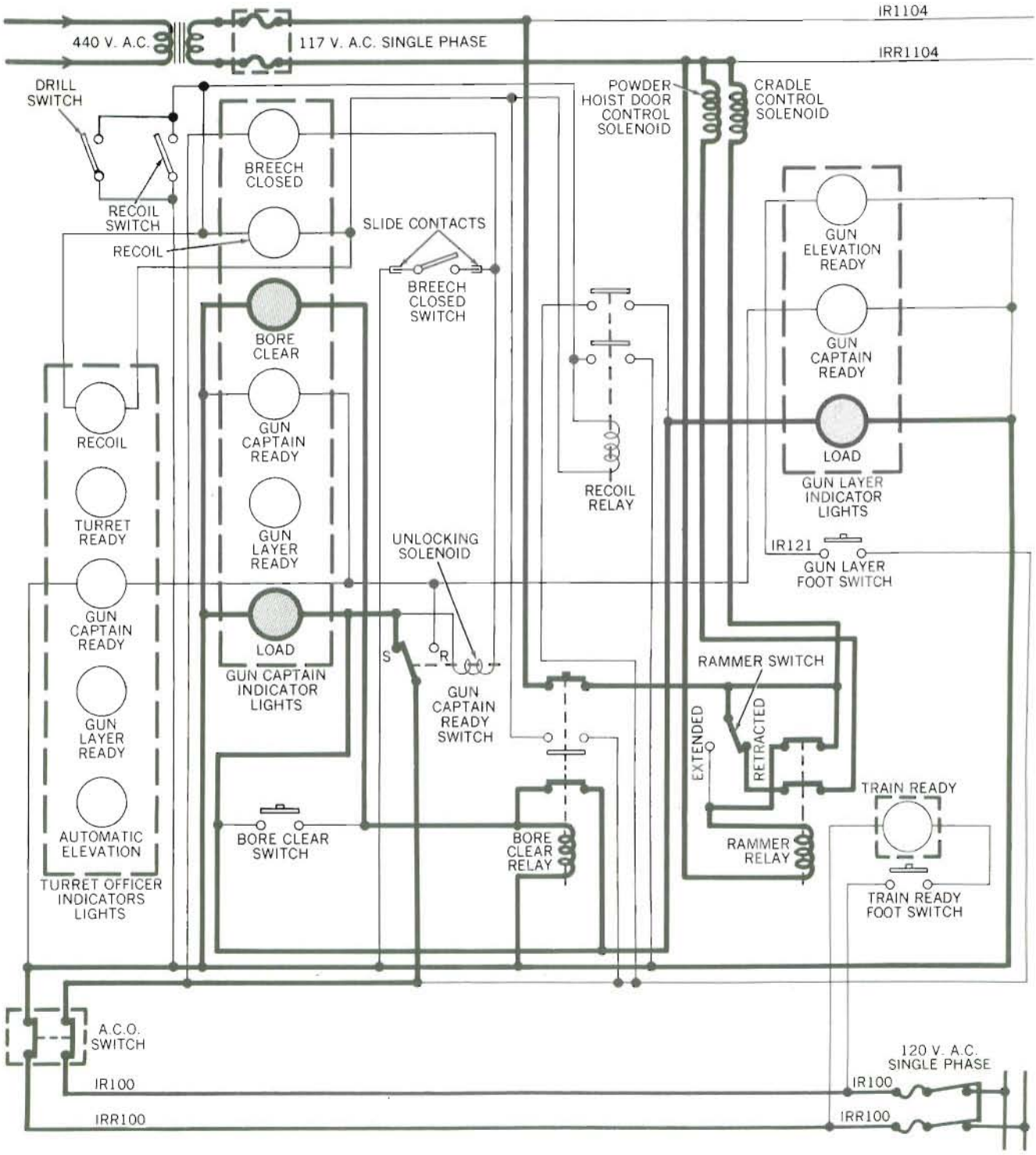

Figure 15-35F. Rammer Retracted After Ramming Projectile

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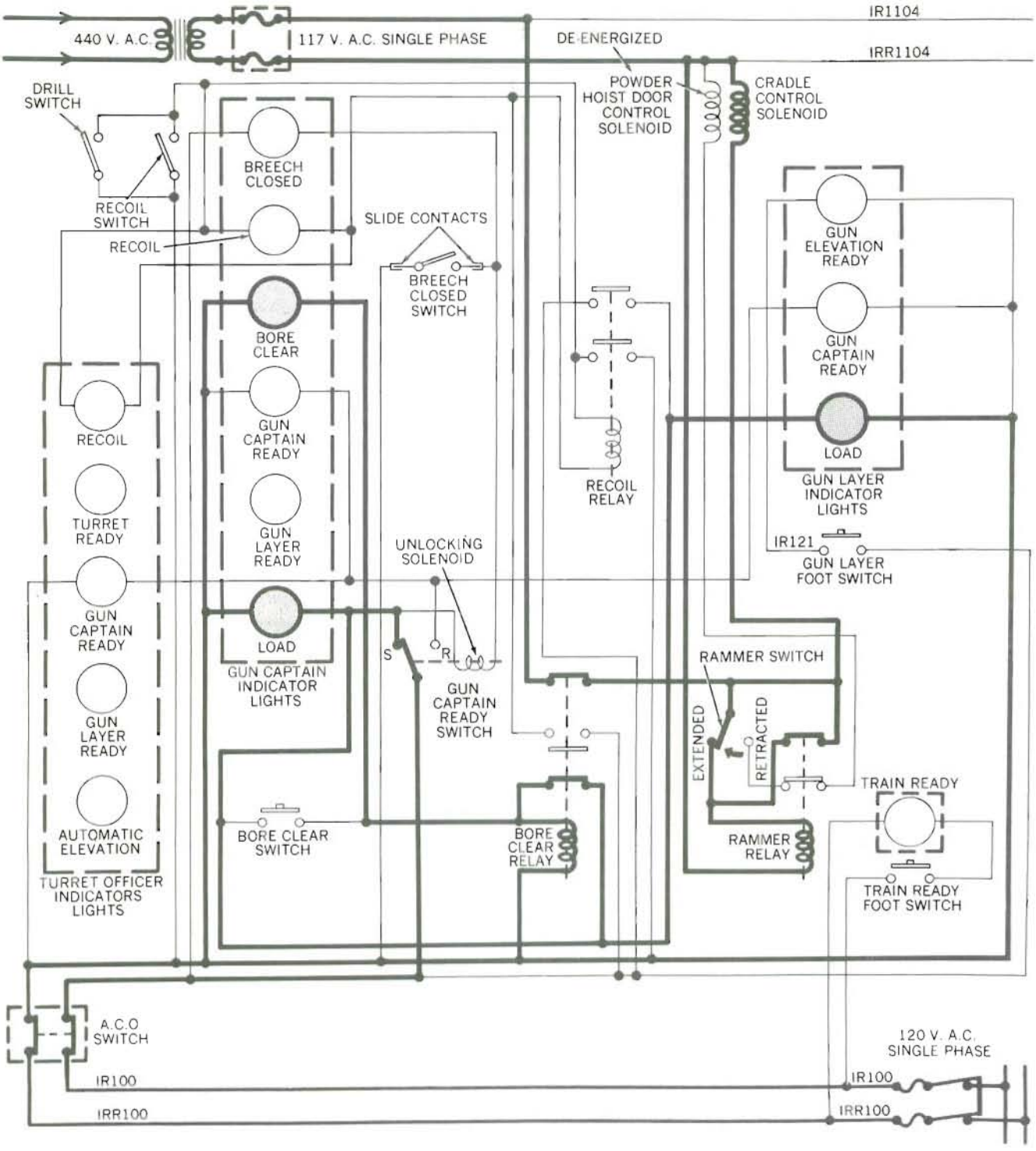

Figure 15-35G. Rammer Extended to Ram Powder Bags

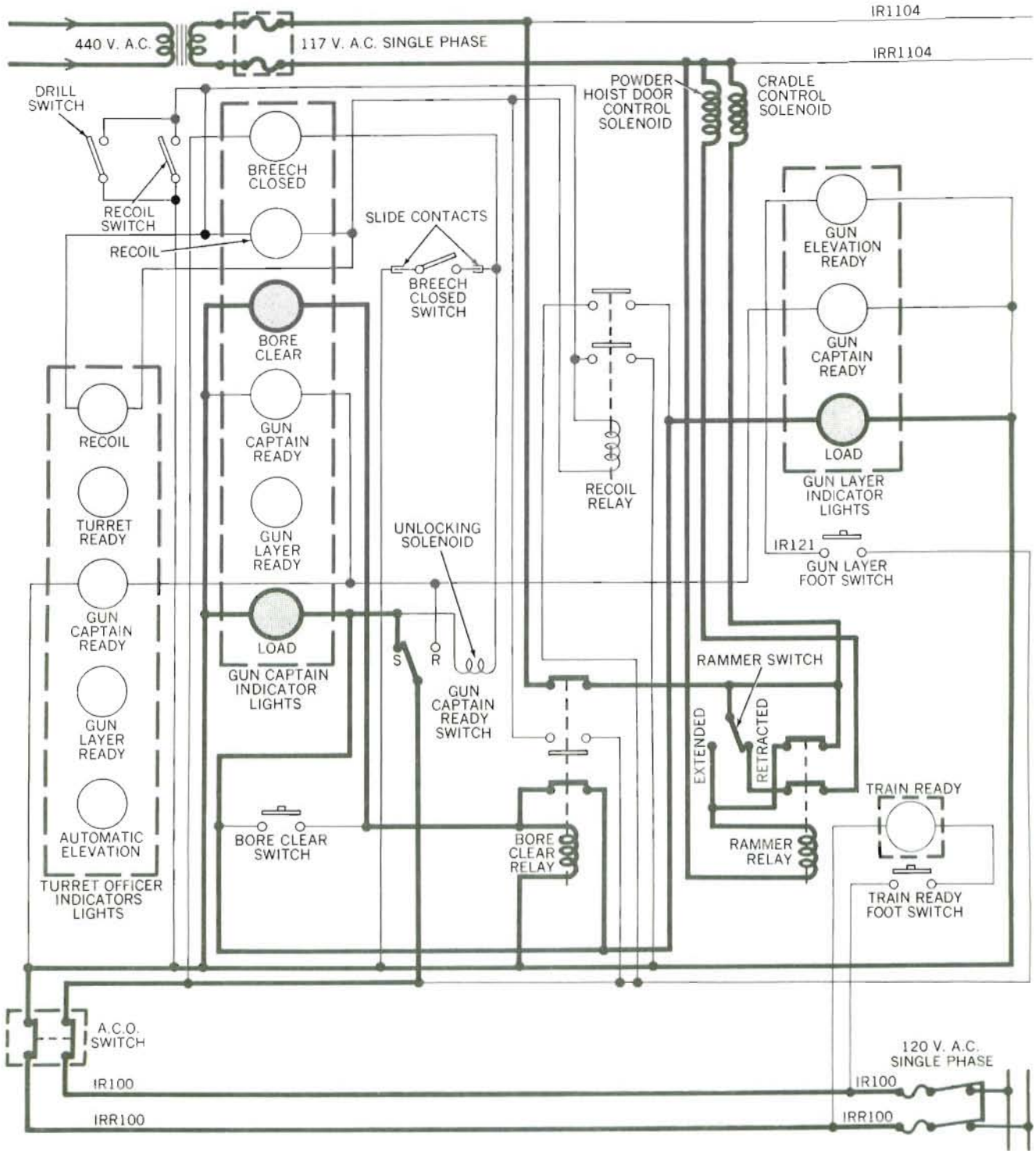

Figure 15-35H. Rammer Retracted After Ramming Powder Bags, Powder Door Closed, and Cradle Raised

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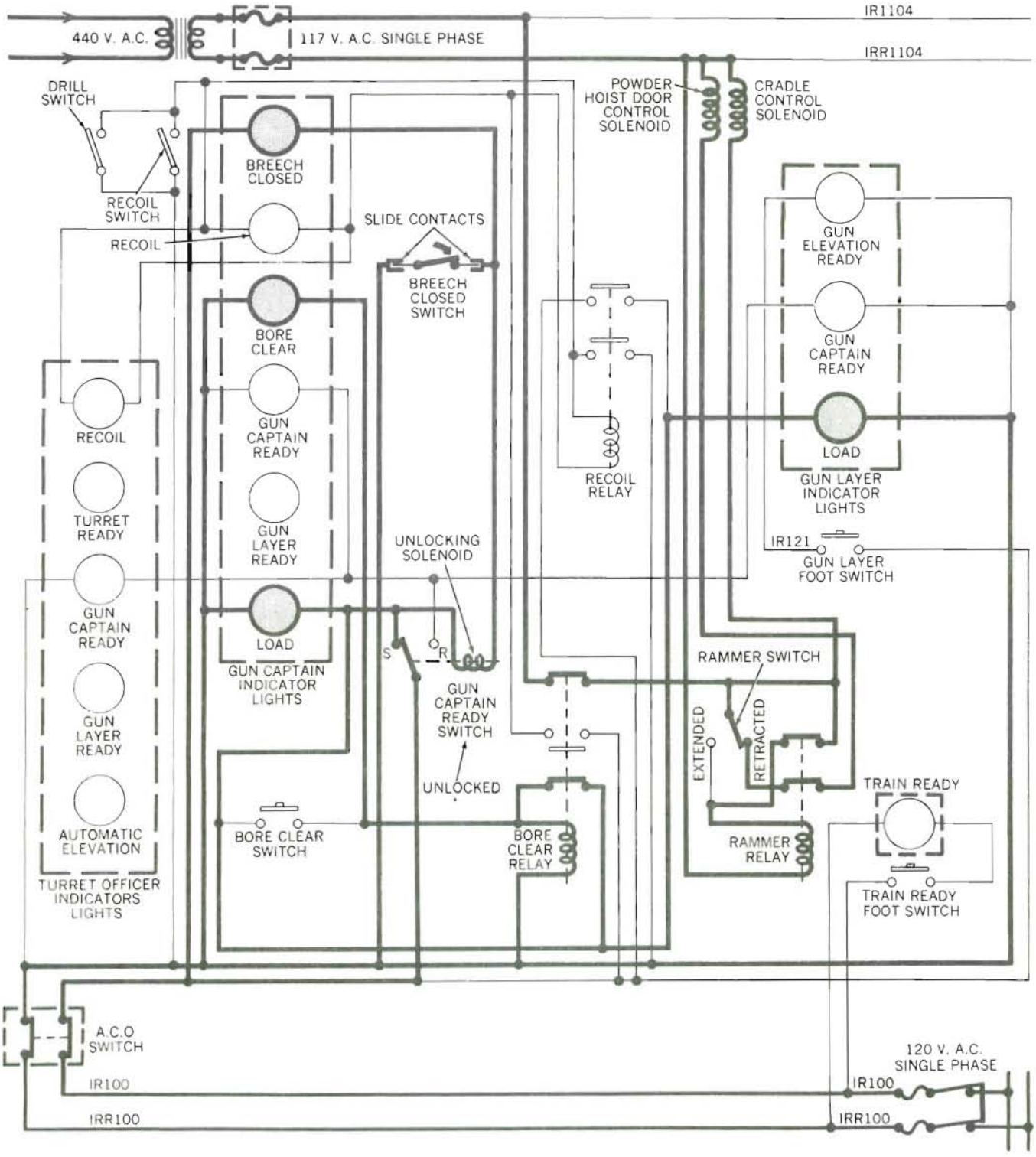


Figure 15-35I. Breech Closing Action After Loading

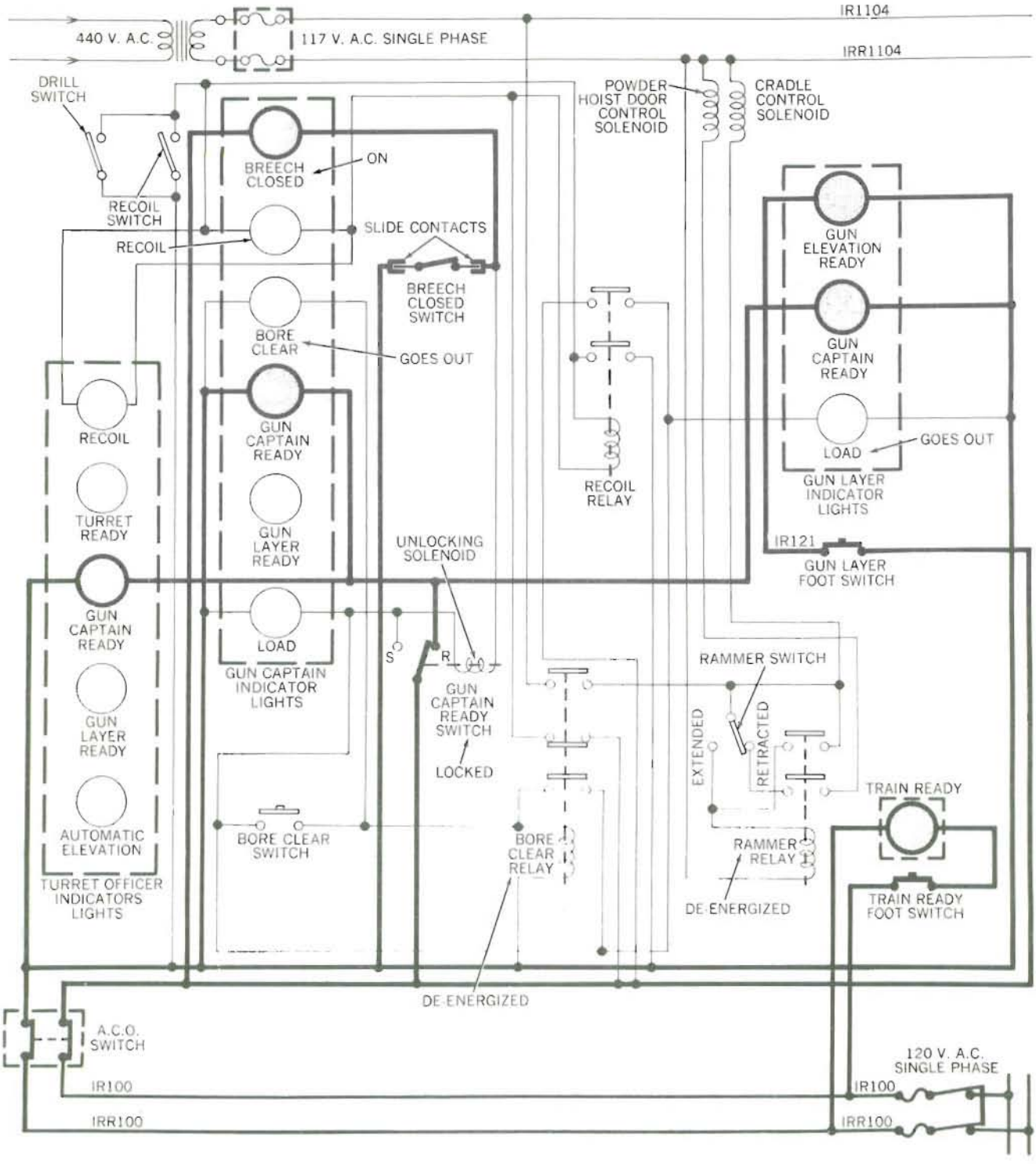


Figure 15-35J. Gun Captain's Ready Switch Positioned to Ready

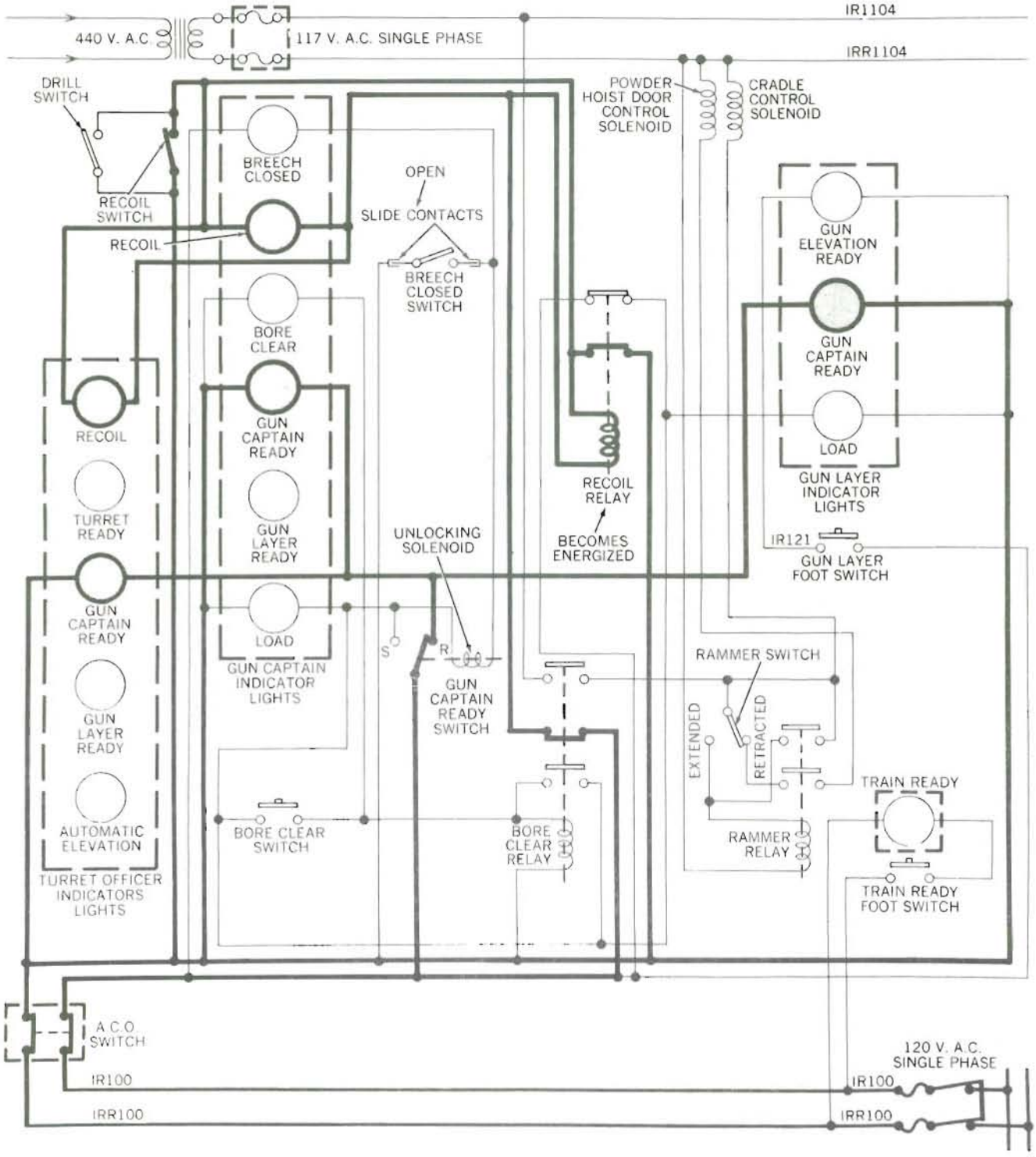


Figure 15-35K. Firing and Recoil

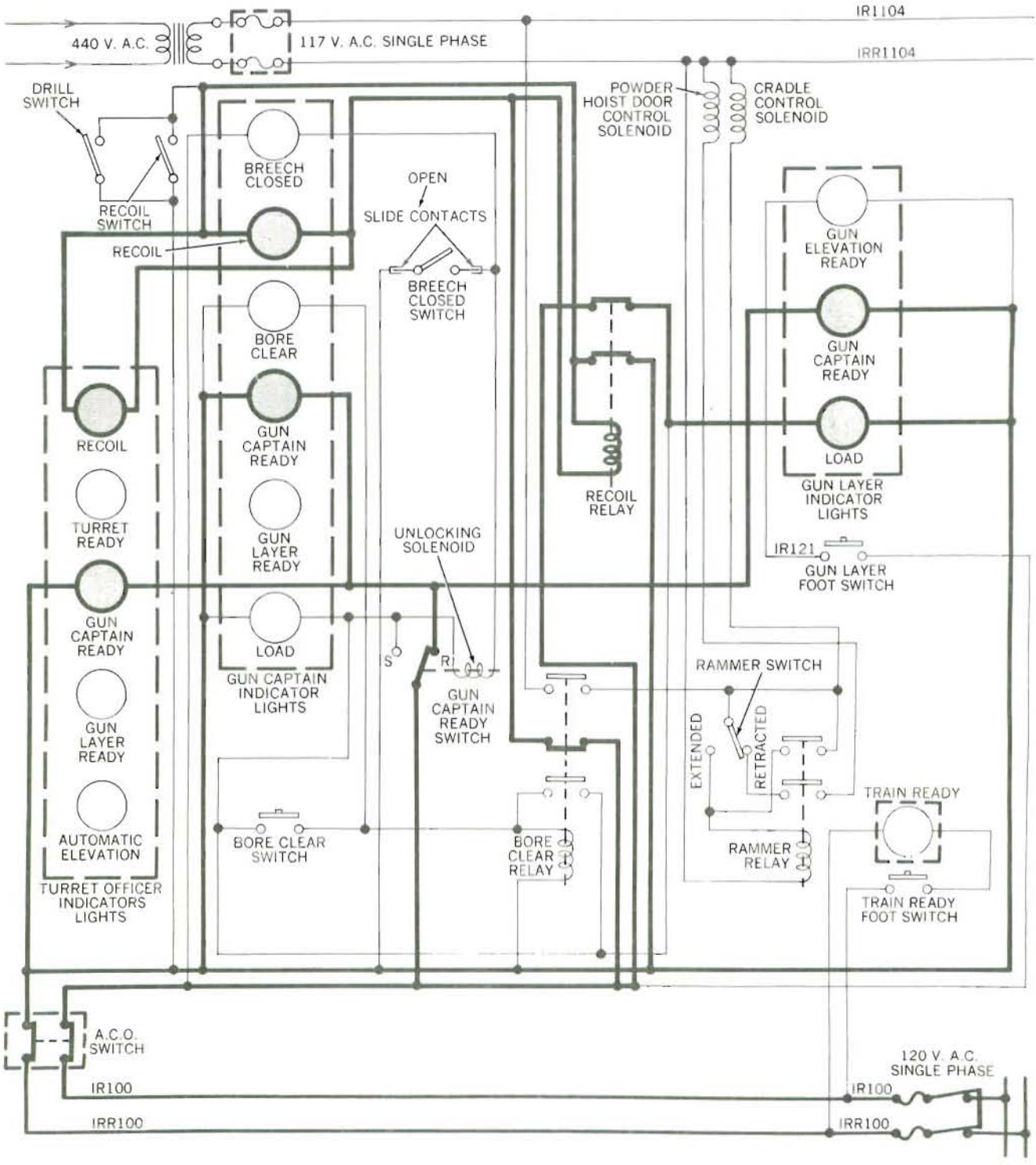


Figure 15-35L. Counterrecoil

Salvo signal circuit (1VB). Circuit 1VB provides the means for transmitting to turret personnel the command to fire. It also serves to transmit an audible warning to turret personnel when the guns are to be fired.

Circuit description. Salvo signals may be initiated in the turret or at fire control stations elsewhere in the ship. Circuit components in the turret consist of 10 buzzer-type horns, three contact makers, and the turret officer's transfer switch. The 120-volt, 60-cycle supply for the circuit is selected by the position of the turret officer's transfer switch. Figure 15-35 shows the circuit wiring arrangement.

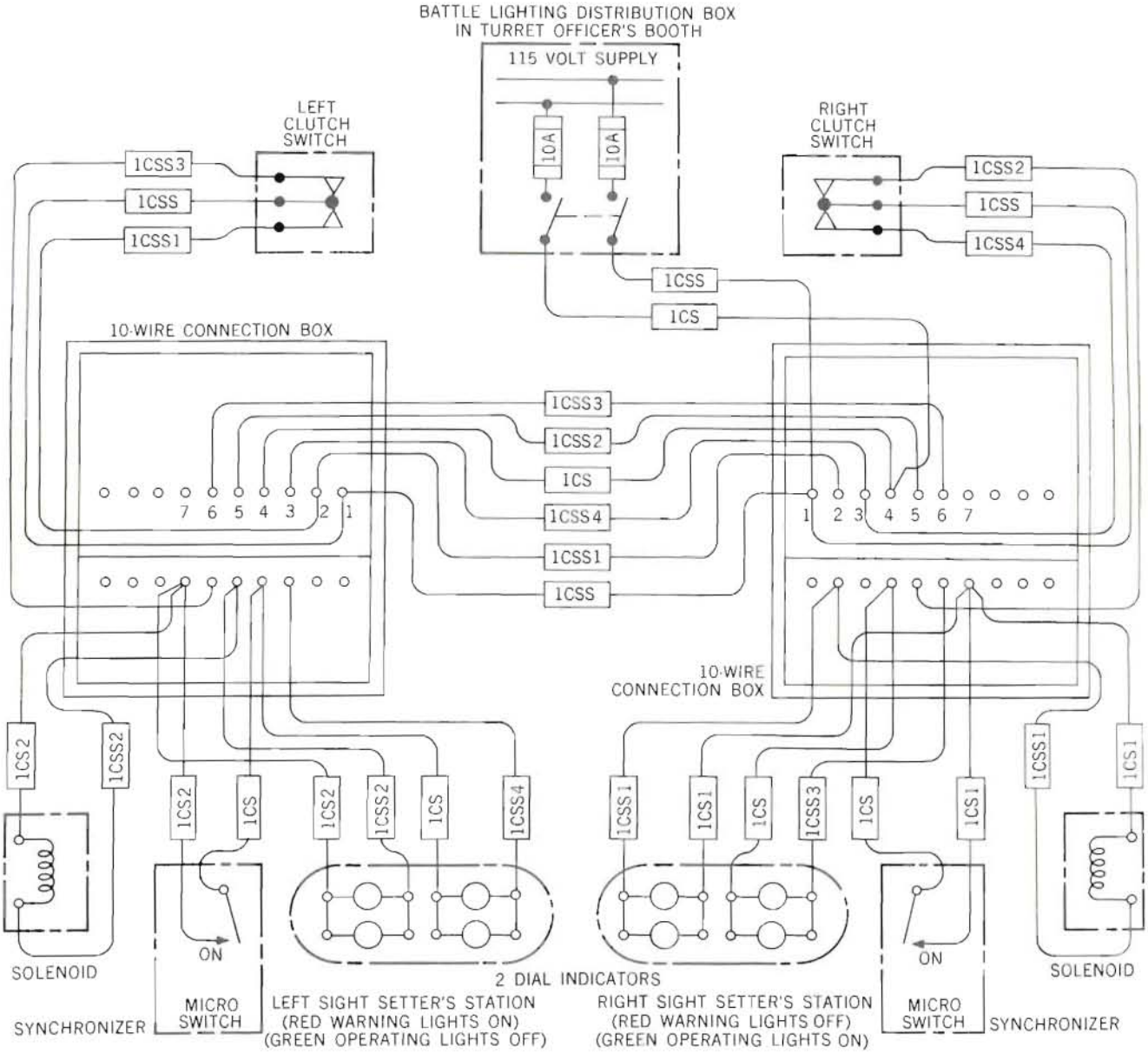


Figure 15-36. Sight Setter's Clutch Indicator Circuit CS. Elementary Wiring Diagram

Turret officer's transfer switch. When the turret officer's transfer switch (fig. 15-28) is turned to the LOCAL position, the salvo signal circuit can be energized only by operating the turret officer's contact maker. Under this condition, supply for the circuit is from either the forward or after IC switchboards, as selected by the rotary transfer switch on the turret transfer switchboard. When positioned to DIRECTOR, the salvo horns may be sounded from any of several control points outside the turret or from a sight pointer's contact maker in any turret. When sounded from one of the control points, the circuit supply is derived from the forward or after IC switchboards. When the signal or originates at a sight pointer's contact maker in any turret, the circuit is supplied from the respective turret's IC and FC panel.

Contact makers. Contact makers are of two types: the portable type "J," installed in the turret officer's compartment, and the handwheel grip type (Firing Key Mk 16 Mod 10) installed on the left handwheels of the left and right sight pointers. Type "J" is cylindrical in shape with a thumb-operated button at one end and a flexible connection cord at the opposite end. The handwheel grip type is almost identical to the sight pointer's firing keys but is of opposite hand and does not have a latch lock.

Buzzer type horns. Ten watertight, high intensity, buzzer type H2 horns are installed throughout the turret at the locations listed below.

Turret officer's booth (1)
Left, center, and right gun chambers (3)
Left and right sight pointer's stations (2)
Left, center, and right gun layer's stations (3)
Train operator's station (1)

Cease firing signal circuit (1U). Circuit 1U is the "cease firing" signal circuit for the main battery. It extends from the plotting rooms and the directors to the turrets.

Circuit description. The command to turret personnel to cease firing consists of ringing a type B4 bell, located on a bracket-mounted panel in the left rear corner of the turret officer's compartment. The bell is energized by ship's 120-volt, 60-cycle supply, transmitted via either the forward or after main battery switchboard. The rotary transfer switch on the turret transfer switchboard is used to transfer control of the circuit to plot aft or plot forward. The circuit cannot be operated by turret personnel.

Sight setter's clutch indicator circuit (CS). Circuit CS provides the two sight setter's stations with a clutch interlock and visual warning signal.

Circuit description. Components of the circuit are two sight setter's clutch indicators, two clutch switches, two micro switches, and two solenoids. The circuit functions to prevent engaging one sight setter's clutch while the other sight setter's clutch is engaged. Power supply is derived from the lighting system distribution box in the turret officer's compartment. A wiring diagram of the system is shown in figure 15-36.

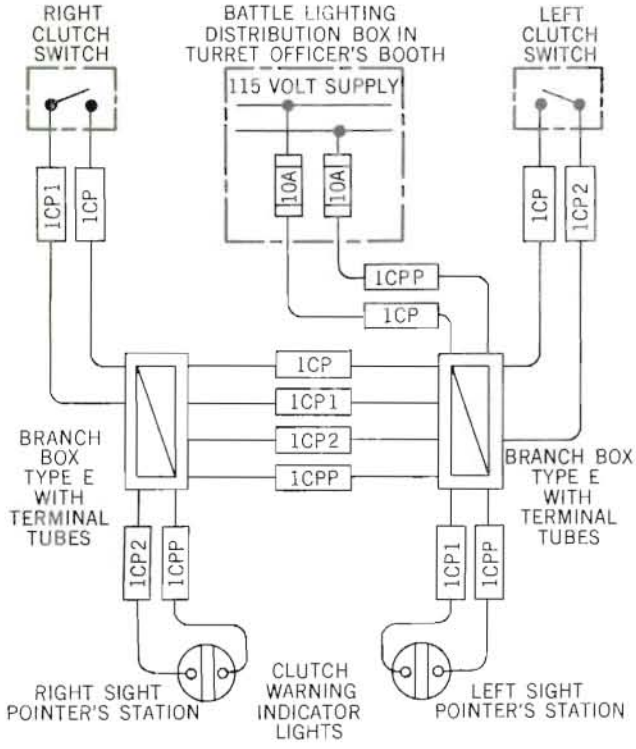


Figure 15-37. Sight Pointer's Clutch Indicator Circuit CP. Elementary Wiring Diagram

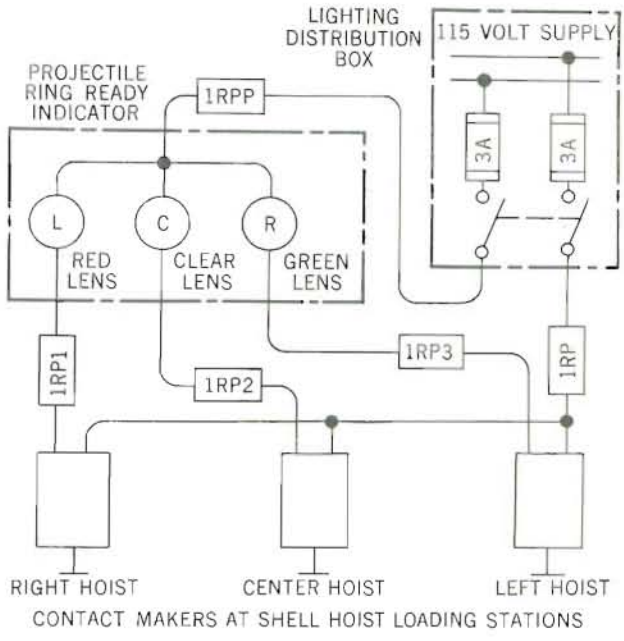


Figure 15-38. Projectile Ring Ready Light Circuit RP. Wiring Diagram

Sight setter's clutch indicators. The sight setter's clutch indicators (fig. 15-29), mounted at each sight setter's station, indicate to the sight setter's the relative positions of both clutches. With the green operating light illuminated, the sight setter may "clutch in" his sight drive. When the red warning light is on, he is warned that the opposite sight setter's clutch is engaged and is prevented from "clutching in" by a solenoid plunger.

Clutch switches. The clutch switches are single-pole, double-throw elements. One is mounted on each sight setter's clutch bracket and is actuated by a push-rod from the clutch operating lever. In conjunction with the micro switches, they provide circuit closing and opening of the interlocking solenoids and the related red and green indicator lights at each sight setter's station.

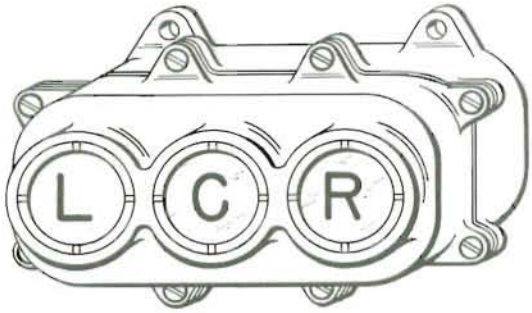


Figure 15-39. Projectile Ring Ready Indicator

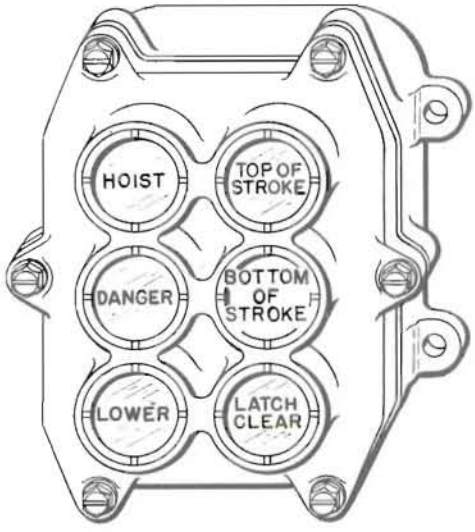


Figure 15-40. Projectile Hoist Interlock Indicator

Micro switches. One micro switch is used in each synchronizing mechanism. In conjunction with the clutch switches, they are so arranged as to close and energize their respective sight station's clutch solenoid and green indicator light while simultaneously lighting the red light and de-energizing the clutch solenoid at the opposite sight setter's station.

Solenoids. A solenoid is mounted over each sight setter's indicator bracket to actuate an interlocking mechanism of each clutch assembly. The solenoids are energized by switch action as described above. When energized, the solenoid retracts an interlocking plunger, to permit the sight setter to "clutch in" his sight drive.

Pointer's clutch indicator circuit (CP). Circuit CP provides a visual warning system to each sight pointer, to indicate when his clutch may be engaged.

Circuit description. A single dial light indicator and a clutch actuated switch are located on the handwheel bracket of each sight pointer. These are so connected that when either sight pointer is "clutched in," an indicator light warns the other sight pointer not to engage his clutch. The circuit is supplied by 120-volt, 60-cycle current from the lighting distribution box in the turret officer's compartment. The wiring of the system is shown in figure 15-37.

Pointer's clutch indicators. A pointer's clutch indicator (page 15-23) is mounted on each sight pointer's handwheel bracket. When the red warning light is illuminated, the operator is warned that the opposite sight pointer's clutch is engaged.

Switches. The switches are plunger-actuated by their respective sight pointer's clutch lever when a sight pointer is "clutched in." This closes the indicator light circuit to the opposite sight pointer, warning him not to engage his clutch.

Projectile ring ready light circuit (RP). Each projectile handling lever is provided with a ready light circuit (circuit RP) to notify the projectile ring operator when the ring may not be moved.

Circuit description. Each circuit comprises three contact makers and a three-dial light indicator. Power supply for the circuit is 120 volts, 60 cycles, derived from the lighting distribution box. Figure 15-38 shows the wiring arrangement of the circuit.

Contact makers. Contact makers are located at each hoist operator's station. Each closes only the circuit to its own corresponding dial on the projectile ring ready indicator.

Projectile ring ready indicator. A three-dial lamp indicator, figure 15-39, is mounted at each projectile ring operator's station. The three glass lenses are lettered L, C, and R and are colored, respectively, red, clear, and green When any one of the three dials is illuminated, it indicates to the projectile ring operator that it is unsafe to rotate the ring.

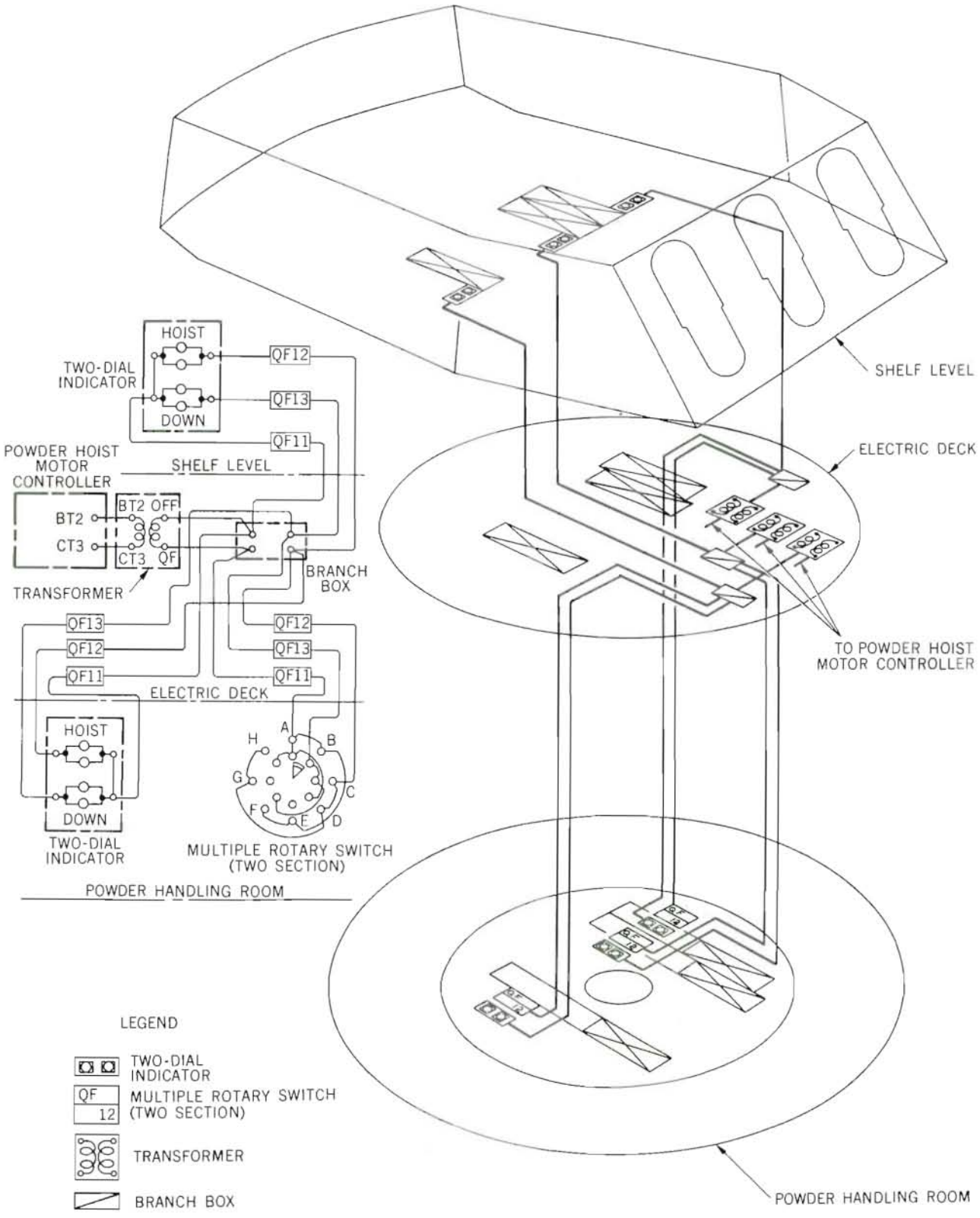


Figure 15-41. Powder Hoist Signal Indicator Circuit QF. Isometric and Elementary Wiring Diagram

Projectile hoist interlock circuit (QE). Each of the three projectile hoists is provided with an electrical interlock system, circuit QE, which prevents starting the power motor and blocks movement of the function control lever unless both hoist control handles are in the neutral position. The system further provides that the operating handles cannot be moved from neutral unless all door and shutter interlock switches are closed.

Circuit description. Each circuit consists of the following components:

2 neutral start interlock switches
1 function control lever solenoid
8 door and shutter interlock switches
2 operating handle solenoids

Power supply for each circuit is 440 volts obtained from the projectile hoist motor controller (fig. 15-15).

Neutral start interlock switches. A neutral start interlock switch is located on the underside of each operating handle bracket. Each is plunger-operated by a cam on the underside of the operating handle. The switches are connected in series and are so arranged in the controller starting circuit that the motor cannot be started unless they are closed. They are also series-connected with their respective function control valve solenoid so that the solenoid will not be energized to release the function control lever unless the switches are closed.

Function control lever solenoid. A solenoid, enclosed in a watertight case, is installed to the rear of each function control lever on the opposite side of the transverse bulkhead. It operates to prevent a function control lever from being moved except when the operating handles of its hoist are to neutral. The solenoid plungers, when de-energized, extend forward through the bulkhead into the path of their respective function control levers and block lever movement up or down. When related operating handles are at neutral, the neutral interlock switches are closed, the solenoid is energized, retracting its plunger, and the function control lever may be moved.

Door and shutter interlock switches. Each hoist assembly utilizes eight door and shutter interlock switches, four at each loading level. A switch is installed at the upper and of each shutter and is closed only when the shutter is closed. All eight switches are connected in series with one another and with a pair of interlock solenoids ("A" and "B").

Operating handle solenoids. A solenoid is mounted on the underside, near the outer end, of each operating handle bracket. These are designated "A" and "B" for their respective upper and lower levels. The solenoids are connected in parallel with one another and are connected in series with the door and shutter interlock switches described above. When de-energized, their armature plungers extend upward through the supporting bracket and into a recess on the underside of their respective operating handles, when in neutral position. The handles cannot be moved from neutral until the solenoids are energized upon closing of all eight door and shutter switches.

Projectile hoist control interlock circuit (Q). Each of the three projectile hoists is provided with an operating handle interlock system, circuit Q, to prevent hoisting under certain conditions and to provide the hoist operators with visual and audible signals of the hoist cycles.

Circuit description. Circuit Q comprises the following elements:

2 six-dial indicators
2 hoist ready gongs
1 gong relay
4 solenoids
1 function control lever switch
1 projectile indicator lever switch
1 projectile latch switch

The circuit is supplied by 120-volt, single-phase, 60-cycle current derived from the secondary winding of a 440/120-volt step-down transformer associated with the respective projectile hoist motor controller.

Indicators. A six-dial indicator, figure 15-40, is located on a supporting bracket adjacent to the hoist at each loading level. The dials are colored as follows: HOIST, green; DANGER, red; LOWER, green; TOP OF STROKE, clear; BOTTOM OF STROKE, clear; LATCH CLEAR, clear. The TOP of STROKE and BOTTOM OF STROKE dials serve circuit QB only.

Hoist ready gongs. A hoist ready gong is mounted at each loading station. The gongs are of the single stroke type. They are connected in parallel and are sounded once on each hoisting cycle at the instant the HOIST dial is illuminated.

Gong relay. A gong relay, designated the time delay cutout relay, is installed on a supporting bracket at the upper loading level. This relay is designed to de-energize the supply circuit of the gongs after the first stroke on any one cycle of hoist operation.

Solenoids. Four solenoids, designated 1, 2, 3, and 4, are arranged and connected in circuit Q. These solenoids have spring-backed armature plungers which extend upward through their related mounting brackets and when de-energized, form barriers to stop or limit movement of their respective operating handles. Solenoids 1 and 3 serve to limit operating handle movement (and hence tilting plate movement) to only a few degrees when lowering projectiles. Solenoids 2 and 4 prevent moving their respective operating handles to hoist, during hoisting operations, when a shell is in the cradle or when the empty cradle has not been returned to alignment with the hoist tube.

Function control lever switch. The function control lever switch is installed on the transverse bulkhead adjacent to the function control lever. It is a twin switch unit, a plunger and linkage actuated by the function control lever. It is connected in the supply line and serves to distribute current for operation of the system.

Projectile indicator lever switch. The projectile indicator lever switch is mounted on the cradle fulcrum and is similar to the function control lever switch. Its actuating linkage is so arranged that the switch plunger is depressed whenever a shell is in the cradle or whenever the cradle is out of alignment with the hoist tube.

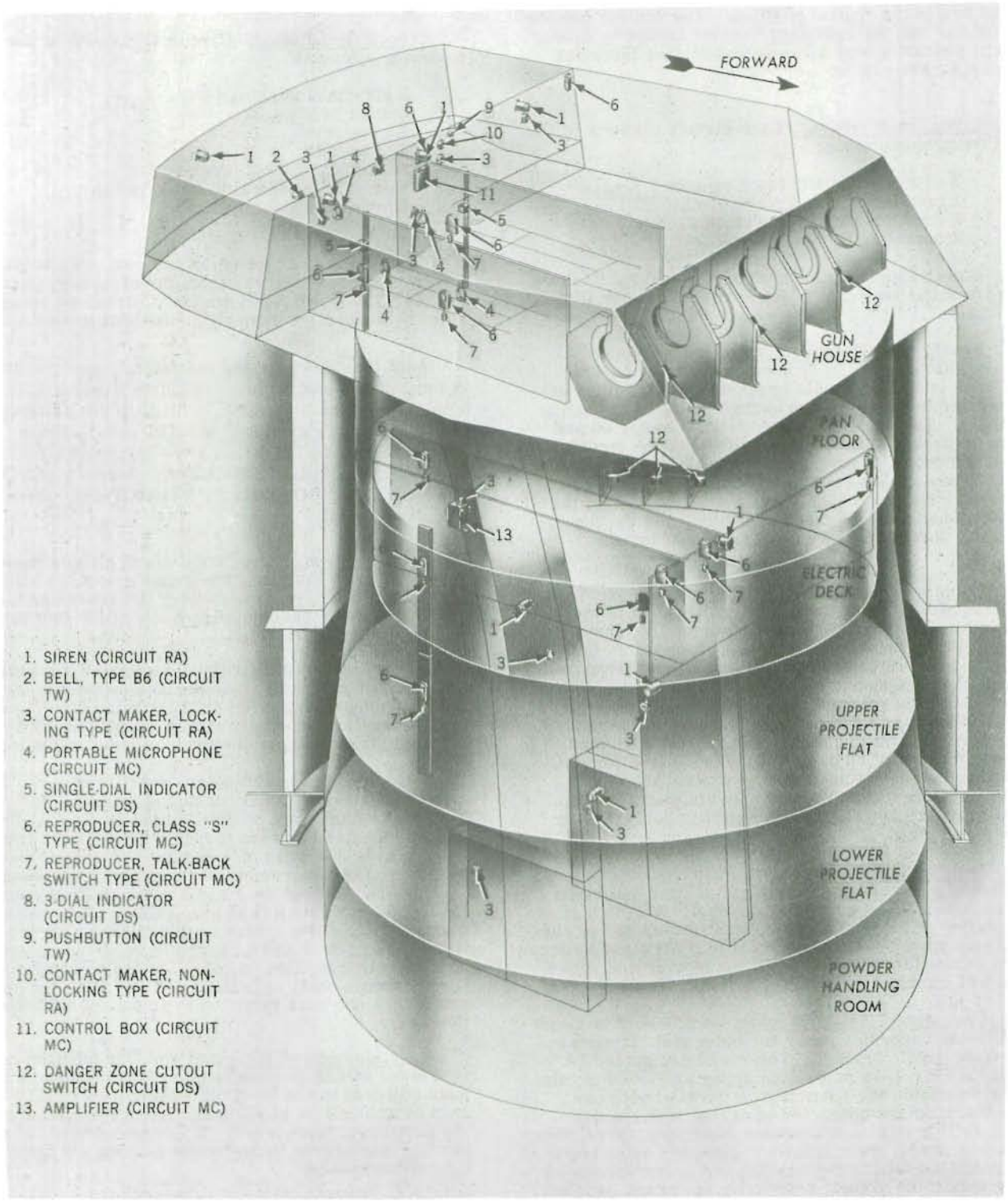


Figure 15-42. Turret Interior Communications System, General Arrangement

Projectile latch switch. The projectile latch switch is located on the cradle fulcrum bracket and is operated by linkage through the bracket from a latch at the base of the cradle. It is of the same plunger-actuated design as the two previously described switches but is of the single unit type. The switch closes when the latch is manually positioned to clear a shell in the cradle during lowering operations.

Projectile latch indicator circuit (QB). Circuit provides the projectile hoist operators with a visual signal, indicating when the hoist has completed a hoisting or lowering cycle (stroke). The circuit also provides a means through the use of a solenoid operated interlock to prevent inadvertent reversal of the projectile hoist prior to the completion of a cycle (stroke).

Circuit description. The circuit consists of twelve automatic limit switches connected to the TOP OF STROKE, and BOTTOM OF STROKE indicator dials, and the interlock solenoid on the control mechanisms at the lower projectile handling levels. Power is derived from the 120-volt, 60-cycle supply of the FC and IC panel.

Limit switches. Four limit switches are installed in the projectile latch indicator system QB for each hoist. Two of these four switches are installed on each hoist tube at pan floor level. These switches are actuated by the crosshead when the hoist has completed its raising cycle. One switch operates the interlock solenoid on the control mechanism at the lower projectile handling level and one operates the top of stroke indicator lights. The other two limit switches are installed on the bottom of the lower projectile handling platform casting. These two switches are actuated by the rack bar when the hoist has completed its lowering cycle. One switch operates the interlock solenoid on the control mechanism at the lower projectile level and one operates the bottom of stroke indicator light.

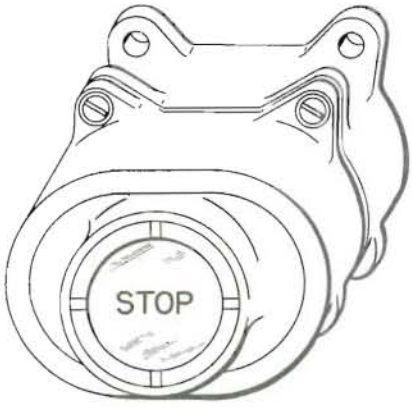


Figure 15-43. Depression and Train Stop Indicator, Gun Captain's Station

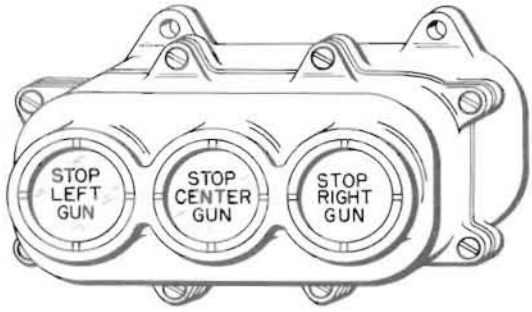


Figure 15-44. Depression and Train Stop Indicator, Turret Officer's Station

Indicators. The six-dial indicators utilized here are the same indicators used in circuit Q. In this circuit, however, only the upper right "TOP OF STROKE" dial and the center right "BOTTOM OF STROKE" dial are utilized. The cycled position of the crosshead and rack bar determine which dial is illuminated. The dial will be illuminated for as long as the crosshead and rack bar remain in the completed cycle position.

Solenoid operated interlocks. Each hoist is equipped with a solenoid operated interlock installed on the control mechanism at the lower projectile handling level. The solenoid operated interlock is operated by the top of stroke limit switch and the bottom of stroke limit switch upon completion of each cycle. This solenoid operated interlock locks the control levers at HOIST or LOWER, until the completion of the hoisting or lowering cycle. The hoist control levers cannot be moved from HOIST to LOWER, or from LOWER to HOIST, until the hoisting or lowering cycle is completed. This prevents inadvertent reversal of the projectile hoist which would cause the seating of projectiles on the nose of lower projectiles.

Powder hoist interlock circuit (QC). Each powder hoist system utilizes an arrangement of interlocking solenoids and switches, designated circuit QC, to vent the hydraulic drive system and set a spring-loaded brake upon arrival of the powder car at loading level or at upper or lower unloading level. The circuit also functions to prevent hoisting or lowering the powder car when either the lower or upper door of the powder hoist trunk is opened or undogged.

Circuit description. Each circuit comprises nine switches and three solenoids. Power supply for the circuit is derived from the associated powder hoist motor controller (fig. 15-17).

Switches. The nine switches of circuit QC are the starting switch, loading position switch, upper and lower unloading position switches, upper and

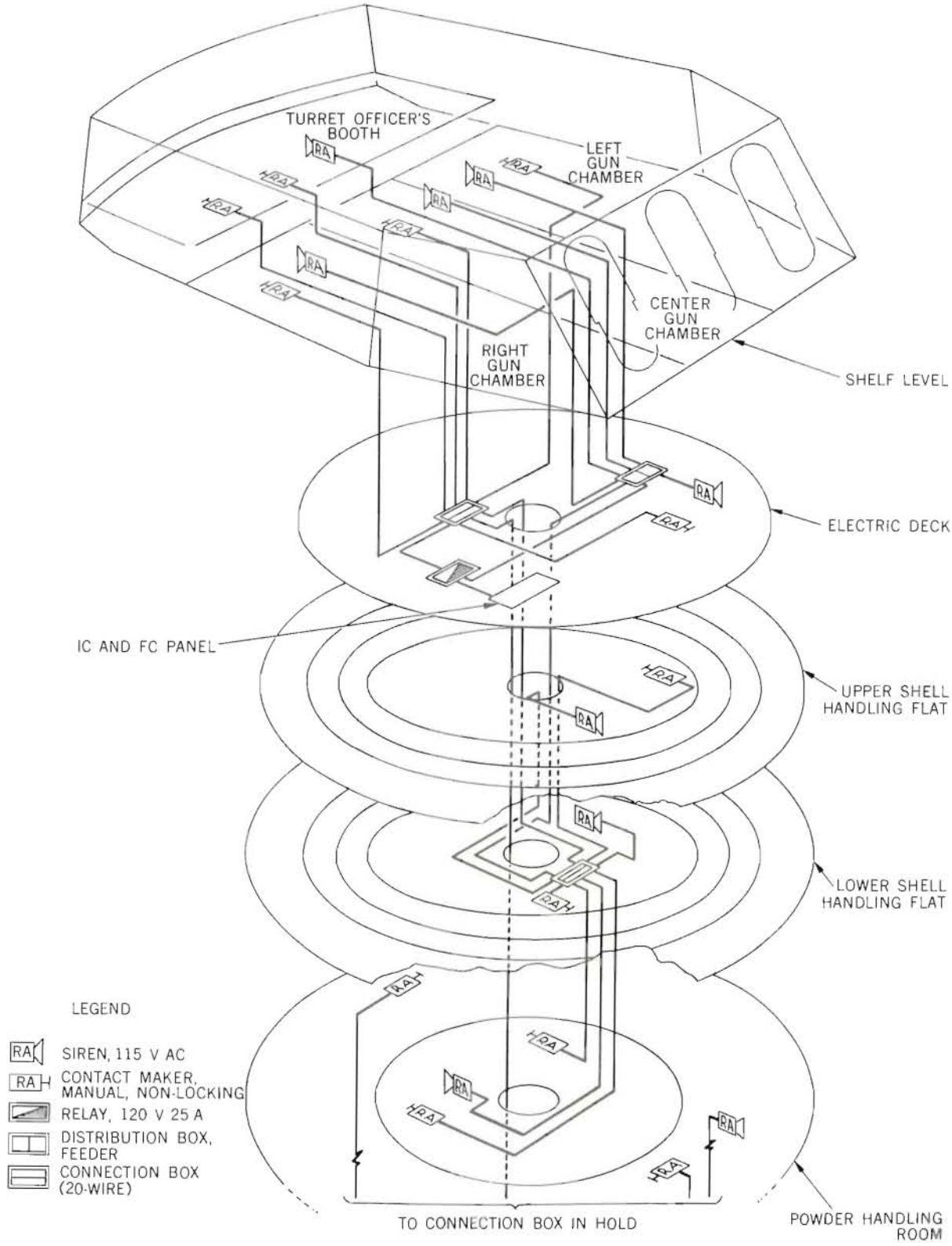


Figure 15-45. Intra-Turret Emergency Alarm Circuit RA. Isometric Diagram

lower door interlock switches, upper door bypass switch, lower door lock interlock switch, and upper door dog interlock switch. Each switch is a normally open or normally closed spring-return-type. Refer to chapter 11 for additional details of these switches.

Solenoids. The three solenoids in each circuit are the venting valve solenoid, the starting lever solenoid, and the power failure valve solenoid. The venting valve solenoid operates the venting valve lever. The starting lever solenoid interlocks the starting lever with the lower and upper door interlock switches. The power failure valve solenoid operates the power failure valve. For further details, refer to chapter 11.

Hoist signal indicator system. The hoist signal indicator system, figure 15-41, operates in conjunction with powder car movement and informs the hoist operator when the car is loaded and ready to hoist. Each powder hoist system comprises two two-dial indicators, mounted at the upper and lower hoist stations, a rotary switch at the lower hoist station, and a 440/110-volt step-down transformer, mounted inside the powder hoist motor controller. The circuit is energized by 110 volts derived from the transformer. The primary winding of the transformer derives its supply from the motor controller.

The rotary switch has two positions, DOWN and HOIST. When the powder car is at the lower level and ready for hoisting, the lower dials of both indicators, marked DOWN, are illuminated. The lower door operator turns the switch to HOIST, extinguishing the DOWN indicator dials and lighting the upper dials, marked HOIST. The powder car is then hoisted to the upper position and unloaded. When the hoist operator returns the car to loading position, a cam on the car trips the rotary switch, moving it to DOWN. The HOIST indicator lights go out and the DOWN lights come on.

Range finder stabilizer. The range finder stabilizer circuit operates a gyroscope controlled mechanism which serves to hold the rangefinder line of sight horizontal.

General. A voltage induced by the stabilizing unit is fed into the control panel. The control panel amplifier amplifies this voltage and the output is sent to the motor-amplidyne. The output of the motor-amplidyne rotates the rangefinder, keeping the line of sight in a horizontal plane. Power supply for the circuit is derived from the miscellaneous equipment power panel (page 15-4).

Control panel. The control panel (page 14-7) is a steel encloxure mounted on the rear armor plate bulkhead of the gun house. It houses a main line switch, a rotary control switch, supply transformer, amplifier unit, selenium rectifier, and various fuses.

Stabilizing unit. The stabilizing unit (page comprises a gyroscope, power motor, limit stop switch and clutch switch assemblies, and the gear train assembly which drives the rangefinder through external linkage. The stabilizing unit is mounted on the after side of the rangefinder stand, to the left of the turret centerline.

Motor amplidyne generator set. The motor-amplidyne generator set (page 14-8) comprises a two-bearing motor and generator located on the rear armor plate bulkhead of the gun house. This unit functions to generate the power outputs for driving the power motor of the stabilizing unit.

Motor-alternator. The motor-alternator (page 14-8), consisting of a two-bearing motor and an alternator, generates the high-frequency current which drives the gyroscope.

Interior communications system

The interior communication system in each turret consists of eight electrical circuits through which various types of audible signals are transmitted and received. These circuits are listed below and described in subsequent paragraphs. Station equipment for these circuits is shown in figures 15-42 and 15-49.

Symbol	Circuit Name
DS	Depression and train stop signal system
RA	Intra-turret emergency alarm system
TW	Turret warning system
MC	Turret announcing system
JA	Battle telephone system
XJ	Turret officer's supplementary telephone system
J	Ship's service telephone system
E	Sound powered telephone and voice tube call bell system

Power supply. All circuits of the interior communication system, except the telephone circuits, are operated on 120-volt, 60-cycle, single-phase alternating current from the IC and FC panel.

Depression and train stop signal system circuit (DS). Circuit DS provides a firing cut-out and warning light system which functions to break the firing circuit of individual guns and, by indicator light, to warn whenever a gun's line of fire closely approaches own ship's structure. The danger sectors are different for each gun. Details of the cams and arc of firing cut-out are contained in chapters 5 and 6.

Circuit description. The circuit is energized by 120-volt, 60-cycle supply from the turret's IC and FC panel. The components of the circuit installed in a turret are as follows:

6 danger zone cut-out switches
3 single dial indicators
1 three-dial indicator

The two switches serving each gun, one for elevation and one for train, have their normally closed contacts connected in parallel, one switch with the other, and these in turn are connected in series with the firing key circuits of their respective guns. This circuit arrangement requires that both the elevation and the train danger zone switches of a gun's firing circuit be actuated before the firing circuit of the gun is broken. The normally open contacts of these same switches are connected in series so that both must be actuated before completing their respective indicator light circuit.

Danger zone cut-out switches. The danger zone cut-out switches are dual switch units, each comprising a normally open and a normally closed switch. Three dual switches function in elevation and three in train. All switches have attached roller-tipped plunger assemblies which are actuated by cams upon which the rollers ride when the guns are aligned in danger zones. The three elevation switches are mounted on the right trunnion block of each gun. Their adjustable actuating cams are secured to each gun's shield plate bracket. The train switches are bracket mounted, with provision for adjustment on the holding down clip of the circular bulkhead. The triple segmental cam which actuates them is located on inner supporting webs of the conical bulkhead below the lower roller path approximately 290 degrees from the forward centerline.

Single-dial indicator, gun captain's station. A single-dial indicator is located at each gun captain's station. Each is a watertight case with a red glass window marked STOP, figure 15-43. The case encloses a light well in which are two lamps, connected in parallel. These lamps light when their respective elevation and train danger zone switches energize the circuit to them.

Three-dial indicator, turret officer's station. The three-dial indicator, figure 15-44, is a watertight housing which encloses three twin lamp light wells, each with a red circular glass window. The windows are marked as follows: STOP LEFT GUN, STOP CENTER GUN, and STOP RIGHT GUN. The indicator is located in the turret officer's compartment over the door to the right powder hoist operator's station. The dials are lighted as their respective elevation and train danger zone switches are closed.

Intra-turret emergency alarm system circuit (RA). The intra-turret emergency alarm system circuit provides a means for audibly warning turret personnel that danger exists or that serious casualty has occurred within the turret.

Circuit description. Each circuit consists of nine electrically operated sirens and eleven contact makers. The circuit is energized by 120-volt, 60-cycle supply from the turret's IC and FC panel. Figure 15-45 shows the wiring arrangement.

Sirens. The sirens serve to sound the intra-turret emergency alarms. Each is a high-pitch, low-intensity, S-4 type unit. One siren is mounted at each of the following locations:

Turret officer's compartment
Each gun chamber
Machinery floor
Upper and lower shell handling flats
Lower powder handling room
Powder passing space

Contact makers. The contact makers, figure 15-46, are the normally open, double contact, lever operated, locking type. All are of identical construction and are located as follows:

Turret officer's compartment
Each gun chamber
Machinery floor
Upper and lower shell handling flats
Lower powder handling room (2)
Powder passing space (2)

A second contact maker, of a non-locking design, is mounted in the turret officer's compartment. This contact maker is in one portion of the supply. It is normally closed but can be held open by hand against a spring return, to break the supply to the system when the turret officer so wishes. It provides a means of cutting off the sirens so that instructions and orders may be transmitted and heard over other communication circuits in the turret.

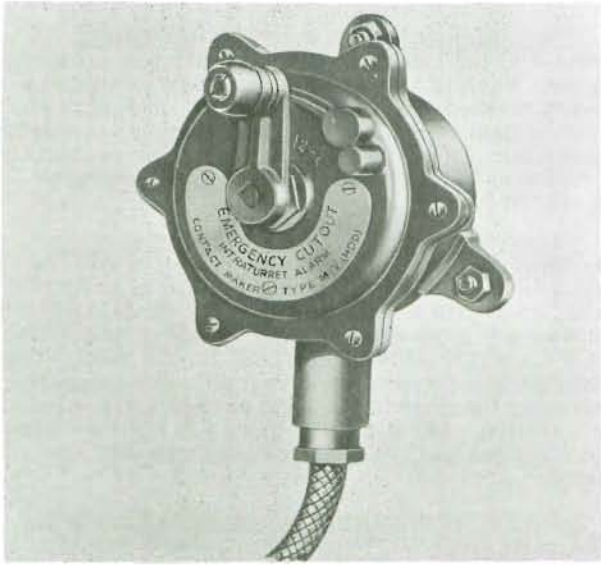


Figure 15-46. Emergency Alarm Contact Maker

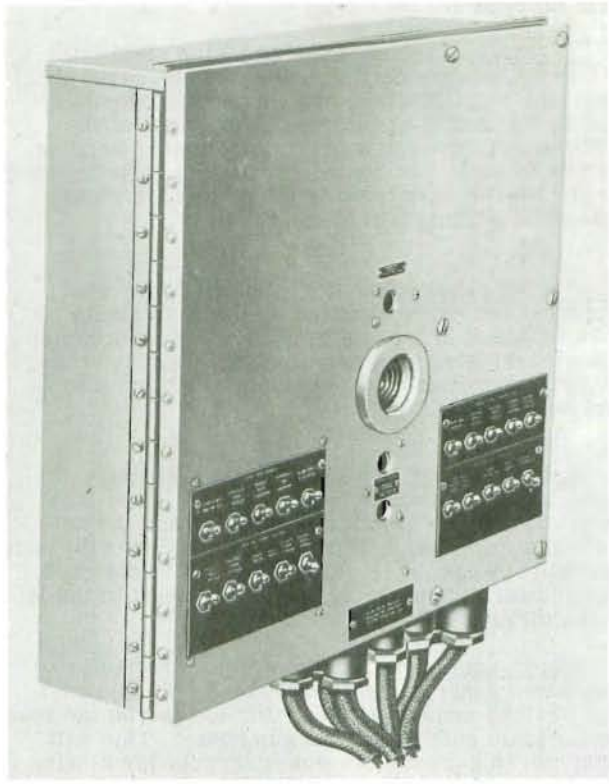


Figure 15-47. Transmitter Control Box

Train warning signal system circuit (TW). A train warning signal circuit is provided in each turret to audibly warn ship's personnel on deck when the turret is about to train. The signal is sounded at times other than general quarters.

Circuit description. Circuit components consist of a bell and a push button. Power supply is 120-volt, 60-cycle, single-phase alternating current from the IC and FC panel.

Bell. A vibrating bell, mounted under the turret's overhang, is provided in each train warning signal circuit to sound the train warning signal. The bell is a high-intensity, B6-type, watertight assembly designed for operation on 120-volt alternating current.

Push button. A single push button, located at the turret captain's station, is provided in each train warning signal circuit to close the circuit to the warning bell described above. The push button is a watertight, RS-type unit.

Turret announcing system circuit (11MC, 12MC and 13MC, turrets I, II and III respectively). Circuit MC provides a means for the turret officer and the turret captain to communicate with any one, any combination, or all principal compartments of the turret. It also provides transmission of general alarm and chemical attack signals.

Circuit description. Each circuit is supplied with 120-volt, 60-cycle, single-phase, alternating current obtained from the IC and FC panel. Components of the system are an amplifier, a transmitter control box, a turret officer's microphone, two non-talk-back type reproducers, and 14 talk-back type reproducers, each with attached switch and indicator control box.

Amplifier. Circuit MC utilizes an amplifier to increase the intensity of circuit signals as necessary for satisfactory reception. The amplifier is located near the electrician's station on the machinery deck. The unit is supplied by 120-volt, 60-cycle supply from the IC and FC panel and, in turn, it supplies power for the operation of the circuit.

Transmitter control box. Circuit MC includes a transmitter control box, figure 15-47, located in the turret officer's compartment on the transverse bulkhead, to the left of the door to the center gun chamber. The box provides switch control of the amplifier and also provides a group of key type switches by means of which any combination of the talk-back reproducers may be tied into the system. In addition, it provides cut-out switches by means of which any combination of reproducers may be cut out of the system in the event of trouble in their individual circuits.

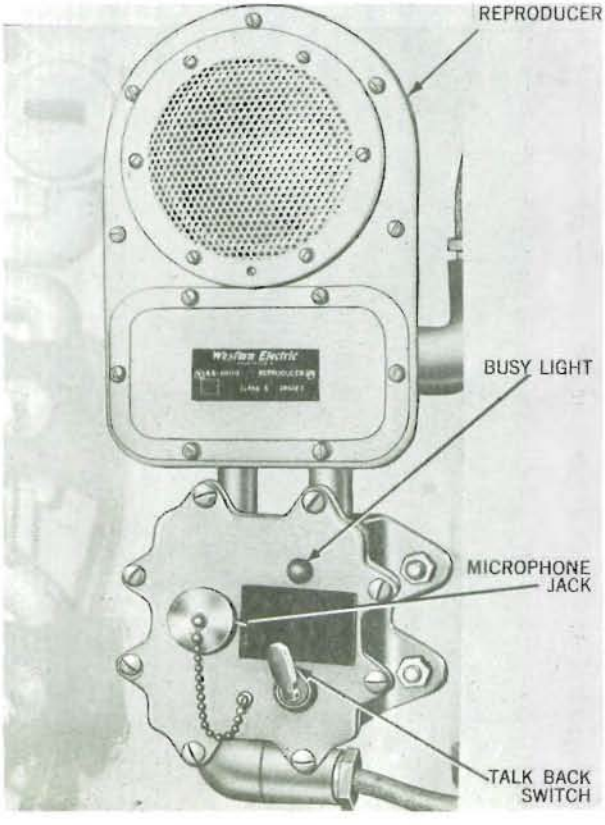


Figure 15-48. Talk-Back Type Reproducer

Turret officer's microphone. The microphone at the turret officer's station is attached by a 20-foot cord to the transmitter control box. It is supported on the user by a breastplate and neckband and utilizes a press-to-talk button.

Reproducer (non-talk-back type). Two non-talk-back type reproducers are located in the turret officer's compartment, one immediately above the transmitter control box and the other mounted near the left end of the transverse bulkhead. They serve only to receive information from reproducers from other turret talk-back stations and from transmitter equipment elsewhere in the ship.

Reproducer (talk-back type). Fourteen talk-back type reproducers, shown in figure 15-48, are installed throughout the turret in the following locations:

Each gun chamber (3)
Left and right sight stations (2)
Left, center, and right gun layer's stations (3)
Train operator's station (1)
Electrician's station (machinery deck) (1)
Upper and lower shell flats (2)
Powder handling room (1)
Powder passing chamber (1)

These units are constructed to serve both as reproducers and transmitters when connected to talk switch control boxes. Each talk switch box is provided with a 2-position, key-type switch which rotates clockwise to TALK. On each talk switch panel is an indicator light which illuminates to indicate BUSY when the turret officer is using his microphone. Each talk switch panel also is provided with a jack into which a microphone may be plugged to substitute for the reproducer should the noise level in the compartment be objectionable.

Announcement of general alarm and chemical attack signals. General alarm and chemical attack signals are transmitted to and reproduced over the turret announcing system in the following manner: when the turret officer has positioned the amplifier switch on the transmitter control box to OFF and has tied in each reproducer of the system, the general alarm or chemical attack signals, originating in one or more remote stations, are routed to all reproducers in the turret. If the turret announcing system amplifier is ON, and irrespective of the local tie-in arrangement of reproducers, the general alarm or chemical attack signals are shunted by automatic relay to the reproducers in the turret officer's compartment and in the lower powder handling room only. The general alarm signal consists of a discordant gong tone of 90 strokes per minute. The chemical attack signal is an intermittent 1000-cycle note, 1/3-second on and 1/3-second off.

Telephone system. Three types of telephone systems in each turret provide a means of communication within the turret and between the turret and stations outside the turret. Their general arrangements are shown in figure 15-49. The three systems are:

Battle telephone system
Turret officer's telephone system
Ship's service telephone system

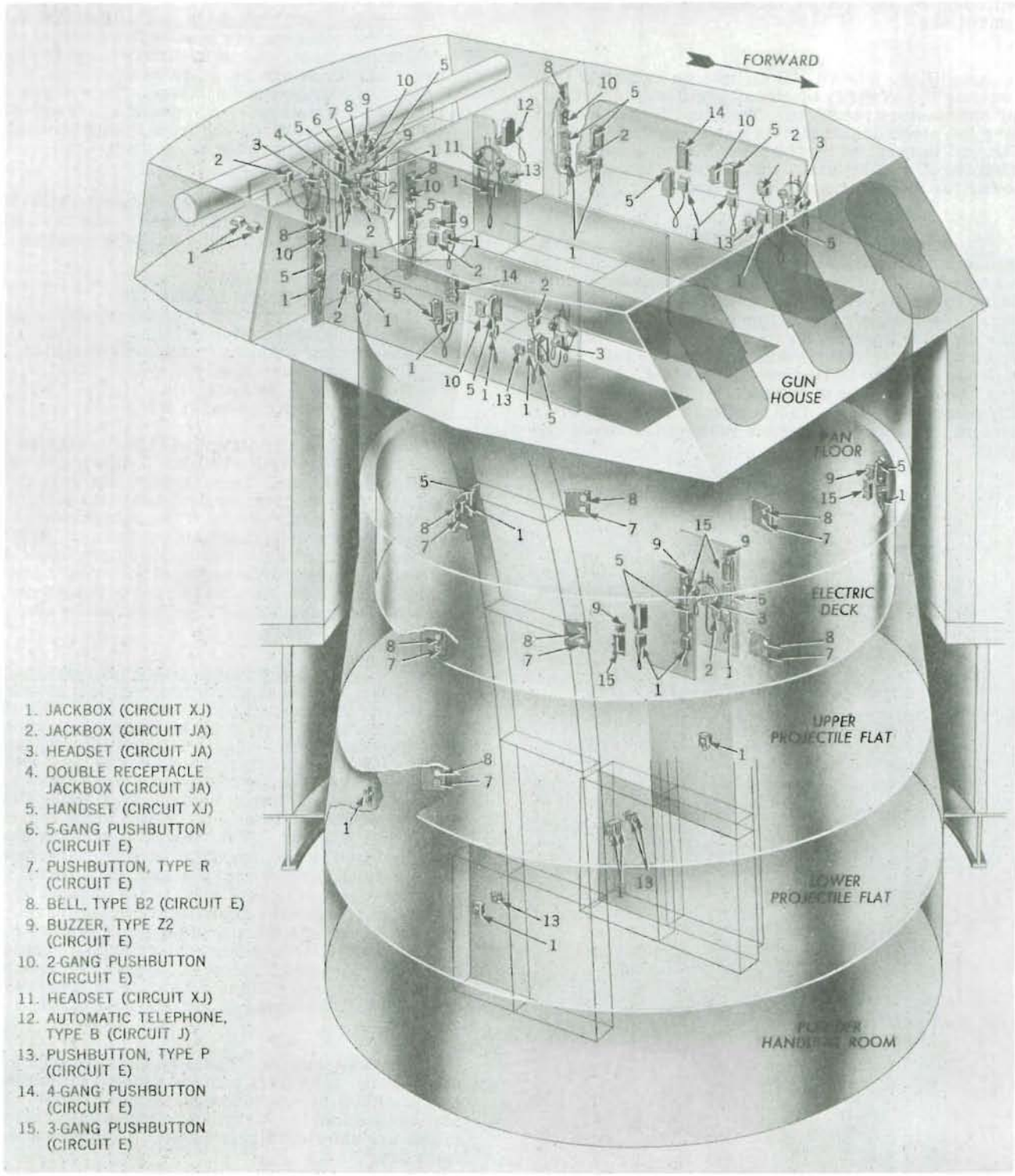


Figure 15-49. Turret General Communications System, General Arrangement

The battle telephone system and the turret officer's system are of the sound-powered type. They utilize push-to-talk button handsets and headsets with breastplate supported and push-button controlled transmitters. Communication between some stations of the sound-powered system is initiated through call bell circuit E described on page 15-43.

The ship's service system is of the conventional dial type, operated through the ship's central switchboard.

Battle telephone system circuit (JA). Circuit JA is a sound-powered system which provides several means of communication between the turret and either of the plotting rooms and directors. The turret arrangement of the system is shown in figure 15-50.

Circuit description. The battle telephone system comprises five circuits, each connecting with forward and after main battery plotting rooms through tie switches. The tie switches are in a telephone switch box, type 10-C (see page 15-43), located to the right of the turret officer's transfer panel. In the event of casualty to either the forward or after sections of the circuit, the damaged portions may be isolated by opening the tie switches in the switch box. The letter designations and functions of the five battle telephone circuits are listed in the following paragraphs.

Control circuit (JD). Circuit JD connects the turret officer with the associated director and control station.

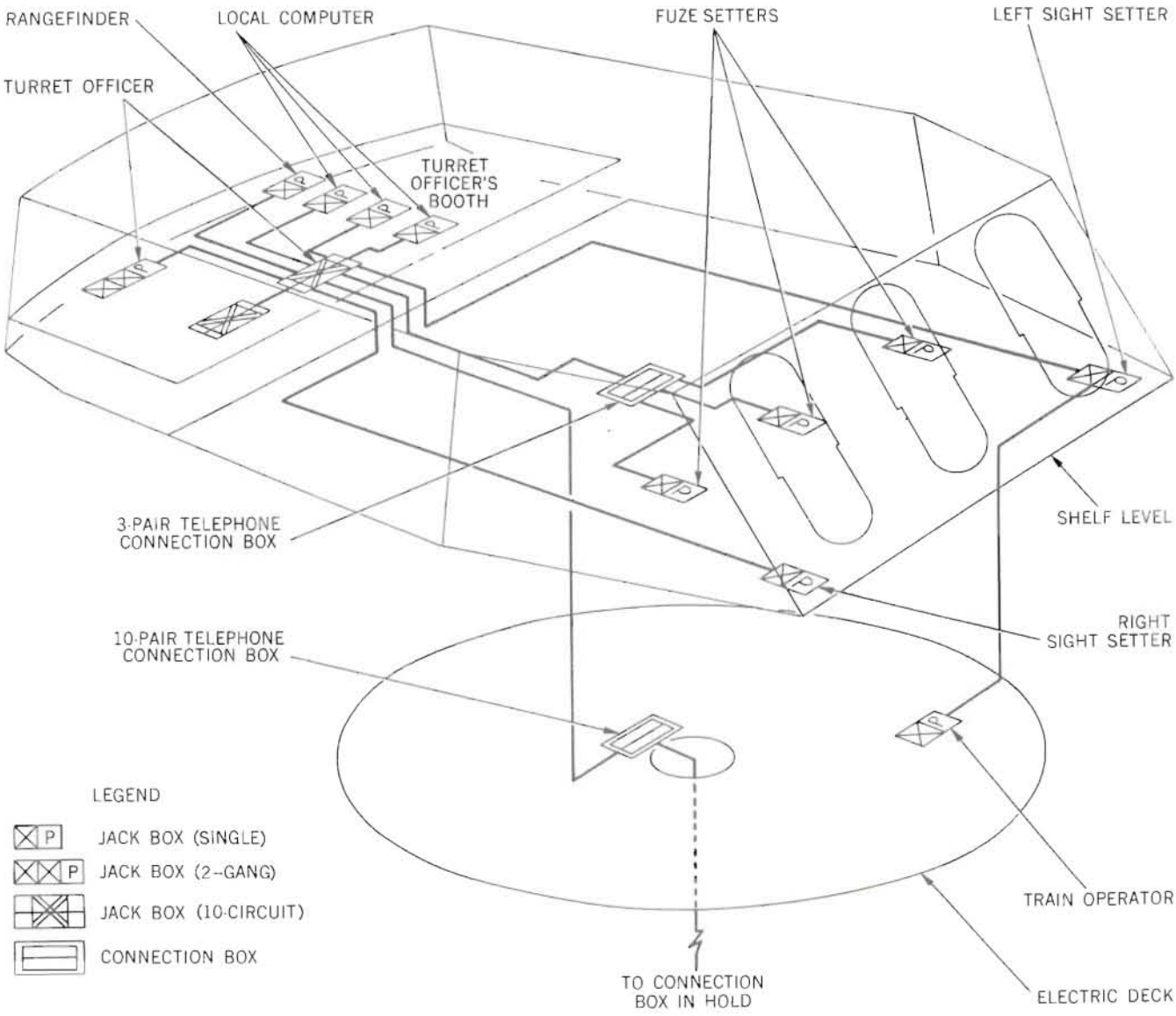


Figure 15-50. Battle Telephone Circuit JA. Isometric Diagram

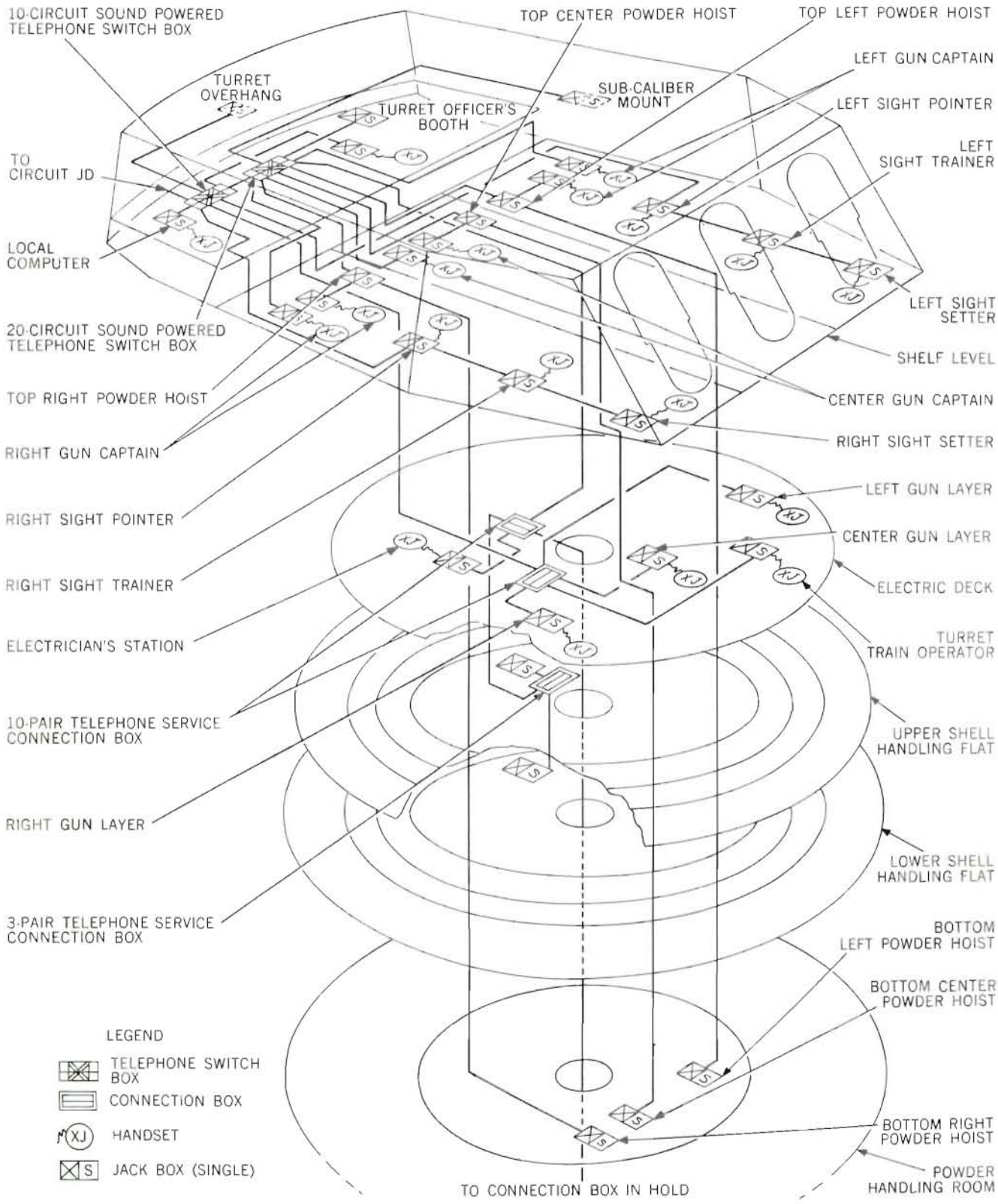


Figure 15-51. Supplementary Telephone Circuit XJ. Isometric Diagram

Sight setter's circuit (JE). The sight setter's circuit, JE, provides communication between the left and right sight setters, the train operator, and local computer, and the associated computer, director, and control station.

Fuze setter's circuit (JK). This circuit connects the fuze setter to the secondary battery computer fuze follow-up operator.

Rangefinder's circuit (JW). Circuit JW connects the local rangefinder and local computer to the graphic plot operator and range receiver operator in the associated plotting room and director.

Spotter's circuit (JB). The spotter's circuit connects the local computer to the associated plotting room, control station, director, and combat information center.

Turret officer's telephone system circuit (XJ). This sound-powered system provides a channel of intercommunication between turret personnel responsible for the operation of all hoists and the equipment used to lay and fire the guns. The wiring arrangement of the system is shown in figure 15-51.

Turret I. Circuit XJ in turret I comprises six supplementary local circuits, some with tie-in arrangements as indicated below.

CIRCUIT XJ

STATION INTERCONNECTION FACILITIES

Circuit Designation	Circuit Name	Stations Interconnected
X101J	Pointer's circuit	Turret officer Local computer Turret train operator Right and left sight setters Right and left sight pointers Right and left sight trainers Left, center, and right gun layers
X102J	Ammunition circuit	Left, center, and right gun captains Machinery deck Upper and lower shell handling platforms Lower powder handling room Safety watch (turret overhang)
X103J	Subcaliber circuit	Turret officer's compartment Subcaliber mount
X104J	Right powder hoist circuit	Right gun captain to right projectile hoist operator on upper and lower projectile flats
X105J	Center powder hoist circuit	Center gun captain to center projectile hoist operator on upper and lower projectile flats
X106J	Left powder hoist circuit	Left gun captain to left projectile hoist operator on upper and lower projectile flats

Turret II. The telephone installations are identical to those in turret I but are designated X201J to X206J, respectively.

Turret III. The installations are identical to those in turrets I and II but are designated X301J to X306J, respectively.

Telephone switch boxes. Two 10-circuit and one 20-circuit telephone switch boxes are mounted vertically on a stand at the right of the turret transfer switchboard. The upper 10-circuit box serves circuit JA. The other two boxes serve circuit XJ. Each box is enclosed by a hinged door behind which are knife-type "line," "tie," "tie+" switches of various circuit branches, all appropriately labeled. The tie switches, normally open, permit tying together those circuits which connect to them. Similar "tie+" switches, normally closed, provide for isolating any circuit which has become inoperative through casualty. The arrangements provide for connecting circuit X101J, turret I, to its counterpart circuits of turrets II and III, circuits X201J and X301J. Similarly, from turret II, circuit X201J may be tied to X101J and X301J of turrets I and III. Turret III can be tied to turrets I and II in the same manner. These inter-turret ties provide for fire control of any turret from any other turret in the event of casualty to both main battery control stations.

Ship's service telephone system circuits (J). The ship's service telephone system J provides a means of communication between the turret and the ship's service telephone outlets throughout the ship.

Circuit description. Circuit J comprises conventional dial type telephones. One is installed in the turret officer's compartment and one in the machinery deck. These connect through a central switchboard to any similar dial telephone in the ship.

Sound-powered telephone and voice tube call bell system circuit (E). An audible call system, which parallels various circuits of the turret officer's telephone system and most voice tubes, is installed in each turret. Its extent is shown in figure 15-52.

Power supply. Power supply is derived from the turret's IC and FC panel. It is 120 volts, single phase, 60 cycles.

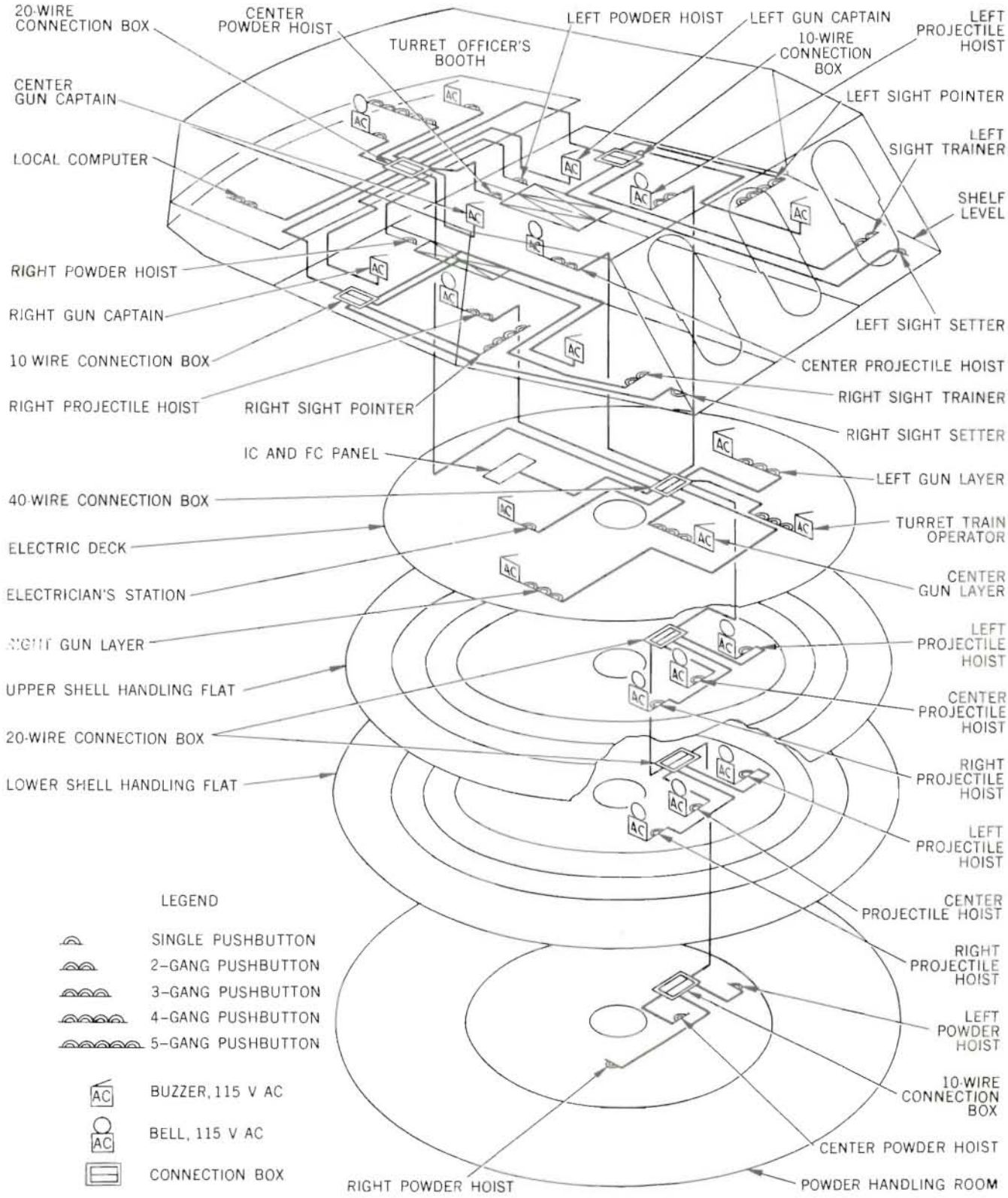


Figure 15-52. Sound Powered Telephone and Voice Tube Call Bell Circuit E, Isometric Wiring Diagram

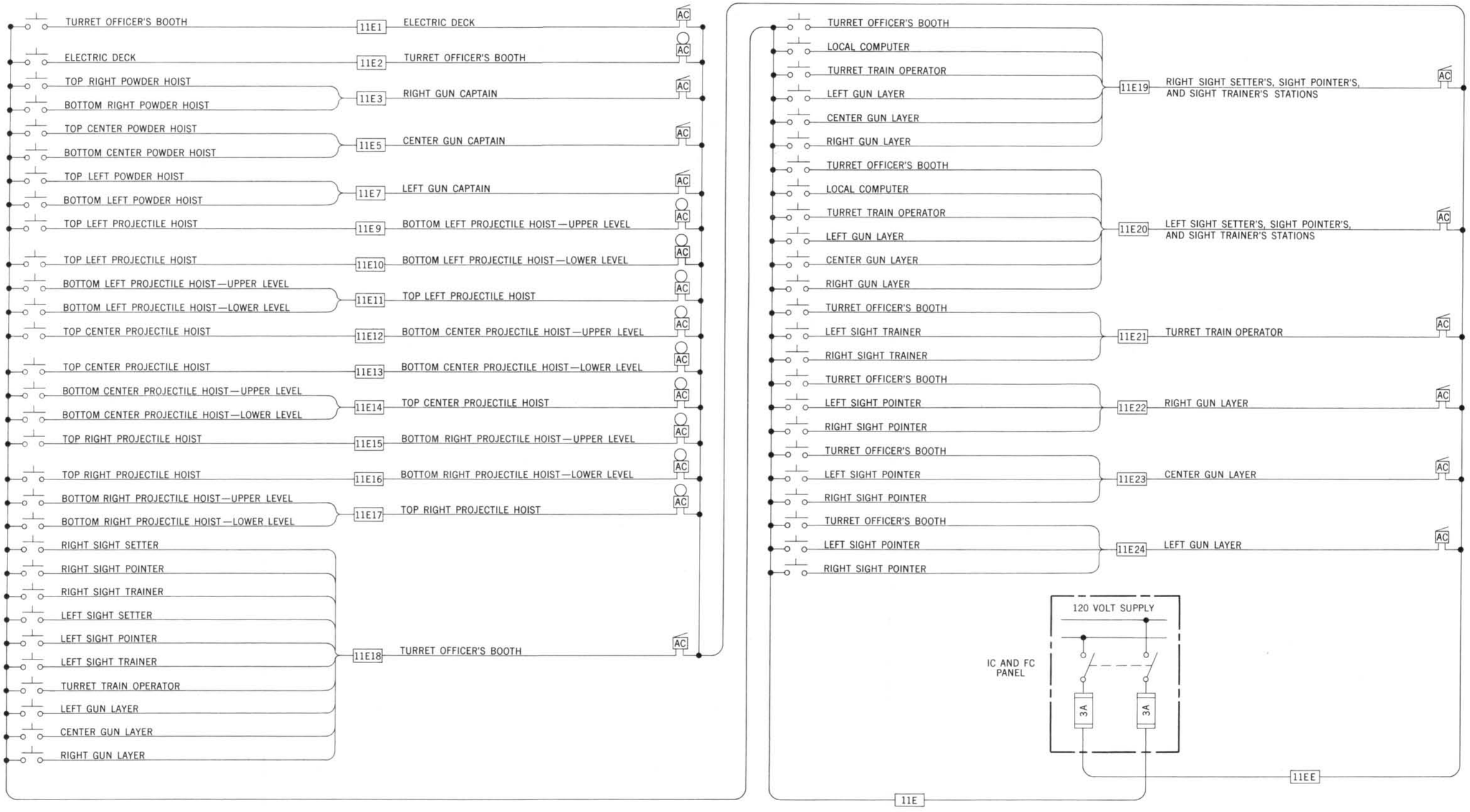


Figure 15-53. Sound Powered Telephone and Voice Tube Call Bell Circuit E. Elementary Wiring Diagram

Circuit description. The circuit comprises single or multiple gang push-buttons and their related bells and buzzers. With one exception, bell circuits parallel the voice tubes and buzzer circuits parallel the telephones. The exception is the telephone circuit from the machinery deck to the turret officer's compartment, which is served by a bell. The circuit wiring arrangement is shown in figure 15-53.

Buzzers. Buzzers are installed throughout the turret (fig. 15-52). They are a low-intensity, watertight type, rated at 115 volts, alternating current.

Bells. Circuit E uses low-intensity, 2 1/2-inch gong type B2 bells (fig. 15-52). They are a splashproof design rated at 115 volts, alternating current.

Push buttons. Push buttons, both single-and multiple-gong type, are installed at principal stations throughout the turret (fig. 15-52). Each push button is housed in a watertight case and is labeled with the designation of the station which it ring or buzzes.

Lighting system

The lighting system in each turret comprises a general lighting circuit and an instrument illumination circuit with arrangements as shown in figure 15-54.

Circuits. The general lighting circuit is of Bureau of Ships cognizance. It consists of equipment and wiring for the general illumination of each turret, as shown in figure 15-55. The instrument illumination circuit consists of equipment and wiring for the illumination of various instrument dials and telescope crosslines.

Power supply. The general lighting circuit derives normal and emergency power supply from the 120-volt, 60-cycle ship's service system. Transfer from normal to emergency power supply is effected through an automatic bus transfer panel, located in the left gun girder box weldment, forward of the hoist trunk above the pan plate.

Current for the instrument illumination circuit is supplied through 120-volt to 6-volt step-down transformers which derive their supply from the IC and FC panel. Upon failure of this supply, the circuits may be energized from emergency 6-volt storage batteries.

General lighting. The general lighting circuit comprises lighting fixtures, switch and receptacle units, hand lanterns, branch boxes, distribution boxes, and suitable wiring.

General illumination throughout the turret is provided by fixtures of the deck, bulkhead, and magazine type. Combination switch and receptacle units which provide an outlet source for trouble lights and various electrically operated portable devices are installed at convenient locations in each turret level. Hand lanterns, energized by self-contained dry-cell batteries, are located at convenient locations in the turret to provide emergency lighting.

Battle (instrument) lighting. Battle lighting comprises three divisions of a 6-volt system. Two of these divisions illuminate instruments in the gun chambers and sight stations and the various reference marks and scales of the rangefinder in the turret officer's compartment. The third division provides instrument lighting on the machinery floor at the stations of the train operator and the three gun layers, figure 15-56.

Instruments in gun chambers and sight stations. The sight station telescopes, sight setter's indicators, and the auxiliary computer are illuminated by this division of the battle lighting system. Current for the circuit is supplied through a step-down transformer and an emergency 6-volt storage battery.

Rangefinder. The rangefinder circuit is energized by the same transformer as that used for the instruments in the gun chambers and sight stations. Illumination is supplied to the left and right reticle lamps, left and right collimator lamps, correction scale lamp, deflection indicator lamp, inside and outside range scale lamps, and the rangefinder trainer's and pointer's telescope crossline lamps.

Instruments on machinery floor. Instrument lighting on the machinery floor is energized by a transformer and emergency battery supply, similar to that used above. Illumination is supplied to the gun elevation indicators and the turret train indicator and transmitter.

Rangefinder de-icing equipment. A de-icing mechanism is provided for each rangefinder telescope to blow heated air over the exposed window at each outer end of the rangefinder. Components of the system are two rotary, vane-type, electric-motor-driven blowers, one mounted on each end of the rangefinder stand, and two nichrome wire type heater elements, strapped near the outer ends of the rangefinder tube.

Magazine sprinkling system (electric)

An electrically operated valve system provides turret sprinkler control from a number of locations within the turret, from outside the turret on the overoverhang, or from the related damage control station. The system operates to provide controlled sprinkling of the projectile stowage areas of each projectile handling platform and the powder passing scuttles of the lower powder handling room. It is a separate system, separately controlled, and is not part of a conventional mechanical and hydraulically operated sprinkling system which provides protection at each gun breach, loading tray, and projectile and powder hoist trunk.

Circuits. The system comprises globe valve operating motors, motor controllers, and remote pushbutton stations. The latter are located and arranged to give sprinkling control of specific areas as indicated in figure 15-57.

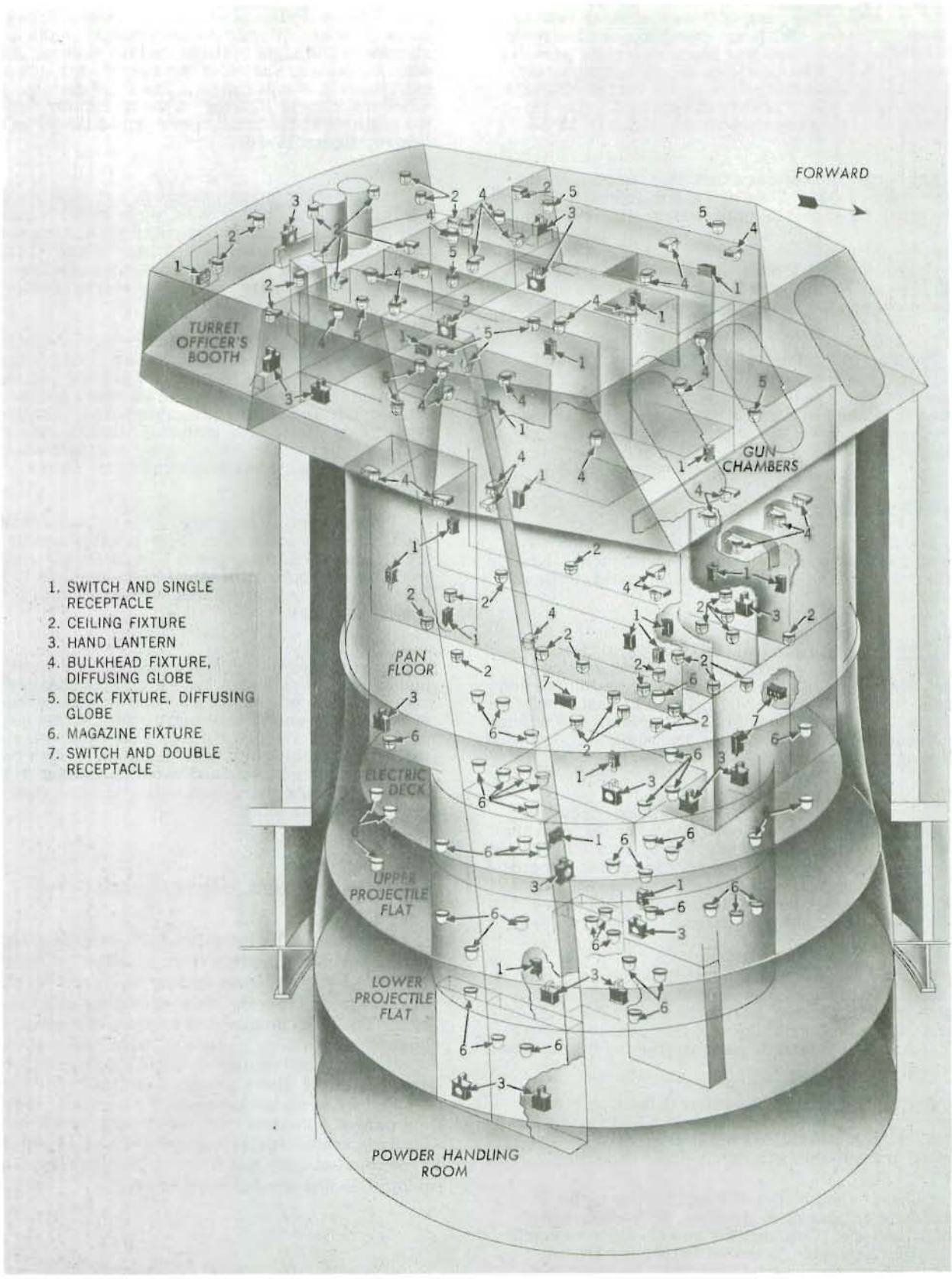


Figure 15-54. Turret Illumination, General Arrangement

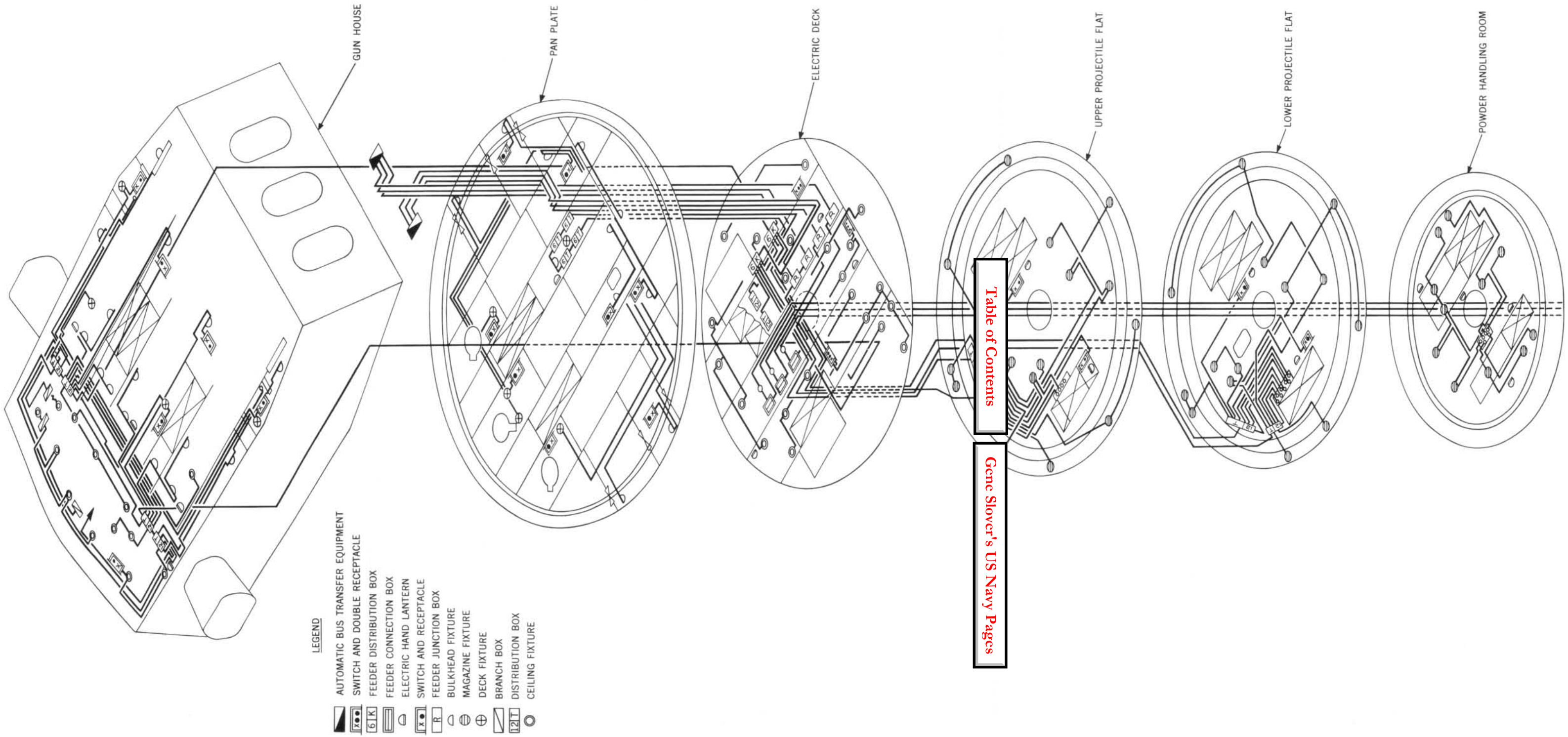


Figure 15-55. Turret Illumination, Isometric Diagram

Power supply. Power supply for the system is 440 volts, 3 phase, 60 cycles, from either of two sources as indicated in the tabulation below. Upon failure of the main supply, an emergency supply is cut in automatically by a watertight bus transfer panel in the magazine lighting control booth, located immediately aft of the cable trunk space at the base of each turret.

Electrically Controlled Sprinkling System
Power Supply

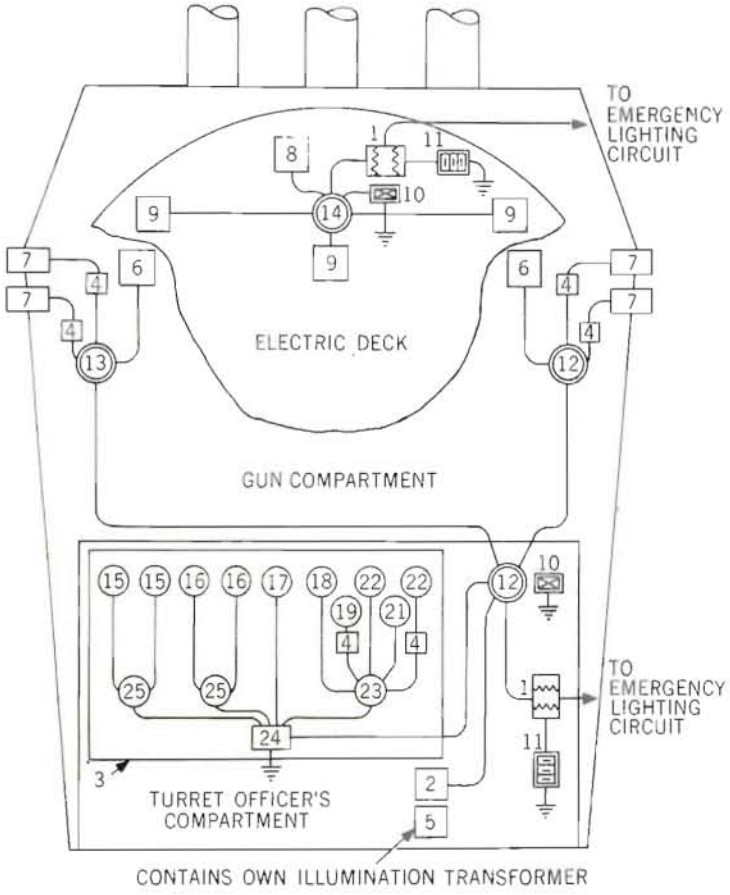
Turret	Main Switchboard	Emergency Switchboard
I	1	Forward
II	1	Forward
III	4	After

Electric motors. Two reversible 1/8-horsepower motors, located in the annular powder passing space of the lower powder handling level of each turret, are utilized to open or close the globe valves of the turret electric sprinkling system. Each motor functions through a worm and gear drive, incorporating a limit stop switch system and a supplementary operating handwheel. The motors are designed to withstand submersion in 30 feet of salt water for 24 hours.

Motor data. The motors include the following design and construction features.

Type	Squirrel cage, induction
Design features	Horizontally flange mounted, watertight housing, natural draft cooled
Horsepower	1/8
R. P. M., synchronous	1800
R. P. M., full load	1750
Rotation	Reversible
Speed class	Varying
Voltage	440
Amperes, full load	1
Amperes, locked rotor	5.2
Phases	3
Cycles	60
Ambient temperature, C	40°
Torque class	normal
Weight lbs	35
Manufacturer	Electric Specialty Co.
Manufacturer's designation	
designation	KS2.5 submersible
Drawing number (BuShips)	354913

Controllers. A reversing across-the-line, magnetic type controller is utilized to control each sprinkler valve motor. These controllers are located in the annular powder passing space of the powder



SYMBOL	ELEMENTS BATTLE ILLUMINATION SYSTEM
1	ILLUMINATION TRANSFORMER
2	COMPUTER
3	RANGEFINDER (TURRETS II AND III ONLY)
4	RHEOSTAT
5	MULTIPLE TURRET TRAIN INDICATOR
6	SIGHT SETTER'S INDICATOR
7	TELESCOPE
8	TURRET TRAIN INDICATOR AND TRANSMITTER
9	GUN ELEVATION INDICATOR
10	SNAP SWITCH
11	STORAGE BATTERY
12	20-WIRE CONNECTION BOX-W.T.-TYPE-5
13	5-WIRE CONNECTION BOX-W.T.-TYPE-7
14	10-WIRE CONNECTION BOX-W.T.-TYPE-5
15	RIGHT AND LEFT RETICLE
16	RIGHT AND LEFT COLLIMATOR LAMPS
17	CORRECTION SCALE LAMP
18	DEFLECTION INDICATOR LAMP
19	SIGHT TRAINER'S CROSSLINE LAMP
20	INSIDE RANGE SCALE LAMP
21	OUTSIDE RANGE SCALE LAMP
22	SIGHT POINTER'S CROSSLINE LAMP
23	JUNCTION BOX, MK 10
24	LIGHTING SWITCH
25	JUNCTION BOX, MK 4

Figure 15-56. Instrument Lighting Arrangements

handling level. Each uses two line contactors, one energized by the OPEN pushbutton and the other energized by the CLOSE pushbutton. The contactors provide phase reversal of the motor supply and hence reversal of motor direction. Limit stop switches, in the drive gear housing, are connected into the control circuit to stop the motor automatically when the valve has reached its limit of travel in either direction.

Controller data. The controllers include the following design and construction features.

Type	Motor starting and reversing, a-c across-the-line, magnetic, watertight
Ampere rating, full load	1
Protection:	
Overload	none
Short-circuit	none
Shock rating	150
Weight, lbs.	125
Manufacturer	Ward Leonard Electric Co.
Drawing number (BuShips)	355532

Push-button control stations. Each push-button station comprises a housing with appropriate indicator lights to show the OPENED or CLOSED position of the valve and with a "break glass" lower front for access to the OPEN and CLOSE push lever. Each control station has a plate label designation of the valve it controls.

Turret ventilating equipment

General. Each turret level above the powder handling room is ventilated under forced draft. Fresh air is drawn from intakes on the underside of the overhang by electric-motor-driven fans. Air pressure is maintained at one pound per square inch by means of adjustable spring-loaded shutters in the exhaust ducts. Manually operated doors in the intake and exhaust ducts prevent the entrance of water in heavy weather. Electrical components of the ventilating system consist of eight supply motors, eight motor controllers, and various pushbutton control stations.

Supply motors. Supply motors are of two sizes, three horsepower and four horsepower. There are four of each size serving the turret ventilating system. Each motor is coaxially aligned with its vent duct and each motor drives a multibladed fan mounted on its drive shaft. The motors are 2-speed type, with speeds selected at master pushbutton stations. Location of the motors, their horsepower rating, and the air delivery of each at full speed are listed below.

No.	Motor Location	H.P.	Fan C.F.M.
1.	Turret officer's compartment, above platform level, on rear armor plate to left of turret centerline	3	4000
2.	Left rear corner of overhang, below platform level	3	4000

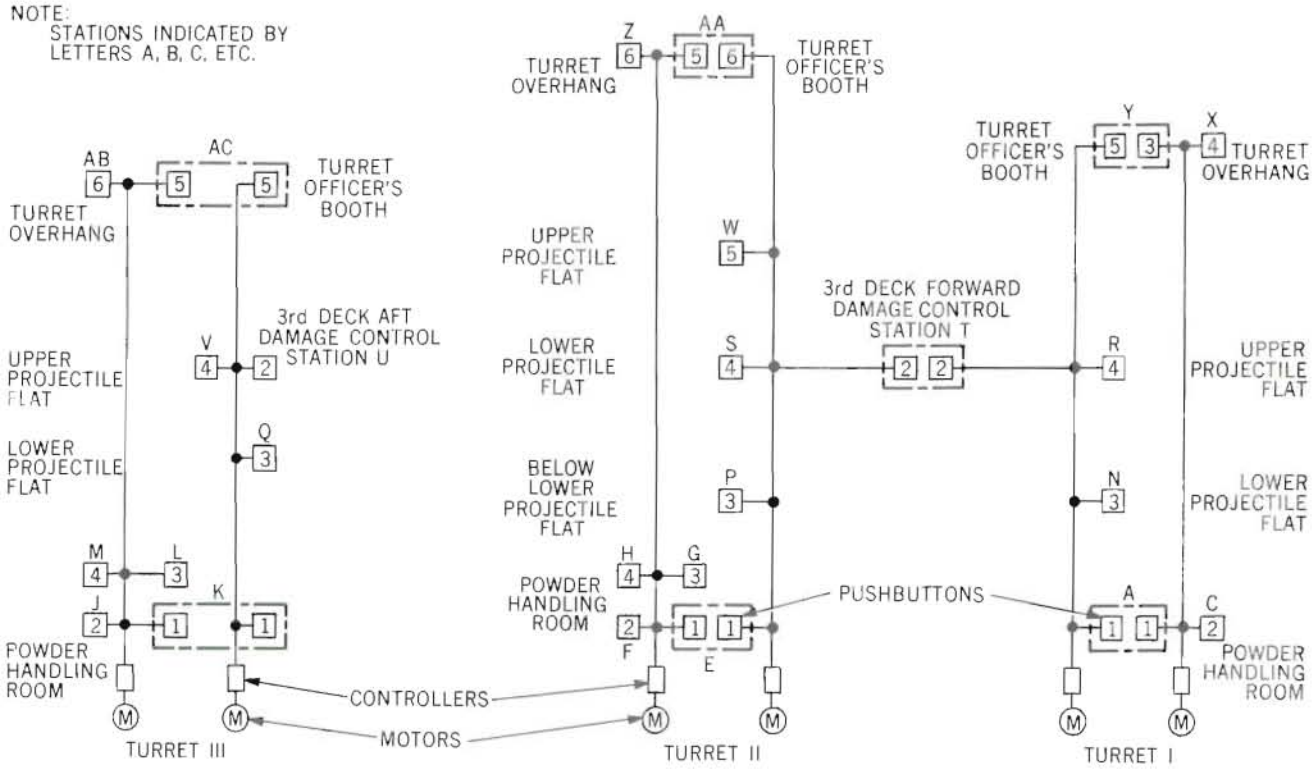


Figure 15-57. Electrically Controlled Sprinkler System. Elementary Wiring Diagram

No.	Motor Location	H.P.	Fan C.F.M.
3.	Right rear corner of overhang, below platform level	3	4000
4.	Rear of center projectile hoist, approximately 6 ft. above pan plate	3	4000
5.	Pan plate, right wing, rear of transverse centerline	4	6000
6.	Pan plate, right wing, forward of transverse centerline	4	6000
7.	Pan plate, left wing, rear of transverse centerline	4	6000
8.	Pan plate, left wing, forward of transverse centerline	4	6000

Ventilating motor data (3-horsepower type). The three-horsepower ventilating motors include the following design and construction features.

Type	Squirrel cage, induction, 2-speed
Design features	Vertically or horizontally mounted, direct drive, waterproof, natural draft cooled
Horsepower	3
R.P.M., synchronous	1800 and 1200
Voltage	440
Amperes, full load	4.38 and 2.42
Amperes, locked rotor	35 and 17
Phases	3
Cycles	60
Ambient temperature, C	40°
Torque class	normal
Weight, lbs.	185
Manufacturer	Star Electric Co.
Manufacturer's designation	29773
Drawing number (BuShips)	354541

Ventilating motor data (4-horsepower type). The four-horsepower ventilating motors include the following design and construction features.

Type	Squirrel cage, induction, 2-speed
Design features	Vertically mounted, direct drive, waterproof, natural draft cooled
Horsepower	4
R.P.M., synchronous	1800 and 1200
Voltage	440
Amperes, full load	3.13*
Amperes, locked rotor	40 and 25
Phases	3
Cycles	60
Ambient temperature, C	40°
Torque class	normal
Weight, lbs.	205
Manufacturer	Star Electric Co.
Manufacturer's designation	29773
Drawing number (BuShips)	354541

* At 1200 rpm

Controllers. The motor controllers serve, through related pushbuttons, to select either of two speeds and to start and stop the ventilating fan motors. A controller is utilized for each motor. Each controller has a mechanical interlock which prevents connecting both motor windings (high speed and low speed) to the line at the same time. The controller locations and motors served are listed in the following tabulation.

Motor Served	Controller Location
No. 1	Passageway to left sight control station, on right hand bulkhead
No. 2	Passageway to left sight control station, on right hand bulkhead
No. 3	Passageway to right sight control station, on left hand bulkhead
No. 4	Pan floor, near rear of center gun pocket, on right hand bulkhead
No. 5	Pan floor, right wing, below shelf level
No. 6	Pan floor, right wing, below shelf level
No. 7	Pan floor, left wing, below shelf level, on circular bulkhead
No. 8	Pan floor, left wing, below shelf level, on circular bulkhead

Controller data. The motor controllers include the following design and construction data.

Type	Semi-automatic, magnetic, across-the-line starter; speed selection, controlled by remote pushbutton; water-tight enclosure, with cover interlock
Shock rating	150
Weight	140.5
Manufacturer	Ward Leonard Electric Co.
Drawing number (BuShips)	355248

Pushbuttons. Each pushbutton is labeled with designation of the ventilation unit it operates. Pushbuttons operating the ventilating motor supplying the turret officer's compartment and the two ventilating motors located in the left wing below shelf level, are located in the turret officer's compartment near the left end of the transverse bulkhead. Near the right end of the transverse bulkhead are pushbuttons controlling the two ventilating motors in the right wing. Pushbuttons for control of the gun chamber ventilation motors are located in their respective gun chambers at the gun captain's stations.

INSTRUCTIONS

General

All turret electrical equipment and circuits require periodic inspections and tests to check voltage, insulation, and conductivity. The schedule for periodic inspections and tests depends upon frequency of operation, type of duty, atmospheric conditions, and climate. Follow the various applicable instructions on maintenance of electrical installations, as outlined in the Bureau of Ships Manual of Engineering Instructions.

When practicable, all turret electrical elements and wiring circuits are designed and constructed to resist moisture and other deteriorating or damaging factors. However, to obtain maximum service and efficiency from these devices, it is most important that turret personnel maintain all equipment and associated wiring as directed.

Trouble analysis

Troubles which are most frequently encountered in electrical elements and wiring are insulation failures due to moisture absorption or oil accumulation; open circuits due to overloads, blown fuzes, flexing, shock, or corrosion; abrasive wear of cable insulation; pitted contacts; and fuze failures. Precautions and remedies for these troubles are detailed in the following paragraphs.

CAUTION: Turret personnel should exercise extreme care when near live electrical circuits. On shipboard, conditions of damp salt air, metal structure, and ship's movement combine to increase the hazard of electrical shock. Under certain conditions 110 volts can be fatal; 440 volts frequently is fatal.

Moisture absorption. This is one of the principal sources of trouble in electrical installations. It reduces insulation values of insulated wires and frequently is the source of grounds or short circuits. Grounds cause false circuits that may cause unexpected starts, prevent stopping by normal means, eliminate overload protection, and cause erratic operation. Moisture may occur from condensation, humid atmosphere, spray, overhead dripping, or other conditions.

Routine maintenance should include keeping switch and control panels, and instrument and connection box terminal boards, dry at all times. Watertight doors and covers should be kept securely closed or fitted. Deteriorated or damaged door gaskets must be replaced. Surface moisture on panels may be removed with a clean, dry, absorbent cloth or by the application of heat in the manner specified by the Bureau of Ships Manual of Engineering Instructions.

Oil accumulation. The presence of oil on the surfaces of insulated cables and on panel surfaces presents a constant hazard to the safe and efficient operation of electrical installations. Oil has a deteriorating effect on most insulating materials. It also acts as an adhesive and a "catch-all" for dirt and dust particles, which reduce insulating values and restrict ventilation. Oil film and dirt on panels and terminal boards reduce the efficiency of the circuits involved. In telephone, signal, and synchro circuits this condition may cause leakage, resulting in inefficient operation of the system.

Be particularly careful to prevent oil from dripping onto insulated cable or other electrical elements. Inspect and clean these items regularly.

Carbon tetrachloride (chemically pure) is a fire-safe solvent which is appropriate for use on shipboard, if care is taken not to breathe its fumes. When disssolving oil or grease with carbon tetrachloride, the working area must be thoroughly and continuously ventilated, or gas masks must be worn by those in the area. Consult the Bureau of Ships Manual of Engineering Instructions for further warnings concerning the use of toxic solvents.

Open circuited conductors. This trouble may be due to one or more of several factors which are outlined later with maintenance instructions.

Open circuits occur when fuzes blow or when circuit breakers open, as a result of overloads. These faults are usually caused by short circuits or grounds that must be located and corrected. Intermittent breaks sometimes occur in conductors of flexible cables which are subject to considerable flexing, or which may be damaged by shock of gunfire. These breaks usually are disclosed by erratic operation. Damaged cable can be located by flexing it while it is under continuity test. Damaged cable must not be spliced. It must be replaced from terminal with a complete new cable. In the event spare cables are not available, spare conductors of like or larger capacity in adjacent cables may be used to complete emergency connections.

Open circuits may be caused also by such defects as poor connections due to improper securing, by dirty connections, or by missing screws. The brass screws used for making connections do not have the strength of steel screws. When tightening, exert just enough pressure to make sure that connections are tight without danger of stripping the threads. Broken connections also are likely to occur when connections are made by twisting wire or strands into loops. This is not good practice and should not be resorted to except to provide an emergency connection which must be replaced later with properly soldered lugs.

Loose terminals. Loose terminals on switchboards, terminal blocks, and panels are common and require constant vigilance to detect them. They should be checked and tightened regularly and lock washers should be installed wherever practicable. Due to the relative non-resilience of copper terminals and lugs, and because of the vibration encountered aboard ship, all terminal connections tend to loosen with time even when held by lock washers.

Corrosion also affects circuit resistance at terminals. It is best removed with a wire brush. Battery terminals are the ones most subject to this trouble and, when cleaned, they should be given a coat of petrolatum, Navy Specification 14-P-1c.

Abrasive wear. Defective wiring is an outstanding cause of electrical troubles and fires.

Regular inspection is necessary. All wiring should be kept in good condition, particularly when subjected to chafing or rubbing against unprotected surfaces, and where cables make loose bends and are subject to vibration. In such cases, additional protection against wear should be provided if such protection does not interfere with the functioning of the cable or adjacent mechanisms. This protection may consist of a simple suspension rig to hold the rubbing area free or of added wrappings over the affected area.

Pitted contacts. Contacts are the basic functional parts of all motor control, and proper operation depends upon their being maintained in good operating condition. Contacts should be renewed when badly pitted or burned and when worn thin. They should be clean but need not be smooth. A clean contact with a roughened surface comparable to coars sandpaper is in satisfactory condition.

The method of cleaning contacts is important. See the Bureau of Ships Manual of Engineering Instructions for instructions concerning the cleaning of silver contacts.

When contacts are replaced, the surface against which they are bolted should be thoroughly cleaned. This usually is a current-carrying joint and a clean contact bolted to a clean surface will give best results. The screws or bolts that hold contacts in place should be tight at all times. A loose contact surface offers high resistance and develops heat.

Fuze failure. Remember that a fuze is a safety device. Fuzes are placed in a circuit in order to blow and thus to open the circuit, before other portions of the circuit will be damaged. Fuze failure is proof of trouble in its related circuit. A temporary overload on a circuit will blow a fuze. In such instance, the circuit is not necessarily in danger, and the replacement of the fuze may solve the difficulty. However, if the second fuze blows immediately, the cause of the trouble should be located and corrected before attempting to replace the fuze. Fuzes never should be replaced with those of higher ampere ratings. To over-fuze a circuit is to lose the designed protection.

CAUTION: Fuzes and fusetrons are not interchangeable, one with the other. Replace burned-out fusetrons with fusetrons of identical value. Under no condition must they be replaced with fuzes.

Premature blowing of fuzes may be the result of undue heating caused by low contact pressure at the ferrule and fuze clips. This trouble may be eliminated by keeping the contact clips and ferrules bright and clean, and by assuring that the contact clips give good contact pressure on the fuze. Should fuze clips become annealed due to heating, replace them with new clips, preferably of the positive-pressure type.

Maintenance

Care of power system. Systematic inspection of the power system cables, motors, and controllers must be made according to the routine outlined in the Bureau of Ships Manual of Engineering Instructions.

Controllers must be kept free from accumulations of dirt, dust, grease, or oil, both inside and outside. Clean the operating mechanism and the contacts with a clean, dry cloth. Small and delicate mechanical parts may be cleaned with a small, stiff bristle brush and a non-inflammable cleaning fluid.

Moving parts should move freely, without binding or sticking, in their normal operating travel. Contacts should be inspected regularly and should be filed or dressed when necessary.

All connections should be inspected at regular intervals and tightened securely if loose. A loose connection on a controller panel often may be detected by excessive heat at the point of looseness. The high temperatures cause increased resistance and the formation of copper oxide, resulting in erratic operation. Causes of loose connections may be any one of a number of conditions such as vibration, expansion, and contraction due to temperature changes, unusual shocks and strains, oversight in tightening screws, etc. The importance of having clean, tight electrical connections cannot be over-emphasized. Electrical connections should be soldered wherever practicable. It is important that the wing nuts or bolts which secure the controller panels be kept tight to prevent moisture from leaking in around the gaskets.

When opening the front panel of a controller, the securing wing nuts should be backed out to their limit to prevent bending of the bolts when the door is pulled open. An occasional check should be made to determine if overload relays are adjusted to trip at rated current. Tripping current data are listed in the table of controller data on page 15-5.

Motors require very little attention, and with proper maintenance will render long and efficient service. There are four principal causes of motor failure: dirt, moisture, friction, and vibration.

Dirt in any form can be harmful to a motor and every precaution should be taken to see that motors are not allowed to collect dust or dirt. Regular cleaning prevents dust or dirt from gumming up through union with oil or moisture.

Moisture, like dirt, can be harmful to a motor. It soaks and softens windings until the insulation will no longer hold the voltage. Once inside a motor, moisture will unite with any dirt present to form a sticky mass. Motors always should be guarded against the accidental intrusion of water from drip or splatter. Motors should be run a little once a week to guard against moisture condensation during periods of idleness.

Friction may be prevented if the correct lubricating procedures are followed. Always follow exactly the lubricating instructions of the motor manufacturer. Always supply the right lubricant, in the right quantities, in the right way.

CAUTION: Do not overgrease motors.

More motors have been damaged by excessive lubrication than by inadequate lubrication. Excess lubrication promotes friction. Care should be exercised to wipe away any leakage of oil which may collect on a motor case. This is essential to prevent seepage through the motor housing, which would result in damage to the windings and the armature. Motor air ducts must be kept free of dirt; otherwise, excessive heating will result.

Care of fire control equipment. Fire control elements are to be serviced only by fire control in strument maintenance personnel.

The firing circuit requires special precautions and maintenance to keep circuit resistance low, on account of the low voltage of the system. Total resistance of any individual gun firing circuit, with all instruments connected and with a specially rigged empty short case in place, shall not exceed 2.0 ohms. To make this test, the short case must be especially fitted with a solid plug in place of a primer plug.

Experience has shown that the following special precautions should be observed to maintain the firing circuit at full efficiency.

1. Make regular instrument tests (megger, voltmeter, ohmeter, etc.) as required under the instructions of the Bureau of Ships Manual of Engineering Instructions.

2. Keep firing keys, switches, wiring, batteries, and transformer in good condition; all contacts should be clean, all connections tight, and the battery properly charged.

3. Wipe oil or dirt from the firing cable, particularly at points when the cable is attached with clamps.

4. Check the breech firing lock terminal for looseness.

5. Avoid spinning the handwheels without clasping the firing key grip. This prevents winding of the firing cable over the handwheel and shaft with consequent damage to the firing cable.

6. Check storage batteries daily for voltage, and frequently for the specific gravity of the electrolyte.

7. When firing, close the key for approximately one-half second (see NAVORD Circular Letter X-609).

Care of communication circuits. All communication circuits are to be serviced by IC maintenance personnel according to instructions of the Bureau of Ships Manual of Engineering Instructions, manufacturer's directions, and other pertinent instructions. Turret personnel, however, have a definite responsibility to handle all communication equipment with care, especially telephone equipment of the sound-powered type. Sound-powered telephones must be ready for any emergency. This means that they must be kept in condition and be handled properly at all times. There are two types of sound-powered telephones, the headset and the headset. The following precautions must be observed when handling these instruments:

When the handset telephone is not in use, be sure to position it securely in the bracket, to prevent it from falling to the deck.

When preparing to use a headset telephone, hold the transmitter unit and the heavy lead in the left hand. Hook the metal headband over the transmitter yoke, in the space between the mouthpiece and the chestplate. This will prevent the earphones from being dropped. Insert the plug into the jack box, and, while holding the plug with one hand, screw the collar on firmly. If these directions are followed, no portion of the instrument will hang by the cords. After using a headset telephone, be sure to screw the cover on the jack box. Stow telephone in the box provided and close box tightly so that no moisture or dust can enter. The 20 foot plug cord should never be cut. It should be shortened as required by sheepshank, so that it will remain interchangeable with other similar units.

General lighting circuit maintenance. All fixtures of this circuit are designed to provide the necessary protection from gunfire and moisture. The circuit requires only occasional testing for insulation resistance. Continuity of circuit is disclosed by operation or failure of the various lighting elements. Experience has shown that little trouble is caused by switch failure; if contacts arc and cause faulty operation, they should be replaced.

CAUTION: Powder handling room switches must not be operated while the circuit is energized and flameproof covers are off for replacement of a burned-out lamp, or for checking. Similarly, burned-out magazine fixture bulbs must not be replaced while the circuit is energized.

Instrument illumination circuit maintenance. Maintenance of this circuit requires that personnel follow instructions as outlined in the Bureau of Ships Manual of Engineering Instructions.

The storage battery should be checked daily, and maintained in good condition and at full charge. The following precautions are to be observed in the care and handling of storage batteries:

1. Always charge a battery in accordance with the nameplate data.

2. Always keep the density of the electrolyte within the specified limits.

3. Never let the electrolyte level get below the top of the plates.

4. Always use pure distilled water when adding to the electrolyte in a cell.

5.5. Keep the battery clean at all times; use a dilute soda solution, if necessary, to wipe the top.

6. Keep the battery terminals and posts clean and covered with a light film of vaseline, or a mixture of vaseline and backing soda.

Lamp replacement should be made promptly in the event of a burn-out. Most lightwell units have twin lamp sockets with parallel connected lamps. This arrangement provides illumination at half-value for a given area when one of the lamps fails. When the light from a lightwell drops appreciably, the lightwell should be opened to determine the cause. If a lamp has failed, it should be replaced immediately.

Chapter 16

TURRET AUXILIARY INSTALLATIONS

INTRODUCTION

General

This chapter contains a description of turret auxiliary installations which include power supply, illumination supply, ventilating systems, and Bureau of Ships design and cognizance. Their features and general arrangement are described in the following paragraphs.

DESCRIPTION

Power supply

Normal, alternate, and emergency electric power is supplied to each turret from two of the ship's four main 440-volt, 3-phase, 60-cycle twin turbo-generators. This power is supplied to each turret through flexible feeder cables originating at connection boxes in the wiring trunk below the base casting of the central column. Cables lead upward through spacer blocks in the central column to a wiring recess at the top of the column, just below the electric deck. Slack in the cables at the bottom of the column permits the cables to twist and flex during turret rotation. From the wiring recess, the normal and alternate cables are routed to a manual bus transfer panel located in the machinery space of the upper projectile flat. The panel is equipped with switches and indicator lights for selection of either normal or alternate power supply. From the manual bus transfer panel, power is supplied to five circuit breaker power panels. These comprise three for gun equipment (one for each gun), one for training gear equipment, and a miscellaneous equipment power panel. These panels supply power to all power drive controllers and the several auxiliaries, except for the illumination system. The emergency cable is routed to the I.C. and F.C. power panel located in the electric deck.

Illumination supply

Power for the illumination system is supplied to each turret from the 120-volt, 60-cycle, ship's electric service system. The power is supplied to the turret by flexible cable, through the central column, similar to the arrangements described in the preceding paragraph. From the wiring recess at the top of the central column, the cable is routed to two automatic bus transfer panels located on the electric deck and pan floor. The panels automatically transfer the 120-volt supply from normal to emergency, or vice versa, when required.

Ventilating system

Eight self-contained ventilating systems (fig. 16-1) supply fresh air under forced draft to all turret levels and spaces, except the powder handling room. All systems have fresh air intake through the gun house overhang and are provided with two speed remote pushbutton operating controls. Each system comprises an electric motor-driven fan set and necessary air supply ducts. The fan sets are equipped with three- or four-horsepower motors and supply air (at the rate of 4000 or 6000 cubic-feet-per-minute, respectively) as follows:

4000 Cubic Feet Per Minute Sets

Set 1 supplies air to the turret officer's booth through a vertical supply duct located near the rear armor plate, left of the turret center line. The system intake and supply trunk is at the rear of the gun house with an air supply passage directly below the fan set and duct. The ON-OFF and speed selection pushbutton control is located in the turret officer's booth on the transverse bulkhead (left end).

Set 2 supplies air to the left gun chamber through a horizontal duct with exhaust into the passage to the left sight control station. The system intake and supply trunk is at the left, rear corner of the gunhouse with an air supply passage leading to the fan set and duct. The ON-OFF and speed selection pushbutton control is located in the turret officer's booth on the transverse bulkhead (left end).

Set 3 supplies air to the right gun chamber through a horizontal duct with exhaust into the passage to the right sight control station. The system intake and supply trunk is at the right, rear corner of the gunhouse with an air supply passage leading to the fan set and duct. The ON-OFF and speed selection pushbutton control for this system is located in the right gun chamber adjacent to the gun captain's station.

Set 4 supplies air to the center gun chamber of the gun chamber below the shelf plate. The system intake and supply trunk is at the rear of the gunhouse (right of the turret center line) with an air supply passage leading to the fan set and duct. The ON-OFF and speed selection pushbutton control for this system is located in the center gun chamber adjacent to the gun captain's station.

6000 Cubic Feet Per Minute Sets

Set 1 supplies air to the right side of the electric deck, and the right side of the upper and lower projectile flats. The system intake and supply trunk is forward of the right, rear corner of the gunhouse with a vertical air passage aft of the fan set. The ON-OFF and speed selection pushbutton control for this system is located in the turret officer's booth on the transverse bulkhead (right end).

LEGEND FOR FIGURE 16-1.

4000 Cubic Feet per Minute Sets

Set 1 — From turret overhang (rear, left of centerline) to turret officer's booth

4. Intake and supply trunk
5. Fan set and air supply duct

Set 2 — From turret overhang (left rear corner) to left gun chamber and left sight station passage.

11. Intake and supply trunk
15. Air supply duct

Set 3 — From turret overhang (right rear corner) to right gun chamber and right sight station passage.

1. Intake and supply trunk
55. Air supply duct

Set 4 — From turret overhang (rear, right of centerline) to center gun chamber

2. Intake and supply trunk
53. Fan set and air supply duct

6000 Cubic Feet per Minute Sets

Set 1 — From turret overhang (forward of the right, rear corner), to right side of electric deck and upper and lower projectile flats

44. Air supply ducts, lower projectile flat
45. Air supply duct, upper projectile flat
46. Air supply duct, electric deck
48. Fan set
52. Air passage opening
56. Intake and supply trunk

Set 2 — From turret overhang (forward of the right, rear corner) to right sight control station, right powder hoist, powder hoist and training gear power drive spaces, and right side of electric deck and upper and lower projectile flats

7. Air supply duct, hoist operator's station
13. Automatic air supply shutter
23. Air supply duct, right sight station
24. Air supply duct, powder hoist machinery space
35. Air supply duct, training gear right B-end
36. Air supply duct, center gun layer's station
37. Air supply duct, right gun layer's station
38. Air supply duct, machinery space upper flat
41. Air supply duct, lower projectile flat
42. Air supply duct, machinery space lower lower flat
47. Fan set
52. Air passage opening
56. Intake and supply trunk

Set 3 — From turret overhang (forward of the left, rear corner) to left side of electric deck and upper and lower projectile flats

12. Intake and supply trunk
17. Air passage opening
25. Air supply duct, electric deck
26. Fan set
31. Air supply duct, upper projectile flat
39. Air supply duct, lower projectile flat

Set 4 — From turret overhang (forward of the left, rear corner) to left sight control station, left and center powder hoists, powder hoist and training gear power drive spaces, and left side of electric deck and upper and lower projectile flats

9. Air supply duct, center hoist operator's station
10. Air supply duct, left hoist operator's station
12. Intake and supply trunk
14. Automatic air supply shutter
16. Air supply duct, left and center powder hoist machinery space
17. Air passage opening
19. Air supply duct, left sight station
20. Automatic air supply shutter
21. Air supply duct, left powder hoist machinery space
22. Air supply duct, center powder hoist machinery space
27. Fan set
30. Air supply duct, left gun layer's station
32. Air supply duct, training gear left B-end
33. Air supply duct, train operator's station
34. Air supply duct, upper projectile flat
40. Air supply duct, upper projectile flat

Allied Equipment

3. Intake holes in overhang
6. Exhaust holes in overhang
8. Manually operated airtight cover (exhaust opening) turret officer's booth
18. Air circulation duct, left sight station
28. Air circulation holes
29. Air exhaust holes in foundation bulkhead
43. Gas and air seal
49. Pressure relief shutters from powder hoists
50. Automatic exhaust shutters in right and left box girder weldments
51. Air circulation duct, right sight station
54. Exhaust shutters from powder hoists and gun chambers

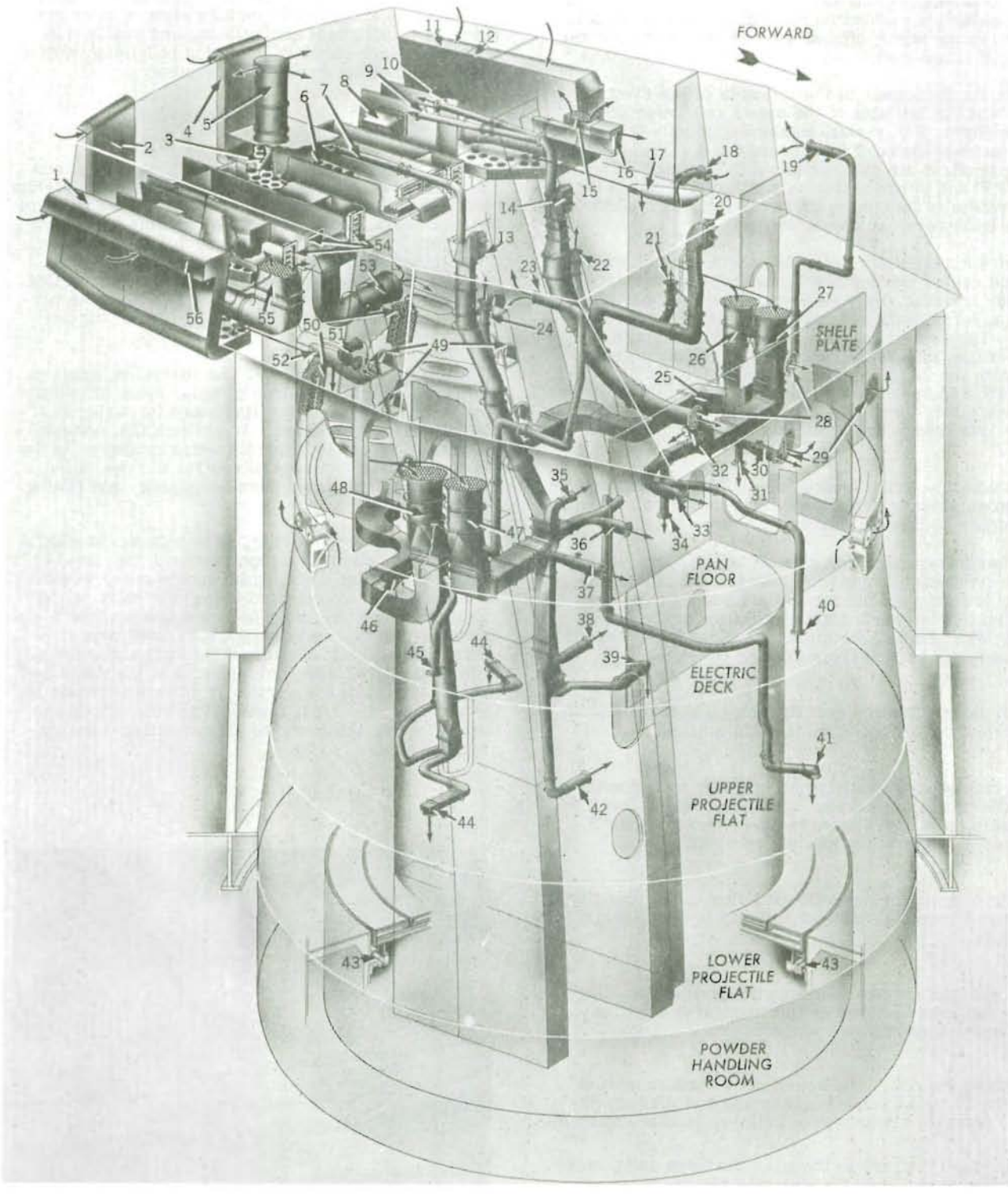


Figure 16-1. Turret Ventilating Systems. General Arrangement

Set 2 supplies air to the right sight control station, right powder hoist and hoist power drive spaces, training gear right B-end, and the right side of the electric deck and upper and lower projectile flats. The system intake and supply trunk is forward of the right, rear corner of the gunhouse (common with the intake and supply trunk for Set 1). The ON-OFF and speed selection pushbutton control for this system is located in the turret officer's booth on the transverse bulkhead (right end).

Set 3 supplies air to the left side of the electric deck, and the left side of the upper and lower projectile flats. The system intake and supply trunk is forward of the left, rear corner of the gunhouse with a vertical air passage aft of the fan set. The ON-OFF and speed selection pushbutton control for this system is located in the turret officer's booth on the transverse bulkhead (left end).

Set 4 supplies air to the left sight control station, left and center powder hoists and hoist power drive spaces, training gear left B-end, and the left side of the electric deck and upper and lower projectile flats. The system intake and supply trunk is forward of the left, rear corner of the gunhouse (common with the intake and supply trunk for Set 3). The ON-OFF and speed selection pushbutton control for this system is located in the turret officer's booth on the transverse bulkhead (left end).

In addition to the intake and supply trunks, and the fan sets described above, the ventilation systems have other equipment described below.

There are intake and exhaust holes in the shelf plate (overhang). Arranged between the intake and supply trunks, and the system air supply passages, the intake holes permit air circulation while providing less armor protection. Exhaust holes permit regulated air escape from exhaust passages.

An air circulation duct in each sight station aids in circulating air through the sight station.

A manually operated airtight cover over the turret officer's booth exhaust opening provides for regulation of air pressure build-up and for wet weather closure of the exhaust opening.

Air circulation and exhaust holes in the foundation and electric deck bulkheads aid in keeping air in motion.

A gas and air seal between the powder handling room and lower projectile flat maintains air pressure in the upper turret spaces.

Pressure relief and automatic exhaust shutters (fig. 16-2) in the powder hoists and box girders prevent excessive air pressure build-up in these spaces.

Exhaust shutters in the gun chambers and powder hoist operators' stations maintain air pressure at these stations.

The ventilating systems maintain air pressure slightly in excess of 1.0 pound per square inch. This is controlled by exhaust arrangements which include spring- and weight-loaded automatic shutters. Manually operated doors in intake and exhaust ducts prevent entrance of water in heavy weather.

Electrical components of the ventilating systems, described in chapter 15, include eight motors provided with individual controllers, and pushbutton stations. Each pushbutton station is labeled with a designation of the system it operates.

Sprinkling system

The turret sprinkling system shown in figures 16-3 and 16-4, provides a quick and efficient means of sprinkling all ammunition in the turret - whether in the ammunition hoists, in the loading trays, or ready for loading at the gun breech. It is an electrically and hydraulically operated system which permits selective or over-all control of sprinkling from both local and remote stations within the turret, as well as from a station outside the turret.

General arrangement. The sprinkling system includes a primary source of water from the ship's fire main, and two sprinkling tanks for water storage within the gun house. In addition the system has an air supply to maintain water pressure in the tanks and an assortment of control and operating valves, and associated nozzles, piping, and tubing.

Turret firemain tubing. Water from the ship's fire main is led up to a pipe manifold (fig. 16-14) located in the non-rotating structure of the powder handling room. Connected to a globe valve at the top of the manifold, a 2.50-inch diameter fire hose connects fire main water to a 2.50-inch copper-nickel alloy tube in the turret rotating structure. This tube, fitted with a globe valve at its lower end (fig. 16-13), extends vertically upward adjacent to the right powder hoist trunk. The tube extends to the sprinkling tanks and to all sprinkling-head operating valves.

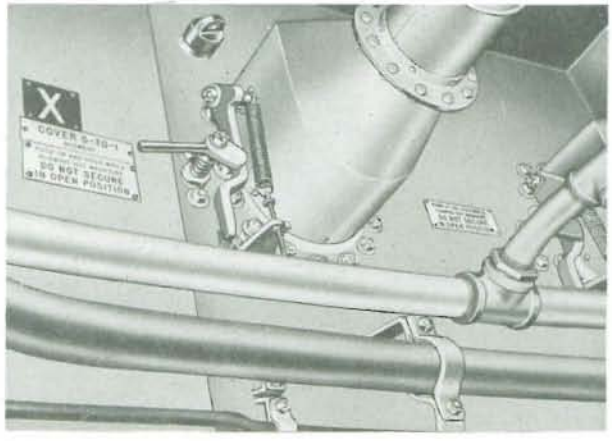


Figure 16-2. Ventilating System Air Exhaust Shutter. General Arrangement

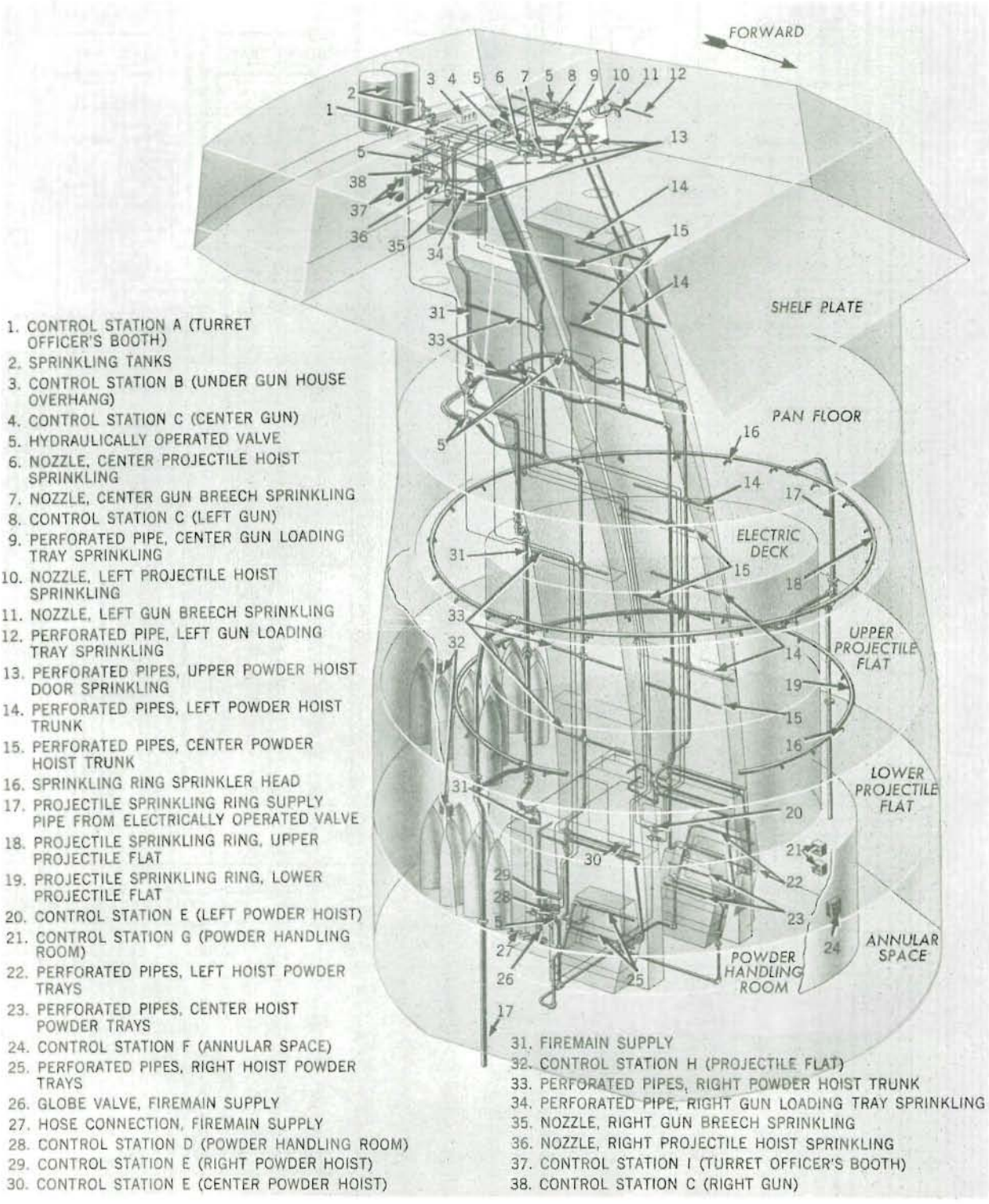


Figure 16-3. Turret Sprinkling System, General Arrangement

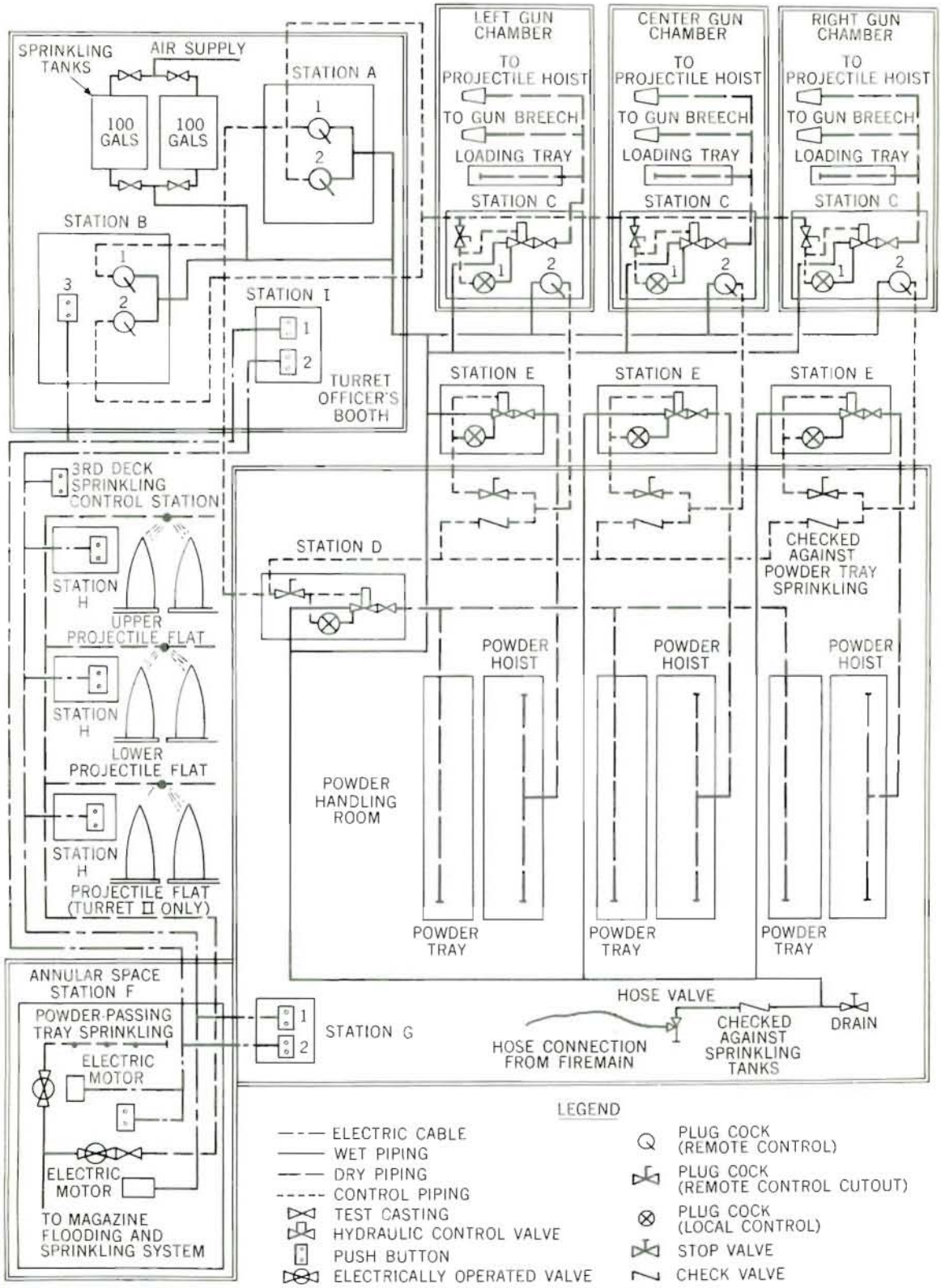


Figure 16-4. Turret Sprinkling System. Schematic Diagram

Sprinkling distribution system. The sprinkling system section described in the preceding paragraph is the wet sprinkling piping (fig. 16-4). During normal turret operation, this tubing contains water at all times. All wet sprinkling piping is copper-nickel alloy, seamless pipe and tubing. Fittings are flanged or socket-type, bronze, silver-soldered, and threaded bronze. Connected to this section is the dry sprinkling piping which leads to and sprinkles the various ammunition units. In normal turret operation this piping contains no water. Only when the complete system, or a portion thereof, is operated do these pipes contain water. All dry sprinkling pipes are brass seamless tubing with brass or bronze fittings, silver-soldered or threaded in position.

The dry sprinkling piping for the powder hoists is connected to the fire main through four hydraulically operated control valves located in the powder handling room. Piping leading from the valves is mounted on the exterior of the hoist trunks with 3/4-inch perforated sprinkling pipes extending into the trunks at five places (six places in turret II) from

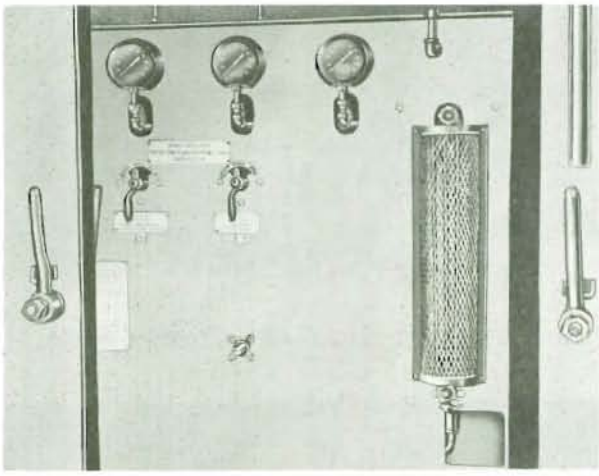


Figure 16-5. Magazine Sprinkling Control Station in Annular Space. General Arrangement

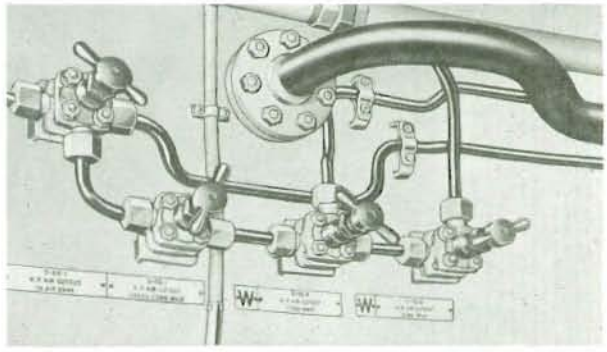


Figure 16-7. High Pressure Air System, Cutout Valves. Lower Projectile Flat, General Arrangement

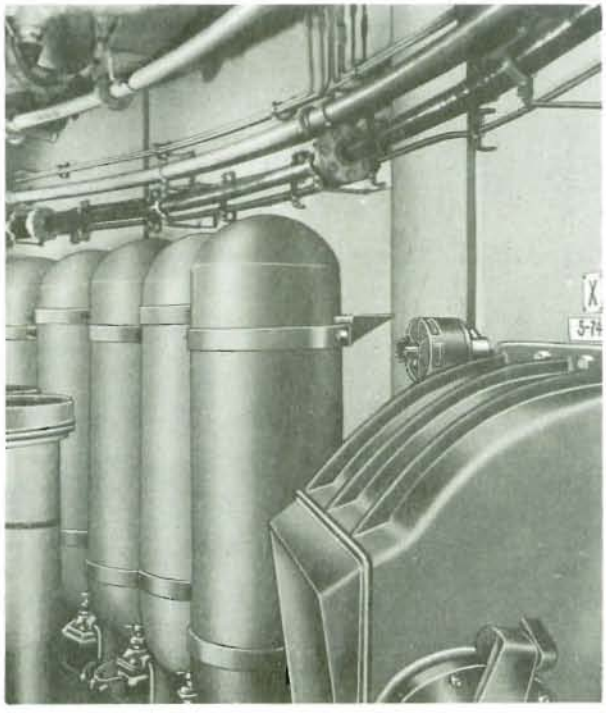


Figure 16-6. High Pressure Air Bottles in Annular Space. General Arrangement

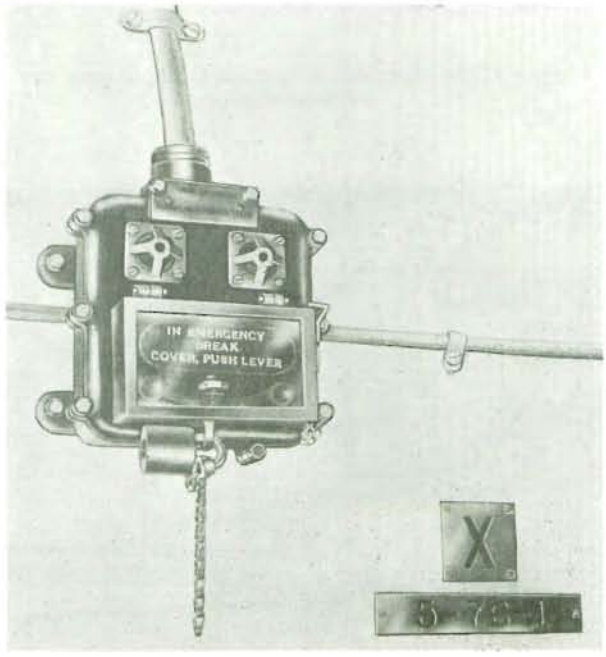


Figure 16-8. Turret Sprinkling Control Station F

the lower end to the upper end of each. These perforations are 5/32-inch in diameter and are equally spaced in each pipe length. There are additional perforated sprinkling pipes at the powder trays and the upper trunk door. The arrangement is such that the powder tray or trunk and upper door of each hoist can be sprinkled individually.

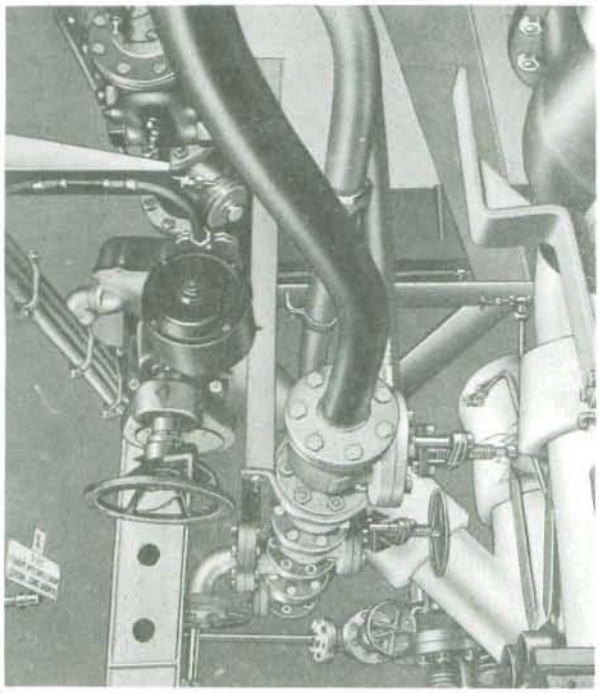


Figure 16-9. Sprinkling System Components in Annular Space

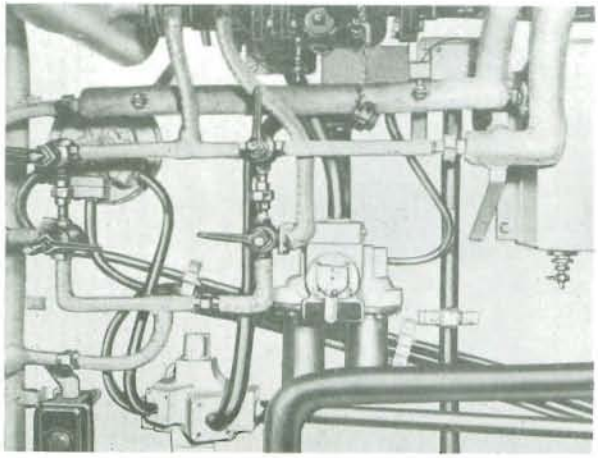


Figure 16-10. Sprinkling System Components on Electric Deck

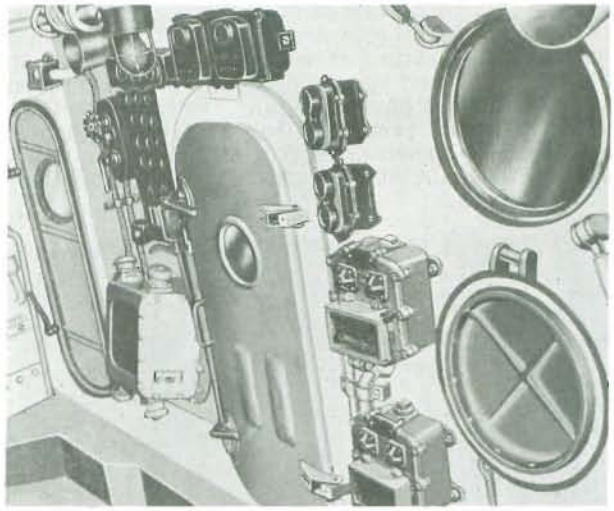


Figure 16-11. Turret Sprinkling Control Station I

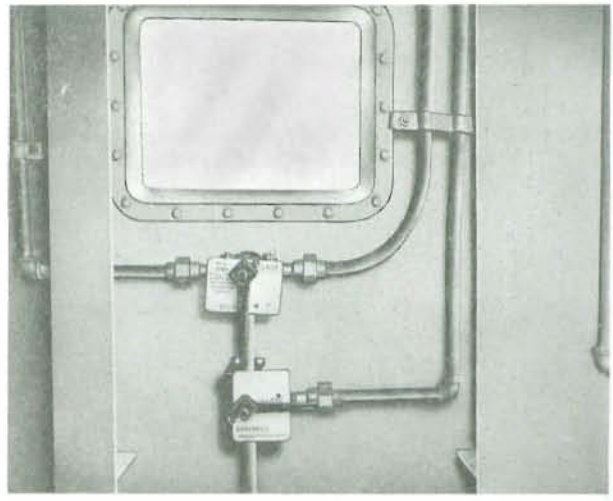


Figure 16-12. Turret Sprinkling Control Station E

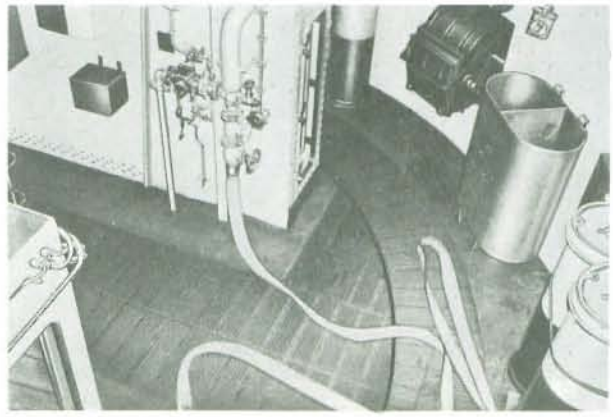


Figure 16-13. Firemain Connection in Rotating Structure

The dry sprinkling piping for the stowed projectiles is connected to the fire main through an electrically operated control valve located in the annular space outside the powder handling room (fig. 16-15). Piping leads from this valve up to the projectile flats, forming a sprinkling ring on each flat. Constructed of 2-inch pipe, the rings are mounted above and encircle the stowage areas of each flat. Each ring has 24 sprinkler heads which are equally spaced throughout 360 degrees to provide for sprinkling of every stowed projectile.

The dry sprinkling piping for the gun breeches is connected to the fire main through three hydraulically operated control valves, one located in each gun room. The installation comprises 1-1/4-inch perforated sprinkling pipes with 1-inch hose nozzles directed down the projectile hoist tubes and 1-1/4-inch hose nozzles aimed at the gun breech.

Vent and gage air piping system. A third piping system, essential to operation of the turret sprinkling system, is the vent and gage air piping system. This system uses air pressure, derived from the gas ejecting system main air supply, to maintain pressure on the water stored in the sprinkling tanks. The air supply take-off piping is fitted with a gate valve, a pressure reducing valve (dropping the pressure from175 to 100 pounds per square inch), and a relief valve (set at 105 pounds per square inch). The piping that leads from the relief valve is fitted with a swing check valve, and with a gate valve and a three-way, two-port plug cock in the turret officer's compartment. From one port of the three-way valve, piping extends to both of the sprinkling tanks. Before entering each tank, the piping is fitted with a locked-open gate valve. From the second port of the three-way valve, piping leads to a tank vent and overboard overflow line.

The gate valve in the air supply take-off piping has a 1-1/4-inch line that leads into the turret officer's compartment and is connected to a system pressure gage. The sprinkling tanks have a 1/4-inch line that is connected to a system pressure gage.

Hydraulic control piping system. The fourth piping system within the turret sprinkling system is the hydraulic control piping system. This is an arrangement of hydraulically operated valves located to control sprinkling flow in parts of the dry pipe system. None of the sprinkling control cocks is located on the fire main. Instead, each control cock operates a hydraulically operated control valve which opens the system and permits water flow from the fire main into the dry sprinkling piping. The hydraulic control piping system utilizes water in the wet sprinkling piping, under pressure, as a control fluid.

Turret sprinkling control stations. Selective control of the turret sprinkling system is provided at both local and remote control stations (fig. 16-5). These are designated alphabetically, and consist of stations A to I inclusive.

CONTROL STATION A is located in the turret officer's compartment, left side just below the overhead. Mounted separately on the transverse bulkhead, the control station comprises 2 two-position valves, each being marked SPRINKLE and CLOSE. Valve 1 controls powder hoist sprinkling. Turning the handle to SPRINKLE permits water to flow into the three powder hoists. Valve 2 controls gun room sprinkling. Turning the handle to SPRINKLE permits water to flow into the projectile hoist, gun breech, and loading tray in each gun room.

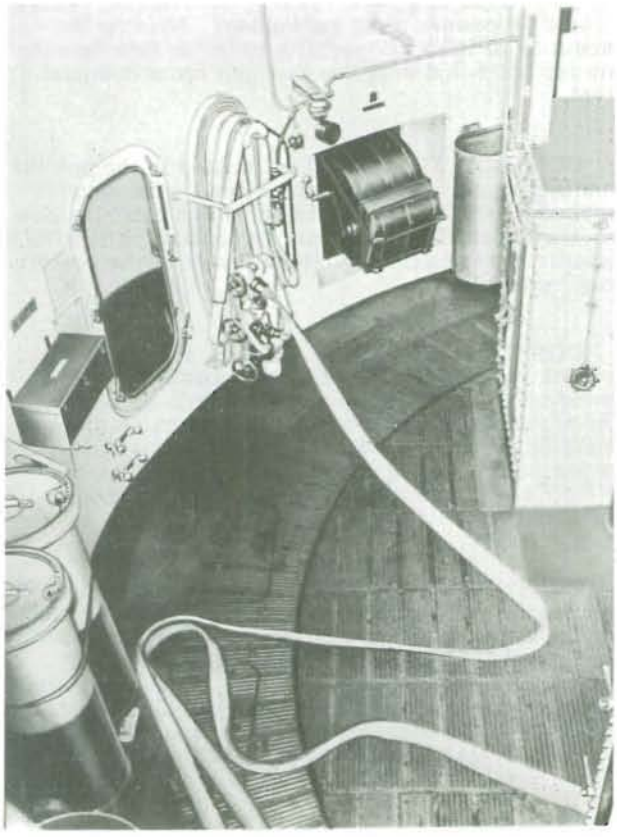


Figure 16-14. Firemain Connection in Non-rotating Structure

CONTROL STATION B is located beneath the turret overhang, within a glass-faced lock box. It comprises 2 two-position valves, each being marked SPRINKLE and CLOSE. There is also a pushbutton station with the indicator and lever each marked OPEN and CLOSE. Valve 1 controls powder hoist sprinkling. Turning the handle to SPRINKLE permits water to flow into the three powder hoists. Valve 2 controls gun room compartment sprinkling. Turning the handle to SPRINKLE permits water to flow into the projectile hoist, gun breech, and loading tray in each gun room compartment. The pushbutton station electrically controls sprinkling in the annular space. Pressing the lever on the end marked OPEN causes the electrically operated valve in the annular space to permit water flow to sprinkle the powder passing trays.

CONTROL STATION C. There are three C control stations, one located in each gun room compartment adjacent to the rammer operator's station. The station comprises 2 two-position valves, each being marked SPRINKLE and CLOSE. Valve 1 controls (locally) gun room compartment sprinkling.

Turning the handle to SPRINKLE permits water to flow into the projectile hoist, gun breech, and loading tray in the local gun room compartment. Valve 2 controls powder hoist sprinkling. Turning the handle to SPRINKLE permits water to flow into the powder hoist that supplies that gun room compartment.

CONTROL STATION D is located in the powder handling room. It comprises a two-position valve marked SPRINKLE and CLOSE which controls powder tray sprinkling. Turning the handle to SPRINKLE permits water to flow into both levels of the powder tray assemblies.

CONTROL STATION E. There are three E control stations (fig. 16-12), one located on each powder hoist trunk in the powder handling room. The station comprises a two-position valve marked SPRINKLE and CLOSE which controls powder hoist sprinkling. Turning any of the three handles to SPRINKLE permits water to flow into the powder hoist that the valve is mounted on.

CONTROL STATION F, located on the outer bulkhead in the annular space is a glass-faced lock box pushbutton station with the indicator and lever each marked OPEN and CLOSE (fig. 16-8). It electrically controls sprinkling in the annular space. Pressing the lever on the end marked OPEN causes the electrically operated valve in the annular space to permit water flow to sprinkle the powder passing trays.

CONTROL STATION G is located on the bulkhead in the powder handling room. It comprises two glass-faced lock box pushbutton stations with the indicator and lever of each marked OPEN and CLOSE Pushbutton station 1 controls projectile flat sprinkling Pressing the lever on the end marked OPEN causes the electrically operated valve in the annular space to permit water flow to sprinkle all projectile flats. Pushbutton station 2 controls sprinkling in the annular space and operated identically to the pushbutton at control station F.

CONTROL STATION H. There are three H control stations, one located on the outer bulkhead of each projectile flat. They are identical glass-faced lock box pushbutton stations with the indicator and lever each marked OPEN and CLOSE. Each station controls projectile flat sprinkling and operates identically to pushbutton station 1 at control station G.

CONTROL STATION I. There are two I control stations (fig. 16-11), both located on the transverse bulkhead in the right side of the turret officer's compartment. They are identical glass-faced lock box pushbutton stations with the indicator and lever each marked OPEN and CLOSE. Pushbutton station 1 controls sprinkling in the annular space (fig. 16-9) and operates identically to the pushbutton at control station F. Pushbutton station 2 controls projectile flat sprinkling and operates identically to pushbutton station 1 at control station G.

Air control plug cock. Adjacent to sprinkling control station A is the turret officer's three-way air control plug cock which is marked VENT and AIR SUPPLY. In filling the sprinkling tanks, before operation, the cock is set to VENT position. After water appears at the overflow, and as soon as both tanks are free of air, the cock is set to its normal AIR SUPPLY position. Should any sprinkling control valve be operated, water will be supplied from the sprinkling tanks or directly from the fire main, depending upon which is under higher pressure. Should air appear at the sprinkling nozzles, it indicates that the sprinkling tanks are empty. To continue sprinkling, it is necessary to close the gate valve (marked AIR TO SPRINKLING TANKS) fitted into the system piping before the three-way valve. This is necessary to relieve the air pressure within the system, which may build up greater pressure than firemain pressure, preventing filling or sprinkling. Sprinkling tanks are filled with water at all times, but air pressure is not added to the tanks until preparing for battle condition.

Testing system operation. A combination flush-out and test plug assembly is provided to test the operation of the hydraulically operated control valves. The test should be performed at least once a week on all hydraulically controlled valves. To test, the cover must be removed from the bottom of the valve, and the test plug assembly screwed in all the way, until solidly engaged. With the test plug assembly installed, any one of the sprinkling control cocks controlling the valve may be turned to SPRINKLE.

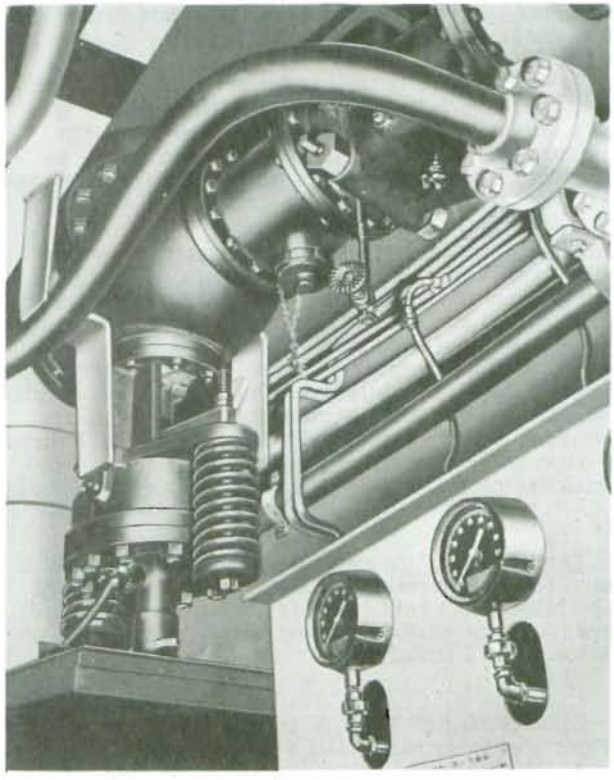


Figure 16-15. Electrically Operated Sprinkling Control Valve

CAUTION: Make sure that the proper control cock is operated. Should a control cock be turned which operates another hydraulically controlled valve, sprinkling will ensue.

After opening the control cock, open the pet cock at the bottom of the test plug assembly. If water flows, the valve is serviceable. If there is no water flow, replace the valve. To complete the test, it is necessary to reset the open sprinkling cock to CLOSE position, then remove the test plug assembly and install the bottom cover.

Counterrecoil air charging system

The counterrecoil air charging system provides a source of high pressure air (figs. 16-6 and 16-7) for the counterrecoil system. Air from the high pressure air bottles in the annular space flows through a portable pipe connection to a turret pipe system. The pipe system leads upward to a separator in the rear part of the center gun pocket. Refer to chapter 4 for detailed description of the counterrecoil system.

Chapter 17

HYDRAULIC EQUIPMENT INSTRUCTIONS

GENERAL

This chapter contains specific instructions for the care and operation of hydraulic power equipment. In all hydraulic equipment, and particularly hydraulic regulator units, the fine clearances of valves, pistons, and plungers, and rotating vanes and other devices - necessitate great care when installing and servicing, in order to prevent fouling, etching, seizing and similar malfunctions. Cleanliness is of the utmost importance. Every possible effort must be exerted to keep foreign matter out of the system. More trouble and unnecessary delay are caused by foreign matter in systems than by any other source of trouble. Cleanliness at all times in the handling of hydraulic equipment cannot be overemphasized. Procedures for care and maintenance of all hydraulic gear are prescribed in the following paragraphs.

Purpose of instructions

The purpose of these instructions is to provide necessary information to install and maintain hydraulic equipment properly, so that maximum performance may be obtained from the units. Hydraulic drives of ordnance equipment are rugged, proven machines, of types that are manufactured, inspected, and tested with such care that, if properly handled, installed, and maintained, they will operate satisfactorily for an indefinite period of time. Satisfactory operation is designed performance of power output, speed, and control. These factors are essential to accurate gun laying and retention of the turrets designed rate of fire with good patterns.

Adherence to prescribed instructions will eliminate firing delays and repair work, and will prevent injury to personnel and equipment. A correctly installed hydraulic system, exercised daily and serviced with extreme care, will not only retain design characteristics of power, speed, and control, but will eliminate expensive dismantling and replacement cost. The turret installations do not require a general overhaul on each occasion of the ship's overhaul at navy yards if all instructions are observed and practiced. Thus the hydraulic drive instructions of preceding chapters and the installation and maintenance instructions below, are important to the turret crew and are vital to turret-gunnery efficiency.

INSTALLATION INSTRUCTIONS

Initial installation

When installing the various pipes, pumps, filters, and fittings of a hydraulic system, be sure that they are absolutely clean, free from scale and all kinds of foreign matter. A new hydraulic unit delivered from the Naval Gun Factory spares or from the manufacturer has all openings into the system closed with wooden or metal shipping covers or plugs. These must remain in place until immediately before connection into the system.

All dirty work in progress in the installation area must cease, and the air must be free of dust, fumes which may condense, or any other foreign matter which may foul freshly opened leads. All personnel in the turret should be cautioned against sweeping or using compressed air to clean the working area, while the unit is being installed. Clean, lint free cloth should be used for wiping hydraulic parts. The use of waste material is undesirable because it is rarely clean and shreds are easily snared inside hydraulic pipes and units. If temporary closures are necessary, plugs or caps of such size that close but cannot get into the pipes should be provided. Officers and supervisors in charge should keep the procedure under close observation at all times.

Overhauled installation

When an overhauled unit is installed in the turret, the same precautions should be observed as for installing a new unit. The overhauled unit should be flushed clean, air-dried, and all openings appropriately closed until immediately before connection into the system.

Special fitting, cleanliness

When installing a unit which requires special fitting of pipes or connections at an exposed, unsealed port, use extreme care to prevent entrance of metal slivers, fittings, or dust; thoroughly inspect the seat and the opening before closing the port. If it is necessary to bend the pipe to make a fit, the piping must be removed after bending and thoroughly cleaned. This is necessary to remove any scale that may have broken loose from the pipe while in the process of

bending. All such pipe, in addition to receiving the hot bath treatment (described on page 17-3), must be scrubbed internally with a frayed wire-rope pipe cleaner.

When drilling, welding, soldering, or other work is done on or near dismantled hydraulic equipment, keep all openings closed or covered. A thin metal covering of the same size as the port cover and with suitable bolt holes for the attaching bolts makes an excellent cover. As an alternative covering, grease-proof adhesive wrapping paper or fabric may be used. Such covers must never be removed until all metal chips, metal slivers, dirt, and other foreign matter have been removed from the area. Even a single metal chip or welding flake is enough to cause scoring of the internal parts and affect the accuracy and smoothness of operation.

Spare hydraulic equipment

Spare equipment, completely assembled but not connected for operation, cannot be stored indefinitely without deteriorating. This is particularly true of the elevation and train receiver-regulators. These units require a fill of hydraulic fluid and periodic exercise under operating pressure through full cycles of control action in each method of control selection. When such units are received for replacement installation, they should be installed with the least possible delay.

Partial installations

If the replacement schedule requires partial installation of the hydraulic equipment, the installed, hydraulic elements and all piping should be completely filled with hydraulic fluid and sealed. Hydraulic units that are not sealed accumulate considerable dirt and condensed moisture. Great care must be taken when operating a partially installed system to ensure proper lubrication of all moving parts. When the hydraulic units are completely installed and conditioned for operation under local control before the drives and automatic controls are installed or available, care should be taken that the auxiliary pumps which supply control and supercharge pressures are not operated without lubrication. These pumps and the valve block units of the regulators are normally lubricated by fluid circulation in the control and supercharge systems.

Threading pipe

Pipe threads must be cut clean and smooth. The dies and pipe-cutting tools must be sharp so that they will not drag metal. Threads that are not clean and smooth will fit poorly; leakage will probably result, and slivers of the poorly cut threads may enter the system. Oil should be used liberally when cutting threads.

After pipe has been cut or threaded, the ends should be inspected for burrs. All projections and sharp edges, inside and out, should be removed. If this is not done, the burr will obstruct the flow of fluid, and loose metal particles may get into the pipe line and damage the system.

Metal is removed when a pipe is threaded, thinning the pipe and exposing new and rough surfaces for chemical action. Corrosive agents work more quickly at such points than elsewhere. If pipes are assembled with no protective compound on the threads, corrosion sets in and the two sections stick together so that the threads seize when disassembly is attempted. The result is damaged or broken threads and pipes.

To prevent seizing, Permatex or some similar antiseize compound should be used on the threaded portion of the pipe after engaging the first three threads at the end. Antiseize compound should not be placed at the extreme end of the threading, because particles may enter the pipe line and damage the system. The compound should be used sparingly and on male fittings only.

Flanged pipe fitting

Flanges are used on most hydraulic pipe lines of the turret installations. They consist of a male and a female flange secured to the pipe ends with a seal placed between the joining flanges, which are then bolted together. If the flanges are designed to take a gasket, one of proper thickness must be used between the mating surfaces of the flanges in order to make a tighter connection. The gasket must be trimmed as described on page 17-4 , before installation. Flanges are occasionally screwed to a threaded section of the pipe and back-welded or brazed. The flanges are usually smooth bore-fitted units, silver-brazed on the end of the pipe. This method of assemblage eliminates any possibility of leakage between the flange and pipe.

Flanges must be squarely aligned when they are assembled together. The bolts diametrically opposite should be set up fairly tight, and the remaining bolts tightened an equal amount. Tighten each bolt an equal amount until on the last round all are equally tight.

Flared pipe fitting

To obtain a firm compression connection for flared tube fitting, the ends of tubes must be flared properly. The flare is made by slipping the tube nut over the end of the tube, inserting the ball-end of the flaring tool into the tube, and rolling the side of the tool over the end of the tube to flare the tube against the nut. The seat of a good flare is smooth and even, with the flared end projecting just beyond the end of the tube nut.

When the tube is properly flared and the tube nut tightened, the flare will seat firmly in the machined recess of the tube coupling. The tube will not turn when the nut is tightened and the flare will assume

the shape of any irregularities in the machined recess making a leakproof connection.

Cleaning pipe

Great care is required when hydraulic pipe is installed in the turret. A reconditioned pipe, or a pipe that has been removed for repair or servicing of an assembly, must be thoroughly cleaned before being installed. A pipe that has been removed and repaired, or to which any new connection, vent plug, gage plug, or other fitting has been added, requires the same cleaning as a new pipe. New pipe is shipped with metal discs or plug inserts to keep dirt out. It has been factory-inspected and, although presumably clean, must be recleaned before installation. All piping must be shaped to make a perfect fit to the various hydraulic units before final cleaning. Pipes should not be forced into place to make them fit, but should be removed and reshaped. If, at the time of installation, it is found necessary to reshape or to bend a pipe even slightly, remove the pipe and repeat the cleaning procedure described below. All piping should be cleaned after all other work is finished and just prior to installation. If, for any reason, the cleaned piping is not immediately installed in a closed system it must be recleaned before assembly. After cleaning, both ends of the pipe must be sealed until ready to install. To clean pipe proceed as follows:

Copper pipe.

1. Treat machined surfaces and threaded parts with hot paraffin wax.
2. Dip in acid-bath solution of two parts sulphuric acid, one part nitric acid, and four parts fresh water.
3. Wash in fresh, cold water.
4. Immerse for one minute in a neutralizing bath of 1-1/2 pounds of Magnus Number 2-1/2 per gallon of fresh water.
5. Soak in boiling water for 10 minutes.
6. Pass frayed wire rope through pipe (rope diameter to agree with size of pipe).
7. Wash internally with fresh, cold water at high pressure.
8. Dry thoroughly (do not use waste), do not leave threads or lint in the pipe.
9. Seal both ends until ready to install. Alternatively, copper pipe may be cleaned as follows:

Alternatively, copper pipe may be cleaned as follows:

1. Immerse in lye solution to remove grease and oil.
2. Rinse in warm, fresh water.
3. Immerse in 20 percent sulphuric acid solution for one-half hour. (When sand is used in bending copper tubing, immerse in a solution of 20 percent sulphuric acid and five percent hydrofluoric acid for one-half hour. This solution is prepared by adding hydrofluoric acid to the previously prepared 20 percent sulphuric acid solution.
4. Rinse in warm, fresh water.
5. Immerse in lye solution.
6. Rinse in warm, fresh water.
7. Immerse in sodium cyanide solution (four ounces to the gallon) for four minutes.
8. Rinse in warm, fresh water.
9. Dry by compressed air.
10. Brush
11. Blow out by compressed air.
12. Seal both ends until ready to install.

Steel Pipe.

1. Treat machined surfaces and threaded parts with hot paraffin wax.
2. Dip in acid-bath solution of one part sulphuric acid and 15 parts fresh water, remove immediately.
3. Wash in fresh, cold water.
4. Immerse for one minute in a neutralizing bath of 1-1/2 pounds of Magnus Number 2-1/2 per gallon of fresh water.
5. Soak in boiling water for 10 minutes.
6. Pass frayed wire rope through pipe (rope diameter to agree with size of pipe).
7. Wash internally with fresh, cold water at high pressure.
8. Dry thoroughly (do not use waste), do not leave threads or lint in the pipe.
9. Seal both ends until ready to install.
10. Oil to prevent rusting.

Alternatively, steel pipe may be cleaned as follows:

1. Immerse in hot lye solution to remove grease and oil.
2. Rinse in warm, fresh water.
3. Immerse for one-half hour in 30 percent hydrochloric acid at room temperature.
4. Rinse in warm, fresh water.
5. Immerse in lye solution.
6. Rinse in warm, fresh water.
7. Immerse in sodium cyanide solution (four ounces to the gallon) for two hours.
8. Rinse in warm, fresh water and brush until smut is removed.
9. Dry by compressed air.
10. Seal both ends until ready to install.

Making pipe connections

After cleaning and during installation, hydraulic equipment shall be opened only for as short a time as necessary for making connections, then connected as quickly as is consistent with good workmanship. The actual assembly of the hydraulic unit should be done when a minimum of other work is going on in the turret. Seals or plugs should be removed from pipe openings only when the joints are completed. Maximum care must be exercised to prevent foreign matter from entering the system. Joints must never be left open or unsealed when the mechanic in charge is absent from the job.

Cases may arise where the design of the hydraulic piping system is such that certain parts of the system must be welded, brazed or soldered in place and cannot be disassembled and removed to the shop for subsequent pickling and cleaning. Such piping should be fabricated away from the job, then cleaned before being

taken to the ship. Scale deposited by welding or other heat during installation should be removed. The pipe should then be blown clear with compressed air before the section is assembled in the system.

In fitting hydraulic pipe for the exact location of flanges, it is necessary to remove the airtight seals over the ports of the hydraulic units. During the fitting of the pipe, the interior of the units should be protected by a blank sheet-metal gasket of the same thickness as the gasket that will be used in the joint. The airtight seal must be replaced immediately after the fitting is made or the template taken.

When the final joint is made, the inner diameters of flat gaskets must be cut back slightly, so that the gasket material does not protrude into the system.

Sealing sleeves must be seated with careful initial alignment, with the connection drawn up evenly and without canting. A distorted or marred sleeve will leak and may produce a burr as it seats.

Pipe connection test

All piping, tubing, and fittings must be subjected to a hydrostatic test before installation into the system. These tests are to be performed on a suitable test stand provided for that purpose. Perform the following operation before and during the hydrostatic test:

1. Remove the rust-preventive compound on the interior surfaces of the tubing by washing with solvent Navy Specification P-S-661, before the hydrostatic tests.
2. Water used in the hydrostatic tests must contain 0.66 ounce of neutral CP sodium chromate to a gallon of water (to retard rust formation).
3. The pipe-testing rig should be filled with water and subjected to a test pressure of approximately 50 percent more than the maximum planned working pressure for each part.
4. After the test has been completed, drain the solution from the pipe, tube, or fitting and dry the interior with compressed air.
5. After the interiors of steel pipes have been dried, apply rust-preventive compound 52C18 (Grade 2) inside and out, if the pipe is not installed immediately.
6. Seal both ends of pipe until ready to install.

Shaping and securing pipes

Piping and tubing must be accurately bent and fitted so that it will not be necessary to force a section into place to make a satisfactory connection. Piping or tubing which has a length of greater than 50 diameters between fittings, and particularly pipe or tube sections which are subject to rapid variations of pressure, must have pipe clamps or brackets, or some other support near each bend. Vibration in such tubing will affect normally smooth operation of the equipment and will result in leaks. Stress must be minimized throughout the system.

Filling hydraulic drive systems

When a new hydraulic drive system or a drained system which has been repaired or serviced, is filled with fluid, great care must be taken to insure that the fluid is not exposed to dust, fumes, or moisture. Fill the system with the prescribed fluid and proceed as follows:

1. Assemble full containers of an adequate supply of the hydraulic fluid required for the specific system.
2. Close all drain connections and, following specific instructions for the system to be filled, pour the fluid into a 200-mesh screened funnel (a 120-mesh screened funnel may be substituted if the system is being filled with 51F23 (Ord)). Cloth or rags must never be used to filter the fluid.
3. Vent the system according to specific instructions after it has been filled.
4. Replenish the system with additional fluid until the system fluid level is at the proper level.
5. Take test samples of fluid from principal units of the hydraulic system. Examine and test each sample for foreign matter, water, sludge, and acidity as described on page 17-5. If any test is positive, drain the fluid and flush the system until satisfactory samples are obtained.
6. When the system is clean, set the controls and operate the drive as described in the instructions given in the next paragraph.

Procedure for initial period of operation

Filling and flush-cleaning operations should be performed, wherever possible, without operating the power drive of the system that is being filled. If this is not practicable, operation of the drive should be at an absolute minimum until test samples establish that the system is clean. When a new or overhauled replacement unit has been installed, flushed clean, and refilled to the proper fluid level, the following operating plan should be followed:

Set all controls at neutral and start the electric motor of the hydraulic drive. Build up response pressure of main and auxiliary pump circuits, and for ten minutes permit such circulation to take place as will occur with the controls at neutral. This circulation will be small, comprising in most systems the oil leakage through valve block ports and past valve surfaces. However, it is an important operation to remove particles at or near contact surfaces which otherwise might produce scoring. It is essential that no valves or other parts having very fine clearances be moved even the slightest amount until the system is as clean as possible.

After this period of operation, examine the screens or filters (if any), in the system, and, if any evidence of foreign matter is found, drain all oil, flush, and refill the system.

When the filters remain clean, start moving the controls, creeping very slowly and gradually building up speed and power. During such operation, watch for symptoms of valve sticking, for evidence of binding of parts, and for leaks. At the first sign of such conditions, stop operations, diagnose the trouble and correct. Do not attempt to "work out" stiffness, lag, vibration, or any other malfunction. Always stop the machine, locate and correct the trouble.

MAINTENANCE INSTRUCTIONS

General

When installing the various pipes, tubes, and fittings of a hydraulic system, it is essential that the installation instructions in this chapter be followed carefully.

Cleanliness is as important when servicing a hydraulic system as during the initial installation. The maximum possible effort must be exerted to prevent the entrance of foreign matter into the system.

After a hydraulic system has been properly installed, has been thoroughly cleaned, has passed a dynamic test, and is filled with clean hydraulic fluid of the correct specification, it should perform satisfactorily for an indefinite period. Observe the following instructions to keep the system operating properly:

1. Keep all fluid clean, neutral, and free of residue. Filters should be examined frequently after the system has been put into use. Fluid should be checked monthly (daily for a new installation) for evidence of acidity, moisture, and sludge.
2. When ships return to their fitting-out yards after the shakedown cruise, and monthly thereafter, samples from each system should be drawn and checked.
3. All residue, metal particles, and other foreign matter found in filters must be identified in order to determine the source.
4. Fluid must be filtered by pouring it into a 200-mesh screened funnel (a 120-mesh screened funnel may be substituted if the system is being filled with 51F23 (Ord)) when filling the system. Never use cloth or rags to filter hydraulic fluid. See filling instructions on page 17-4.
5. Maintenance instructions for each system in other chapters - and the exercise, fluid purity, and other instructions in this chapter - must be observed at all times.

Daily exercise

All hydraulic mechanisms of the turret should be exercised daily. It is not necessary to train or elevate guns to their limits, nor to put other assemblies to the limits of their cycles. Response pressure should be built up, and parts moved relative to each other, in order to prevent residue from forming and causing sticking valves. When exercising hydraulic gear, take care to operate initially in HAND and AUTO at very slow (creeping) speeds. Such operation will enable personnel to recognize the first sign of trouble by observing the quickness of response and the general performance at slow speeds. It facilitates locating and isolating troubles by observing under which control selection the troubles occur. During exercise operation, watch for symptoms of valve sticking, for evidence of binding, and for leaks. At the first sign of such conditions, stop the equipment, diagnose the trouble, and correct it. Do not continue to operate in an attempt to "work out" the malfunction.

Hydraulic fluid

The fluid specified for use in the turret elevating and training gears is a special hydraulic fluid compound designated by Bureau of Ordnance Specification Number 51F21 (Ord). Hydraulic fluid designated 51F23 (Ord) is used in all other turret hydraulic systems and may be used as a substitute for 51F21 in the elevating and training gears. Both hydraulic fluids described in chapter 18, will blend if a mixture is necessary or desirable.

Use of filters to maintain fluid purity. Filters in each system must be opened, examined, and cleaned at regular periods; not less than once weekly. Foreign matter in filters must be identified as to source, if possible. The parts producing such particles must be disassembled and corrected, and replaced if necessary. When such filter evidence is apparent, the systems must be drained and flushed clean. Make certain, when filling hydraulic units, that the fluid is free from sediment and water. Fluid should be tested as described in following paragraphs, and the system should be filled as described on page 17-4. Care must be taken to keep the fluid storage drums sealed and in a relatively cool location.

Test for water. If the hydraulic fluid develops a cloudy appearance, need for purification to remove water is indicated. Test for presence of water is made by using a microscope with a magnification of approximately 50 diameters. Place a few drops of the fluid on a slide which has been dusted with a light coating of very finely divided dry dye, such as neutral red, which is water-soluble but not oil-soluble. Examine the specimen for staining of the bubbles in the fluid. Bubbles of water will make red stain, bubbles of air will not.

Test for acidity. Hydraulic fluid should be renewed when its acidity increases to the point where the neutralization number becomes 0.50 or higher. This number is determined by the number of milligrams of potassium hydroxide required to neutralize one gram of fluid. To test the fluid for excess acidity,

prepare a mixture of 50 cubic centimeters of alcohol, 50 cubic centimeters of distilled water, and 20 grams of the fluid to be tested. Heat the mixture to the boiling point and agitate by swirling gently. Add one-tenth cubic centimeter of phenolphthalein indicator and sufficient N/10 potassium hydroxide to produce a definite pink color. The neutralization number of the fluid is determined by the number of milligrams of potassium hydroxide added to the test sample to give this color.

Test for sediment. Hydraulic fluid may be tested for sediment content by the following procedure which requires the use of two clean test tubes and medicine droppers, and filter paper. Fill one tube 2/3 full with a sample of fresh, filtered fluid of the same specification number as the fluid to be tested. Fill the second tube with an equal amount of the fluid to be tested. Shake both tubes vigorously for 1/2-minute and then fill the medicine droppers with samples from each tube. Place ten drops of each fluid on separate pieces of filter paper. If, after a comparison is made, the sample from the system shows an appreciable amount of sediment the system should be drained, flushed, and refilled with fresh fluid.

Hydraulic system service maintenance

System installations for servicing. The turret hydraulic drives include service fittings for venting, for attaching pressure-test-gages, for opening and cutting off system lines, and for maintaining turret flame-seal of compartments and spaces. These fittings have different locations in the different systems and the schematic diagram for the hydraulic drive to be serviced should be referred to.

Venting of hydraulic systems. Hydraulic systems which are not self-venting must be vented periodically. Air in a system results in noise in pump, motor, or pressure pipe line, and causes irregular operation. To vent the system, operate the unit and open the air-vent valves (located at the system high points) until the escaping fluid ceases to have a frothy appearance. If the noise still continues it is an indication of mechanical trouble, and should be checked and corrected immediately.

Gage fittings. Gage fittings consist of a gage connection boss and a gage plug. On pipes of large diameter, the gage connection boss is positioned on the pipe and brazed in place. Gage fittings on small diameter pipes actually become part of the pipe in which they are installed. Connection lines are inserted into opposite ends of the gage boss and are brazed in place. A 1/4-inch gage plug is screwed into the boss at all times except when a gage is installed.

Drain-plug fittings in pipe lines. Drain-plug fittings, as installed in the pipes of the various systems, consist of a boss brazed to the underside of the pipe, and a plug threaded into the boss. The boss is undercut at the surface of contact with the pipe and permits flush brazing.

Special shut-off valve arrangements. The turret hydraulic systems are equipped with shut-off valves which are at all times locked in either the OPEN or CLOSED position, depending on the line in which they are installed.

Maintenance of valves. All valves must be handled carefully. If a valve is dropped, a part vital to its dependable operation may be broken or deformed. Valves should be located where they are not exposed to damage from blows. They should be accessible, and it should be possible to open or close them fully. Valves should not be installed where they must carry the weight, sag, or expansion of a line.

Valves should be in the closed position during installation. Operating parts are less likely to become twisted, and areas of closure are protected. The packing in a new valve should be tightened after it has been in use a short time, but it must not become tightly compressed.

Open and close valves slowly. Do not force the disc against the seat. If a valve refuses to seat properly, open it slightly so that sediment on the seat will be flushed away. If the valve still fails to seat, the system must be shut down and the valve disassembled to locate and correct the trouble. Valves that have been shut when the system is hot should be tested for closure when the system has cooled.

Inspect all valves regularly. Keep them locked in the position required. Never turn a valve knob or stem with a wrench. Valves should be tested four times a year.

In disassembling, be sure that the valve is open. Do not use a long-handled wrench to release the valve. A few light hammer taps on a short wrench are more effective, and will not twist the valve.

Use only the correct tools when reassembling and be sure that the valve is in the closed position during installation. Valve repair parts should be ordered by giving the manufacturer, serial number on the valve, its size and type, and the name (and number) of the part.

Successful operation of a hydraulic system depends upon the proper operation of the valves in that system. The operator should know what valves must be open, and what valves must be closed. Always check the valve to make sure it is in the correct open or closed position before starting the system.

Improper action of a hydraulic system can often be traced to faulty valve action. This is usually due to foreign matter in the valve seat, scoring or grooving of mating parts, or plugging of openings. As a result, the valve may stick, or may fail to close completely so that the system pressure is low, fluctuating, or non-existent.

The usual remedy for such conditions is to disassemble the valve, clean all parts thoroughly, replace damaged parts, and reassemble the valve.

Leakage through a valve may be due to foreign matter, to scoring of the valve, or to distortion of the valve seat because the valve is not strong enough for the system. Regrind the valve or install a new seat.

If the valve leaks through the stuffing box (around the packing gland), the gland must be set up by tightening the gland nut. Do not tighten too much or the stem will stick. It may be necessary to replace the packing to prevent leaking. If the stem does stick, the packing gland nut should be backed off slightly to release the packing. The stem may stick because it is rusty or dirty, and in need of a cleaning.

If the valve has been opened too far and allowed to jam, it may be necessary to use a wrench, which should be applied carefully so that the valve seat will not be damaged. If the stem threads are stripped or burred, replace the stem. Valve malfunction may be due to broken or weak springs. These should be replaced as soon as discovered.

Flame-seal and oil-stop fittings. Piping which extends from one level to another, or through a turret bulkhead, passes through flame-seal fittings which are designed to accommodate one or more pipes. When installing flame-seal fittings on the turret floor plate, first place a support stool in position on the plate and run a 1/8-inch fillet-weld around its base where it comes in contact with the plate. The flame seal proper comprises two castings, formed to the pipe contour, held together with socket head screws, nuts, and lockwashers. Each half of the casting is bolted to the support stool with socket head screws, nuts and lockwashers. Sheet gaskets 1/16-inch thick separate the flame seal from the top of the support stool and the outside of the pipe. Mating surfaces of the flame seal are coated with red lead at assembly.

Flame seals installed in turret bulkheads differ from the floor seals in that they consist of three pieces instead of two. Also, a support stool is not used. Mating surfaces of the flame seal are coated with red lead at assembly. All gaskets are tucked firmly into place before tightening the socket head screws.

For all fittings, after the socket head screws are tightened, nuts are tack-welded in place.

Precautions for hydraulic system dismantling and servicing

Satisfactorily operating hydraulic systems. Do not open hydraulic systems which perform satisfactorily and which show no evidence of sludge, rust, or malfunction. Keep all cover nuts tightly secured to discourage removal without good reason.

Operating precautions - instructions for engineering assistance. Systems which are operating unsatisfactorily, and for which the trouble and correction cannot be ascertained, must not be operated, except in emergency, until replacement can be made or until a representative of the manufacturer can be secured to make correction. If it is deemed advisable to request a service engineer from the manufacturer, the request must be accompanied by a complete report about the abnormal characteristics. If parts are damaged, explain the phase of operation in which the casualty occurred. Such a report will facilitate restoring equipment to service.

Ordering replacement parts. When ordering replacement parts for hydraulic equipment, give the manufacturer, the manufacturer's piece number (from the piece), the ordnance number (from the drawing), and the name of the part and a description of it. Inspect mating or attached parts for evidence of damage. Order replacement parts, similarly, if they are required.

Chapter 18

LUBRICATION INSTRUCTIONS

GENERAL INSTRUCTIONS AND INFORMATION

In order to give design performance, the many types of ordnance equipment and mechanisms installed in the turret require regular application of appropriate lubricants. For proper lubrication of equipment ranging from heavy-duty instruments, several kinds of oil, grease, and compounds must be applied at different specified times or intervals. Every moving component of automatic equipment used in the turret must be regularly and properly lubricated to ensure efficient turret operation. Regardless of difficulty of access, all mechanisms must have proper lubrication at all times. It is vitally important that the instructions on the lubrication charts, in the preceding chapters, and in the following paragraphs be adhered to at all times.

Turret lubrication facilities

All bearing surfaces and moving parts of all turret assemblies have provision in the design for lubrication. The access facilities include pressure fittings, grease cups, cover plates, filling caps, and other devices, the positions of which are shown on the lubrication charts. Certain fixtures and mechanisms have sump or reservoir arrangements, and some are equipped with self-contained circulating systems. Moving parts within the hydraulic units are lubricated by the fluid which circulates within the systems. Special fluid is prescribed in each instance for such systems.

Selection of lubricants

The selection of lubricants for the various bearing surfaces is based on design and service use. The oils, greases, compounds, and fluids specified by the lubrication charts are tabulated below.

TABLE OF PRESCRIBED LUBRICANTS

LUBRICANT NAME		PRESCRIBED SYMBOL
MIL-L-15016	Lubricating Oil, General Purpose MS 3042, MS 3150	
MIL-O-6082	Oil, Lubricating, Aircraft Engine MS 1065	
51F21(Ord)	Fluid, Power Transmission	
51F23(Ord)	Fluid, Hydraulic	
MIL-G-16908 (BuOrd)	Grease, Bearing	
MIL-L-3503	Lubricating Oil, Preservative, Light	
MIL-L-3572	Lubricant, Colloidal Graphite in Oil (Grade C - Heavy)	
NAVORD OS 1400	Lubricant, Worm Gear	
MIL-L-7866(Aer)	Lubricant, Molybdenum Disulfide	
MIL-L-16785(BuOrd)	Lubricating Oil, Breechblock	

Lubricant reference information. All materials of the above list are described and their limiting characteristics and purposes are defined, in "Lubrication of Ordnance Equipment, Ordnance Data 3000 Revision B." This publication is a reference book of general information prescribed for lubrication care of the 16-inch turrets.

Adulterants

Detection of harmful adulterants. For the purpose of sabotage, a wide variety of soluble, corrosive, gumming, and generally harmful agents may be added to lubricating oils and compounds. The detection of soluble adulterants in petroleum products requires tests that can be performed only by trained personnel with appropriate testing equipment. However, if there are indications of the presence of solid insoluble abrasives such as emery, carborundum, silica, pumice, etc., detection may be made by diluting a drain sample of the oil or grease with several volumes of gasoline (or solvent P-S-661) and filtering the mixture through chamois. If the presence of harmful agents in any lubricant is suspected, do not use it. Operate the equipment with an approved substitute of known purity. For the essential purity of hydraulic fluids, refer to chapter 17.

PRINCIPLES OF GOOD LUBRICATING PRACTICE

Effective and efficient lubrication maintenance depends on certain fundamental principles and practices indicated in the following paragraphs:

Function

The primary purpose of a lubricant, whether oil or grease, is to maintain an unbroken oil film between the surfaces of moving and stationary elements or moving parts. The oil film is intended to reduce friction and thus prevent excessive heat and rapid wear. Another function is to protect the surfaces from moisture, fumes, and acids -- thus preventing rust and corrosion. To apply and maintain the required oil film, various types of devices are incorporated in the turret mechanisms.

Frequency

The lubrication charts prescribe application of lubricants at regular periods. The periods are given as "Daily," "Weekly," and "Monthly," or with alternative "period of operation." In addition, other periods are designated on the charts or in the instructions of preceding chapters for certain parts or mechanisms as "Before operating," "Before firing," "Before assembly," "After firing," and "At overhaul." These prescribed intervals are essential to good operation and preservation.

Distribution

Unless the lubricants are properly distributed over the bearing surfaces, the parts may become galled or scored, and in some cases become seized or frozen. To ensure adequate distribution of lubricants, the equipment should be exercised during or immediately after lubrication. This obviously does not apply to elements which require the application of oils or compounds only after the gun is fired.

Lubricant distribution obtained by exercise is a design feature of the bearing, gear housing, oil bath sump, and pump supply system details of most mechanisms. These design features comprise grease grooves in bearing surfaces, oil scoops or traps in gear housings, and pressure supply pump and pipe distribution.

Lubrication of antifriction bearings

The fundamentals of lubrication of antifriction-type bearings (ball and roller bearings) vary greatly from those involved in the lubrication of other bearing surfaces (sleeve and sliding types). In the latter type bearing, the journal load is supported by an oil film. The maintenance of this film under various speed, load, and temperature conditions influences the selection of the type of lubricant and the method by which it is to be applied. With antifriction bearings, the high unit pressure existing on the very small contact surfaces of the ball or roller tends to break the oil film and make the formation and maintenance of an unbroken oil film impracticable. The load is supported directly by the balls and rollers, and races which are in direct metal-to-metal contact with the moving elements of the equipment.

Because an unbroken oil film does not exist between contact surfaces of the balls or rollers and their races, the ability of these parts to support heavy loads is due to deformation or flexing action within the ball or roller. This continual flexing action generates heat which, if not dispelled by lubricants, would cause rapid wear and serious damage to the entire bearing assembly. To dispel this heat, the lubricant must be of a type and consistency to provide a proper lubricating film between the balls or rollers and the separators or cages. The lubricant must prevent rust or corrosion of the bearings and isolate them from dirt, water, and other foreign matter.

Any scratching, etching, or other destructive action, on the surfaces of the races, balls or rollers of antifriction bearings, rapidly destroys their load-carrying ability. Great care must be taken when cleaning, handling, packing, installing, and servicing all types of such bearings.

Oil used to lubricate antifriction bearings should be drained as soon as it becomes dirty, which indicates the presence of foreign matter. The bearings and related parts should be flushed with mineral oil and again drained before new, approved lubricant is applied. If the approved lubricant is grease which cakes or becomes dirty, flushing with mineral oil will not be sufficient to completely remove the grease. It will be necessary to remove the bearing, immerse it in solvent Navy Specification P-S-661, and rotate the balls or rollers until the old grease is completely removed. Cover the bearing assembly until ready to install. Apply a few drops of light mineral oil symbol 3042 to the moving parts of the bearing before packing it with grease. When packing the bearing at reassembly, apply absolutely clean lubricant to each ball or roller and use the fingers to force the grease into and around each part. It is essential that all bearing parts receive a light coating of lubricant. It is not essential to completely fill all bearing cavities; most bearings operate cooler and last longer if not completely filled with grease. To pack the bearing properly, use only one-half to two-thirds of the amount it would take to fill all openings in the bearing assembly completely. This will permit lubricant expansion caused by the churning action of the parts. Unless provision is made to compensate for such expansion, the parts will overheat and oil seals will become distorted.

Caution must be used in the application of grease with the pressure gun because of the danger involved in overpacking the bearing assemblies.

There are exceptions to these general rules for grease lubrication of antifriction bearings: for example, deck lug bearings should be completely filled with grease at all times.

Excessive lubrication

Many lubricating points of the ordnance installation have limited capacity for lubricants. Sparing application is required, though in some instances the application must be frequent. Excessive lubrication can cause serious damage in addition to the exuding grease and oil. This is particularly true of turret electrical installations. Excess oil and grease destroy the insulation of power and communication leads, cause malfunction of switches and solenoids, and ruin motor armatures. All motors must be sparingly lubricated, and the excess lubricant accumulation in motor cases and at the grease retaining basins of main shaft bearings of some designs must be removed by opening the drains at least once a month.

Enclosed gear boxes with provision for oil-bath lubrication will overheat and may cause splash penetration into adjacent switch and motor units if the lubricant is added above design level. All such units are equipped with high- and low-level trycocks or plugs, or an oil gage. Units to which these instructions particularly apply are the motor base bearing brackets of the parbuckling gear assemblies, the rammer reduction gear, and the projectile ring pinion drive speed reducers.

Cleanliness

When handling, applying, and storing lubricants, the importance of cleanliness cannot be overstressed. Because the lubricant comes into direct contact with the bearing surfaces of moving elements, the presence of foreign matter in the lubricant will quickly cause serious damage to the vital parts. To prevent such damage by contaminated lubricants, the following rules must be observed:

1. Always use clean, fresh lubricants when refilling oil or grease reservoirs and when applying greases or compounds to bearing surfaces.

2. Always make sure that the lubrication guns and equipment, as well as the hands, are free from dust, dirt, chemicals, moisture, or other foreign substances.

3. In the instance of disassembled grease-lubricating bearings, the old grease must be completely removed, and the bearings and housings must be washed thoroughly before the fresh grease is applied.

4. Always store unused lubricants in waterproof and dustproof containers with the cover securely seated.

Preservation

Many of the parts of the gun, the slide, the power drives, and the control and securing devices of the turret installations are exposed finished-steel surfaces that cannot be preserved by painting. "Easy victims" for rust corrosion, they must be constantly observed and coated with prescribed lubricants of other preservatives. This lubrication principle applies particularly to "After firing" application of preservative coating to the bore and powder chamber, all bright work of the breech mechanism, and the exposed portion of the gun slide. It is not sufficient merely to apply the preservative coating. The surfaces must first be thoroughly cleaned, and all finger and hand impressions must be neutralized and wiped dry.

Substitution

The most important principle of good lubrication practice is consistent adherence to the lubricating plan. More damage can be done to ordnance equipment by mistaken judgment in selection of lubricants than will occur if the lubricant is omitted. Careless substitution can cause serious casualties and will result inevitably in poor performance. Substitution of a heavy lubricant (or one not proper for expected cold weather) in housed mechanisms that are lubricated by oil bath will groove the lubricant, resulting in damaged gear teeth and overheated, galled, and seized bearings. Similarly, substitution of grease for the light preservative oil in sight and gun attachment mechanisms will cause signal error in the shaft transmission system due to frictional-torque. Avoid trouble by always using the lubricants prescribed by the lubrication charts.

Temperature variations

The oils, greases, and compounds specified on the lubrication charts are for use under all normal operating conditions and temperatures. In extremely cold weather, some of the greases and oils may congeal to a point which precludes satisfactory application, distribution, and operation. When this occurs, the parts affected and the associated oil grooves, reservoirs, feeding channels and fittings should be thoroughly cleaned. Care must be taken to prevent trapping of appreciable quantities of any cleaning fluid in the operating mechanism. Where internal grooves cannot be reached for manual cleaning, light oil should be injected at the lubrication point. After application of the light oil, the equipment should be wiped dry and liberally coated with a light mineral oil to provide adequate lubrication. The oil should be one which will not congeal to a point where adverse operation effects may be encountered. Such application must be repeated more frequently than prescribed by the chart. Systematic inspection must be made at regular intervals to ensure that there will be no rusting of working parts. Immediately upon return to regions where operation temperatures are within the higher ranges, the original specified lubricants should be restored.

LUBRICATION CHARTS

Detailed lubrication instructions for all turret assemblies are given on the series of lubrication charts listed below. The charts are designed to ensure that no lubrication point will be missed, and that the frequency of lubrication will be adequate under all service conditions.

Lubrication Charts For
16-Inch 3-Gun Turrets U.S.S. IOWA Class

Name of Assembly	Drawing Number
Breech mechanism	252446
Slide	252447
Deck lugs	252448
Elevating gears	252449
Training gear, above electric deck	252450
Training gear, above pan floor	252451
Rammer	252452
Projectile ring	252453
Parbuckling gear	252454
Projectile hoist	252455
Powder hoist, car, and hoist indicator	252456
Powder hoist, upper end of trunk	252457
Powder hoist, motor and speed gear	252458
Powder hoist, control stations and lower end of trunk	252459
Sight station	252460
Sight stations and shafting	252461
Rangefinder stand	252462

Detailed lubrication features

Lubrication features of all ordnance assemblies include pressure grease fittings, grease cups, and lubricant reservoirs in addition to lubricant circulating systems. Some assemblies have special fittings or features, described in the following paragraphs, for application of the prescribed lubricant.

Breech mechanism. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 3. The salvo latch mechanism, the breech plug forward and rear bearings, the gas ejector bearing pin, the rotation cam rollers, and other parts requiring daily lubrication are oil can lubrication points, some of which are equipped with ball-check fittings.

Gas check pads. Lubricate with molybdenum disulfide, MIL-L-7866 (Aer), as follows:

1. Remove all foreign matter from the surfaces of the pads with a clean dry cloth.

2. Sprinkle the molybdenum disulfide over all pad surfaces and rub it in thoroughly with a clean dry cloth coated with the dry lubricant.

3. Examine pads at periodic intervals and lubricate as noted above when required.

CAUTION: Neoprene gloves should be worn while handling the dry lubricant. Prolonged contact with the skin may cause dermatitis (inflammation of the skin).

Slide. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 4. There are numerous oil can lubrication points such as the plunger cover latches, and the differential indicator rod brackets.

Deck lug. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 4. The trunnion radial and thrust bearings are lubricated through tubing connected to a manifold block mounted on the trunnion cover plate. This block is provided with four pressure grease fittings.

Elevating gear. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 5. There are numerous oil can lubrication points such as the handles on the control handwheels, the response gear coupling, and the roller and plunger of the danger zone cutout switch. The power drive flexible couplings are lubricated by removing two socket head plugs from the coupling and then filling the unit.

Training gear. Refer to the applicable lubrication charts and to the special lubrication instructions given in chapter 6.

Electric deck. Oil can lubrication points include the control handwheel handles, the neutral return hand pump handle, and the plunger and roller of the danger zone cutout switch.

Pan floor. Oil can lubrication points include the power-off brake linkage and shoe pins. The power drive flexible couplings and response gear upper bracket are lubricated by removing socket head plugs and then filling the unit.

Rammer. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 10. Oil can lubrication points are numerous and include the control lever pivot, control shaft bracket link, and linkage housing seal and clevises. The sprocket wheel roller bearings are lubricated through tubing connected to a manifold block located in the turret officer's compartment. This block is provided with pressure grease fittings.

Projectile ring. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 7. The auxiliary pump, response, and electric motor couplings are lubricated by removing socket head plugs and then filling the unit.

Parbuckling gear. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 8. The shaft bearing units are lubricated by removing plugs and then filling the units.

Projectile hoist. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 9. Oil can lubrication points are numerous and include the rack pawl shaft and plungers, tube pawl control mechanism, bell cranks, control handle bearing and solenoid plunger, and cradle latch operation shaft. The motor flexible coupling is lubricated by removing the socket head plug and then filling the unit.

Powder hoist. Refer to the applicable lubrication charts and to the special lubrication instructions given in chapter 11.

Powder car and indicator mechanism. Oil can lubrication points include the dumping trays handle latches and the lower switch lever.

Upper door, door locking mechanism sheave and safety latches. Oil can lubrication points are numerous and include the dog locking mechanism, selector lever and control lever brackets, safety latch brackets, and the locking dog operation linkage.

Motor and speed gear assembly. Oil can lubrication points are numerous and include the external cam links and speed gear control linkage, the servo selector linkage, and the valve control linkage and brackets. The motor and speed gear flexible coupling is lubricated by removing the socket head plugs and then filling the units.

Control stations and lower door. Oil can lubrication points are numerous and include the lower door sheaves, the lower door latch mechanism, the upper door dog operating mechanism, the starting lever, and the lower door limit switch levers.

Sight. Refer to the applicable lubrication charts and to the special lubrication instructions given in chapter 13. Oil can lubrication points include the pointers' and trainers' handwheel handles and seat pedestals, the telescope locking devices, and adjustable couplings.

Rangefinder stand. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 14. Oil can lubrication points include the operators' seats, and the hood shutter-operating handwheel shaft bearings.

Chapter 19

TOOLS AND ACCESSORIES

GENERAL DESCRIPTION

Turret equipment identified in this chapter comprises tools and accessories for servicing, adjusting, testing, and replacing parts of the ordnance installation. This equipment includes all devices required to secure and maintain alignments, verify positions, make repairs, replace parts, and perform "trouble shooting" tests. Included are items of special design and limited, specific use. All other items are standard, general-purpose tools of stock design and issue.

Special equipment

Wrenches, screw drivers, test outfits, gun tools, and other items designed to perform a particular operation or to hold or assemble, load, and test a single unit or class of equipment, are "special tools and accessories." They are identified and listed under that category in the listings of the following pages. Use of each item is limited to performing the operations for which it was designed.

Standard equipment

Hammers, pliers, grease guns, adjustable spanners, socket wrenches, and all similar stock items are "standard tools and accessories." They are intended for use in servicing any turret installation. All such items are identified in the following pages under the lists of "standard" tools.

Identities

Each tool is identified by an ordnance drawing part number (Navy Bureau of Ordnance), of Federal Standard Stock Catalog number, or an Item number of the Catalog of Navy Material. These identities are stamped or cast on the device or on an attached metal tag.

Types

16-Inch turret ordnance tools and accessories include various types of equipment, most of which are manually operated. Some equipment comprises engineering instruments and others are ordnance rigs for IOWA class turrets. All are classified in one of the following categories:

Ammunition handling equipment
Conditioning and preservation equipment
Servicing tools and accessories
Disassembly tools
Test and exercise apparatus

Ammunition handling equipment. Two groups of accessories are provided for handling powder and projectile units. These are Bureau of Ordnance items, identified in this chapter, and other items of Bureau of Ships cognizance. Bureau of Ships accessories include ammunition loading trunk fittings, portable beams and sheaves, fixed whip hoists, monorail trolley-type conveyors and chain hoists, and other accessories and devices specially designed for serving ammunition to the turret magazine and projectile stowage.

Bureau of Ordnance equipment complements that of the Bureau of Ships. It comprises powder tank and projectile handling trucks, projectile carriers, powder tank carriers, and similar devices required for transporting ammunition when stowing.

Conditioning and preservation equipment. Principal tools and accessories for conditioning and preserving the ordnance installations are the gun maintenance items. These are the bristle sponges for cleaning the bore and powder chamber, the plug gage for locating constrictions in the bore, and the lapping head for removing such constrictions. They are supplemented by the tompion and muzzle cover which protect the gun interiors from weather.

Servicing tools and accessories. A large number of special and standard tools and accessories are provided for servicing the ordnance installation. This equipment comprises all items required for filling and charging the assemblies with liquid and air, all items for lubricating, and other devices for aligning and securing. A broad class of equipment, it is identified throughout the listings of the following pages.

The use of such items as the recoil and counterrecoil system pneumatic and fluid charging apparatus comprising the portable pipes, funnel, and pump (pages 19-11 and 19-12), and the wrenches and tools employed in charging and during performance of "running-in" operations.

Disassembly tools. Most of the standard tools and many of the special items are provided for purposes of dismantling and reassembling the ordnance installations when making adjustments, repairs, and replacements. This class of equipment includes hydraulic packing tools and socket wrenches, spanner wrenches, and other special devices for pulling and inserting the sealing elements of high pressure components.

Test and exercise apparatus. A group of important test and exercise accessories are identified in the following pages. This equipment includes hydraulic gage devices, fire control alignment and dial accuracy checking equipment, and other items. The use of equipment of this class is specified in applicable chapters.

INSTRUCTIONS

General

Special tools and all accessories are designed for specific applications and should not be used for other

purposes. Standard tools are for conventional use according to the instructions of the officer in charge. Use wrenches only when they fit the parts precisely, to avoid damaging the parts and wrenches. Do not abuse tools; proper fit of tool and engaged part minimizes wear and possibility of breakage. Improper fit may result in damage to both the tool and the engaged part. Also failure of an over-stressed tool may result in personal injury. Tools and accessories must be kept clean, properly lubricated, and in good working order. They should be cleaned and lubricated, and returned to the stowage box immediately after use. Storing instructions are given in the next column.

Operating precautions

When using any type of tool or accessory which has more than one application, be certain that the tool fits properly. Use of spanners and wrenches which are not exact fits will result in damage to the tool and to the part being worked on, and may result in injury to personnel. Use of pressure gages or other test apparatus of improper capacity may result in destruction of such apparatus. Improper fit of packing guides and oil seal leaders may result in damaged packings and oil seals. These tools must be handled with great care to prevent nicks and burrs which would damage a piston rod or cause a new packing or oil seal to leak. Before applying force to any rotating tool or wrench, examine the threads for the proper direction of rotation. Open-end wrenches must be applied with the direction of pull toward the short jaw. A steady, even application of force is preferable to a jerk or a sudden surge.

Paint or other protective coating on tools should be renewed whenever it wears thin or becomes broken. Unpainted or bright surfaces should be protected with medium preservation lubricating oil MIL-L-3150 at all times.

Service operations which require any type of rigging should be carefully planned in advance. All rigging must be adequate and secure to prevent breakage or slippage which might cause damage to tools or mechanisms, and injury to personnel. Tapped holes for eyebolts are provided for hoisting most heavy equipment. Where this provision is made, such equipment should be used in preference to blocking and cribbing.

Threaded, hinged, sliding, and telescoping tools and accessories, as well as gages, should be exercised periodically to prevent rust formation, corrosion, and accumulation of dirt which might eventually make the assembly useless.

After tools have been used, return them to their designated position in the turret tool box, spare parts box, or storeroom as the case may be. Place pointed, edged, and fragile tools in racks of compartments so that they cannot be damaged by contact with other tools.

Storing

Preservative materials must be applied over clean surfaces. All tools must be cleaned thoroughly before storing. Use a Navy-approved solvent and a wire brush to remove dirt from metal surfaces. Dry cleaning solvent, Navy (Federal) Specification P-S-661, stocked by Federal Standard Catalog No. 51-C-1326-75 in 50- to 55-gallon drums is recommended for general use in the cleaning of tools and accessories. Commercially available materials such as Stoddard Solvent and Varsol meet this specification.

After tools and accessories have been thoroughly cleaned, those which are subject to corrosion are not to be handled again with bare hands. Clean cotton or leather gloves should be worn to prevent contamination of the cleaned surfaces with perspiration.

Moisture must be removed from the surfaces that are to be coated or otherwise treated with preservative. The preferred methods of drying are:

1. Air-drying by compressed air
2. Oven drying
3. Wiping thoroughly

Choose the proper preservative material and application method for the tool being stored. The preferred methods of applying preservative are:

1. Dipping
2. Spraying
3. Brushing
4. Flowing the coating on
5. Flooding or immersion

The preservative material must be applied immediately after cleaning.

Place all instruments in waterproof cases provided for the purpose, or wrap them in waterproof material before storing.

Keep tools and accessories which have rubber elements out of direct sunlight and away from excessive heat. Do not permit oil or solvent to come into contact with rubber.

When preparing tools and accessories for indefinite storage, follow one of the recommended methods of preservation. The material applied must provide satisfactory protection over a long period of time, and be of a type which permits easy removal.

When tools are removed from storage, clean all preservative material from the tools and lubricate them with light oil.

TABLE 19-1. GUN TOOLS AND ACCESSORIES

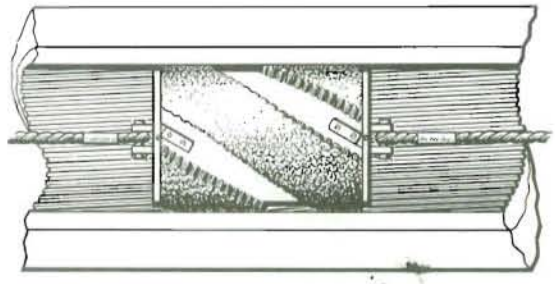
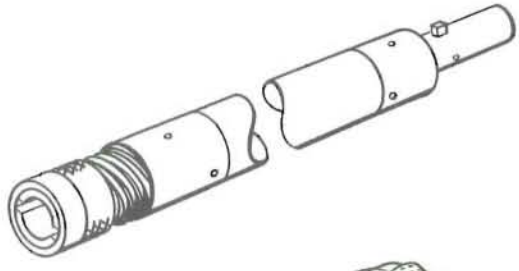
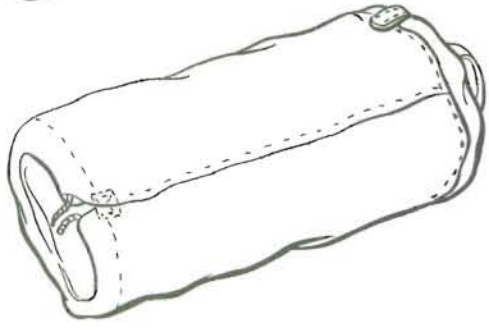
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Bristle sponge (bore)	8-Z-854	Clean the bore of the gun	
Bristle sponge (chamber)	8-Z-823	Clean the powder chamber	
Section handle	8-Z-825	With bore lapping head or similar accessories	
Bristle sponge canvas cap (bore)	8-Z-855	Protect bristle sponge (8-Z-854) when not in use	

TABLE 19-1. GUN TOOLS AND ACCESSORIES (cont)

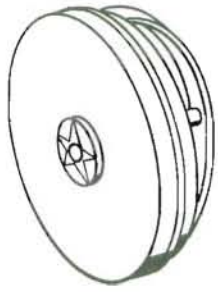
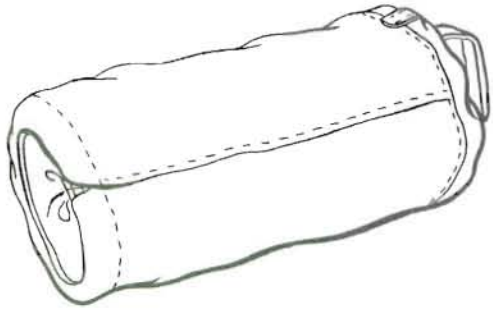
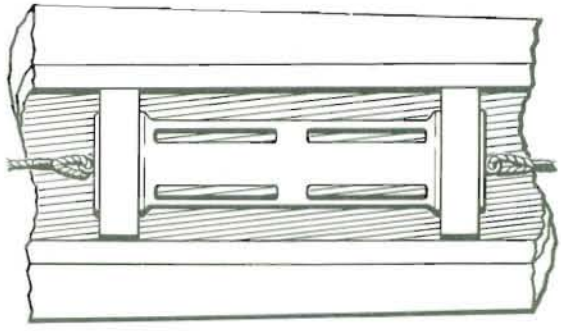
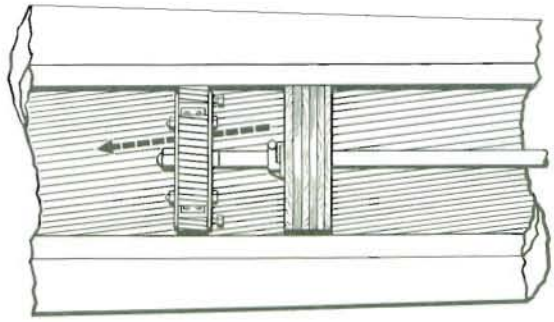
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Tompion	49830	To seal the muzzle end of the bore when the gun is not in use	
Bristle sponge canvas cap (chamber)	8-Z-849	Protect bristle sponge (8-Z-823) when not in use	
Bore plug gage	52120	Check gun bore for constrictions	
Bore lapping head	SK.12032	Clean bore and rifling of the gun	

TABLE 19-1. GUN TOOLS AND ACCESSORIES (cont)

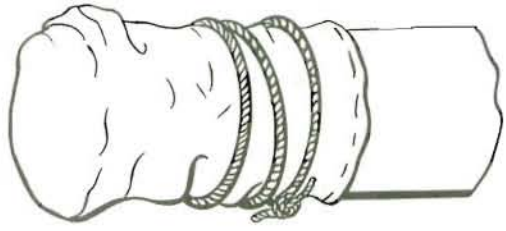
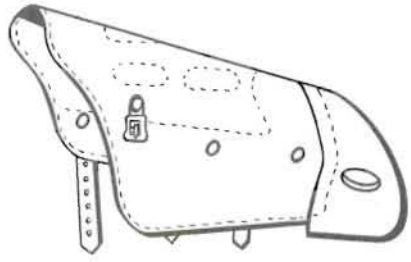
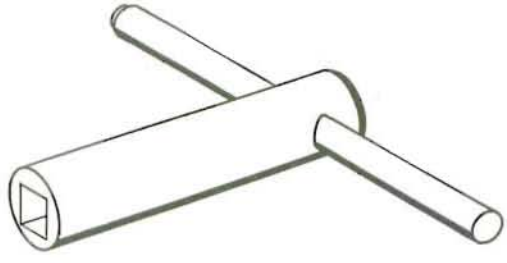
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Canvas cap	Fabricate locally	In addition to tompion to cover gun muzzle	
Gun captain's (base) sleeve	440598	To protect gun captain's arm when wiping mushroom after firing	
Gun captain's (cover) sleeve	440599	To protect gun captain's arm when wiping mushroom after firing	
Breech mechanism tools:			
Lifting bolt for Mason valve	50266-18	Removing the main valve	
Socket wrench for Mason valve	50266-20	Adjusting the valve (air pressure)	

TABLE 19-1. GUN TOOLS AND ACCESSORIES (cont)

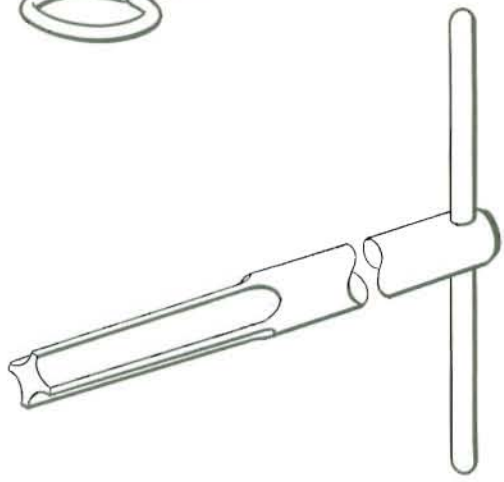
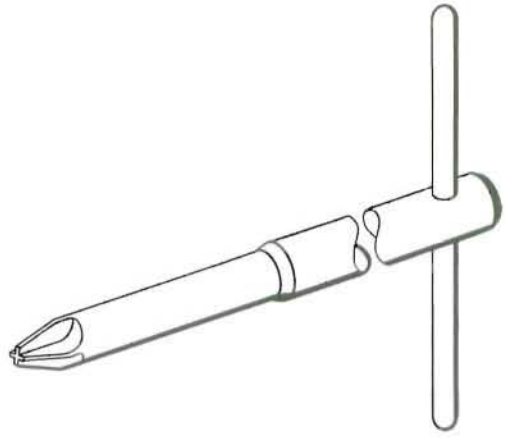
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Vent cleaner and priming bit	8-Z-901-9	Cleaning the hole drilled through the mushroom and stem	
Primer seat cleaner	8-Z-901-10	Cleaning the primer seat (mushroom stem)	
Primer vent cleaner	8-Z-901-12	Cleaning the mushroom vent hole	
Handle for primer seat and vent cleaners	8-Z-901-11	Turn primer seat and vent cleaners	

TABLE 19-1. GUN TOOLS AND ACCESSORIES (cont)

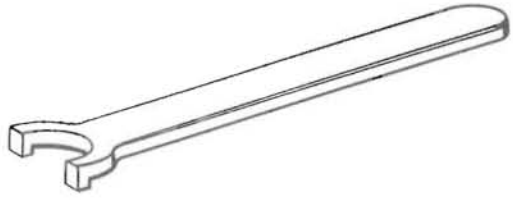
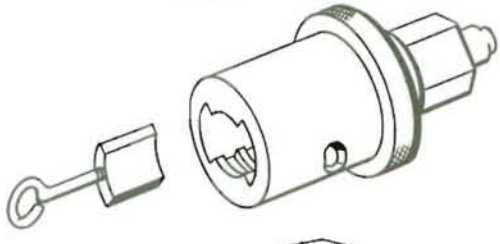
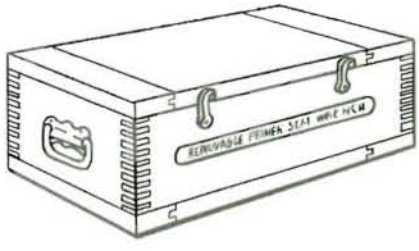
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Wrench for mushroom nut	8-Z-905-2	Tighten and loosen nut on end of mushroom stem	
Spanner wrench, face type	8-Z-918-4		
Spanner wrench, face type	8-Z-918-5		
Removable primer seat wrench	8-Z-922	Removing and replacing mushroom primer seat	
Removable primer seat wrench box	8-Z-857	To hold the removable primer seat wrench when it is not in use	
Packing bolt and plug	8-Z-954	Sealing air duct in screw box liner	

TABLE 19-1. GUN TOOLS AND ACCESSORIES (cont)

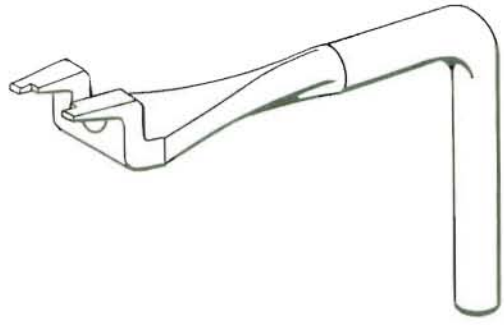
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Packing gun	8-Z 966	Sealing air duct in screw box liner	
Hydraulic grease gun	12-Z-339	Gun lubrication	
Mushroom stem protecting cap	26563-2	Protect mushroom stem when firing lock is removed	
Firing lock tools:			
Spanner wrench	8-Z-910-8	Removal of firing pin assembly	
Pin	8-Z-911-4	Adjust cocking lever spring tension	

TABLE 19-1. GUN TOOLS AND ACCESSORIES (cont)

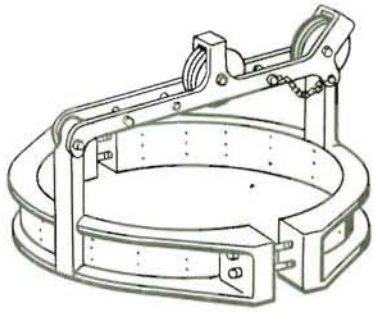
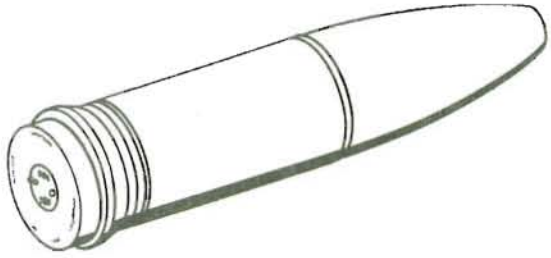
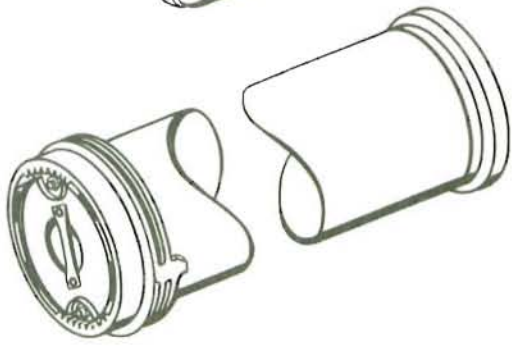
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Exercise accessories:			
Muzzle sheave rig, backing out rammer	236161	Remove drill projectiles seated in the gun	
Backing out rammer	236162	Remove drill projectiles seated in the gun	
16-inch Drill Projectile Mk 2	267650	Turret practice	
Drill powder bag	245791	Turret practice	
Powder tank Mk 4 Mod 0 Mk 4 Mod 1 Mk 8 Mod 0	 227612 330100 562265	Container for drill or service powder bags	

TABLE 19-1. GUN TOOLS AND ACCESSORIES (cont)

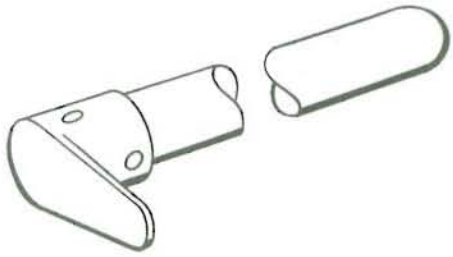
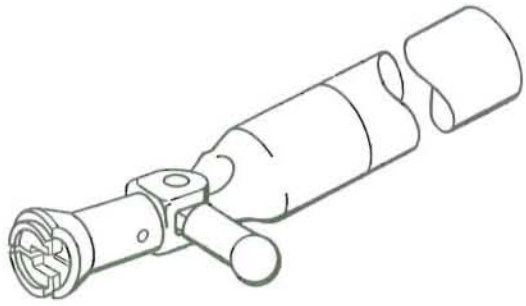
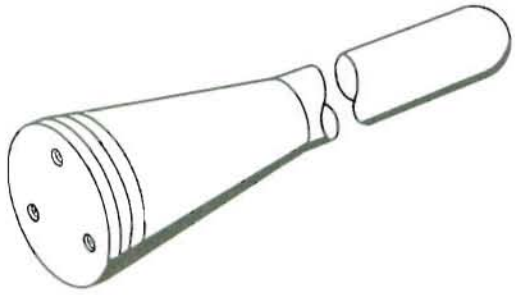
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Powder unloading tool	49401	To remove powder bags from powder tanks or gun chamber	
Repriming	8-Z-931	Insert primers, live, or dummy, in firing lock	
Hand rammer	8-Z-883	Seat projectiles, live or dummy, in gun	
Shell eye bolt Mk 2	66346	Pulling projectiles, live or dummy, out of gun	

TABLE 19-2. SLIDE TOOLS AND ACCESSORIES

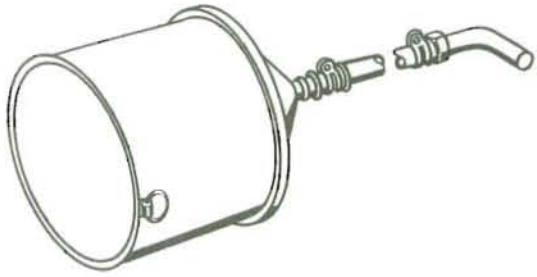
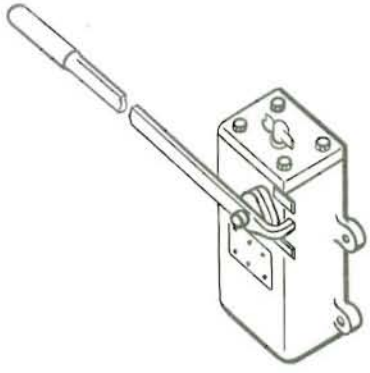
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Recoil system charging tools:			
Funnel assembly	8-Z-801		
Funnel adapter	8-Z-801-3		
Liquid charging pump	118218	Charging counterrecoil liquid system	
Portable air pipes (123 inches long)	232385-1	Charging counterrecoil pneumatic system, right and center guns	
Portable air pipes (123 inches long)	232385-2	Charging counter-recoil pneumatic system, left gun	

TABLE 19-2. SLIDE TOOLS AND ACCESSORIES (cont)

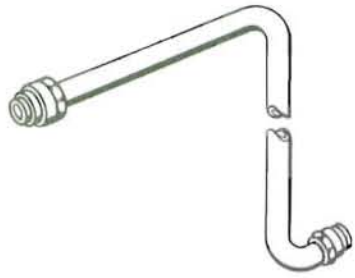
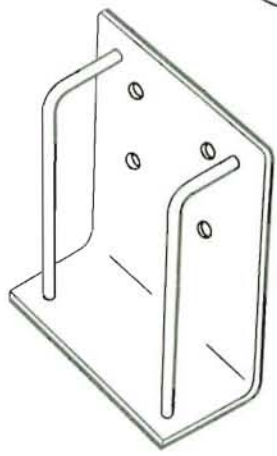
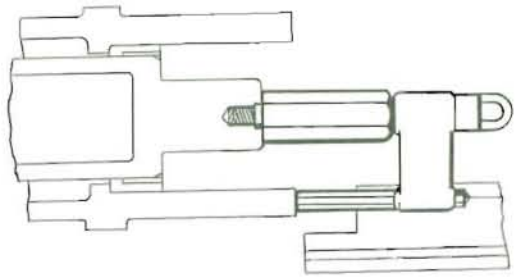
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Portable liquid pipes (93.50 inches long)	232384-1	Charging counterrecoil liquid system	
Liquid pump gage assembly	164698	Liquid pressure gage for charging pump	
Liquid pump stand	118768	Stand for liquid charging pump	
<u>Slide servicing tools</u>:			
Counterrecoil plunger support and stop	236064	When removing counterrecoil plunger packing	

TABLE 19-2. SLIDE TOOLS AND ACCESSORIES (cont)

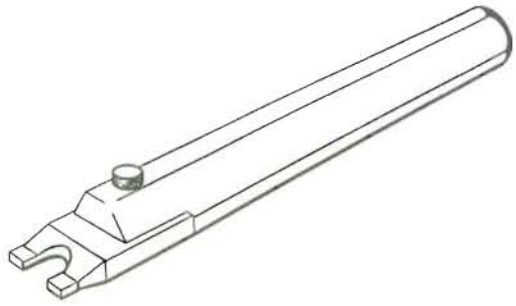
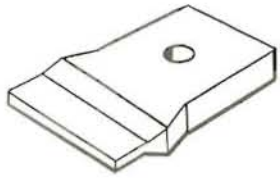
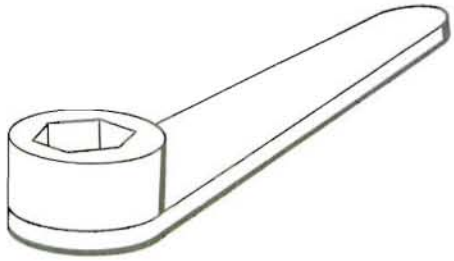
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Special screw driver assembly	8-Z-909-5, 7, 8	General maintenance and repair work	
Screw driver blade (1.50 inches wide)	8-Z-909-9	Used with handle of screw driver assembly	
Socket spanner wrench	8-Z-948-1	Tighten or loosen counterrecoil valve assembly gland	
Diaphragm guide	8-Z-949-2	Assembling differential cylinder diaphragm in safety gage plate	
Socket wrench, handle type	8-Z-955-1	Tighten or loosen recoil cylinder strap bolts	

TABLE 19-2. SLIDE TOOLS AND ACCESSORIES (cont)

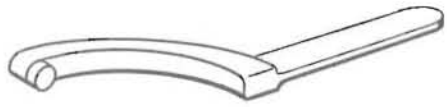
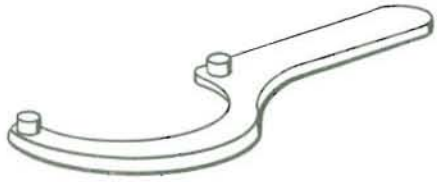
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Spanner wrench, hook type (7.375 inches radius)	8-Z-955-2	Tighten or loosen recoil cylinder piston rod nut	
Spanner wrench, hook type (8.375 inches radius)	8-Z-955-3	Tighten or loosen recoil cylinder head nut	
Face spanner wrench	8-Z-955-6	Tighten or loosen depression buffer piston packing gland	
Face spanner wrench (5.75 inches diameter)	8-Z-960-1	Tighten and loosen yoke rod nuts	
Face spanner wrench (8.25 inches diameter)	8-Z-960-2	Tighten and loosen depression buffer gland nut	
Face spanner wrench (3.50 inches diameter)	8-Z-960-3	Tighten and loosen elevation buffer gland nut	

TABLE 19-2. SLIDE TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Face spanner wrench, barrel type	8-Z-960-4	Tighten and loosen slide securing pin adapter	

TOOL NAME	DESIGN IDENTITY	TOOL NAME	DESIGN IDENTITY
Standard tools			
Adjustable angle wrench	12-Z-706-9		
Pin spanner wrench (6.0 in. diameter)	12-Z-713-0114		
Face spanner wrench	12-Z-714-0137		
Engineer's single head wrench (open end, 1-7/8 in.)	12-Z-721-14		
Engineer's single head wrench (open end, 3 in.)	12-Z-721-17		
Engineer's double head wrench (open end, 1-7/16 and 1-5/8 in.)	12-Z-721-37		
Engineer's double head wrench (open end, 1-13/16 and 2 in.)	12-Z-721-39		
Engineer's double head wrench (open end, 2-1/4 and 2-5/8 in.)	12-Z-721-40		
Cap screw wrench (5/8 in.)	12-Z-723-9		

TABLE 19-3. ELEVATING GEAR TOOLS AND ACCESSORIES

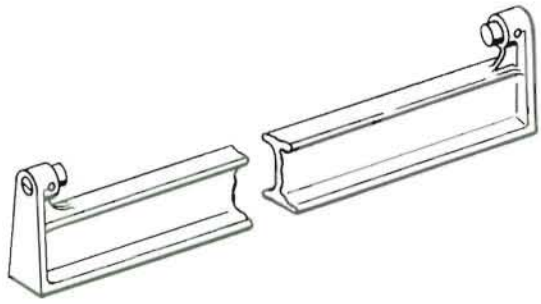
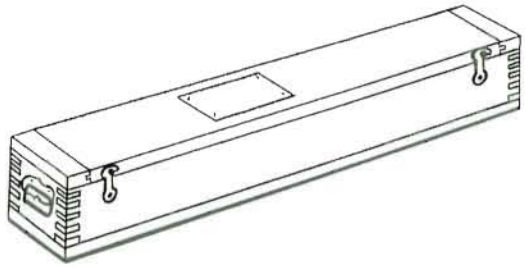
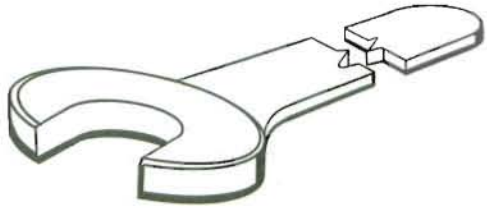
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Tram	8-Z-934	To locate precisely the gun position in train and elevation	
Tram test gage	8-Z-935	To check the tram	
Tram and test gage box	8-Z-1215	To hold the tram and test gages when they are not in use	
Maintenance tools:			
Engineer's single head wrench (5.0 inches opening)	8-Z-919-2	Tighten or loosen elevating screw pivot pin	

TABLE 19-3. ELEVATING GEAR TOOLS AND ACCESSORIES (cont)

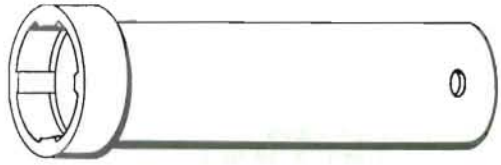
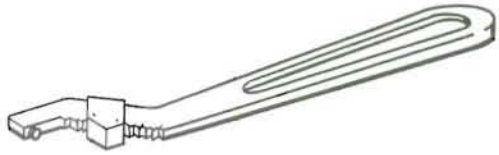
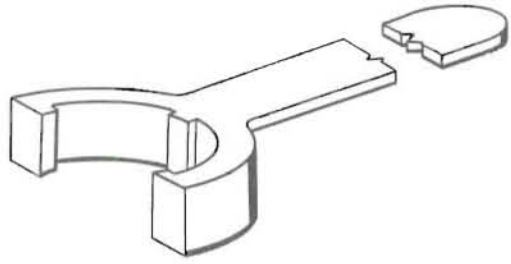
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Socket wrench (for ball bearing locknuts 1-3/4 inches)	8-Z-943-7	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing locknuts 3-5/8 inches)	8-Z-943-15	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing locknuts 5-7/16 inches)	8-Z-943-24	Tighten or loosen ball bearing locknuts	
Handle for socket wrench	8-Z-943-22	Turn socket wrenches	
Handle for socket wrench	8-Z-943-23	Turn socket wrenches	
Face spanner wrench	8-Z-958-6	Tighten or loosen oscillating bearing adjusting nuts	

TABLE 19-3. ELEVATING GEAR TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	TOOL NAME	DESIGN IDENTITY
Standard tools			
Engineer's single head wrench (open end, 3/8 in.)	12-Z-721-1		
Engineer's double head wrench (open end, 7/16 and 1/2 in.)	12-Z-721-25		
Engineer's double head wrench (open end, 9/16 and 5/8 in.)	12-Z-721-26		
Engineer's double head wrench (open end, 3/4 and 13/16 in.)	12-Z-721-27		
Engineer's double head wrench (open end, 7/8 and 15/16 in.)	12-Z-721-28		
Engineer's double head wrench (open end, 1 and 1-1/8 in.)	12-Z-721-34		
Engineer's double head wrench (open end, 1-1/16 and 1-1/4 in.)	12-Z-721-35		
Engineer's double head wrench (open end, 1-5/16 and 1-1/2 in.)	12-Z-721-36		

TABLE 19-4. TRAINING GEAR TOOLS AND ACCESSORIES

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Spanner wrench (adjustable pin type)	8-Z-936-3	General use in tightening and loosening packing nuts	
Spanner wrench	8-Z-958-1		
Socket wrench	8-Z-958-2		

TOOL NAME	DESIGN IDENTITY	TOOL NAME	DESIGN IDENTITY
Standard tools			
Socket wrench, offset handle offset handle (7/16 in.)	12-Z-720-2		

TABLE 19-5. PROJECTILE HOIST TOOLS AND ACCESSORIES

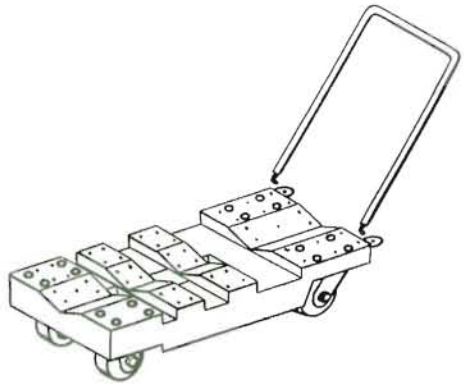
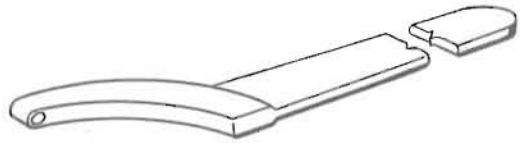
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Projectile handling equipment:			
Projectile truck	SK 140109	Handling projectiles	
Projectile Carrier Mk 3 Mod 1	242653	For projectile stowage handling	
Handling tongs	242657	Handling projectiles in passageways (use with 16-inch Projectile Carrier Mk 3, Mods 1 and 4	

TABLE 19-5. PROJECTILE HOIST TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	TOOL NAME	DESIGN IDENTITY
Standard tools			
Screw driver (standard, 12 in.)	12-Z 705-5		
Monkey wrench (adjustable to 1-3/4 in.)	12-Z-706-7		
Single end wrench (open, 11/16 in. U.S. standard nuts)	12-Z-707-05		
Single end wrench (open, 25/32 in. U.S. standard nuts)	12-Z-707-06		
Single end wrench (open, 1-1/4 in. U.S. standard nuts)	12-Z-707-010		
Single end wrench (open, 2 in. U.S. standard nuts)	12-Z-709-014		
Spanner wrench (pin-type, 3 in. dia. circles)	12-Z-713-0110		
Spanner wrench (adjustable-type, 2 to 4 in. circles)	12-Z-715-0119		

TABLE 19-6. RAMMER TOOLS AND ACCESSORIES

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Spanner wrench, pin-type	8-Z-921-2		

TOOL NAME	DESIGN IDENTITY	TOOL NAME	DESIGN IDENTITY
Standard tools			
Screw driver (standard, 6 in.)	12-Z-705-5		
Monkey wrench (adjustable from 2-1/8 in.)	12-Z-706-3		
Double end wrench (open, 11/16 and 7/8 in. U.S. standard nuts)	12-Z-711-059		
Double end wrench (open, 1-1/16 and 1-1/4 in. U. S. standard nuts)	12-Z-711-066		
Spanner wrench (pin-type, 3 in. dia. circles)	12-Z-713-0108		
Socket wrench, off-set handle (1-1/8 in.)	12-Z-720-11		

TABLE 19-7. POWDER HOIST TOOLS AND ACCESSORIES

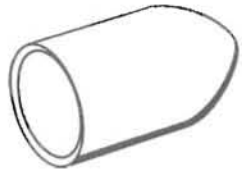
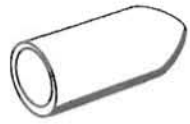
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Oil seal leader	274347-4	To protect the oil seal, when reassembling the the piston in the brake cylinder	
Oil seal leader	274349-2	To protect the oil seals when reassembling the safety car stop release valve and the latch and vent valve	
Oil seal leader	274349-4	To protect the oil seal when reassembling the piston rod in the safety car stop device cylinder and lever assembly	
Oil seal leader	274349-3	To protect the oil seal when reassembling the piston rod in the dashpot cylinder assembly	
Oil seal leader	274350-2	To protect the oil seal when reassembling the control pump gear case assembly	

TABLE 19-7. POWDER HOIST TOOLS AND ACCESSORIES (cont)

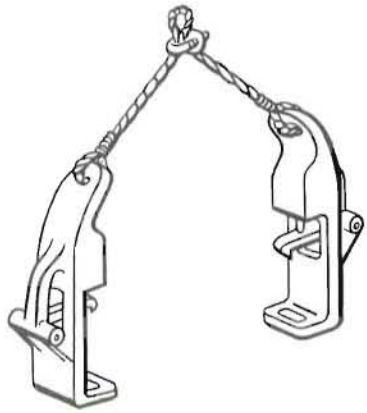
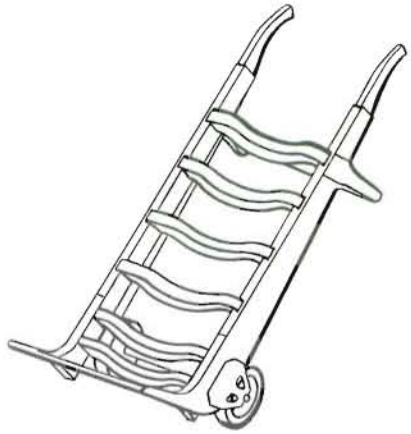
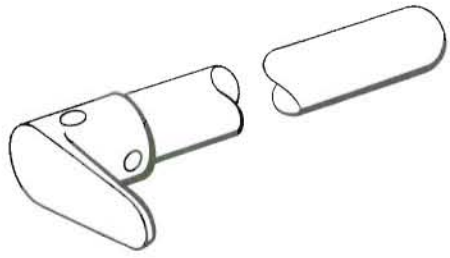
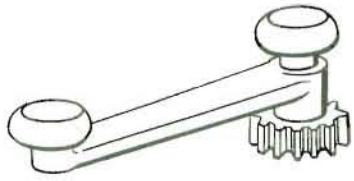
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Powder handling equipment:			
Powder Tank Carrier Mk 2 Mod 0	SK 140116	For powder stowage handling	
Powder Tank Truck Mk 1 Mod 0	SK 84701	Handling powder tanks	
Powder unloading tool	49401	To remove powder bags from powder tanks	
Powder tank opening tool	204245	To open powder tanks	

TABLE 19-7. POWDER HOIST TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY
Standard tools	
Socket wrench (1/4 in.)	12-Z-700-0156
Socket wrench (3/8 in.)	12-Z-700-0158
Socket wrench (1/2 in.)	12-Z-700-0160
Socket wrench (5/8 in.)	12-Z-700-0162
Socket wrench (3/4 in.)	12-Z-700-0163
Socket wrench (7/8 in.)	12-Z-700-0164
Single end wrench (open, 1/2 in. U.S. standard nuts)	12-Z-707-03
Single end wrench (open 19/32 in. U.S. standard nuts)	12-Z-707-04
Single end wrench (open 7/8 in. U. S. standard nuts)	12-Z-707-07
Single end wrench (open 1-1/16 in. U.S. standard nuts)	12-Z-707-09
Spanner wrench (face-type, 1 in. center-to-center of pins)	12-Z-714-0125
Spanner wrench (face-type, 1-1/4 in. center-to-center of pins)	12-Z-714-0126
Spanner wrench (face-type, 1-1/2 in. center-to-center of pins)	12-Z-714-0127
Spanner wrench (face-type, 1-3/4 in. center-to-center of pins)	12-Z-714-0128
Spanner wrench (face-type, 2-1/4 in. center-to-center of pins)	12-Z-714-0130
Spanner wrench (face-type, 2-1/2 in. center-to-center of pins)	12-Z-714-0131
Spanner wrench (face-type, 2-3/4 in. center-to-center of pins)	12-Z-714-0132
Spanner wrench (face-type, 3 in. center-to-center of pins)	12-Z-714-0133
Spanner wrench (face-type, 3-1/4 in. center-to-center of pins)	12-Z-714-0134
Spanner wrench (face-type, 3-1/2 in. center-to-center of pins)	12-Z-714-0135
Spanner wrench (face-type, 3-3/4 in. center-to-center of pins)	12-Z-714-0136
Spanner wrench (adjustable-type, 2 in. to 4 in. circles)	12-Z-715-0118
Pressure gage (hydraulic)	12-Z-323

TABLE 19-8. TOOLS AND ACCESSORIES FOR SIGHTS AND GUN ATTACHMENTS

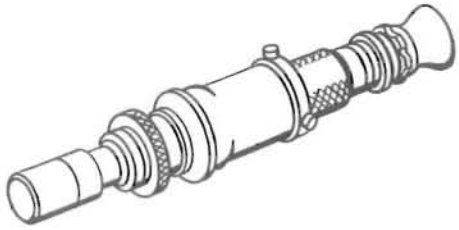
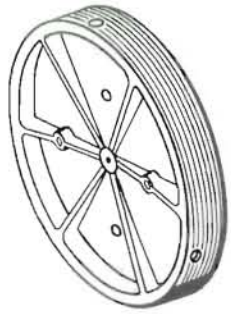
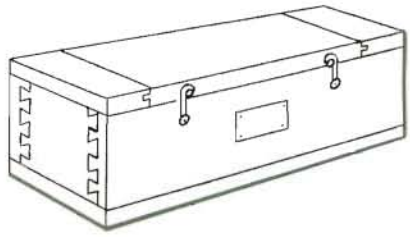
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Testing accessories:			
Telescope (bore sight assembly, breech end)	233261	Ensure the maintenance of correct alignment of the lines-of-sight of the telescopes with respect to the bore axis	
Telescope holder (bore sight assembly, breech end)	54613-1	Ensure the maintenance of correct alignment of the lines-of-sight of the telescopes with respect to the bore axis	
Muzzle disc (bore sight assembly, muzzle end)	54613-3	Ensure the maintenance of correct alignment of the lines-of-sight of the telescopes with respect to the bore axis	
Bore sight box	236090	Stow bore sight telescope	

TABLE 19-8. TOOLS AND ACCESSORIES FOR SIGHTS AND GUN ATTACHMENTS (cont)

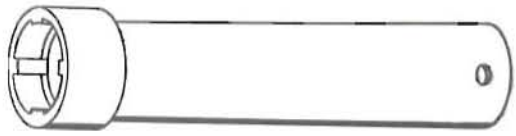
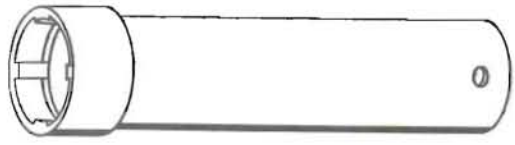
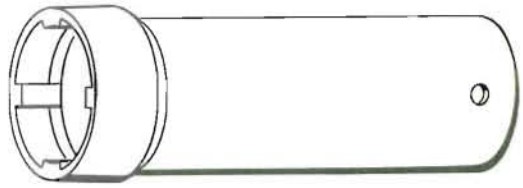
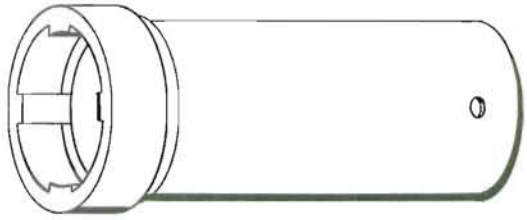
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Maintenance tools:			
Socket wrench (for ball bearing locknuts, 3/4 inch)	8-Z-943-1	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing locknuts, 7/8 inch)	8-Z 943-2	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing locknuts, 1 inch)	8-Z-943-3	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing locknuts, 1-1/8 inches)	8-Z-943-4	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing locknuts, 1-3/8 inches)	8-Z-943-5	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing locknuts, 1-1/2 inches)	8-Z-943-6	Tighten or loosen ball bearing locknuts	

TABLE 19-8. TOOLS AND ACCESSORIES FOR SIGHTS AND GUN ATTACHMENTS (cont)

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Socket wrench (for ball bearing locknuts, 2-inches)	8-Z-943-8	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing locknuts, 2-1/4-inches)	8-Z-943-9	Tighten or loosen ball bearing locknuts	
Handle for socket wrench	8-Z-943-22	Turn socket wrenches	

TOOL NAME	DESIGN IDENTITY	TOOL NAME	DESIGN IDENTITY
Standard tools			
Screw driver (standard, 8 in.)	12-Z-705-4		
Monkey wrench (adjustable from 1-1/4 in.)	12-Z-706-4		

Appendix 1

GENERAL TURRET DATA

Ship data
- Displacement (standard), tons 45,000
- Length, feet 888
- Beam, feet 108
- Amplitude of roll, degrees
- Period of roll, seconds
- Amplitude of pitch, degrees
- Period of pitch, seconds

Main battery positions
- Turret I
  - From bow, *feet 224
  - Above waterline, **feet 26.15
- Turret II
  - From bow, *feet 296
  - Above waterline, **feet 34.65
- Turret III
  - From bow, *feet 642
  - Above waterline, **feet 28.40

Main battery director positions
- Forward director
  - From bow, *feet 401
  - Above waterline, ***feet and inches . . . 151-0
- Aft director
  - From bow, *feet 570
  - Above waterline, ***feet and inches . . . 97-6
- Control station
  - From bow, *feet 343
  - Above waterline, ***feet and inches . . . 98-9
- Reference point
  - From bow, *feet 343
  - Above waterline, ***feet and inches . . . 69-3

* Vertical axis from forward perpendicular at 34.6-foot waterline.
** Trunnion axis above 34.6-foot waterline.
***Line-of-sight above 34.6-foot waterline.

Appendix 2

ORDNANCE DATA

Internal ballistics
- Length of gun, inches 816.0
- Bore diameter, inches 16.0
- Bore length, inches 800.0
- Projectile travel, inches 689.67
- Powder chamber length, inches 105.82
- Powder chamber volume, cubic inches . 27,000.0
- Powder chamber pressure (service charge), pounds per square inch 35,000.0
- Number of grooves 96
- Length of grooves, inches 682.46
- Depth of grooves, inches 0.15
- Twist . . . . Uniform, right hand, one turn in 25 cals.

External ballistics
- Muzzle velocity, AP Projectile (service charge), feet per second 2425
- Muzzle velocity, HC Projectile (service charge), feet per second 2690
- Range, AP Projectile (service charge), yards 40,185
- Range, HC Projectile (service charge), yards 41,622

Range tables
- Armor-piercing 16-inch projectile . . . . OP 1457
- High-capacity 16-inch projectile . . . . . OP 1100

Weight pounds, each turret
- Turret roller path load 4,030,000
- Total ordnance installation 1,540,000
- Gun assemblies, right, center, left, each:
  - Gun, with screw box liner 239,156
  - Gun, with recoiling parts. 292,000
  - Yoke 38,500
- Elevating gear, right, center, left, each:
  - Electric motor (including speed reducer) 1880
  - Electric motor controller 165
  - Receiver-regulator 240
- Training gear:
  - Electric motor 4500
  - Electric motor controller 1800
  - Reduction gear 3100
  - Receiver-regulator 320
- Projectile ring, upper or lower:
  - Electric motor 1200
  - Electric motor controller
    - First design 130
    - Second design 150
- Parbuckling gear, upper or lower:
  - Electric motor 650
  - Electric motor controller 110
- Projectile hoist, each:
  - Electric motor 1900
  - Electric motor controller 235
  - Speed reducer 375
  - Cradle 755
  - Spanning tray 184
- Rammer, each:
  - Electric motor (including speed reducer) 1750
  - Electric motor controller 165
- Powder hoist, each:
  - Electric motor. 2550
  - Electric motor controller 235
  - Powder car (empty) 2050
- Train limits, all turrets
  - Right train, degrees 150
  - Left train, degrees 150
- Elevating limits, each gun
  - Elevation, degrees 45
  - Depression, degrees. . . . . -2
  - Depression, (turret II), degrees 0

Ammunition data
- Armor-piercing projectile, 16-inch:
  - Designation . . . . . Mk 8 Mod 0
  - Weight, pounds 2700
  - Length, inches. 72
  - Radius of ogive, inches 144
- High-capacity projectile, 16-inch:
  - Designation . . . . . Mk 13 Mod 0
  - Weight, pounds 1900
  - Length, inches 64
  - Radius of ogive, inches 144
- Powder charge, 16-inch:
  - Number of bags (service charge) 6
  - Total weight (service charge), pounds . . 650

Projectile stowage
- Service projectiles:
  - Turret I
    - Upper projectile flat, outer ring 120
    - Lower projectile flat, outer ring . . . 126
    - Each inner ring 72
    - Total stowage 390
  - Turret II
    - Upper projectile flat, outer ring 70
    - Lower projectile flat, outer ring . . . 125
    - Each inner ring 72
    - Fixed stowage, third level 121
    - Total stowage 460
  - Turret III
    - Upper projectile flat, outer ring 100
    - Lower projectile flat, outer ring . . . 126
    - Each inner ring 72
    - Total stowage 370
- Drill projectiles:
  - Turret I 9
  - Turret II 9
  - Turret III 9

Gun data
- Center of gravity, from breech, inches . . . 280.6
- Distance of recoil, design length, inches . . 47
- Distance of recoil, maximum, inches . . . 48
- Gun oscillating weight, pounds 387,900
- Gun laying speeds:
  - Maximum training gear rate, degrees per second 4
  - Max.elevating gear rate, deg. per second 12

Appendix 2 - cont'd.

Gun firing order	L,R,C
Firing delay period, second	0.06
Firing load, trunnion pressure, gun at 45 degrees elevation, pounds, each gun	1,677,648
Gun brake load, pounds	1,380,782
Recoil system pressure, 42 degrees elevation (service charge), psi	2900
Counterrecoil buffing pressure, 0 degrees elevation psi	7200
Counterrecoil system air pressure, psi	1550
Counterrecoil pressure, full recoil, psi	2153
Counterrecoil force, full recoil, pounds	372,857
Recoil period, 15 degrees elevation, second	0.43
Counterrecoil period, 15 degrees elevation, second	0.90
Gun spacing, centerline of center gun to centerline right and left guns, inches.	122
Lines-of-sight data:	
Depression of line-of-sight (includes 20 degrees of roll), degrees	50
Elevation of line-of-sight (for 20 degrees of roll) degrees	20
Deflection movement (left), mils	100
Deflection movement (right), mils	175

Appendix 3

INDEX OF ASSEMBLIES

16-INCH TURRET ASSEMBLY NO. 84

TURRET I - USS IOWA

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-0	9-1	9-2
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	12-5	--
Auxiliary Computer	--	3-2	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-4	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-2	--	3-3
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-5	--
Periscope	29-0	--	29-0
Periscope Mount	5-10	--	5-10
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.
** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 62268, 62560.

16-INCH TURRET ASSEMBLY NO. 85

TURRET II - USS IOWA

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-3	9-4	9-5
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Rangefinder Stand	--	52-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	12-5	--
Auxiliary Computer	--	3-2	--
Rangefinder Stabilizer	--	4-1	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-5	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-2	--	3-3
Elevation Receiver-Regulator	10-2	10-0	10-0
Train Receiver-Regulator	--	18-6	--
Periscope	28-0	--	28-0
Periscope Mount	5-11	--	5-11
Rangefinder	--	52-0	--
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.
** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 62269, 62560.

Appendix 3 - cont'd.

16-INCH TURRET ASSEMBLY NO. 86

TURRET III - USS IOWA

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-6	9-7	9-8
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Rangefinder Stand	--	52-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	12-6	--
Auxiliary Computer	--	3-2	--
Rangefinder Stabilizer	--	4-1	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-6	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-2	--	3-3
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-7	--
Periscope	28-0	--	28-0
Periscope Mount	5-11	--	5-11
Rangefinder	--	52-0	--
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.
** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 62270, 62560.

16-INCH TURRET ASSEMBLY NO. 87

TURRET I - USS NEW JERSEY

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-0	9-1	9-2
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	12-5	--
Auxiliary Computer	--	3-2	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-4	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-2	--	3-3
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-5	--
Periscope	29-0	--	29-0
Periscope Mount	5-10	--	5-10
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.
** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 62271, 62560.

Appendix 3 - cont'd.

16-INCH TURRET ASSEMBLY NO. 88

TURRET II - USS NEW JERSEY

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-3	9-4	9-5
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Rangefinder Stand	--	52-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	12-5	--
Auxiliary Computer	--	3-2	--
Rangefinder Stabilizer	--	4-1	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-5	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-2	--	3-3
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-6	--
Periscope	28-0	--	28-0
Periscope Mount	5-11	--	5-11
Rangefinder	--	52-0	--
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.
**One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 62272, 62560.

16-INCH TURRET ASSEMBLY NO. 89

TURRET III - USS NEW JERSEY

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-6	9-7	9-8
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Rangefinder Stand	--	52-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	12-5	--
Auxiliary Computer	--	3-2	--
Rangefinder Stabilizer	--	4-1	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-6	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-2	--	3-3
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-7	--
Periscope	28-0	--	28-0
Periscope Mount	5-11	--	5-11
Rangefinder	--	52-0	--
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.
**One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 62273, 62560.

Appendix 3 - cont'd.

16-INCH TURRET ASSEMBLY NO. 90

TURRET I - USS MISSOURI

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-0	9-1	9-2
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	11-2	--
Auxiliary Computer	--	3-2	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-4	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-4	--	3-5
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-5	--
Periscope	29-0	--	29-0
Periscope Mount	5-10	--	5-10
Telescopes, Pointers' and Trainers'	66-0	—	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.
** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 92469, 107912.

16-INCH TURRET ASSEMBLY NO. 91

TURRET II - USS MISSOURI

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-3	9-4	9-5
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Rangefinder Stand	--	52-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	11-2	--
Auxiliary Computer	--	3-2	--
Rangefinder Stabilizer	--	4-1	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-5	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-4	--	3-5
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-6	--
Periscope	28-0	--	28-0
Periscope Mount	5-11	--	5-11
Rangefinder	--	52-0	--
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.
** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 92470, 107912.

Appendix 3 - cont'd.

16-INCH TURRET ASSEMBLY NO. 92

TURRET III - USS MISSOURI

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-6	9-7	9-8
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Rangefinder Stand	--	52-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	12-9	--
Auxiliary Computer	--	3-2	--
Rangefinder Stabilizer	--	4-1	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-6	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-4	--	3-5
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-7	--
Periscope	28-0	--	28-0
Periscope Mount	5-11	--	5-11
Rangefinder	--	52-0	--
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.

** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 92471, 107912.

16-INCH TURRET ASSEMBLY NO. 93

TURRET I - USS WISCONSIN

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-0	9-1	9-2
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	11-2	--
Auxiliary Computer	--	3-2	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-4	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-4	--	3-5
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-5	--
Periscope	29-0	--	29-0
Periscope Mount	5-10	--	5-10
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.

** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 92472, 107912.

Appendix 3 - cont'd.

16-INCH TURRET ASSEMBLY NO. 94

TURRET II - USS WISCONSIN

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-3	9-4	9-5
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Rangefinder Stand	--	52-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	11-2	--
Auxiliary Computer	--	3-2	--
Rangefinder Stabilizer	--	4-1	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-5	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-4	--	3-5
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-6	--
Periscope	28-0	--	28-0
Periscope Mount	5-11	--	5-11
Rangefinder	--	52-0	--
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.

** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 92473, 107912.

16-INCH TURRET ASSEMBLY NO. 95

TURRET III - USS WISCONSIN

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-6	9-7	9-8
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Rangefinder Stand	--	52-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	12-9	--
Auxiliary Computer	--	3-2	--
Rangefinder Stabilizer	--	4-1	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-6	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-4	--	3-5
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-7	--
Periscope	28-0	--	28-0
Periscope Mount	5-11	--	5-11
Rangefinder	--	52-0	--
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.

** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 92474, 107912.

Appendix 4

SAFETY PRECAUTIONS

Appendix 4 consists of warnings and safety measures for operation of the turret. It is a recapitulation of the operating precautions of all chapters of Ordnance Pamphlet 769 (First Revision), together with extracts from NavOrd Instructions 5100.1.

This precautionary material is of first importance to the turret organization; every member of the crew should be thoroughly familiar with every warning and the significance or reason for each.

EXTRACTS FROM NAVORD INSTRUCTIONS 5100.1

General

1. To avoid danger of casualties, the observance of the following safety precautions is mandatory. The Bureau of Ordnance shall be informed of any circumstances which conflict with these safety precautions or which for any other reason require changes in, or additions to, them.

2. When in doubt as to the exact meaning of a safety precaution, an interpretation shall be requested from the Bureau of Ordnance. Conditions not covered by these safety precautions may arise which in the opinion of the commanding officer, may render further operation of the equipment unsafe. Under these conditions, nothing in these safety precautions shall be construed as authorizing such further operation.

3. Safety devices provided shall always be used as designated to prevent possibility of accident, and shall be kept in good order and operative at all times. All instructions promulgated by competent authority to insure safe operation or handling of equipment shall be strictly observed.

4. Whenever any motion of a power-driven unit is capable of inflicting injury on personnel or material not continuously visible to the person controlling such motion, the officer or petty officer who authorizes the unit to be moved by power shall, except at general quarters, insure that a safety watch is maintained in areas where such injury is possible both outside and inside the unit, and shall have telephone or other effective voice communication established and maintained between the station controlling the unit and the safety watch. These precautions are applicable to turrets, gun mounts, guns, directors, rangefinders, searchlights, torpedo tubes, rocket launchers, and similar units. Under the conditions stated above, the station controlling shall obtain a report "all clear" from each safety watch before starting the unit. Each safety watch shall keep his assigned area clear and if unable to do so shall immediately report his unit fouled, and the controlling station shall promptly stop the unit until it is again reported clear.

5. In turrets and enclosed mounts, a warning signal shall be installed outside the turret or mount; and whenever power train is used, except at general quarters, the officer or petty officer in charge of the turret or mount shall cause warning signals to be sounded before using power and at intervals during its use.

6. Changes, modifications in, or additions to ordnance material, or other material used in connection therewith, shall not be made without explicit authority from the bureaus concerned.

7. No ammunition or explosive assembly shall be used in any gun or appliance for which it is not designated.

8. No other than drill ammunition shall be used for drill.

9. On guns equipped with hydropneumatic counterrecoil systems, the safety link, locking the gun to the slide, shall be connected at all times except when firing or when testing and overhauling the counterrecoil systems or when a battery is in a condition of readiness for action.

10. Except in action or when specifically authorized, antiaircraft guns shall not be fired at elevations greater than, or fuse settings less than, those prescribed in the current orders for Gunnery Exercises. When firing antiaircraft guns as such, all personnel not required to be exposed shall be kept under cover.

Ammunition Handling and Stowage

1. As familiarity with any work, no matter how dangerous, is apt to lead to carelessness, all persons who may supervise or perform work in connection with the inspection, care, preparation, use, or handling of ammunition or explosives --

(a) Shall exercise the utmost care that all regulations and instructions are rigidly observed.

(b) Shall carefully supervise those under them and frequently warn them of the necessity of using the utmost precaution in the performance of their work.

No relaxation of vigilance shall ever be permitted.

2. Except in case of emergency, ammunition shall not be transferred during fueling operations.

3. All ammunition, explosives, and powder shall be protected from abnormally high temperature. If

so exposed, they shall be handled in accordance with current instructions of the Bureau of Ordnance. Permissible maximum storage temperatures shall be prescribed by the Bureau of Ordnance.

4. Smokeless powder which has been wet from any cause whatever must be regarded as dangerous for dry storage. Such powder shall be handled in accordance with current instructions of the Bureau of Ordnance.

5. Smokeless powder which shows unmistakable signs of advanced decomposition shall be disposed of in accordance with current instructions of the Bureau of Ordnance.

6. To minimize the risk of fire, explosion, and damage to ammunition and its containers from accidental causes, ammunition shall be handled as little as practicable. As the action of denting thin-cased high-explosive ammunition is known to have caused detonation of the explosive in some instances, special care shall be exercised to insure that such ammunition is never struck, dropped, or bumped.

7. Defective bomb type and thin case ammunition shall be disposed of in accordance with current instructions of the Bureau of Ordnance.

8. A fused projectile, whether in a container or not, if dropped from a height exceeding five feet shall be dumped overboard in a manner conforming with regulations for dumping ammunition at sea except when practicable to turn the projectile into a Naval Ammunition Depot. Such ammunition shall be handled with the greatest care.

9. Care must be used to avoid tapping or otherwise striking fused projectiles. This precaution is particularly applicable to attempts to loosen such a projectile in the cartridge case by repeated light blows of a mallet, unloading such a projectile wedged in the bore of a gun, and the striking of a projectile by the recoil of a gun or an ejected case.

10. The covers of switches, circuit breakers, etc., shall be kept securely closed while powder is exposed in the vicinity.

11. Magazines shall be kept scrupulously clean and dry at all times. Nothing shall be stored in magazines except explosives, containers, and authorized magazine equipment. Particular attention shall be paid that no oily rags, waste, or other foreign materials susceptible to spontaneous combustion are stored in them.

12. Naked lights, matches, or other flame-producing apparatus shall never be taken into magazines or other spaces used primarily as magazines while these compartments contain explosives.

13. Before performing any work which may cause either an abnormally high temperature or an intense local heat in a magazine or other compartment used primarily as a magazine, all explosives shall be removed to safe storage until normal conditions have been restored.

14. Black powder is one of the most dangerous of explosives and shall always be kept by itself. Only such quantities as will meet immediate needs shall be taken from the magazines. A container of black powder shall never be opened in a magazine nor in the vicinity of a container in which there is any explosive.

15. Ammunition shall not be altered, nor shall fuses or any other parts be removed or disassembled without explicit instructions from the Bureau of Ordnance.

Service of guns, including ammunition supply

1. Live ammunition shall be loaded into guns for firing purposes only. Test or inspection of ammunition by fitting it into guns is prohibited, except when authorized by specific instructions of the Bureau of Ordnance.

2. During firing no other ammunition than that immediately required shall be permitted to remain outside of the magazine.

3. During gunnery exercises, charges in excess of the amount required to be available for one run shall not be assembled in the vicinity of guns mounted outside of turrets. No charge for a bag gun shall be removed from its tank, nor shall the tops of tanks be removed or so loosened that the bags may be exposed to flame until immediately before the charge is required for loading.

4. When either cartridges or bag charges are outside the magazines, each flame-proof compartment or space which forms a stage of the ammunition train, including the magazines and gun compartments (in or out of turrets), shall, wherever practicable be kept closed from all other compartments or spaces except when the actual passage of ammunition requires it to be open. Where practicable, no flame-proof stage of the ammunition train shall be open to both the preceding and the following stages at the same time.

5. If flame seals be damaged during firing, except in action, so that they can not fulfill their purpose, the gun or guns concerned shall cease firing until the flame seals are again effective.

6. (a) In a magazine or handling room in which powder is removed from tanks to be sent to the guns in bags, not more than one charge per gun, for the guns being served by that magazine or handling room, shall be exposed by removal of tank tops, or by so loosening the tank tops that the bags may be exposed to flame.

(b) In each subsequent flame-proof stage of the ammunition train, not more than one charge per gun, for the guns being supplied through that stage, shall be allowed to accumulate. For this purpose,

the spaces or handling rooms at the tops and bottoms of continuous-chain powder hoists will be considered separate stages (whether or not separated from the hoists by flame-proof doors, flaps or shutters).

(c) In addition to the above, continuous-chain powder hoists may be kept filled; or if hand passing is used, there may be one bag of powder at the station of each man in the train.

(d) It is the intent of this article to permit sufficient powder to be exposed to provide an adequate supply for the guns being served. The maximum amount specified above should be exposed only if a smaller amount will not assure an adequate supply.

7. As there is an inflammable gas present in the chamber of a gun after firing which, under certain conditions, may constitute a danger by igniting the powder charge which is to be used for the next round, and as smoldering remnants of powder bag may also be present, the following precautions shall always be observed:

(a) Bag guns shall not be loaded until a member of the crew has assured himself that the bore is clear of powder gases and remnants and has announced "bore clear" either by voice or by approved signal, such as a hand, whistle, gong, or horn, except that, when the gas ejector system does not readily clear the bore, the combined sponge and rammer (where provided) may be used. The sponge shall be dipped in water for each load.

(b) Until the "bore clear" signal above described is given, or the projectile is rammed home with the wet combined sponge and rammer, powder shall not be exposed closer than four feet to a gun not mounted in a turret.

(c) In turrets fitted with ammunition cars, the car and the center of an open breech shall not be allowed within six feet of one another until the "bore clear" signal has been given. In turrets fitted with continuous-chain powder hoists, or for hand passing, the powder shall not be exposed in the turret chamber, nor shall the flame seal, shutter, or flap between the turret chamber and the next stage in the powder train, be opened or unlocked until the "bore clear" signal is given.

8. If a powder bag is broken to the extent of allowing powder to fall out, the command "Silence" shall be given and the loose powder shall be gathered up. If it is impracticable to utilize this section of the charge satisfactorily in loading, it shall be secured in a flame-proof container or immersed in water.

9. In turrets not fitted with bulkheads between guns, the "bore clear" signal to the turret crew shall not be given until the guns which have been fired and whose breech plugs have been opened are reported clear, at which time one signal to the entire turret crew shall be given.

10. Care should be exercised to prevent projectiles from slipping back from their seats, as unseated projectiles may cause abnormally high pressure. In bag guns, projectiles shall not be rammed by interposing one or more sections of a powder charge between the head of the rammer and base of the projectile.

11. The mushroom of every bag gun shall be wiped after each shot with a sponge or cloth dampened with fresh water.

12. As soon as a gun is loaded the breech shall be closed without delay.

13. When priming a lock of the sliding-wedge type, care shall be taken to insure the primer being pushed in beyond the primer catch to prevent the primer coming out or being crushed by the operation of the wedge in closing.

14. In loading a bag gun, neither the gun ready light switch nor the gun firing cut-out switch (which are combined in some installations) shall be in the closed position until the breech is fully closed and all personnel are clear of the recoil.

15. To guard against blowing out primers which may fire at the instant of closure, care shall be taken whenever the breech of a bag gun with a live primer in the lock is being closed, that the operating lever is followed through during the last part of its travel, to prevent any opening of the lock due to rebound.

16. The breech plug of a bag gun shall never be unlocked or opened while there is a live primer in the lock.

17. A firing lock into which a live primer has been inserted shall never be opened, either independently or by operation of the breech mechanism, unless the firing circuit is broken externally by the lock or breech mechanism (for example, at local pointer's key or gun captain's ready switch), except when it is known that the loaded gun has fired. This applies to the firing of primers at drill, to the operation of loaded guns, and the examination of primers.

18. The limiting position of the breech of the gun or recoil shall be indicated and the gun crew shall be instructed to keep clear.

19. While a gun is being loaded, all personnel not required for the unloading operation shall be kept at a safe distance from the gun.

23. Effective measures shall be taken to guard against prematurely opening the breech of a loaded gun, whether or not the gun is fitted with a salvo latch.

24. If a gun is loaded at the order "cease firing"

(a) The gun shall be kept pointed and trained in a safe direction.

(b) The breech mechanism shall be kept fully closed.

(c) The gun shall normally be cleared by firing as soon as practicable.

25. A loaded and fused projectile, seated in the bore of a gun that is shot from previous firing, presents a hazard, since detonation of the projectile is possible as a result of being heated. Whenever practicable, such projectile should be disposed of promptly by firing the round. Whether a gun is hot or cold, the risks attendant upon removing a loaded and fused projectile seated in the bore, by backing out, are considered unwarranted except in the case of guns for which existing instructions specifically prescribe this procedure.

26. (a) The possibility of a serious accident due to opening the breech of a gun too soon in the case of a hangfire demands the constant exercise of the utmost prudence and caution. A hangfire must be assumed to exist when:

(1) An unsuccessful attempt has been made to fire the gun.

(2) A charge remains in a bag gun, with the possibility of ignition by an undetected ember from the previous round.

(b) The following procedure shall be followed in the cases noted above:

(1) Keep the gun pointed and trained in a safe direction.

(2) Keep the breech mechanism fully closed.

(3) Continue attempts to fire, if desired, repriming bag guns provided such efforts do not involve any movement tending to open the breech.

(c) If the gun is not fired under the above conditions:

(1) Open the firing key and break the firing circuit elsewhere.

(2) Unhook the firing lanyard, if detachable.

(3) Remove the primer from the lock of a bag gun, using the primer tools supplied for this purpose, taking care to avoid danger from recoil or blow-back. For this purpose, or for shifting primers, do not leave the firing lock open longer than necessary.

(4) Do not open the breech for 30 minutes (10 minutes for field or landing guns on shore) after the last attempt to fire. This, at the discretion of the commanding officer, is not obligatory in time of action; nor is it obligatory or advisable with a hot gun if an instruction of the Bureau of Ordnance to prevent a projectile "cook off" recommends earlier opening of the breech when the gun cannot otherwise be cleared by firing it.

(d) The crew shall never leave a loaded gun until the precautions in (b) and (c) (1) to (3) above have been carried out.

(e) Ammunition removed from a loaded gun shall be disposed of in accordance with current instructions of the Bureau of Ordnance.

27. Ships shall cease the firing of any gun whose line of fire is endangering any objects other than the designated target. These objects include friendly ships and aircraft and own ship's structure together with the mounts and launchers and their barrels, fixed or moving. This stipulation applies to objects in the vicinity of the firing point, throughout the trajectory and in the vicinity of the target. Turrets, mounts, guns and launchers which are not firing, while others are firing, shall be trained and elevated if manned, or secured if unmanned, in a manner that will provide the greatest amount of safety from the firing. This position of greatest amount of safety of the unmanned mounts will generally be that position which the firing cut-out mechanism cams of the firing mounts were cut to clear.

TURRET GENERAL PRECAUTIONS

DANGER. Live 440-volt leads are exposed whenever covers of the bus transfer panel, equipment panels, controllers, motor terminal boxes, and many of the control panels and connection boxes are open.

DANGER. Never enter the cable trunk at the foot of the central column or the wiring recess at the top until the 440-volt supply switches are open at NORMAL and ALTERNATE switchboards.

Always open the 440-volt supply switch at the equipment panel as well as the controller concerned when preparing to work on any power driven assembly.

Never position the automatic control circuit transfer switches of the elevating drives at AUTO until all personnel have been cleared from the gun pits.

DANGER. Never fire the guns with personnel in the gun pits.

DANGER. Always close and secure the gun room, sight station, pan floor, and projectile flat batches, and the circular foundation doors before firing the gun.

DANGER. Always start the ventilating systems before firing the guns.

ORDNANCE EQUIPMENT PRECAUTIONS

Personnel Danger

Never fire the guns without first checking the recuperator air pressure and differential fluid.

Never put hands, feet, or head into a hoist way or path of a cradle, spanning tray, slide, or housing when power is on.

DANGER. Never climb through the inner compartment archways of the projectile flats when the projectile ring power drives are operating; always stop the power drive electric motor.

Never parbuckle projectiles directly from the fixed stowage space to the hoist except in an emergency, such as failure of the projectile ring drive.

Never use more than three turns of snubbing rope around a gypsy head when parbuckling; two turns are usually sufficient.

Never start the snubbing action with a jerky, sudden movement when parbuckling; "ease" the projectile into motion.

Never hold the projectile hoist shutters open by hand when parbuckling out of the hoist; latch the shutters open before unloading the hoist.

DANGER. Never perform gun sliding-out exercise without setting the slide securing pin in its 20-degree elevation socket.

Never enter the gun pits except when the slide securing device is engaged.

Never start the elevating gear until the gun pits re cleared of all personnel.

Always operate the elevating gear slowly in HAND control when operating the slide securing device.

Always lash all projectiles carefully, inspecting all toggle links, before going to sea.

Do not unscrew hydraulic adjustments excessively. There is danger of injury to personnel and equipment because of the hydraulic pressure.

WARNING. Always observe all cautions listed under "Turret general precautions."

Equipment Casualty

Gun equipment precautions

PREPARATION PRECAUTIONS

Check recuperator air pressure and differential fluid.

Check recoil cylinder fluid level.

Check the fluid level of the breech opening and operating lever buffers, and the elevating and depression buffers.

Remove the muzzle covers and tompions.

Disengage and stow the gun locking device.

Release the slide securing pin.

Verify breech action, gas ejector supply, and firing lock action by operating the breech through two opening and closing cycles.

FIRING PRECAUTIONS

Before loading live ammunition in the gun verify that the salvo latch locking pin is not in the hole designated B to prevent opening the breech when a misfire or hangfire goes unnoticed in salvo fire.

After each round has been fired, verify that the gun has returned to battery by observing the indicator marks on the yoke and counterrecoil cylinders; the service of the gun shall be stopped should the gun fail to return to battery.

MISFIRE PRECAUTIONS

Position the READY switch at SAFE immediately. Unload or fire the gun, observing NAVORD INSTRUCTIONS 5100.1.

STOWING PRECAUTIONS

Secure the gun locking device immediately after "Cease fire."

Always seat the slide securing pin.

Always install tompions or canvas covers on gun muzzles.

MISCELLANEOUS PRECAUTIONS

Use utmost care to avoid damaging the breech mechanism when removing a drill projectile from the gun chamber by means of the backing-out rammer. If possible, have guns trained fore and aft to minimize the effect of the roll of the ship. Observe "backing-out precautions," page 101.

Use only clean, soft cloth to wipe the counterrecoil plungers. Scratches will cause loss of air charge. No rust-protection oil film is required.

Never use an organic or heavy oil or grease to coat the gun bore, chamber, or gun and slide bright work, or to lubricate the firing lock. Use authorized lubricant only.

Never use abrasives or detergent or caustic solutions to remove discoloration or smoke rings from the gun bore; use an oil-soaked cloth.

Never use kerosene, gasoline, carbon tetrachloride, caustic or soda solutions to clean the firing lock; use alcohol.

Ammunition handling equipment precautions.

Before hoisting projectiles, operate the empty hoist, the cradle, the function control and shut-off valve, and the shutters, to verify normal operation of all indicator and interlock actions.

When hoisting projectiles always hold the hoist

control handle in HOIST position until the TOP OF STROKE indicator is illuminated.

While the first four projectiles are being loaded into a hoist, check the brake action. Verify the solenoid brake release movement and that the brake drum is clean and oil-free.

When operating the first cradle lowering movement with projectile, check the cradle buffer for normal action.

Before lowering projectiles, the cradle operator must verify that the function control and shut-off valve is operating properly.

When lowering projectiles the cradle operator must not move back the cradle projectile latch until the rack is at the top of stroke.

When handling powder between the magazine scuttles and hoist loading trays avoid rough treatment that may cause a powder bag to tear.

Transfer projectiles from the rotating ring to the hoist when loading the hoists, and from the hoist to the rotating ring when unloading. Never parbuckle projectiles directly from the outer ring to the hoist except in an emergency, such as failure of the projectile ring drive.

Turn the snubbing rope twice around the gypsy head for normal parbuckling. Never use more than three turns.

Replenish the rotating ring as it is depleted by parbuckling from fixed stowage to the rotating ring; projectiles must be lashed when in position.

Loop the snubbing rope under the copper rotating band, never above it.

It is preferable to load projectile hoists from the upper flat first; this procedure is not compulsory.

Before parbuckling, make sure that the projectile hoist shutters swing freely.

Make certain that the loading door in the hoist is lowered before parbuckling on the upper flat. Before parbuckling on the lower flat, make certain that the hoist loading door on the upper flat is raised and secured.

Never use the parbuckling gear to snub auxiliary whip hoists; this procedure is not compulsory.

Always stow projectile rings with both centering pins of each securely seated.

Always lash all projectiles carefully, inspecting all toggle links, before going to sea.

Never attempt to load or unload a projectile ring when it is in motion.

Always inspect the projectile ring for loose tools or other obstructions before starting operations.

When reversing the direction of projectile ring rotation, permit the ring to come to a full stop before reversing hand lever movement.

Keep projectiles secured in the projectile ring until rotation stops; then unclamp only the projectiles which are to be parbuckled. In rough weather, unclamp the projectiles one by one as needed for parbuckling.

Refer to the "Personnel danger precautions" on page 587.

Gun laying equipment precautions.

Before attempting to start the power drive electric motor, make sure that the tilting box is at neutral, the control selector lever is at HAND, the gun pits are clear, and operating personnel are in safe positions.

Before shifting to AUTO control, make sure that the synchro receivers are energized and that gun position is in close agreement with gun order.

The gun layer must remain at his station whenever the equipment is in operation. He must be prepared to stop the equipment immediately if any emergency arises.

Always shift the control selector lever to HAND before stopping the power drive.

Protect the elevating gear drive from vibration and settling by setting the slide securing pin at the zero degree secured position whenever the drive is not operating.

WARNING. It is possible to adjust some transfer acceleration limiting valves so that the Hand control line is completely cut off. Every possible precaution must be taken to prevent this condition because neither the handwheels nor the hand stops will have any effect.

Never attempt to improve the operation of an elevation receiver-regulator if the performance is satisfactory.

Training gear equipment precautions.

Always retract both centering pins before starting the training gear drive.

Before attempting to start the power drive electric motor, make sure that the tilting box is at neutral, the control selector lever is at HAND, and operating personnel are in safe positions.

Before shifting to AUTO, make sure that the synchro receivers are energized, and that turret position is in approximate agreement with turret train order.

The train operator must remain at his station whenever the power drive is in operation; he must be prepared to stop the power drive if an emergency arises.

Always shift the control selector lever to HAND before stopping the power drive.

Operate the drive slowly in HAND when locating centering pin positions.

Protect the train drive from backlash and the roller path from deformation by setting both centering pins tight whenever the drive is not operating.

Never attempt to improve the operation of an elevation receiver-regulator if performance is satisfactory.

Fire control equipment precautions.

Never attempt to set the sights when any appreciable effort is required to turn the sight setter's hand cranks. Stop and investigate. Find and remove the cause of the abnormal load before resuming operation.

Exercise the sights and gun attachments periodically and frequently through full range of movements.

Dry out and ventilate sight hoods daily. Clean and dry telescope objectives.

Always keep the sight hood shutters closed when the sights are not in use.

Never make internal adjustments or open any fire control instrument without cause.

When securing fire control equipment after operations, open all transmission, communication, and lighting circuits at the instrument controls as well as the turret officer's transfer switchboard.

Never adjust sights and gun attachments without cause, and then only in the prescribed order. Adjustments made out of order will upset other adjustments.

Never attempt to improve the operation of fire control equipment if performance is satisfactory.

Whenever trouble occurs, test the equipment in all types of control, to isolate the cause, before resorting to disassembly or adjustment.

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