CONTENTS

Components. The powder car consists of the components listed below:

Car
Car guide wheels
Safety latch stops
Safety latches
Safety latch cams
Lower door latch operating cam
Upper door dog unlocking cam
Car hoist rope
Rope guide
Car switch operating bar

Car. The car body (fig. 11-11) is a box-like aluminum casting, open at the tray side. Two cast aluminum powder bag (dumping) trays, horizontally pivoted in ball bearings, are mounted one above the other in the car body front and rear. Both trays have limited tilt and are separately tilted from their normal position by handles. These are located at the rear of the car toward the hoist operator and have detent arrangements to latch the trays in normal position. Steel bar balance weights are attached to the undersides of the trays. Approximately 16 pounds for each tray, the weights prevent tray oscillation when the car is traveling from one station to another.

Car guide wheels. The car guide wheels are pin-mounted in fixed cast steel brackets which are mounted at the four corners of the car body. The wheels are machined steel with bronze bushing inserts for bearings.

Safety latch stops. The safety latch stops comprise four steel blocks bolted two at the front and two at the rear of the powder car at the tray side. Arranged the same at front and rear, one block is located at the bottom of the car and the other is 22.5 inches above the bottom. Contacted by the safety latches, the safety latch stops provide emergency support for the car.

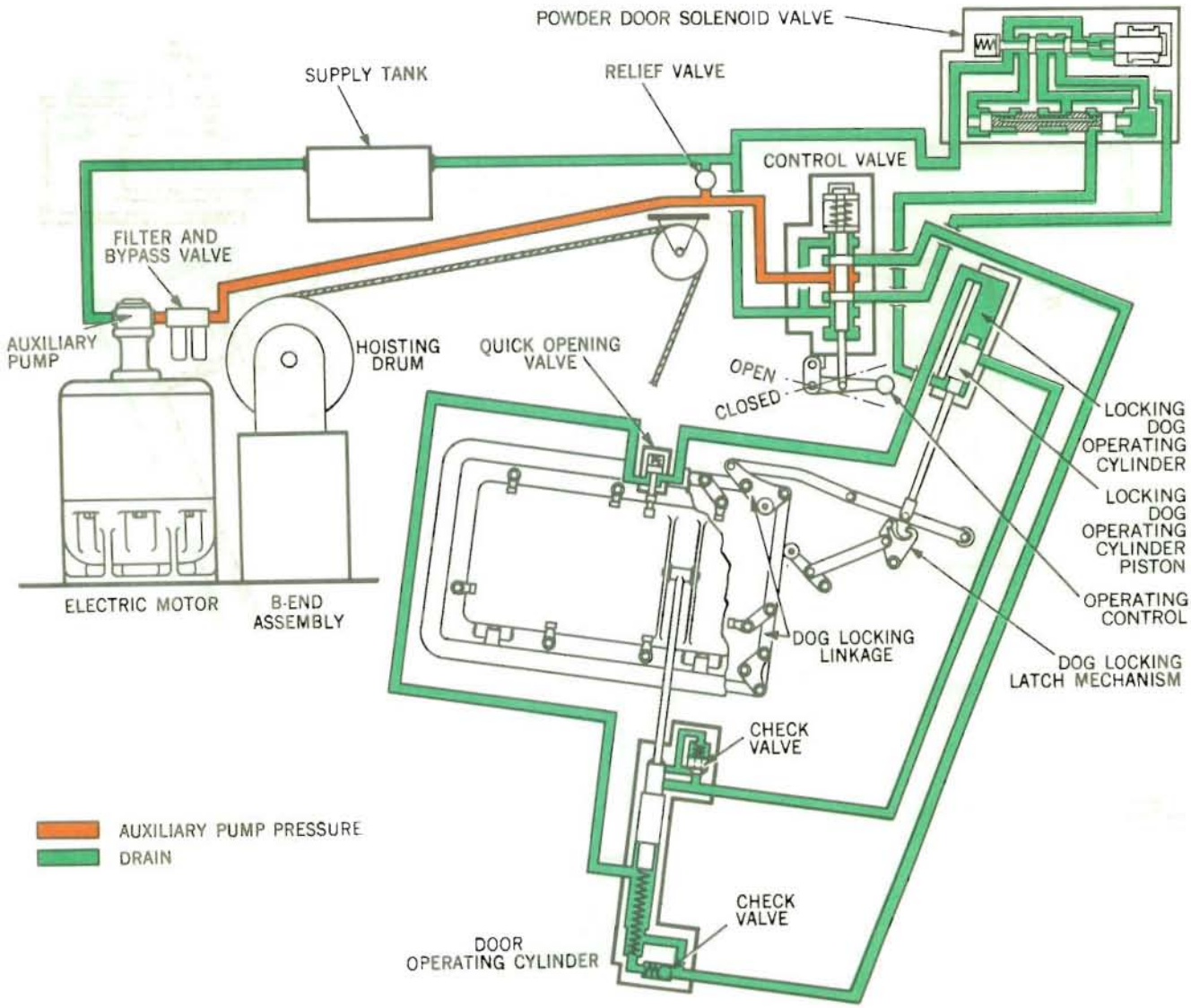

Figure 11-8. Trunk Upper Door Closed, Control Neutral - Schematic Diagram.

Safety latches. The safety latches (fig. 11-12) project into the path of the powder car, to engage the safety latch stops, when the car is at either the upper or lower unloading station. Operated by the safety car stop operating device (described on page 11-7), the two safety latches prevent the car from dropping in the event of hoist rope failure. The safety latches are spring loaded pawls installed with free bearing on the speed gear control shaft. They are located in the hoist trunk below the upper door.

Safety latch cam plates. The two vertical front edges of the powder car are cam surfaces which are extended upward, above the top of the car by two cam plates. These cams displace the safety latches as the ascending car approaches the unloading stations.

Lower door latch operating cam. One of the safety latch stops (page 11-11) is provided with a cam surface. This is the operating element which unlocks the lower door as the descending powder car approaches the loading station. The lower door latch is described on page 11-9.

Upper door dog unlocking cam. The upper door dog unlocking cam is located on the rear side of the car at the top. The cam contacts the arm of the interlock hook and arm lever (page 11-10) to unlatch the hook and actuate an interlock switch.

Car hoist rope. The powder car hoist rope is a 5/8 inch diameter wire rope. Secured to the hoisting drum, the rope passes over the hoisting sheave (page 11-8) and has adjustable attachment to the car. Looped around the wrist pin of the rope adjusting socket bolt after it is passed under the rope guide, the rope end is secured to the standing part by U bolts.

Rope guide. The rope guide, a cast bronze block, is mounted in the center of the powder car top. Grooved for retaining the car hoist rope, the rope guide is mounted with free bearing on a wrist pin which is installed in integral lugs of the car body.

Car switch operating bar. A vertically positioned subassembly, the car switch operating bar includes two adjustable trip brackets located on the forward

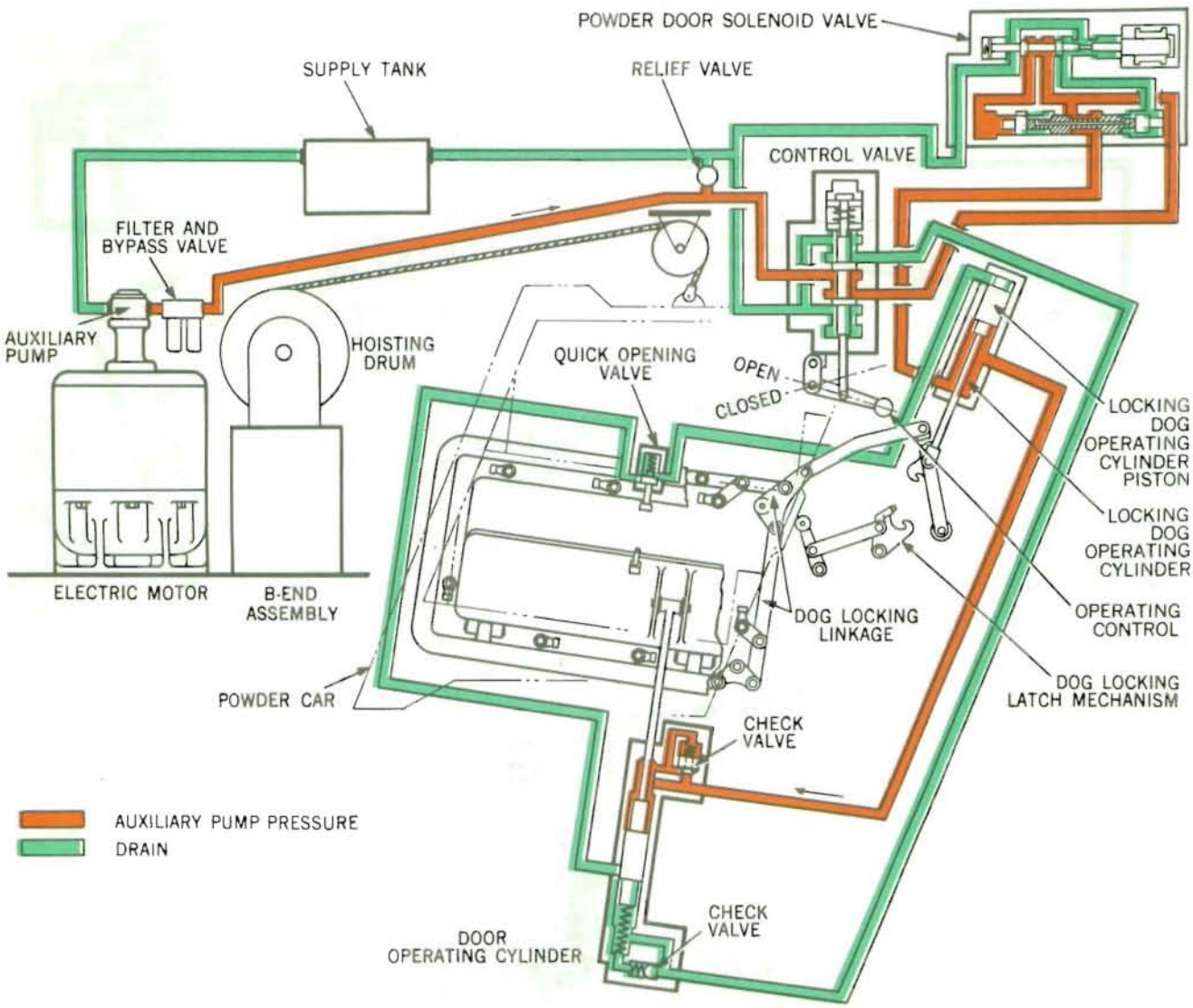

Figure 11-9. Trunk Upper Door Opening, Control at OPEN - Schematic Diagram.

side of the powder car. The bar actuates the levers of limit switches located at the top and bottom of the hoist trunk.

Controls and interlocks

The powder hoist operating controls and interlocks include starting and stopping controls, selection of servo or manual electrical and mechanical controls, powder hoist controls, an interlock and indicator system, power drive controls and interlocks, a power-on circuit, and door and dog latch interlocks. These control devices and their functions are described in following paragraphs:

Start-stop control.

Push-button station. The master start-stop switch for each powder hoist controller is a push-button type located at the hoist operator's station. The switch is of enclosed watertight design with two buttons designated START-EMERG and STOP. Normally open, the switch is closed by pressing the START-EMERG button and opened by pressing the STOP button. The switch is arranged in the controller starting circuit with another switch contact that must be closed to complete the circuit when the START-EMERG button is pressed. This switch contact, the limit switch, is closed when the A-end is at neutral stroke.

Stop switch station. An emergency stop switch is provided for each powder hoist controller. Of enclosed watertight design, a switch is similarly located at each lower door operator's station. The switch is normally closed and is opened by pressing its STOP button.

Powder hoist control. Powder hoist control arrangements at the hoist operator's station include an installation of three levers. These are:

Starting lever
Control lever
Control selector lever

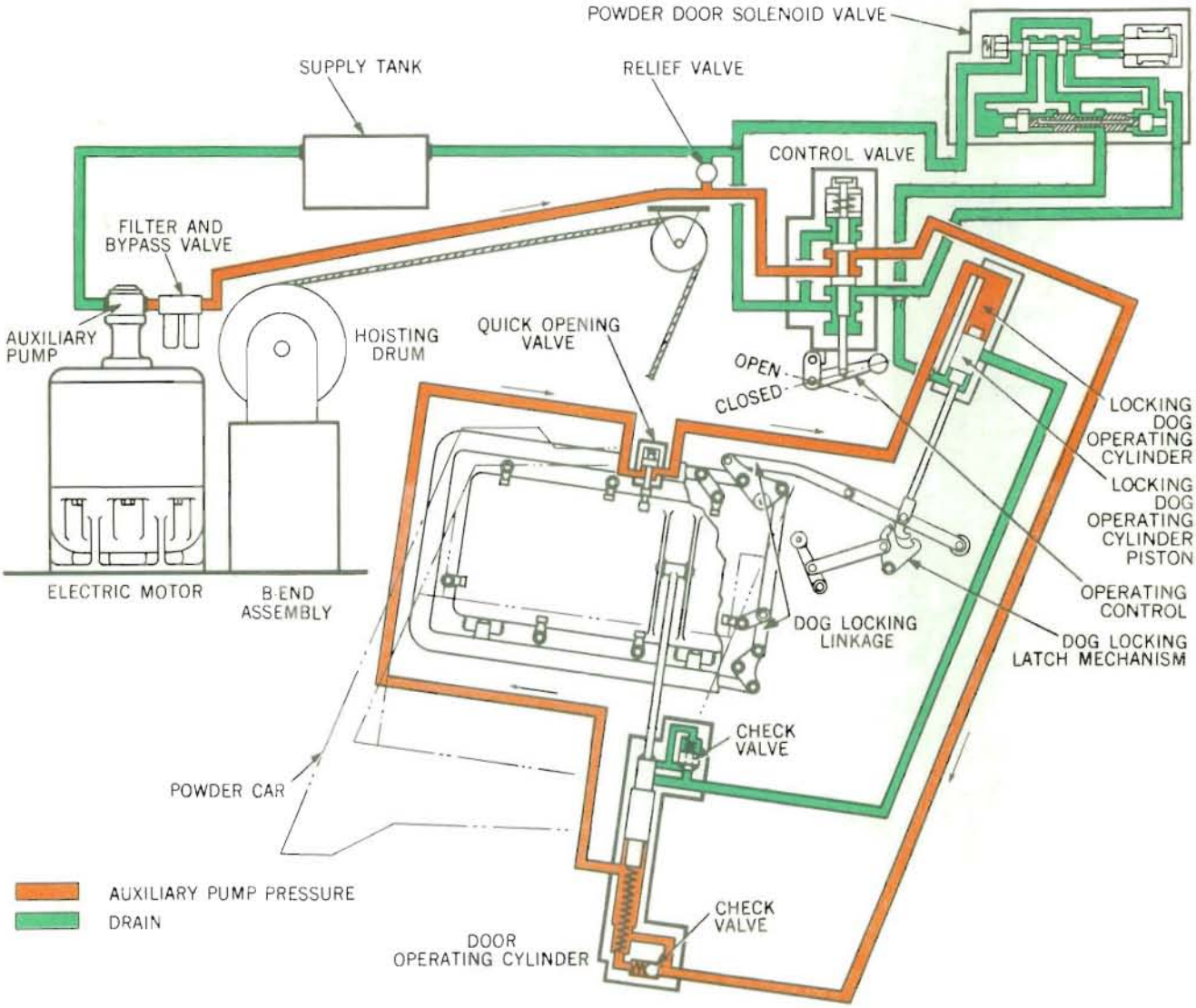

Figure 11-10. Trunk Upper Door Closing, Control at CLOSED - Schematic Diagram.

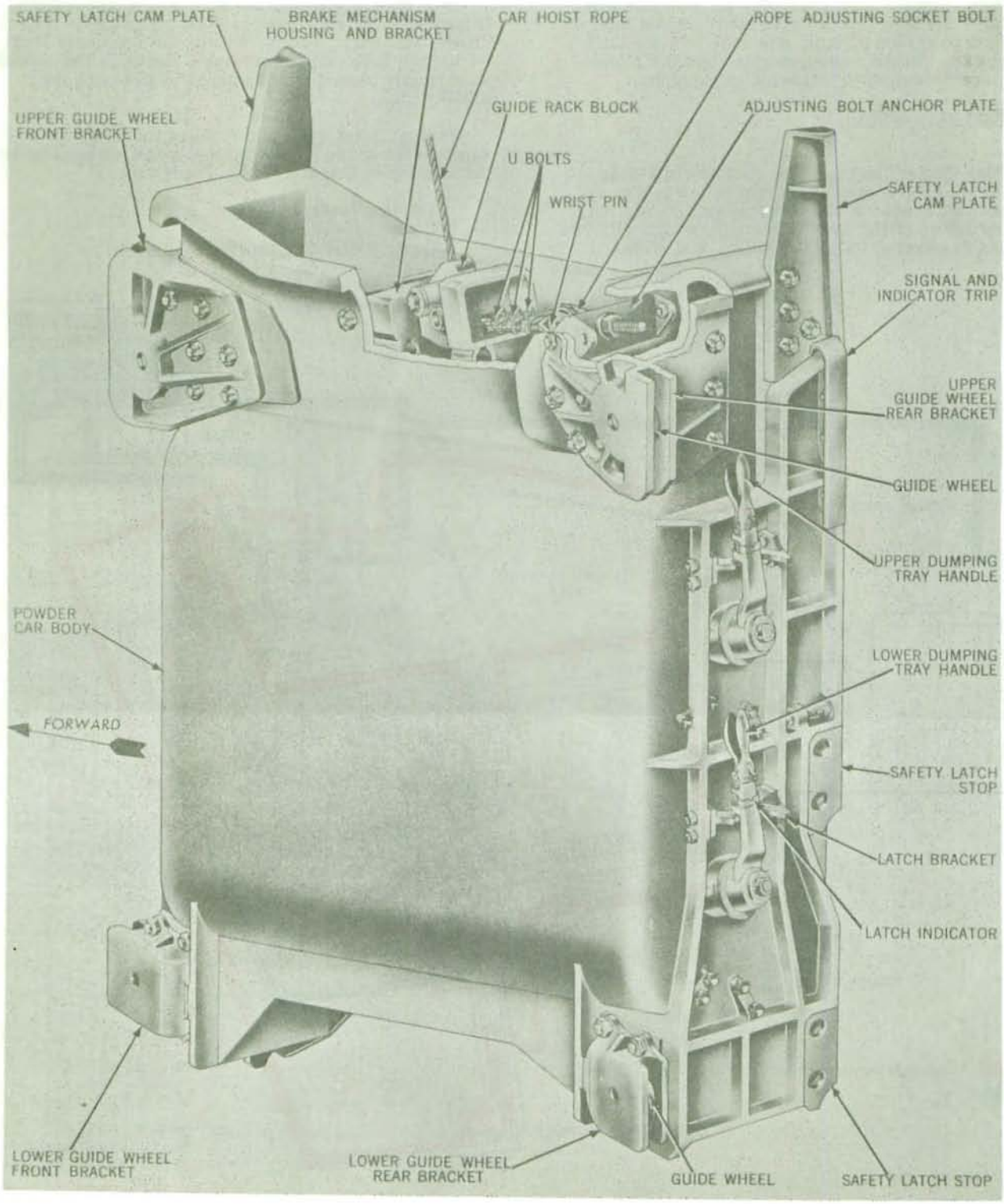

Figure 11-11. Powder Car, Rear View - General Arrangement

Starting lever. The starting lever is bracket mounted on the rear of the hoist trunk rear plate (fig. 11-14). It is connected to operate the safety car stop release valve and one of a series of starting circuit switches. The starting lever is interlocked with the lower door and with the upper door dog-locking latch through a solenoid-operated detent. It has two positions designated START and STOP.

Control lever. The control lever is bracket mounted on the hoist trunk division plate at the hoist operator's station. It is arranged with a guide quadrant which has two positions, designated HOIST and LOWER, in addition to a neutral notch. The lever is keyed to shafts and levers extending forward to the dashpot, A-end pump yoke controls, and the B-end. In SERVO operation, moving the control lever offsets the A-end yoke by displacing the servo valve which controls pressure to the servo piston. In MANUAL operation, moving the control lever moves the pump yoke through a mechanical linkage.

Control selector lever. The control selector lever is bracket mounted adjacent to the control lever. Arranged with a guide, the lever is positively

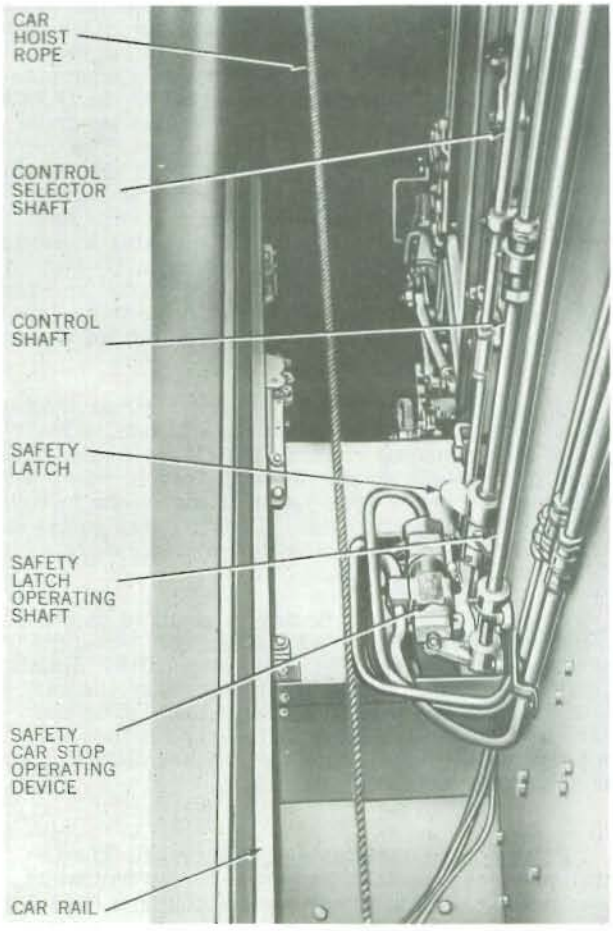

Figure 11-12. Powder Hoist Car Stop Assembly - General Arrangement

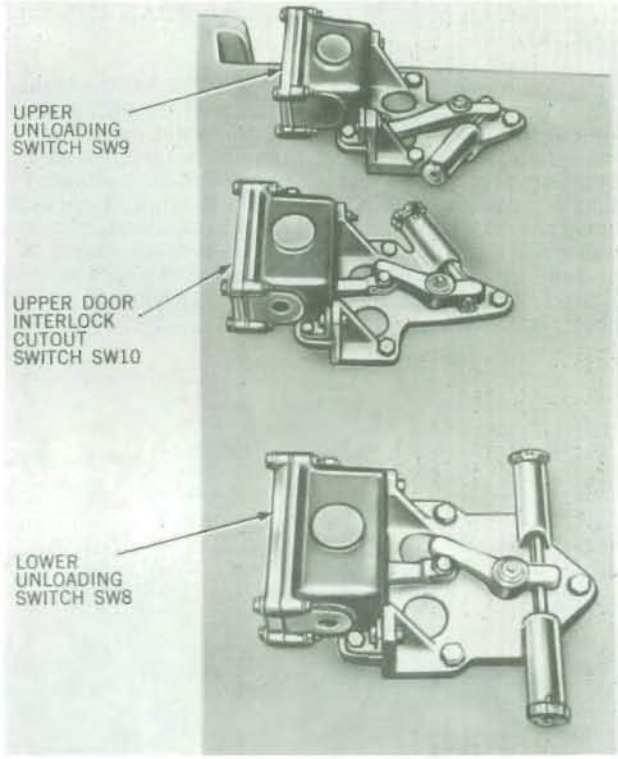

Figure 11-13. Limit Stop and Interlock Switches Trunk Upper End

held in either of two positions, designated SERVO ELECTRICAL and SERVO MECHANICAL AND MANUAL. The lever, keyed to a shaft which extends forward to the A-end pump controls, is provided with linkage connected to a venting valve and a control lever shaft latch.

Starting lever interlock and car indicator system.

Starting lever interlock. The starting lever interlock, comprising a bracket mounted solenoid and starting lever detent assembly, locks the starting lever at STOP when the solenoid (S3) is de-energized. The interlock insures that both hoist doors are closed before starting to hoist, and before starting to lower from the lower unloading station. When both the upper and lower hoist doors are closed, the upper and lower door starting lever interlock switches (SW12 and SW11) are closed. This energizes the starting lever interlock solenoid (S3) which retracts and unlocks the starting lever, and permits its movement to start. When lowering from the upper unloading station (upper door open) the interlock is bypassed by the interlock cutout switch (SW10), which permits starting lever movement to lower the car to the lower unloading station.

The starting lever detent assembly is provided with a manually operated keeper. Located below the solenoid, the keeper locks out the interlock circuit (in the event of interlock circuit or solenoid (failure) by keeping the solenoid retracted.

The circuit is completely independent of the electrical hoist control circuit and is normally in use whether the control selector lever is at SERVO ELECTRICAL or at SERVO MECHANICAL AND MANUAL.

Hoist signal indicator system. The hoist signal indicator system operates in conjunction with powder car movement and informs the hoist operator when the car is loaded and ready to hoist. An electrical system, it comprises two identical indicator light assemblies (fig. 11-15), one located at each of the lower door and hoist operator's stations. These assemblies are arranged with a switch assembly at the lower end, a car mounted cam, and necessary wiring. The system is energized only when the hoist motor is in operation.

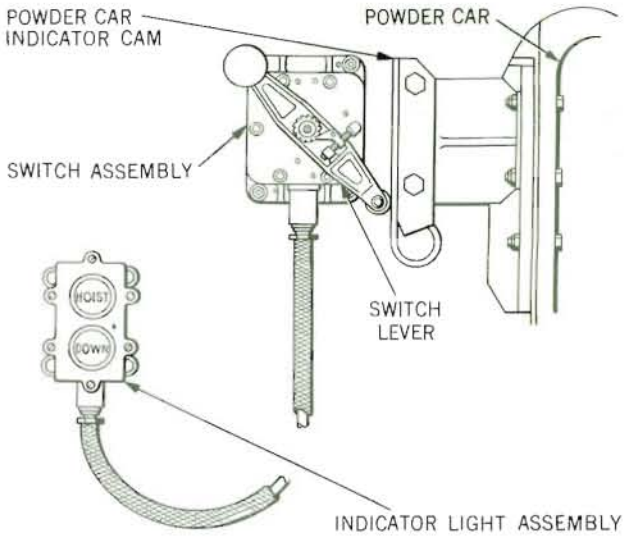

Figure 11-15. Powder Hoist Indicator and Switch Assembly - Trunk Lower End

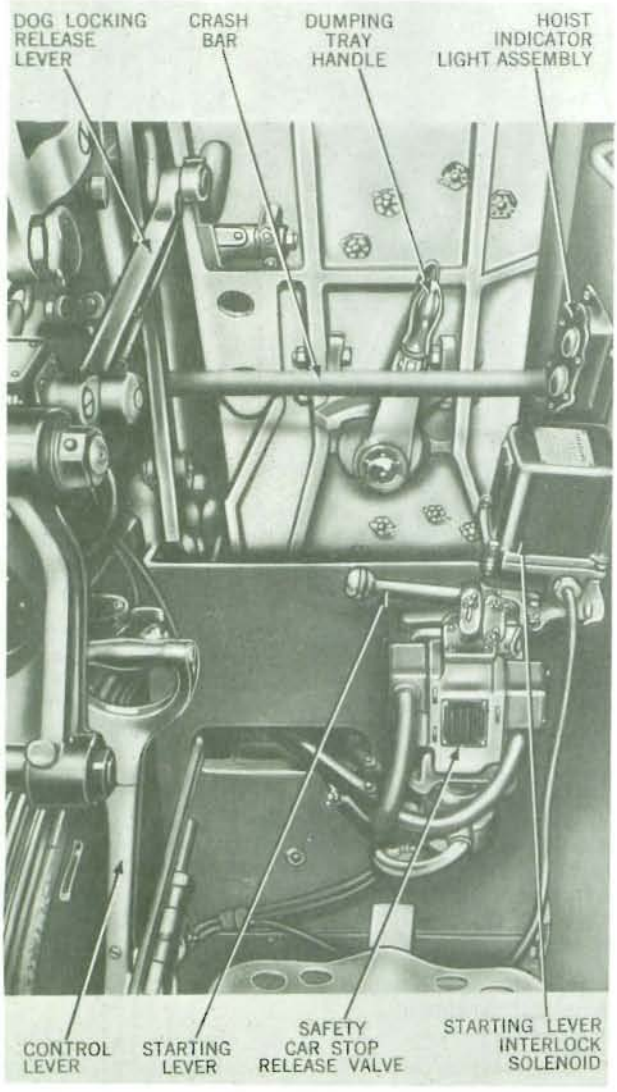

Figure 11-14. Powder Hoist Control Station - General Arrangement

The indicator light assemblies each have two dials, one marked HOIST and the other DOWN. The switch assembly contains a two plate selector switch, each plate having eight connection points. One plate is connected to the HOIST dials, energizing them four times in each rotation of the moving contracts. The other plate is similarly connected to the DOWN dials, but with connections offset 45 degrees from the first to alternate the dial indications. The required 45 degrees switch contact movements are obtained by a pawl on the switch lever and an eight-toothed ratchet on the switch spindle. The switch is held in the correct position by detents on a star wheel in the switch. The switch handle is limited by stop pins to 90 degrees movement between horizontal and vertical. A spring returns the switch handle to horizontal after it is released by the car car or the lower door operator.

Upper end. The indicator is bracket mounted in full view of the hoist operator (fig. 11-14). When the car is at the loading station, DOWN dials are illuminated in both indicators. When the car is ready for hoisting, the lower door operator moves the switch lever to a vertical position. DOWN lights go out and HOIST dials are illuminated in both indicators.

Lower end. The indicator is mounted on the trunk wall below the switch assembly. When the car is at either unloading station the HOIST dials are illuminated in both indicators. When the car is lowered to the loading station, the cam on the car trips the switch lever as the car reaches the hoist bottom. HOIST lights go out and DOWN dials are illuminated in both indicators.

Power drive controls and interlocks. The installed arrangement of the powder hoist hydraulic equipment provides power for hoisting and lowering the car. Car movement is controlled by the operator and hoist interlock switches. The controls include devices to limit acceleration and deceleration rates, and to prevent dropping of the car in event of power failure.

Control arrangement. The powder hoist power drive is designed for normal control through a servo stroking system. This system positions the A-end pump yoke by a servo stroking piston that is operated by pressure from the control and supercharge pump (described on page 11-4). There are two control selections, designated SERVO ELECTRICAL and SERVO MECHANICAL, that use servo stroking control. In MANUAL MECHANICAL control, the pump yoke is manually offset to a stroke position.

Servo electrical control. This control selection utilizes powder car position switches, door interlock switches, and a starting lever switch. These open and close the hoist control circuit to energize a solenoid which shifts the venting valve to build up control pressure. The amount of stroke of the A-end yoke is controlled by manual movement of the control lever toward HOIST or LOWER. Car acceleration, deceleration, and speed are limited by cams in the B-end housing (described on page 11-7). Stopping is controlled by car-operated switches that act to vent the main hydraulic system and apply the brake.

Servo mechanical control. This is a control selection in which the hoist control circuit and the venting valve solenoid are inoperative and the venting valve is manually shifted by the control selector lever and linkage. Movement of the control lever initiates SERVO piston stroke. Powder car acceleration, deceleration, and speed are limited by cams in the B-end housing (described on page 11-7). Stopping is controlled by the latch and vent valve.

Servo control actions, limits, and speeds. The powder car may be stopped and started again at any time during a hoisting or lowering cycle with the control lever. In mid-cycle, acceleration and deceleration rates are limited to less than 16 feet per second per second by the dashpot attached to the control shaft (fig. 11-2). At the beginning and end of cycles, these rates are limited to the same valve by the B-end cams.

Manual control. This is a control selection in which the yoke is offset by mechanical linkage from the control lever. Car acceleration, deceleration and speed are limited by the cams in the B-end housing (described on page 11-7). The hoist control circuit and venting valve solenoid are inoperative as in servo mechanical control. The car may be stopped and started again at any time during a hoisting or lowering cycle by moving the control lever.

Power failure. A power failure valve, solenoid-operated, applies the B-end brake and stops the hoist in the event of electric power failure. This action occurs regardless of the position of the control levers.

Power on circuit. The controller is arranged with a power on circuit connected to a solenoid of the power drive controls. When the controller main contactors are closed the power on circuit is closed and the power failure valve operating solenoid is energized to position the valve as outlined in the previous paragraph.

Door and dog latch interlocks. The upper door assembly is arranged with an upper door interlock switch, and a starting lever detent-operating solenoid switch; these switches are in different circuits. The upper door interlock switch opens the hoist control circuit and de-energizes the venting valve solenoid when the upper door is open, except when the powder car is at the upper unloading station. The upper door interlock switch, series connected with the lower door interlock switch, de-energizes the starting lever interlock solenoid to lock the starting lever when the upper door is open. The starting lever is not locked when the car is at the upper unloading station. This is prevented by the closing of the upper door interlock cutout switch by the car; this keeps the starting lever interlock solenoid energized and the starting lever free to move the car from the upper to the lower unloading station.

OPERATION

General

Powder car hoisting and lowering are power drive operations, servo or manually controlled. The selection of control and the control of starting, stopping, and speed of hoisting and lowering is determined by the position and movement of levers. The powder car cannot be hoisted or lowered manually. Circuit flow conditions and resultant movement of components, shown schematically in figures 11-16 to 11-23 inclusive, are described in the following paragraphs:

Starting

Perform the following operations when starting the electric motor:

1. Place the controller circuit-breaker lever at ON.
2. Place the control lever at neutral.
3. Press the START-EMERG button.

Stopping

Perform the following operations when stopping the electric motor:

1. Move the powder car to the loading station.
2. Place the control lever at neutral.
3. Press the STOP button.

Servo electrical control

The normal control selection is SERVO ELECTRICAL. Hoist operations in this method of control, described below, are shown schematically in figures 11-16 to 11-19 inclusive.

Stop position. The control selector is at SERVO ELECTRICAL, the starting lever is at STOP, and the control lever is at neutral.

1. Main system pressure, vented and bypassed, is insufficient to retract the plungers of centering spring assemblies CS1 and CS2 which hold the pump yoke at neutral (slightly offset toward hoisting). The brake operating cylinder is open to drain which allows its spring to apply the brake. The control circuit is vented because solenoid S1 (de-energized) has positioned venting valve V1 in its vent position.

2. Transmission line T2 is bypassed through check valve V18, lines L15, L24 and L25, venting valve V1, PFV, and line L23 to return line T1.

3. The control circuit is vented through venting valve V1, around bypass valve V4, and servo valve V2 to the supply tank.

4. Restriction R1 maintains low supercharging pressure in lines T1 and T2 when the control (supercharge) circuit is vented.

Controls set ready to hoist. The control selector lever is at SERVO ELECTRICAL, the starting lever is at START, and the control lever is at neutral. With the power drive motor running and a hoisting stroke ready to be initiated, the following conditions exist (fig. 11-17):

1. Starting lever interlock solenoid S3 is energized when interlock switches SW11 and SW12 are closed (upper and lower trunk doors closed). This unlocks the starting lever which, when moved to START, closes starting lever switch SW6 and positions car stop release valve V3 to port main system pressure to the safety car stop operating device. With door interlock switches SW4 and SW5 closed and unloading switches SW8 and SW9 closed, the closing of SW6 by the starting lever completes the circuit to energize venting valve solenoid S1.

2. Energized, solenoid S1 moves venting valve V1 to close the main system and control circuit vents thereby permitting main system and control pressure build-up.

3. Control pressure shifts bypass valve V4, porting control pressure to chamber A of servo stroking piston P1. With servo valve V2 held in neutral position, fluid trapped in chamber B of P1 prevents movement of P1.

4. With the pump yoke held at neutral (slightly offset toward hoisting) by the control lever, main system pressure build up in line T2, ported through check valve V18 and lines L10, L15 and L11 retracts the plungers of centering spring assemblies CS1 and CS2. When the plungers are retracted, the control lever may be moved to offset the pump yoke.

5. Main system pressure build-up in line T2 ported through V18, L15, L24, L25, V1, PFV, L26 line L17, and V6, through line L16 to the brake operating cylinder releases the brake.

6. With the brake released, foot valve V5 maintains back pressure in line L12 to prevent the car from dropping. Check valve V13 and bypass valve V14 block line L12 to prevent B-end rotation.

Hoisting. The control selector lever is at SERVO ELECTRICAL, the starting lever is at STOP, and the control lever is at HOIST. The following conditions exist (fig. 11-20):

1. Moved toward HOIST to initiate a hoisting cycle, the control lever moves linkage L2 which shifts servo valve V2 enough to vent chamber B of piston P1 to the tank. Control pressure in chamber A moves P1 toward the left offsetting the pump yoke to hoisting position, to cause B-end rotation. Movement of the control lever also actuates linkage to move cam follower CR2 to contact and ride on hoisting acceleration cam C1.

2. Hoisting acceleration and deceleration is mechanically controlled by the B-end cams through control linkage L5 which is connected to servo linkage L2. At its lower end, L2 is connected to V2 which is held with restricted movement by locking cam C5. Connected to V2 by L2, P1 will offset the pump yoke whenever V2 is positioned by the control lever. When control lever movement toward hoist is stopped, P1 will continue to move until V2 is closed by L2.

3. When the car rises slightly it permits switch SW7 to close; this bypasses SW6 in the solenoid S1 circuit to keep the solenoid energized. When the starting lever is returned to STOP, it opens switch SW6 and shifts the car stop release valve V3 to vent the safety car stop cylinder and return latch L1 into the path of the car.

4. Hoisting acceleration is controlled by cam follower CR2 riding on cam C1. The car rises at constant speed until CR2 rides on cam C3, which moves V2 enough in the opposite direction to port control pressure to chamber B of P1. This moves the pump yoke toward center and decelerates the hoist. Line T1 is the main system return line; the system is replenished through supercharge check valve V16.

5. As the car reaches the upper unloading station it opens switch SW9. This de-energizes S1 which shifts V1 so that it vents and bypasses the main system and vents the control circuit. When the main system is vented, the brake is applied and the plungers of centering spring assemblies CS1 and CS2 extend to position the pump yoke at neutral.

6. With the car at the upper unloading station, the interlock cutout switch SW10 is closed energizing solenoid S3 and unlocking the starting lever while the upper door is open.

7. The starting lever is moved to START, closing switch SW6. Switch SW9 is spring-operated to close when the car is lowered to the lower unloading station.

8. Moved toward LOWER, the control lever shifts V2 (through L2) to port control pressure to chamber B of P1 which moves the pump yoke to lower.

9. As lowering movement starts, pressure in line T1 is bypassed through check valve V9, to prevent valves RV relieving before the brake releases.

10. After the brake releases, back pressure ported into line L12 closes V9. This closes the main system bypass. Fluid ported through line T1 is at greater pressure than the adjustment of V5 and the B-end rotates to lower.

11. After the car lowers approximately 3 inches from the upper unloading station, switch SW9 closes. The starting lever should be returned to STOP to move latch L1 into the path of the car. If the starting lever is not returned to STOP (upper door open) the car will lower, controlled by cam C2, until switch SW8 is opened. This vents the system and applies the brake at the lower unloading station.

12. As the car lowers, switch SW10 opens, de-energizing solenoid S3 and locking the starting lever.

13. Unlocked when switch SW5 is closed by closing the upper door, the starting lever is moved to START to close SW6.

14. Moved toward lower, the control lever shifts V2, porting control pressure to chamber B of P1 which moves the pump yoke to lower.

15. As lowering movement starts, pressure in line T1 is bypassed through check valve V9, preventing valves RV relieving before the brake releases.

16. After the brake releases, back pressure ported into line L12 closes V9 and closes the main system bypass. Fluid ported through line T1 is at greater pressure than the adjustment of V5 and the B-end rotates to lower.

17. Controlled by cam C2, the pump yoke moves to lower and linkage L3 opens bypass valve V14.

18. As the pump yoke is returned to neutral by cam C4 (at the end of the cycle), V14 is closed by L3. Fluid is ported through line T1 at greater pressure than the adjustment of V5.

19. Switch SW7, opened by the car, de-energizes S1 which shifts V1 to vent the main system and apply the brake.

Power failure.

Hoisting cycle. The control selector lever is at SERVO ELECTRICAL, the starting lever is at STOP, and the control lever is at HOIST. When the motor electric power circuit fails during a hoisting cycle, the following conditions exist (fig. 11-19):

1. When power fails, solenoids S1 and S2 are de-energized causing the main system to be vented and bypassed thereby appling the brake and permitting the plungers QS1 and CS2 to extend and move the pump yoke to neutral.

2. When the brake applies, pump rotation is continued by motor inertia. Brake ratchet assembly BR permits overrun of the drum and B-end. The car decelerates to a gradual stop and is held from dropping by the applied brake.

3. While the pump yoke is offset to hoisting, line L24 opens to line L25 through restriction R2 until the pump yoke is near neutral.

Lowering cycle. The control selector lever is at SERVO ELECTRICAL, the starting lever is at STOP, and the control lever is at LOWER. When the motor power circuit fails during a lowering cycle, the following conditions exist (fig. 11-19).

1. Venting valve solenoid S1 and power failure solenoid S2 are de-energized, bypassing and venting the main system, venting the control circuit, and applying the brake.

2. Simultaneously, pressure drops in line T1, centering spring assemblies CS1 and CS2 are vented to the tank and the plunger of CS1 moves the pump yoke to neutral.

Servo mechanical control

Servo mechanical control operations, described below, are shown schematically in figures 11-20 to 11-23 inclusive.

Stop position. The control selector lever is at SERVO MECHANICAL, the starting lever is at STOP, and the control lever is at neutral. The following conditions exist (fig. 11-20):

1. Movement of the control selector lever to SERVO MECHANICAL actuates linkage which shifts venting V1 and latch and vent valve V6 to vent the main system and control circuit, and in addition drops latch L4 into the notch on cam C6.

2. Vented main system pressure is insufficient to retract the plungers of centering spring assemblies CS1 and CS2 which hold the pump yoke at neutral (slightly offset toward hoisting). In addition the vented main system allows the brake to apply.

3. The main system and control circuit is vented via transmission lines T1 and T2 through check valves V17 and V18, through lines L15, L24, and L25 V1, PFV to line L26, through line L17 to V6, through line L1i to V3 and through lines L19 and L20 to the tank.

4. The main system bypass is closed by V1 which is held in closed position by the control selector lever.

Controls set ready to hoist. The control selector lever is at SERVO MECHANICAL, the starting lever is at START, and the control lever is neutral. The following conditions exist (see fig. 11-21):

1. Movement of the starting lever to START shifts car stop release valve V3 to close the main system thereby permitting main system pressure to build-up. Linkage actuated by the starting lever moves valve V6 up (to port main system pressure to the brake operating cylinder, releasing the brake) and also unlocks cam C6 (by moving latch L4 out of the C6 notch thereby permitting control lever movement).

2. Main system pressure build-up is sufficient to hold the loaded car from falling because the pump yoke is slightly offset toward hoisting when it is held at neutral by the control lever. Pressure ported to CS1 and CS2 retracts the plungers and permits offset movement of the pump yoke.

3. Control pressure shifts bypass valve V4, porting control pressure to chamber A of piston P1. With servo valve V2 held in neutral position fluid trapped in chamber B of P1 prevents movement of P1.

4. With the brake released, foot valve V5 maintains back pressure in line L12 to prevent the car from dropping. Check valve V13 and bypass valve V14 block line L12 to prevent B-end rotation.

Hoisting. The control lever is at SERVO MECHANICAL, the starting lever is at STOP, and the control lever is at HOIST. The following conditions exist (fig. 11-22):

1. Moved toward HOIST to initiate a hoisting cycle, the control lever moves linkage L2 which

shifts servo valve V2 enough to vent chamber B of piston P1 to the tank. Control pressure in chamber A moves P1 toward the left, offsetting the pump yoke toward hoisting, causing B-end rotation. Movement of the control lever also actuates linkage to move cam follower CR2 to contact and ride on hoisting acceleration cam C1.

2. The starting lever, moved to START to begin the hoisting cycle, must be released as soon as car movement begins so that latch L1 is returned into the path of the car.

3. Latch L4 is operated by main system pressure (in the top of valve V6) to ride on cam C6 until the control lever is moved to neutral by either the operator or cam C3. Latch L4 is spring-operated to complete the latching operation after the main system and control circuit are vented by V6 moving L4 into the notch of C6.

4. When the main system is vented, the brake-operating cylinder vents through line L22 to the tank. Centering spring assemblies CS1 and CS2 are vented to the tank through lines L11 and L10 respectively and the plungers extend to position the pump yoke at neutral. The car is at the upper unloading station.

The control lever can not be moved until the starting lever is moved to START.

5. Moved toward LOWER, the control lever shifts V2 porting control pressure to chamber B of P1 which moves the pump yoke to lower.

6. As lowering movement starts, pressure in line T1 is bypassed through check valve V9, to prevent valves RV relieving before the brake releases.

7. After the brake releases, back pressure ported into line L12 closes V9 to close the main system bypass. Fluid ported through line T1 is at greater pressure than the adjustment of V5 and the B-end rotates to lower. The starting lever must be released as soon as car movement begins so that latch L1 is returned into the path of the car.

8. The main system and control circuit are vented by V6. The brake is applied and CS1 and CS2 position the pump yoke at neutral.

9. The starting lever is moved to START and the lowering cycle is continued as in operations 16, 17, 18, 19, 20, and 21 under servo electrical control.

10. The main system and control circuit are vented by V6. The brake is applied and CS1 and CS2 position the pump yoke at neutral.

Power failure.

Hoisting cycle. The control selector lever is at SERVO MECHANICAL, the starting lever is at STOP, and the control lever is at HOIST. When the motor electric power circuit fails during a hoisting cycle, the following conditions exist (fig. 11-23):

1. When power fails, solenoid S2 is de-energized causing the main system and control circuit to be vented thereby applying the brake and permitting the plunger of CS2 to extend and move the pump yoke to neutral.

2. When the brake applies, pump rotation is continued by motor inertia. Brake ratchet assembly BR permits overrun of the drum and B end. The car decelerates to a gradual stop and is held from dropping by the brake.

3. While the pump yoke is offset to hoisting, line L24 opens to line L25 through restriction R2 until the pump yoke is near neutral.

Lowering cycle. The control selector lever is at SERVO MECHANICAL, the starting lever is at STOP, and the control lever is at LOWER. When the motor power circuit fails during a lowering cycle, the following conditions exist (fig. 11-23):

1. Power failure solenoid S2 is de-energized shifting valve PFV to vent the main system and control circuit, and apply the brake.

2. Simultaneously pressure drops in line T1, centering spring assemblies CS1 and CS2 are vented to the tank and the plunger of CS1 moves the pump yoke to neutral.

Interlock system operation

Hoist interlock system arrangements and operation are described in the following paragraphs and are shown schematically in figures 11-24 to 11-26 inclusive. Designated circuit QC, the interlock circuit is described in chapters 12 and 15.

Powder car at loading level; trunk lower door open. With the electric motor running and the starting lever at STOP, the following conditions exist (fig. 11-24):

1. Because the lower door is open and unlocked, the lower door interlock switch SW4 and the lower door starting lever interlock switch SW11 are open. The loading position switch SW7 is held open by contact with the powder car.

2. The starting lever interlock solenoid S3, also de-energized, locks the starting lever at STOP and prevents closure of the starting lever switch SW6.

3. With the starting lever switch SW6 open, the venting valve solenoid S1 is de-energized and positions the venting valve to vent the hydraulic system.

Lower and upper trunk doors closed; car rising. The starting lever is shown after it has been returned to STOP from the START position. As the car is rising, the following conditions exist (fig. 11-25):

1. With the lower door closed and locked, the lower door interlock switch SW4 and the lower door starting lever interlock switch SW11 close Starting lever interlock solenoid S3, energized, unlocks the starting lever. The upper interlock switch SW5 and the lower and upper unloading switches SW8 and SW9 are closed. When the starting lever is positioned at START it closes switch SW6 and completes the circuit to energize venting valve solenoid S1. This closes the hydraulic system and the car rises.

ELECTRICAL SYMBOLS

SW4	LOWER DOOR INTERLOCK SWITCH	SW11	LOWER DOOR, STARTING LEVER INTERLOCK SWITCH
SW5	UPPER DOOR INTERLOCK SWITCH	SW12	UPPER DOOR, STARTING LEVER INTERLOCK SWITCH
SW6	STARTING LEVER SWITCH	S1	VENTING VALVE SOLENOID
SW7	LOADING POSITION SWITCH	S2	POWER FAILURE SOLENOID
SW8	LOWER UNLOADING SWITCH	S3	STARTING LEVER INTERLOCK SOLENOID
SW9	UPPER UNLOADING SWITCH		
SW10	INTERLOCK CUTOUT SWITCH		

HYDRAULIC SYMBOLS

A	STROKING CYLINDER CHAMBER	V5	FOOT VALVE
AV	AIR VENTS	V6	LATCH AND VENT VALVE
B	STROKING CYLINDER CHAMBER	V7	SERVO PUMP BY-PASS VALVE
CSP	CONTROL AND SUPERCHARGE SERVO PUMP	V8	SERVO PUMP RELIEF VALVE
F	OIL FILTER	V9	CHECK VALVE (B-END)
PFV	POWER FAILURE VALVE	V10	CHECK VALVE
P1	SERVO STROKING PISTON	V11	REPLENISHING CHECK VALVES
P2	DASHPOT PISTON	V12	FILTER CONTROL VALVE
RV	MAIN SYSTEM RELIEF VALVES	V13	CHECK VALVE (B-END)
R1	RESTRICTION	V14	BY-PASS VALVE (B-END)
R2	RESTRICTION	V15	SUPERCHARGE CHECK VALVE
R3	RESTRICTION	V16	SUPERCHARGE CHECK VALVE
V1	VENTING VALVE	V17	CHECK VALVE
V2	SERVO VALVE	V18	CHECK VALVE
V3	CAR STOP RELEASE VALVE	V19	DASHPOT FEED CONTROL VALVES
V4	BY-PASS VALVE (A-END)	V20	CHECK VALVES

T1, T2 AND L10 TO L26 INCLUSIVE ARE HYDRAULIC LINES

MECHANICAL SYMBOLS

BR	BRAKE RATCHET ASSEMBLY	CR2	CAM FOLLOWER ROLLER
C1	HOISTING ACCELERATION CAM	CS1	CENTERING SPRING ASSEMBLY
C2	LOWERING ACCELERATION CAM	CS2	CENTERING SPRING ASSEMBLY
C3	HOISTING DECELERATION CAM	L1	SAFETY CAR STOP LATCH
C4	LOWERING DECELERATION CAM	L2	SERVO LINKAGE
C5	SERVO VALVE LOCKING CAM	L3	BY-PASS VALVE LINKAGE (B-END)
C6	HOIST CONTROL LINKAGE CAM	L4	LATCH AND VENT VALVE LATCH
CR1	CAM FOLLOWER ROLLER	L5	CONTROL LINKAGE

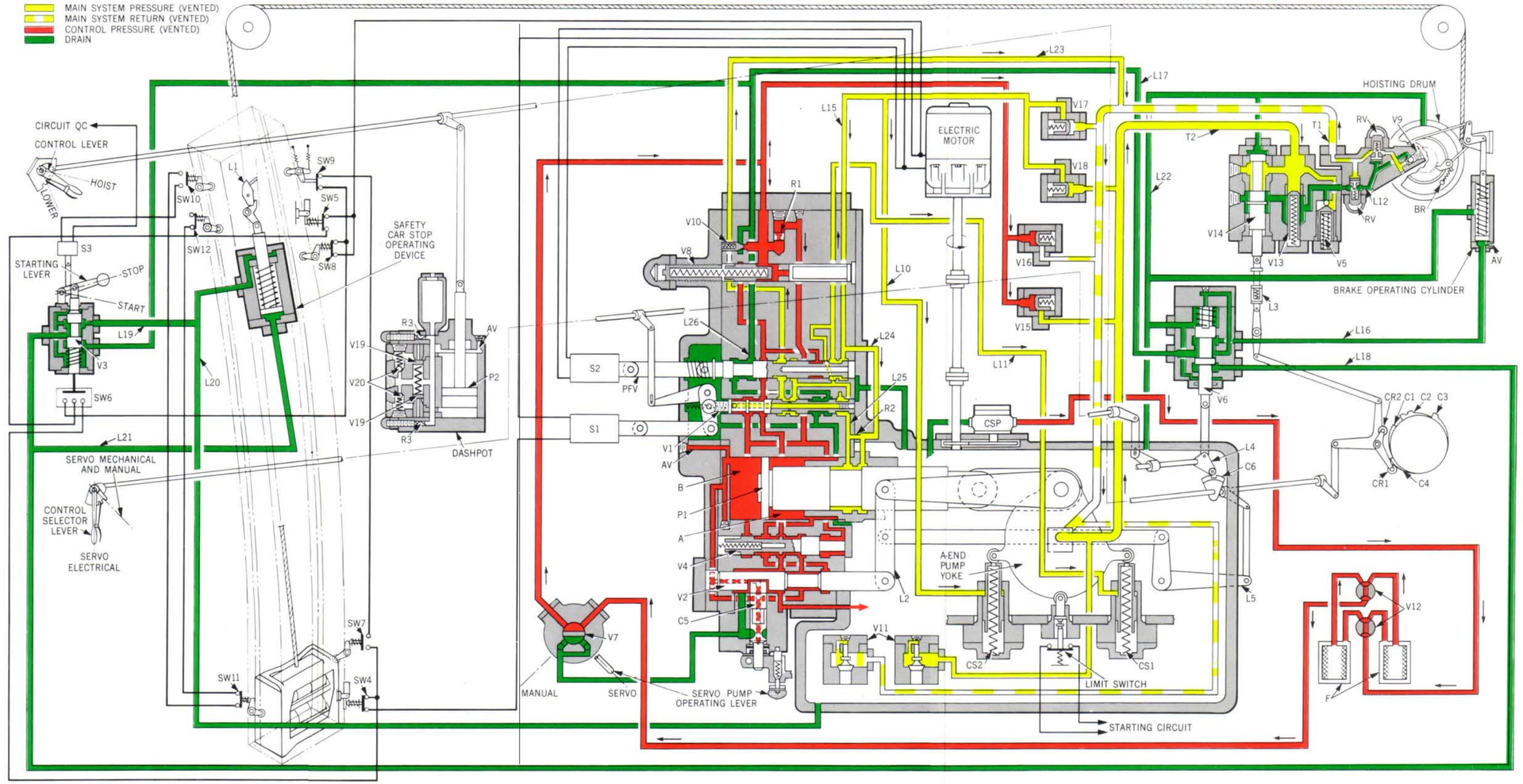

Figure 11-16, Powder Hoist, Servo Electrical Control - Stop Position, Schematic Diagram

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ELECTRICAL SYMBOLS

SW4	LOWER DOOR INTERLOCK SWITCH	SW11	LOWER DOOR, STARTING LEVER INTERLOCK SWITCH
SW5	UPPER DOOR INTERLOCK SWITCH	SW12	UPPER DOOR, STARTING LEVER INTERLOCK SWITCH
SW6	STARTING LEVER SWITCH	S1	VENTING VALVE SOLENOID
SW7	LOADING POSITION SWITCH	S2	POWER FAILURE SOLENOID
SW8	LOWER UNLOADING SWITCH	S3	STARTING LEVER INTERLOCK SOLENOID
SW9	UPPER UNLOADING SWITCH		
SW10	INTERLOCK CUTOUT SWITCH		

HYDRAULIC SYMBOLS

A	STROKING CYLINDER CHAMBER	V5	FOOT VALVE
AV	AIR VENTS	V6	LATCH AND VENT VALVE
B	STROKING CYLINDER CHAMBER	V7	SERVO PUMP BY-PASS VALVE
CSP	CONTROL AND SUPERCHARGE SERVO PUMP	V8	SERVO PUMP RELIEF VALVE
F	OIL FILTER	V9	CHECK VALVE (B-END)
PFV	POWER FAILURE VALVE	V10	CHECK VALVE
P1	SERVO STROKING PISTON	V11	REPLENISHING CHECK VALVES
P2	DASHPOT PISTON	V12	FILTER CONTROL VALVE
RV	MAIN SYSTEM RELIEF VALVES	V13	CHECK VALVE (B-END)
R1	RESTRICTION	V14	BY-PASS VALVE (B-END)
R2	RESTRICTION	V15	SUPERCHARGE CHECK VALVE
R3	RESTRICTION	V16	SUPERCHARGE CHECK VALVE
V1	VENTING VALVE	V17	CHECK VALVE
V2	SERVO VALVE	V18	CHECK VALVE
V3	CAR STOP RELEASE VALVE	V19	DASHPOT FEED CONTROL VALVES
V4	BY-PASS VALVE (A-END)	V20	CHECK VALVES

T1, T2 AND L10 TO L26 INCLUSIVE ARE HYDRAULIC LINES

MECHANICAL SYMBOLS

BR	BRAKE RATCHET ASSEMBLY	CR2	CAM FOLLOWER ROLLER
C1	HOISTING ACCELERATION CAM	CS1	CENTERING SPRING ASSEMBLY
C2	LOWERING ACCELERATION CAM	CS2	CENTERING SPRING ASSEMBLY
C3	HOISTING DECELERATION CAM	L1	SAFETY CAR STOP LATCH
C4	LOWERING DECELERATION CAM	L2	SERVO LINKAGE
C5	SERVO VALVE LOCKING CAM	L3	BY-PASS VALVE LINKAGE (B-END)
C6	HOIST CONTROL LINKAGE CAM	L4	LATCH AND VENT VALVE LATCH
CR1	CAM FOLLOWER ROLLER	L5	CONTROL LINKAGE

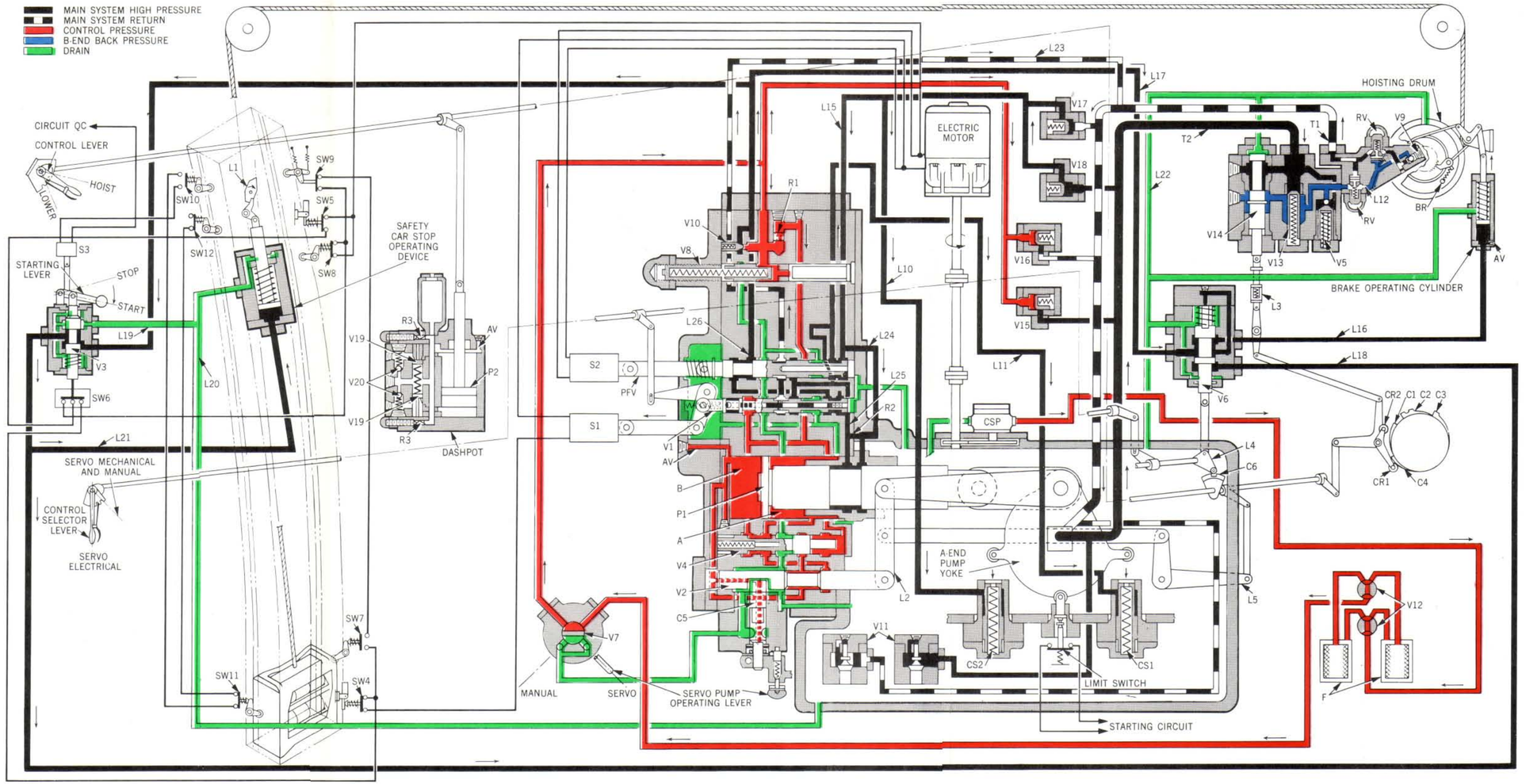

Figure 11-17. Powder Hoist, Servo Electrical Control - Controls Set Ready To Hoist, Schematic Diagram

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ELECTRICAL SYMBOLS

SW4	LOWER DOOR INTERLOCK SWITCH	SW11	LOWER DOOR, STARTING LEVER INTERLOCK SWITCH
SW5	UPPER DOOR INTERLOCK SWITCH	SW12	UPPER DOOR, STARTING LEVER INTERLOCK SWITCH
SW6	STARTING LEVER SWITCH	S1	VENTING VALVE SOLENOID
SW7	LOADING POSITION SWITCH	S2	POWER FAILURE SOLENOID
SW8	LOWER UNLOADING SWITCH	S3	STARTING LEVER INTERLOCK SOLENOID
SW9	UPPER UNLOADING SWITCH		
SW10	INTERLOCK CUTOUT SWITCH		

HYDRAULIC SYMBOLS

A	STROKING CYLINDER CHAMBER	V5	FOOT VALVE
AV	AIR VENTS	V6	LATCH AND VENT VALVE
B	STROKING CYLINDER CHAMBER	V7	SERVO PUMP BY-PASS VALVE
CSP	CONTROL AND SUPERCHARGE SERVO PUMP	V8	SERVO PUMP RELIEF VALVE
F	OIL FILTER	V9	CHECK VALVE (B-END)
PFV	POWER FAILURE VALVE	V10	CHECK VALVE
P1	SERVO STROKING PISTON	V11	REPLENISHING CHECK VALVES
P2	DASHPOT PISTON	V12	FILTER CONTROL VALVE
RV	MAIN SYSTEM RELIEF VALVES	V13	CHECK VALVE (B-END)
R1	RESTRICTION	V14	BY-PASS VALVE (B-END)
R2	RESTRICTION	V15	SUPERCHARGE CHECK VALVE
R3	RESTRICTION	V16	SUPERCHARGE CHECK VALVE
V1	VENTING VALVE	V17	CHECK VALVE
V2	SERVO VALVE	V18	CHECK VALVE
V3	CAR STOP RELEASE VALVE	V19	DASHPOT FEED CONTROL VALVES
V4	BY-PASS VALVE (A-END)	V20	CHECK VALVES

T1, T2 AND L10 TO L26 INCLUSIVE ARE HYDRAULIC LINES

MECHANICAL SYMBOLS

BR	BRAKE RATCHET ASSEMBLY	CR2	CAM FOLLOWER ROLLER
C1	HOISTING ACCELERATION CAM	CS1	CENTERING SPRING ASSEMBLY
C2	LOWERING ACCELERATION CAM	CS2	CENTERING SPRING ASSEMBLY
C3	HOISTING DECELERATION CAM	L1	SAFETY CAR STOP LATCH
C4	LOWERING DECELERATION CAM	L2	SERVO LINKAGE
C5	SERVO VALVE LOCKING CAM	L3	BY-PASS VALVE LINKAGE (B-END)
C6	HOIST CONTROL LINKAGE CAM	L4	LATCH AND VENT VALVE LATCH
CR1	CAM FOLLOWER ROLLER	L5	CONTROL LINKAGE

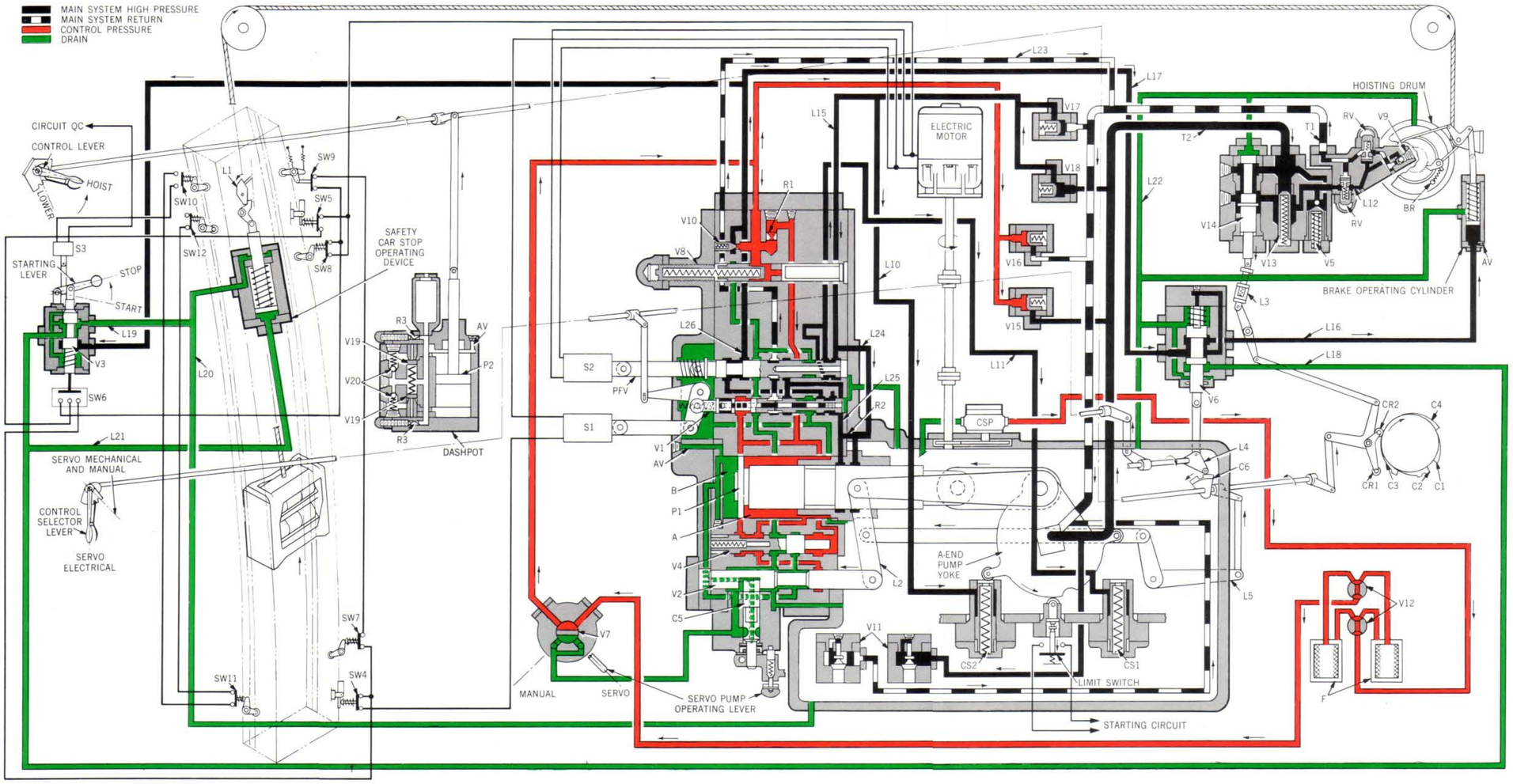

Figure 11-18. Powder Hoist, Servo Electrical Control - Hoist Position, Schematic Diagram

ELECTRICAL SYMBOLS

SW4	LOWER DOOR INTERLOCK SWITCH	SW11	LOWER DOOR, STARTING LEVER INTERLOCK SWITCH
SW5	UPPER DOOR INTERLOCK SWITCH	SW12	UPPER DOOR, STARTING LEVER INTERLOCK SWITCH
SW6	STARTING LEVER SWITCH	S1	VENTING VALVE SOLENOID
SW7	LOADING POSITION SWITCH	S2	POWER FAILURE SOLENOID
SW8	LOWER UNLOADING SWITCH	S3	STARTING LEVER INTERLOCK SOLENOID
SW9	UPPER UNLOADING SWITCH		
SW10	INTERLOCK CUTOUT SWITCH		

HYDRAULIC SYMBOLS

A	STROKING CYLINDER CHAMBER	V5	FOOT VALVE
AV	AIR VENTS	V6	LATCH AND VENT VALVE
B	STROKING CYLINDER CHAMBER	V7	SERVO PUMP BY-PASS VALVE
CSP	CONTROL AND SUPERCHARGE SERVO PUMP	V8	SERVO PUMP RELIEF VALVE
F	OIL FILTER	V9	CHECK VALVE (B-END)
PFV	POWER FAILURE VALVE	V10	CHECK VALVE
P1	SERVO STROKING PISTON	V11	REPLENISHING CHECK VALVES
P2	DASHPOT PISTON	V12	FILTER CONTROL VALVE
RV	MAIN SYSTEM RELIEF VALVES	V13	CHECK VALVE (B-END)
R1	RESTRICTION	V14	BY-PASS VALVE (B-END)
R2	RESTRICTION	V15	SUPERCHARGE CHECK VALVE
R3	RESTRICTION	V16	SUPERCHARGE CHECK VALVE
V1	VENTING VALVE	V17	CHECK VALVE
V2	SERVO VALVE	V18	CHECK VALVE
V3	CAR STOP RELEASE VALVE	V19	DASHPOT FEED CONTROL VALVES
V4	BY-PASS VALVE (A-END)	V20	CHECK VALVES

T1, T2 AND L10 TO L26 INCLUSIVE ARE HYDRAULIC LINES

MECHANICAL SYMBOLS

BR	BRAKE RATCHET ASSEMBLY	CR2	CAM FOLLOWER ROLLER
C1	HOISTING ACCELERATION CAM	CS1	CENTERING SPRING ASSEMBLY
C2	LOWERING ACCELERATION CAM	CS2	CENTERING SPRING ASSEMBLY
C3	HOISTING DECELERATION CAM	L1	SAFETY CAR STOP LATCH
C4	LOWERING DECELERATION CAM	L2	SERVO LINKAGE
C5	SERVO VALVE LOCKING CAM	L3	BY-PASS VALVE LINKAGE (B-END)
C6	HOIST CONTROL LINKAGE CAM	L4	LATCH AND VENT VALVE LATCH
CR1	CAM FOLLOWER ROLLER	L5	CONTROL LINKAGE

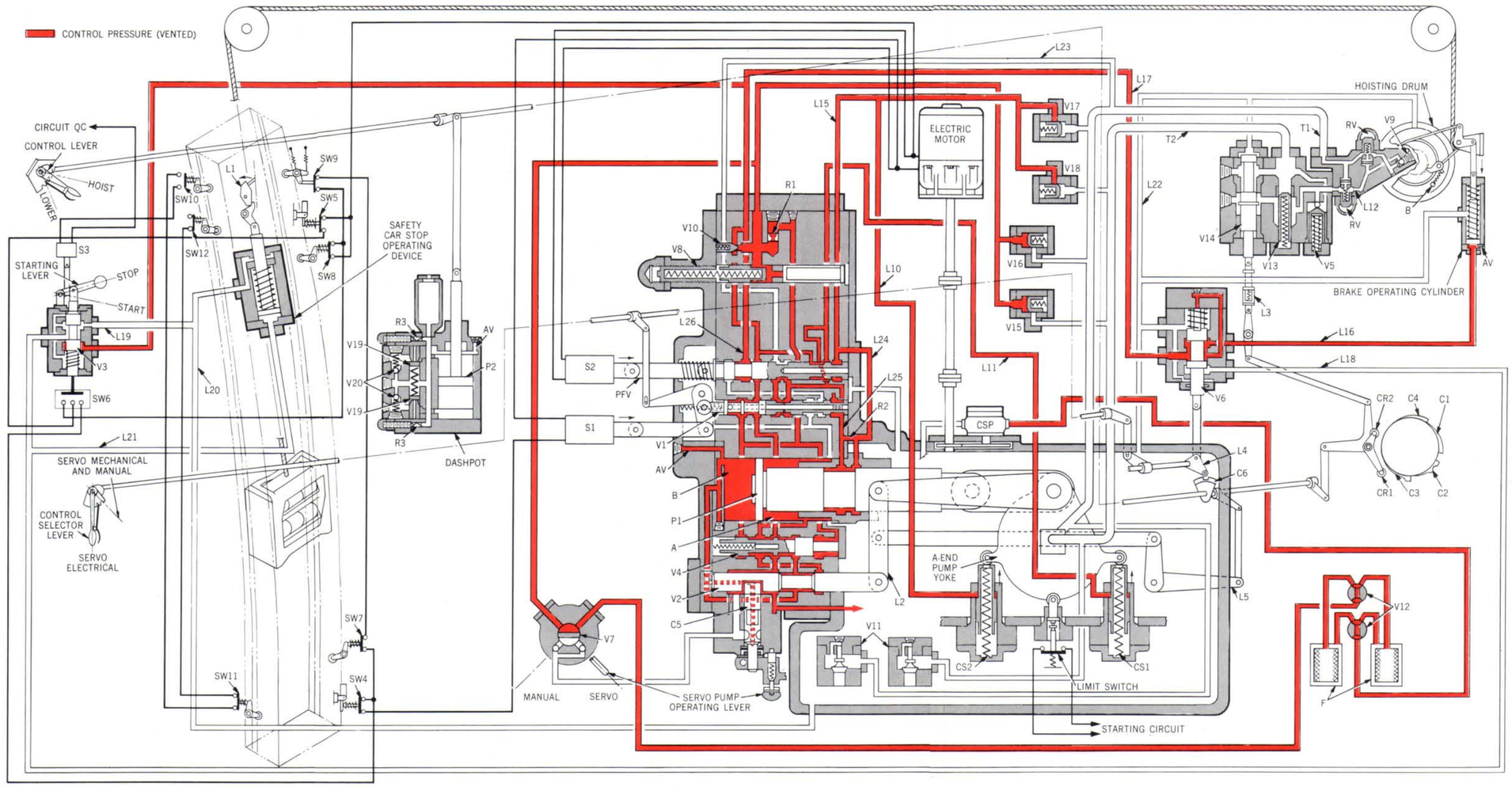

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Figure 11-19. Powder Hoist, Servo Electrical Control - Power Failure, Schematic Diagram

ELECTRICAL SYMBOLS

SW4	LOWER DOOR INTERLOCK SWITCH	SW11	LOWER DOOR, STARTING LEVER INTERLOCK SWITCH
SW5	UPPER DOOR INTERLOCK SWITCH	SW12	UPPER DOOR, STARTING LEVER INTERLOCK SWITCH
SW6	STARTING LEVER SWITCH	S1	VENTING VALVE SOLENOID
SW7	LOADING POSITION SWITCH	S2	POWER FAILURE SOLENOID
SW8	LOWER UNLOADING SWITCH	S3	STARTING LEVER INTERLOCK SOLENOID
SW9	UPPER UNLOADING SWITCH		
SW10	INTERLOCK CUTOUT SWITCH		

HYDRAULIC SYMBOLS

A	STROKING CYLINDER CHAMBER	V5	FOOT VALVE
AV	AIR VENTS	V6	LATCH AND VENT VALVE
B	STROKING CYLINDER CHAMBER	V7	SERVO PUMP BY-PASS VALVE
CSP	CONTROL AND SUPERCHARGE SERVO PUMP	V8	SERVO PUMP RELIEF VALVE
F	OIL FILTER	V9	CHECK VALVE (B-END)
PFV	POWER FAILURE VALVE	V10	CHECK VALVE
P1	SERVO STROKING PISTON	V11	REPLENISHING CHECK VALVES
P2	DASHPOT PISTON	V12	FILTER CONTROL VALVE
RV	MAIN SYSTEM RELIEF VALVES	V13	CHECK VALVE (B-END)
R1	RESTRICTION	V14	BY-PASS VALVE (B-END)
R2	RESTRICTION	V15	SUPERCHARGE CHECK VALVE
R3	RESTRICTION	V16	SUPERCHARGE CHECK VALVE
V1	VENTING VALVE	V17	CHECK VALVE
V2	SERVO VALVE	V18	CHECK VALVE
V3	CAR STOP RELEASE VALVE	V19	DASHPOT FEED CONTROL VALVES
V4	BY-PASS VALVE (A-END)	V20	CHECK VALVES

T1, T2 AND L10 TO L26 INCLUSIVE ARE HYDRAULIC LINES

MECHANICAL SYMBOLS

BR	BRAKE RATCHET ASSEMBLY	CR2	CAM FOLLOWER ROLLER
C1	HOISTING ACCELERATION CAM	CS1	CENTERING SPRING ASSEMBLY
C2	LOWERING ACCELERATION CAM	CS2	CENTERING SPRING ASSEMBLY
C3	HOISTING DECELERATION CAM	L1	SAFETY CAR STOP LATCH
C4	LOWERING DECELERATION CAM	L2	SERVO LINKAGE
C5	SERVO VALVE LOCKING CAM	L3	BY-PASS VALVE LINKAGE (B-END)
C6	HOIST CONTROL LINKAGE CAM	L4	LATCH AND VENT VALVE LATCH
CR1	CAM FOLLOWER ROLLER	L5	CONTROL LINKAGE

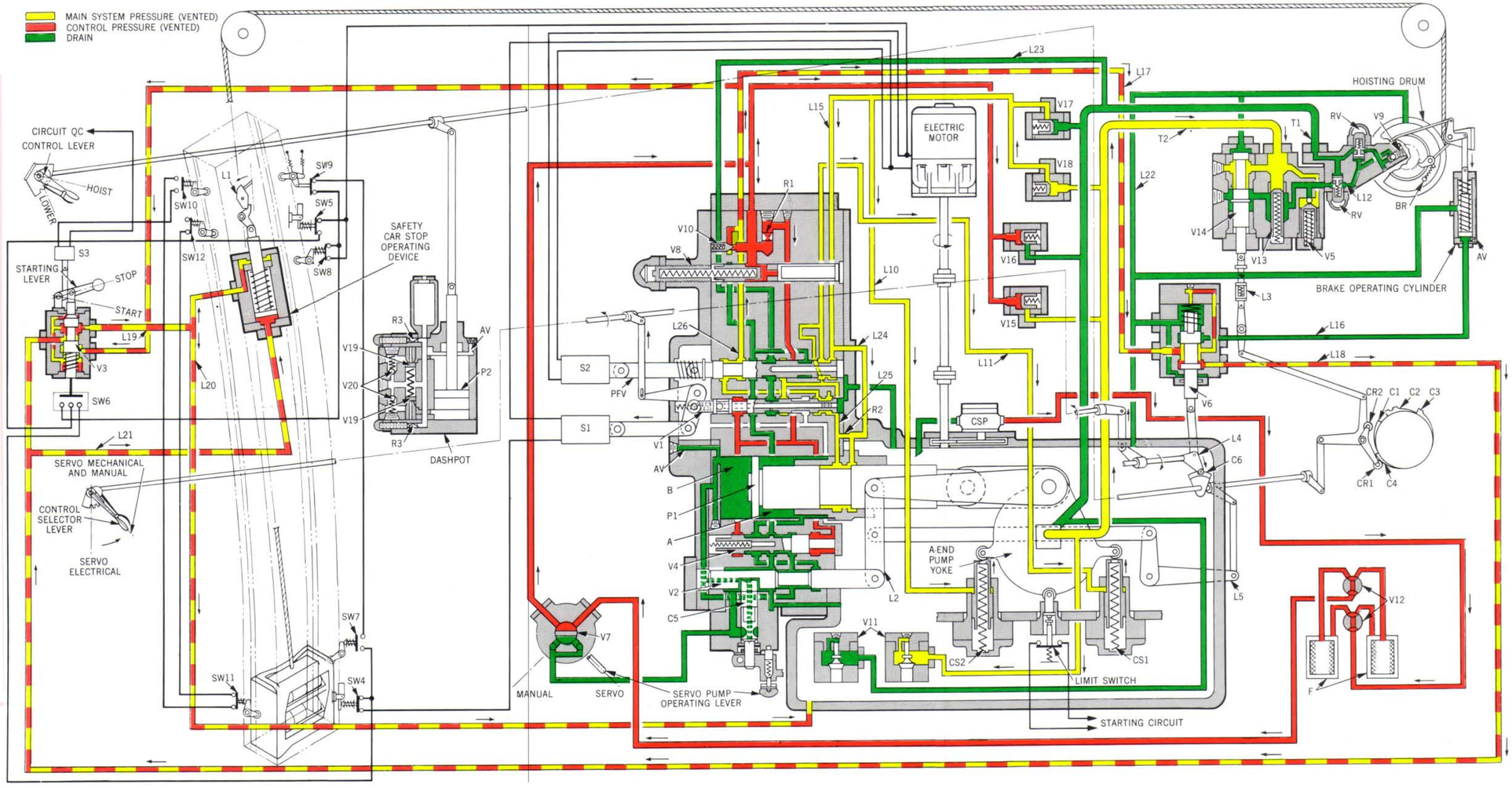

Figure 11-20. Powder Hoist, Servo Mechanical Control Stop Position, Schematic Diagram

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ELECTRICAL SYMBOLS

SW4	LOWER DOOR INTERLOCK SWITCH	SW11	LOWER DOOR, STARTING LEVER INTERLOCK SWITCH
SW5	UPPER DOOR INTERLOCK SWITCH	SW12	UPPER DOOR, STARTING LEVER INTERLOCK SWITCH
SW6	STARTING LEVER SWITCH	S1	VENTING VALVE SOLENOID
SW7	LOADING POSITION SWITCH	S2	POWER FAILURE SOLENOID
SW8	LOWER UNLOADING SWITCH	S3	STARTING LEVER INTERLOCK SOLENOID
SW9	UPPER UNLOADING SWITCH		
SW10	INTERLOCK CUTOUT SWITCH		

HYDRAULIC SYMBOLS

A	STROKING CYLINDER CHAMBER	V5	FOOT VALVE
AV	AIR VENTS	V6	LATCH AND VENT VALVE
B	STROKING CYLINDER CHAMBER	V7	SERVO PUMP BY-PASS VALVE
CSP	CONTROL AND SUPERCHARGE SERVO PUMP	V8	SERVO PUMP RELIEF VALVE
F	OIL FILTER	V9	CHECK VALVE (B-END)
PFV	POWER FAILURE VALVE	V10	CHECK VALVE
P1	SERVO STROKING PISTON	V11	REPLENISHING CHECK VALVES
P2	DASHPOT PISTON	V12	FILTER CONTROL VALVE
RV	MAIN SYSTEM RELIEF VALVES	V13	CHECK VALVE (B-END)
R1	RESTRICTION	V14	BY-PASS VALVE (B-END)
R2	RESTRICTION	V15	SUPERCHARGE CHECK VALVE
R3	RESTRICTION	V16	SUPERCHARGE CHECK VALVE
V1	VENTING VALVE	V17	CHECK VALVE
V2	SERVO VALVE	V18	CHECK VALVE
V3	CAR STOP RELEASE VALVE	V19	DASHPOT FEED CONTROL VALVES
V4	BY-PASS VALVE (A-END)	V20	CHECK VALVES

T1, T2 AND L10 TO L26 INCLUSIVE ARE HYDRAULIC LINES

MECHANICAL SYMBOLS

BR	BRAKE RATCHET ASSEMBLY	CR2	CAM FOLLOWER ROLLER
C1	HOISTING ACCELERATION CAM	CS1	CENTERING SPRING ASSEMBLY
C2	LOWERING ACCELERATION CAM	CS2	CENTERING SPRING ASSEMBLY
C3	HOISTING DECELERATION CAM	L1	SAFETY CAR STOP LATCH
C4	LOWERING DECELERATION CAM	L2	SERVO LINKAGE
C5	SERVO VALVE LOCKING CAM	L3	BY-PASS VALVE LINKAGE (B-END)
C6	HOIST CONTROL LINKAGE CAM	L4	LATCH AND VENT VALVE LATCH
CR1	CAM FOLLOWER ROLLER	L5	CONTROL LINKAGE

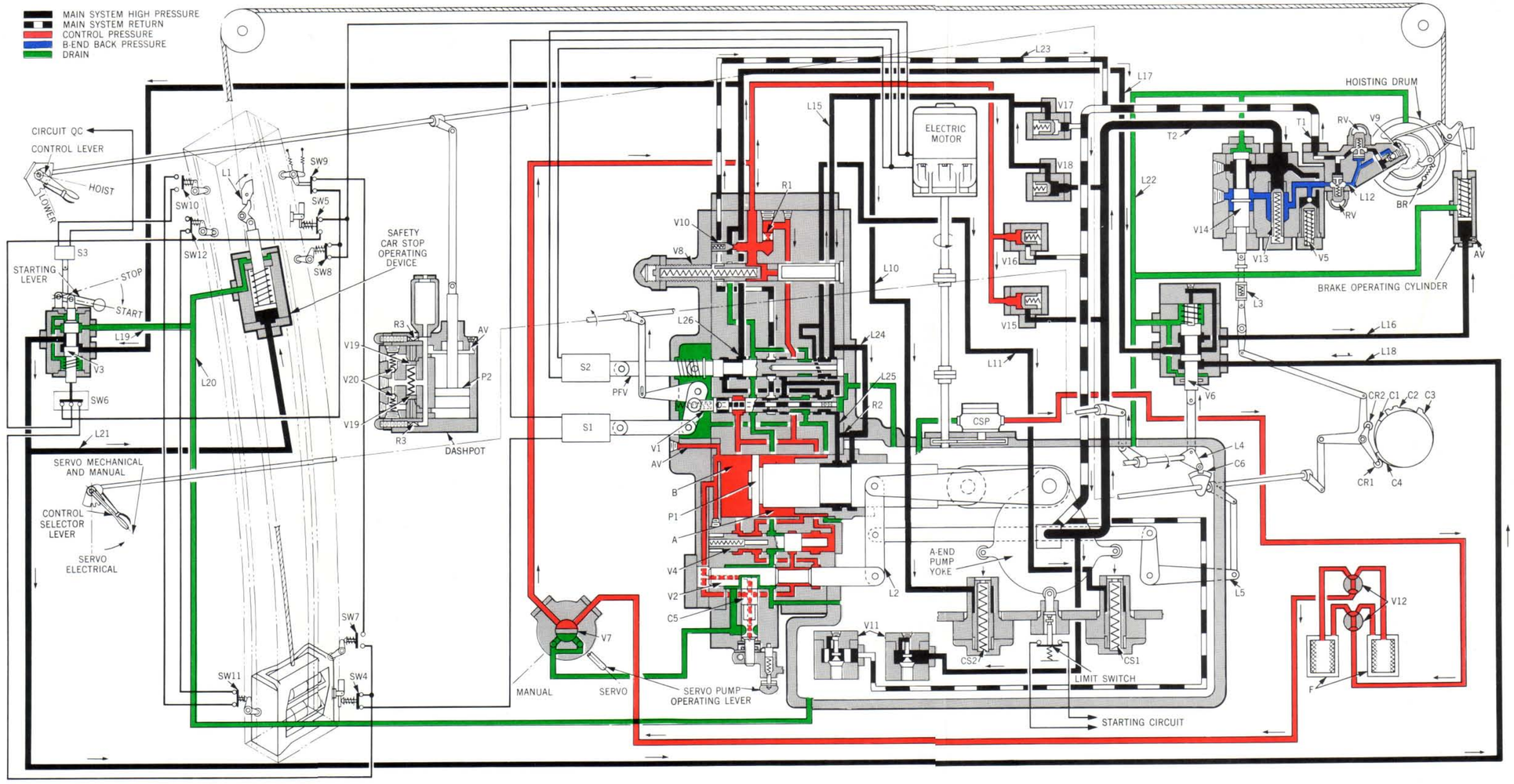

Figure 11-21. Powder Hoist, Servo Mechanical Control - Controls Set Ready to Hoist, Schematic Diagram

ELECTRICAL SYMBOLS

SW4	LOWER DOOR INTERLOCK SWITCH	SW11	LOWER DOOR, STARTING LEVER INTERLOCK SWITCH
SW5	UPPER DOOR INTERLOCK SWITCH	SW12	UPPER DOOR, STARTING LEVER INTERLOCK SWITCH
SW6	STARTING LEVER SWITCH	S1	VENTING VALVE SOLENOID
SW7	LOADING POSITION SWITCH	S2	POWER FAILURE SOLENOID
SW8	LOWER UNLOADING SWITCH	S3	STARTING LEVER INTERLOCK SOLENOID
SW9	UPPER UNLOADING SWITCH		
SW10	INTERLOCK CUTOUT SWITCH		

HYDRAULIC SYMBOLS

A	STROKING CYLINDER CHAMBER	V5	FOOT VALVE
AV	AIR VENTS	V6	LATCH AND VENT VALVE
B	STROKING CYLINDER CHAMBER	V7	SERVO PUMP BY-PASS VALVE
CSP	CONTROL AND SUPERCHARGE SERVO PUMP	V8	SERVO PUMP RELIEF VALVE
F	OIL FILTER	V9	CHECK VALVE (B-END)
PFV	POWER FAILURE VALVE	V10	CHECK VALVE
P1	SERVO STROKING PISTON	V11	REPLENISHING CHECK VALVES
P2	DASHPOT PISTON	V12	FILTER CONTROL VALVE
RV	MAIN SYSTEM RELIEF VALVES	V13	CHECK VALVE (B-END)
R1	RESTRICTION	V14	BY-PASS VALVE (B-END)
R2	RESTRICTION	V15	SUPERCHARGE CHECK VALVE
R3	RESTRICTION	V16	SUPERCHARGE CHECK VALVE
V1	VENTING VALVE	V17	CHECK VALVE
V2	SERVO VALVE	V18	CHECK VALVE
V3	CAR STOP RELEASE VALVE	V19	DASHPOT FEED CONTROL VALVES
V4	BY-PASS VALVE (A-END)	V20	CHECK VALVES

T1, T2 AND L10 TO L26 INCLUSIVE ARE HYDRAULIC LINES

MECHANICAL SYMBOLS

BR	BRAKE RATCHET ASSEMBLY	CR2	CAM FOLLOWER ROLLER
C1	HOISTING ACCELERATION CAM	CS1	CENTERING SPRING ASSEMBLY
C2	LOWERING ACCELERATION CAM	CS2	CENTERING SPRING ASSEMBLY
C3	HOISTING DECELERATION CAM	L1	SAFETY CAR STOP LATCH
C4	LOWERING DECELERATION CAM	L2	SERVO LINKAGE
C5	SERVO VALVE LOCKING CAM	L3	BY-PASS VALVE LINKAGE (B-END)
C6	HOIST CONTROL LINKAGE CAM	L4	LATCH AND VENT VALVE LATCH
CR1	CAM FOLLOWER ROLLER	L5	CONTROL LINKAGE

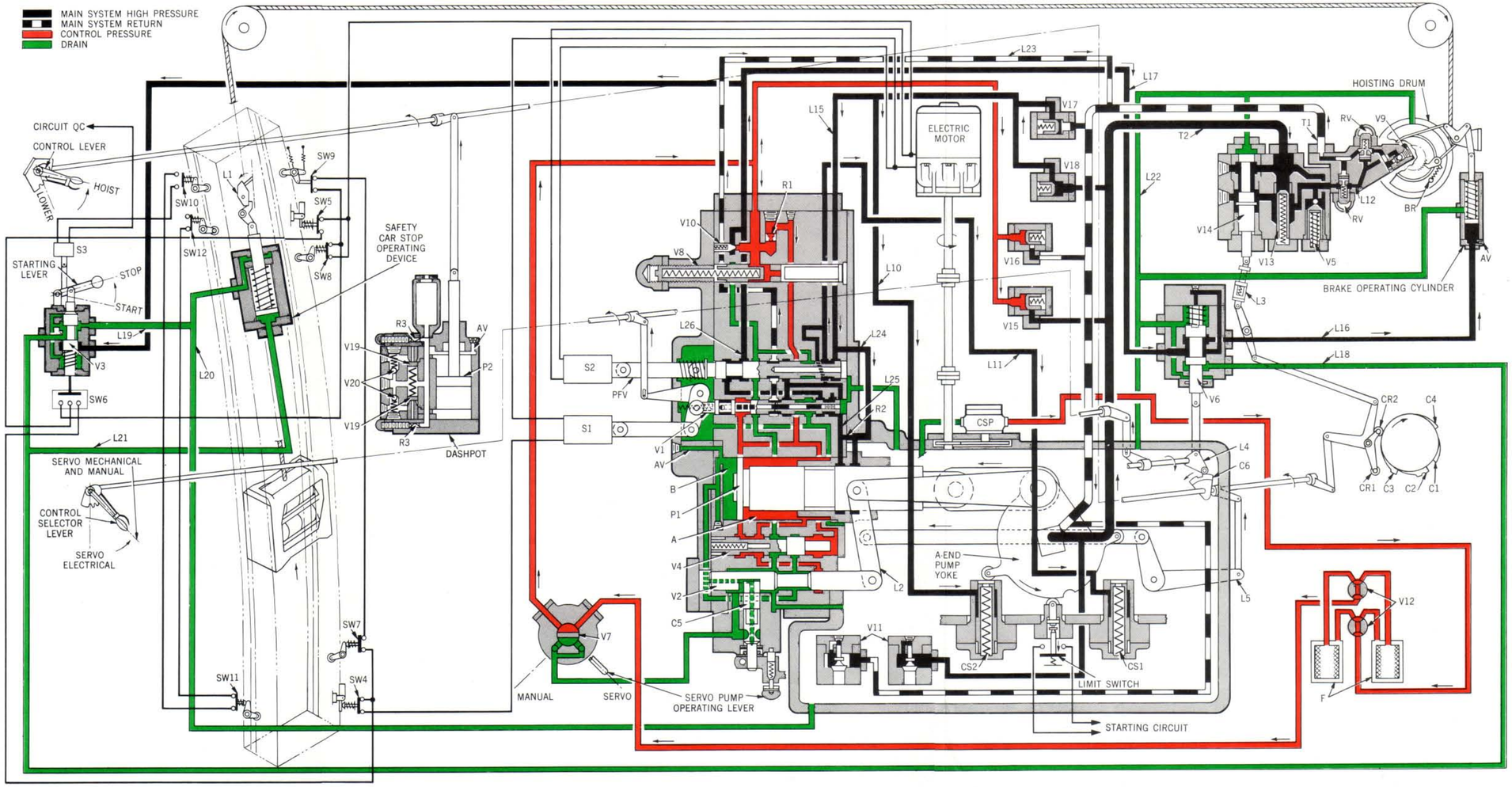

Figure 11-22. Powder Hoist, Servo Mechanical Control - Hoist Position, Schematic Diagram

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ELECTRICAL SYMBOLS

SW4	LOWER DOOR INTERLOCK SWITCH	SW11	LOWER DOOR, STARTING LEVER INTERLOCK SWITCH
SW5	UPPER DOOR INTERLOCK SWITCH	SW12	UPPER DOOR, STARTING LEVER INTERLOCK SWITCH
SW6	STARTING LEVER SWITCH	S1	VENTING VALVE SOLENOID
SW7	LOADING POSITION SWITCH	S2	POWER FAILURE SOLENOID
SW8	LOWER UNLOADING SWITCH	S3	STARTING LEVER INTERLOCK SOLENOID
SW9	UPPER UNLOADING SWITCH		
SW10	INTERLOCK CUTOUT SWITCH		

HYDRAULIC SYMBOLS

A	STROKING CYLINDER CHAMBER	V5	FOOT VALVE
AV	AIR VENTS	V6	LATCH AND VENT VALVE
B	STROKING CYLINDER CHAMBER	V7	SERVO PUMP BY-PASS VALVE
CSP	CONTROL AND SUPERCHARGE SERVO PUMP	V8	SERVO PUMP RELIEF VALVE
F	OIL FILTER	V9	CHECK VALVE (B-END)
PFV	POWER FAILURE VALVE	V10	CHECK VALVE
P1	SERVO STROKING PISTON	V11	REPLENISHING CHECK VALVES
P2	DASHPOT PISTON	V12	FILTER CONTROL VALVE
RV	MAIN SYSTEM RELIEF VALVES	V13	CHECK VALVE (B-END)
R1	RESTRICTION	V14	BY-PASS VALVE (B-END)
R2	RESTRICTION	V15	SUPERCHARGE CHECK VALVE
R3	RESTRICTION	V16	SUPERCHARGE CHECK VALVE
V1	VENTING VALVE	V17	CHECK VALVE
V2	SERVO VALVE	V18	CHECK VALVE
V3	CAR STOP RELEASE VALVE	V19	DASHPOT FEED CONTROL VALVES
V4	BY-PASS VALVE (A-END)	V20	CHECK VALVES

T1, T2 AND L10 TO L26 INCLUSIVE ARE HYDRAULIC LINES

MECHANICAL SYMBOLS

BR	BRAKE RATCHET ASSEMBLY	CR2	CAM FOLLOWER ROLLER
C1	HOISTING ACCELERATION CAM	CS1	CENTERING SPRING ASSEMBLY
C2	LOWERING ACCELERATION CAM	CS2	CENTERING SPRING ASSEMBLY
C3	HOISTING DECELERATION CAM	L1	SAFETY CAR STOP LATCH
C4	LOWERING DECELERATION CAM	L2	SERVO LINKAGE
C5	SERVO VALVE LOCKING CAM	L3	BY-PASS VALVE LINKAGE (B-END)
C6	HOIST CONTROL LINKAGE CAM	L4	LATCH AND VENT VALVE LATCH
CR1	CAM FOLLOWER ROLLER	L5	CONTROL LINKAGE

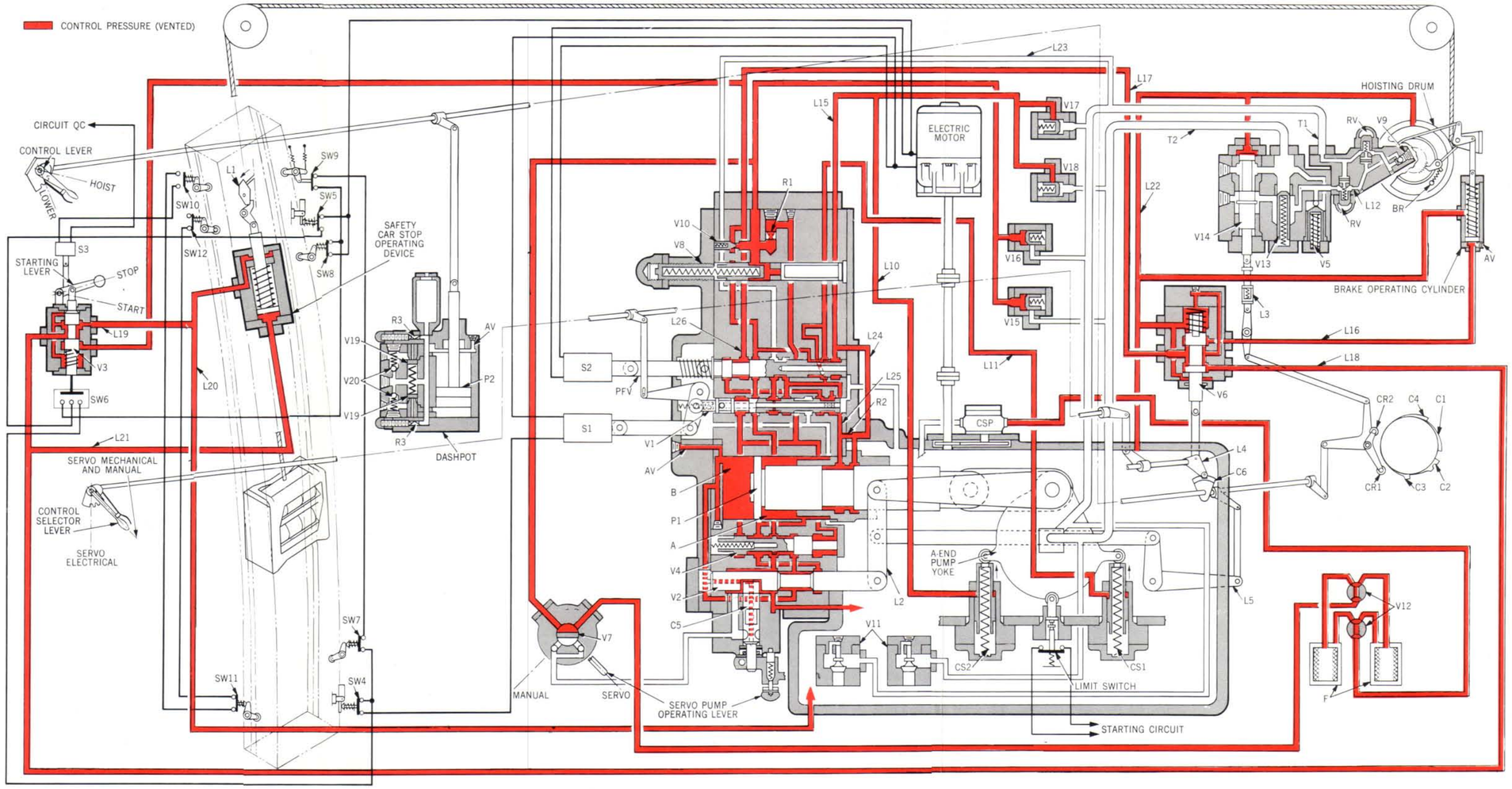
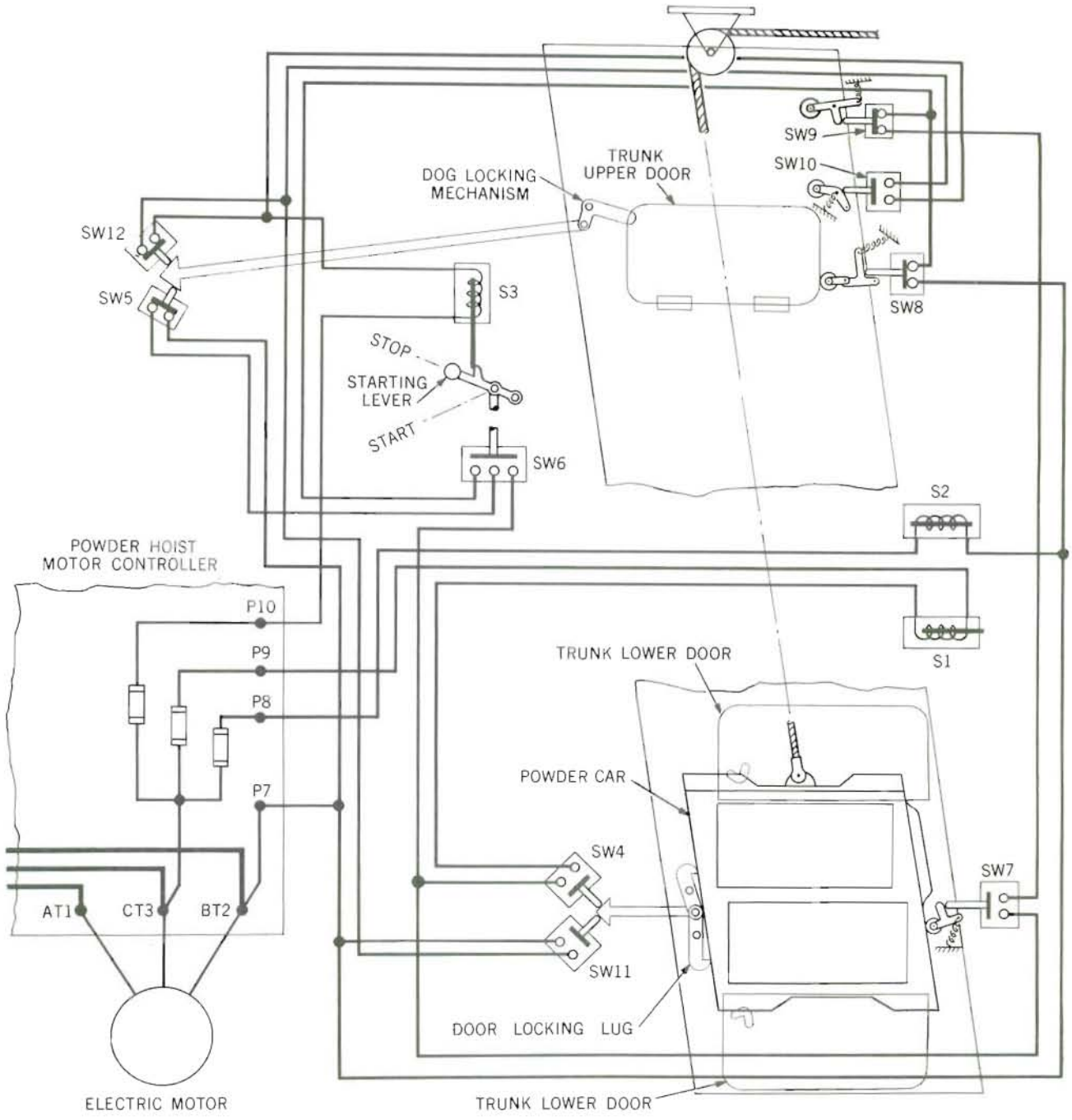


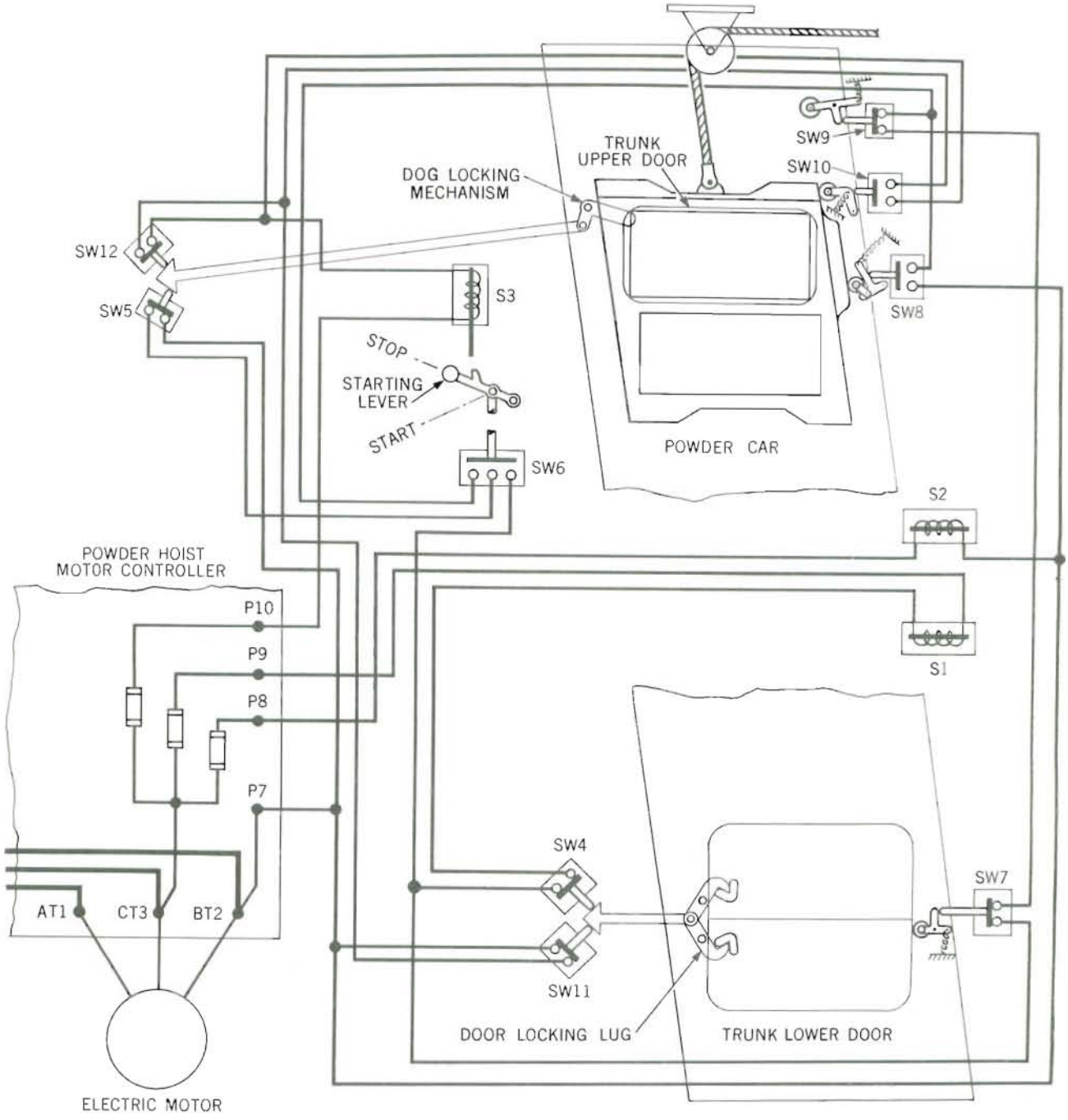
Figure 11-23. Powder Hoist, Servo Mechanical Control - Power Failure, Schematic Diagram



ELECTRICAL SYMBOLS

SW4	LOWER DOOR INTERLOCK SWITCH	SW10	INTERLOCK CUTOUT SWITCH	S1	VENTING VALVE SOLENOID
SW5	UPPER DOOR INTERLOCK SWITCH	SW11	LOWER DOOR, STARTING LEVER INTERLOCK SWITCH	S2	POWER FAILURE SOLENOID
SW6	STARTING LEVER SWITCH	SW12	UPPER DOOR, STARTING LEVER INTERLOCK SWITCH	S3	STARTING LEVER INTERLOCK SOLENOID
SW7	LOADING POSITION SWITCH	P7, P8, P9, P10	TERMINAL POINTS		
SW8	LOWER UNLOADING SWITCH				
SW9	UPPER UNLOADING SWITCH				

Figure 11-24. Powder Hoist Interlock Circuit, Trunk Lower Door Open - Wiring Diagram



ELECTRICAL SYMBOLS

SW4	LOWER DOOR INTERLOCK SWITCH	SW10	INTERLOCK CUTOUT SWITCH	S1	VENTING VALVE SOLENOID
SW5	UPPER DOOR INTERLOCK SWITCH	SW11	LOWER DOOR, STARTING LEVER INTERLOCK SWITCH	S2	POWER FAILURE SOLENOID
SW6	STARTING LEVER SWITCH	SW12	UPPER DOOR, STARTING LEVER INTERLOCK SWITCH	S3	STARTING LEVER INTERLOCK SOLENOID
SW7	LOADING POSITION SWITCH	P7, P8, P9, P10	TERMINAL POINTS		
SW8	LOWER UNLOADING SWITCH				
SW9	UPPER UNLOADING SWITCH				

Figure 11-25. Powder Hoist Interlock Circuit, Trunk Lower and Upper Doors Closed, Car Hoisting - Wiring Diagram

2. When the car rises slightly it permits loading position switch SW7 to close; this bypasses SW6 in the solenoid S1 circuit to keep the solenoid energized when the starting lever is returned to STOP and switch SW6 is opened.

3. As the car approaches the upper unloading stations it contacts the lower unloading switch SW8 (to open it), the interlock cutout switch SW10 (to close it), and the upper unloading switch SW9 (to open it) in that order.

Upper trunk door open; car at upper unloading station. With the starting lever remaining at STOP and the powder car at the upper unloading station, the following conditions exist (fig. 11-26):

1. Upper unloading switch SW9, contacted and opened by the car as it approaches the upper unloading station, de-energizes the venting valve solenoid S1 to vent the hydraulic system and stop the car at the upper unloading station. Lower unloading switch SW8, no longer contacted by the car, closes.

2. While the upper door is open, the upper door interlock switch SW5 and the upper door starting lever interlock switch SW12 are open. This opens the solenoid S3 circuit.

3. With the car at the upper unloading station, interlock cutout switch SW10 is closed energizing starting lever interlock solenoid S3. This bypasses the interlock circuit and unlocks the starting lever while the upper door is open.

4. When the starting lever is moved to START it closes switch SW6 and completes the circuit to energize solenoid S1. This closes the hydraulic system and the car lowers to the lower unloading station. As the car lowers, switch SW9 closes. Switch S10 opens as the car lowers, de-energizing solenoid S3 and locking the starting lever. With the car at the lower unloading station, solenoid S3 can be energized (to unlock the starting lever) only when the upper door is closed and locked thus closing switches SW5 and SW12.

Manual mechanical control

Manual mechanical control, which provides for operating the hoist in the event of control pump circuit failure, is described below. Such failure is indicated, in servo electrical control, by failure of the brake to release, and in servo mechanical control by increased effort required to move the control lever. The hoist control circuit used in servo electrical control is inoperative. The hoist controls are set for manual mechanical operation by:

Moving the control selector lever from its SERVO ELECTRICAL position to the SERVO MECHANICAL AND MANUAL position. This permits movement of the servo pump operating lever to MANUAL.

Moving the servo pump operating lever from SERVO to MANUAL. This positions the control pump bypass valve V7 so that control pressure is bypassed to the tank. It also positions servo valve locking cam C5 so that it locks servo valve V2 in its center position.

Hoist operation in manual mechanical control is the same as in servo mechanical control, except that due to lack of control pressure the pump yoke is moved manually without servo power assistance. The operating conditions are the same as those for SERVO MECHANICAL (beginning on page 11-19) except for the following:

1. Servo valve V2 is locked in the center position by the servo valve locking cam C5.

2. Bypass valve V4 is spring-operated to open the pressure supply lines of servo stroking piston P1 to the tank.

3. Main system lines T1 and T2 are not supercharged; the system is replenished through check valves V15 and V16 by suction.

Limitations of operation. When operating the hoist in manual mechanical control, the following limitations of operation are encountered:

1. Much greater effort is required to position the pump yoke at a stroke position. In addition, the load on the linkage and cam mechanism to return the pump yoke to neutral is greatly increased.

2. The above conditions, combined with stretching of the car hoist rope (which occurs over a period of time in service), greatly increase stopping variation (controlled by latch and vent valve V6) at loading and unloading stations.

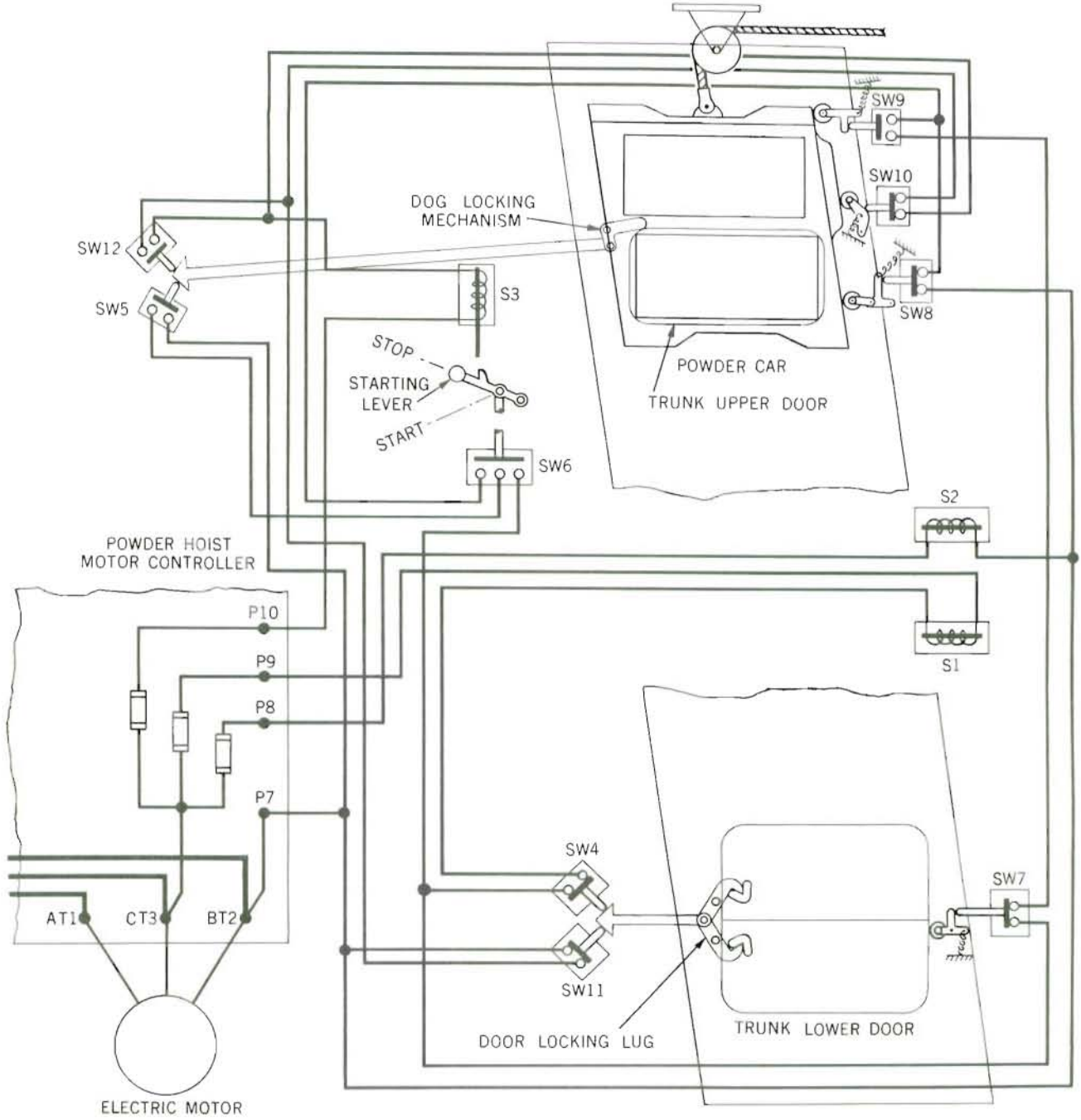
3. Air will be pulled into the main system because lines T1 and T2 will not be supercharged. Air in the hydraulic fluid will cause noise and vibration, if the hoist is run at high speed. Continuous operation under these conditions will cause improper operation of the brake and very slow starting.

Control actions. Operation in manual mechanical control is an emergency measure to be used only if servo pump circuit fails. Circuit failure may be simulated, to train turret personnel in this control operation, by positioning the servo pump operating lever at MANUAL. The following control actions are necessary when operating the hoist in manual mechanical control.

1. Move the control selector lever to SERVO MECHANICAL AND MANUAL. The servo pump operating lever cannot be shifted to MANUAL while the control selector lever is at SERVO ELECTRICAL. If the control pump bypass valve V7 is at manual position, moving the control selector lever to SERVO ELECTRICAL will mechanically return V7 to its servo position.

2. Move the control lever only partially toward HOIST and LOWER positions. Time required to hoist should be increased to 12 to 15 seconds, to lower increased to 10 to 12 seconds.

3. When lowering the car from the upper unloading station the pump yoke is moved from a position offset slightly toward hoisting, through neutral to the lowering position. Main system pressure will drop momentarily as the pump yoke passes neutral, tending to permit the centering plungers to extend and the brake to apply. However venting valve V2 closes the main system, extending the plungers and permitting the brake to apply only by leakage in the main system. If the pump yoke is held at neutral long enough to permit this, the pump yoke may still be moved to LOWER without causing excessive load on the control lever.



ELECTRICAL SYMBOLS

SW4	LOWER DOOR INTERLOCK SWITCH	SW10	INTERLOCK CUTOUT SWITCH	S1	VENTING VALVE SOLENOID
SW5	UPPER DOOR INTERLOCK SWITCH	SW11	LOWER DOOR, STARTING LEVER INTERLOCK SWITCH	S2	POWER FAILURE SOLENOID
SW6	STARTING LEVER SWITCH	SW12	UPPER DOOR, STARTING LEVER INTERLOCK SWITCH	S3	STARTING LEVER INTERLOCK SOLENOID
SW7	LOADING POSITION SWITCH	P7, P8, P9, P10	TERMINAL POINTS		
SW8	LOWER UNLOADING SWITCH				
SW9	UPPER UNLOADING SWITCH				

Figure 11-26. Powder Hoist Interlock Circuit, Trunk Upper Door Open Car at Upper Unloading Station - Wiring Diagram

Failure in the hydraulic system

In the event of rupture or other failure of hydraulic piping when operating the hoist, the following conditions exist (figs. 11-16 to 11-23 inclusive):

1. Failure in line T1 (when in servo electrical control) will vent control pump pressure through line L23 and check valve V10, and apply the brake.

2. Failure in line T2 (when in servo electrical control) will vent control pump pressure through check V9 and line L22, and apply the brake.

3. Failure of any main system line (when in servo mechanical control) will engage the brake.

Oil filter removal during system operation

The oil filters are mounted in parallel in the control pump pressure lines (figs. 11-16 to 11-23 inclusive). One filter at a time may be removed and cleaned (described on page 11-26) while the power drive is operating by moving the filter control valve B12 to by-pass a filter. When V12 is in the center position both filters are in use.

Buffers and overtravel action

If the car overtravels at loading or unloading stations, the following conditions exist:

1. At the upper unloading station the car will contact the upper buffers at low speed.

2. At the lower unloading station the car will come to rest on the safety car stop latch L1. Check valve V9 will open to bypass lines T1 and T2 to prevent B-end rotation and subsequent unwinding of the car hoist rope. It is necessary to hoist the car slightly in order to withdraw latch L1.

3. At the loading station the car will come to rest on the lower buffers. Check valve V9 will open to bypass lines T1 and T2 as in operation 2 above.

System vents.

The hydraulic system is provided with three air vents. Designated AV (figs. 11-16 to 11-23 inclusive) these are located as follows:

At the dashpot, to be used when the unit is being filled.

At the servo stroking piston, to be used when the power drive is started after it has been drained and refilled.

At the brake operating cylinder, to be used when the power drive is started after it has been drained and refilled.

INSTRUCTIONS

General instructions

The powder hoist assemblies are to be operated and maintained, including periodic exercise, adjustment, and lubrication, in accordance with the regulations of the Bureau of Ordnance Manual, the instructions below, and the directions contained in chapter 17.

Operating precautions

The following operating precautions must be observed before operating the hoist under load and before attempting to pass powder bags:

1. Check the hydraulic fluid level in the main system supply tank. Replenish if necessary.
2. Check the hydraulic fluid level in the supply tank for the upper door locking dog mechanism. Replenish if necessary.
3. Check the liquid level in the lower car buffer system. Use the liquid specified below.
4. Perform the "Before operating" lubrication.
5. Inspect the loading trays, powder car trays, upper door, and cradle-spanning tray assembly for burrs or deformations that might tear powder bags.
6. Inspect the hoist drum. Remove burrs.
7. Inspect the car hoist rope and its fastenings.
8. Stow the powder car in the down position when it is not immediately required for use. When stowed in the up position, the car may fall to the bottom of the hoist, if failure of the A-end replenishing check valve seal results in a loss of hydraulic oil in the active system.*

The electric motor may now be started, by pressing the START-EMERG button.

1. Run the motor until the hydraulic fluid is at normal operating temperature.
2. Operate the powder car and doors through full cycles in servo and manual controls.
3. Verify the accuracy of car stopping positions.
4. Verify that all interlocks, the hoist drum brake, brake ratchet assembly, and the car safety latches function.

Speed limitations during manual control operation

In manual control operation, with no control and supercharge pump delivery, air is drawn into the main system. This causes vibration of pipe lines and considerable noise, the amount of air, resultant vibration and noise depending on the speed that the powder hoist is operated. To reduce the air entering the system, the power drive should not be operated at more than one-third full speed (for both hoisting and lowering). Continuous operation at reduced speed should be limited to one hour (vibration, noise, and adverse effects vary for different hoists). In emergency, the hoist may be operated at full speed in manual control but should be limited to 25 or less hoisting-lowering cycles. For drill and training operations, limit manual control speed as specified above.

Buffer liquid. The liquid to be used in the lower car buffer system is recoil cylinder liquid, NAVORD OS 1914. The buffers should be checked for replenishment once a month, at which time they should be inspected as follows:

1. Check for full, normal spring return of the buffer plungers.

2. Check the condition of the plunger packings.

3. Verify the tightness of the buffer assembly securing bolts.

Hydraulic oil. Power transmission fluid 51F23 (Ord) is to be used in the hydraulic system. When the hydraulic system is initially filled, and when replenishing, the fluid should be poured through a fine mesh wire strainer of at least 120 wires to the inch. Cheesecloth or rags must not be used as a strainer. New hydraulic assemblies should be drained after 15 hours (or less) of operation. The hydraulic system should then be thoroughly flushed with new 51F23 (Ord) and refilled with fresh fluid. A test inspection and analysis of a fluid sample from each system should be performed monthly. If there is any evidence of sludge, water, or acidity, the system must be drained, flushed with new 51F23 (Ord), and refilled with fresh fluid. The total amount of fluid required to fill each system, when completely vented, is approximately 32 gallons. The system is vented as described on page 11-25.

Filling hydraulic system. To fill the hydraulic system for the first time, or after it has been completely drained, proceed as follows:

1. Remove the filler plug from the top of the B-end housing and fill with the specified hydraulic fluid.

2. Remove the filler cap from the top of the A-end housing and fill to the upper fluid level with specified hydraulic fluid.

3. Run the electric motor for a few minutes, then stop.

4. Check the fluid level at the A-end fluid level trycocks. Replenish with specified fluid until the fluid level is between the two trycocks.

Maintenance care. When pipe fittings, flanges, or other units of the hydraulic system are disconnected or open, keep the openings covered to prevent the entrance of foreign matter. Do not remove such protection until immediately prior to reassembly. For complete instructions for the care and maintenance of the hydraulic system, see chapter 17.

Cleaning oil filters. The oil filter is equipped with a directional valve to control fluid flow through either or both filter elements. By directing the flow (according to instruction plate directions) through one of the elements, the inoperative element can be removed and cleaned while the power drive is operating. Proceed as follows:

1. Turn the directional valve toward one of the filter elements.

2. Remove the filter cap from the other element.

3. Remove the filter spring and filter element.

4. Clean the filter element with solvent Navy Specification P-S-661, and compressed air.

5. Remove the plug from the bottom of the filter container and drain the contents.

6. Flush the filter container. Replace the plug. Reassemble the filter element, spring, and cap.

7. Turn directional valve toward cleaned filter element and perform the above cleaning operations on other element.

Operating trouble diagnosis

Locating and correcting powder hoist trouble requires a thorough understanding of the equipment described in this chapter. The causes of various troubles which may occur are given in the paragraphs below. The trouble analysis is in a sequence that avoids extensive disassembly until the more common causes have been eliminated as the source of trouble.

No electric power. If the electric motor fails to start when the START-EMERG button is pressed:

1. Check the circuit breaker in the electric controller; it may be open.

2. Check the pilot circuit fuse in the electric controller; it may be blown.

3. Check the limit switch for incorrect connection or adjustment. Limit switch adjustment is described on page

4. Check the main line fuses.

Circuit breaker opens. If the circuit breaker opens:

1. Check for a short circuit in the main circuit supply lines to the electric motor.

2. Check for freedom of movement of motor shaft.

Overload relay opens. If the electric motor starts, but the overload relays in the electric controller open, the trouble is probably a damaged A-end pump or control-supercharge pump.

1. Check the pumps for damage by attempting to rotate the electric motor shaft manually. If a binding condition exists, remove the control-supercharge pump to check which pump is binding.

Control pump binding. If the control pump is binding, this condition must not be corrected by loosening the pump head screws. Remove the pump head and inspect for damage. Remove the pump rotor and inspect the faces of the bronze bushings in the pump body and head for scores. Examine the rotor vanes for sheared brass particles that have become lodged beneath them. Replace the pump head and rotate the pump shaft manually while tightening the screws.

Main pump binding. If the main (A-end) pump is binding, check the control pump gear train to ensure that no foreign matter is wedged in the gear teeth. If the main pump still binds, disassemble for inspection as described on page 11-41.

Hoist inoperative due to pressure failure when the controls are set for a hoisting cycle.

Failure of electrical control circuit. With the electric motor operating, and the controls properly adjusted and positioned for a hoisting cycle (using servo electrical control), pressure should build up

in the system as soon as the starting lever is moved to START: If pressure does not build up immediately, it is probably due to electrical control circuit failure. Check for this condition by shifting the control selector lever to SERVO MECHANICAL. If the hoist functions correctly (requires normal effort to move the control lever) the trouble is in the electrical controls.

1. Check the solenoid fuse in the electric controller. Replace with the proper fuse, if blown.

2. Check to see whether the door interlock switches are open. Verify that the upper and lower trunk doors are closed. If closed, verify that the switches are closed and the contacts are in good condition.

3. Check the solenoids in the valve block assembly. Remove the inspection cover from the solenoid housing and verify that the solenoid S1 shifts the venting valve when the starting lever is moved to START. Also, verify that the power failure valve shifts when the electric power is turned off and on.

4. Check for a stuck venting valve or power failure valve. Operate the valves manually by moving the operating levers within the solenoid housing to verify that no friction exists in the valves and that the valve springs function properly.

5. Check the starting switch for closure and proper contact. Remove the switch cover and verify that the contacts close when the starting lever is moved to START.

6. Check the loading and unloading position limit switches for closure and proper contact. Remove covers of the switches not held open by the car and verify that the contacts are closed and in good condition.

7. Check for a break or short circuit in the wiring.

Failure of control pump circuit. If pressure builds up to perate the hoist (using servo mechanical control), but considerable effort is required to operate the hoist and control lever, the control pump has failed.

1. Check the control pump relief valve. It may be adjusted too low to provide pressure to operate the hoist. Install a pressure gage in the control pump inlet flange. Adjust the relief valve for a pressure of 160 pounds per square inch.

2. Check for a stuck control pump relief valve. Remove the acorn cap nut and valve adjusting screw and verify that the valve is not stuck.

3. Check the A-end oil filter for clogging. Control pump pressure may be correct but a clogged filter will prevent fluid flow to the control pump circuit. Clean the filter as described on page 11-26.

4. Check for clogging at restriction R1. Remove the plug from the top of the valve block assembly and remove and inspect the restriction plug.

5. Check the control pump for damage. Remove and disassemble the control pump as described on page 11-38.

6. Check the by-pass valve in the valve block assembly; it may be stuck in its vented position. Disassemble the valve block as described on page 11-39.

Failure of main circuit. If pressure does not build up to operate the hoist (using servo mechanical control), the trouble will probably be in the main circuit. Refer to drawings 325000 and 325001.

1. Check the main circuit relief valves for too low an adjustment. Adjust the relief valves in the B-end motor head.

2. Check the main circuit relief valves; one or both may be stuck open. Remove the relief valves as described on page 11-43.

3. Inspect the check valve in the B-end motor head. Check valve 206639-5 may be stuck open, omitted, or assembled for opposite rotation.

4. Check the B-end motor head for pipe plug 200075-16; it may be omitted or incorrectly assembled.

5. Check the clearance between the rocker arm rollers and B-end cams, it may be insufficient. Refer to adjustment of B-end cams, page 11-31.

6. Check for a stuck open supercharge or bypass check valve. The supercharge check valves are located on the inlet and outlet main line flanges of the A-end; bypass check valves are in the top of the valve block.

7. Check for a replenishing check valve stuck open. These valves are located within the A-end reservoir. Inspect the check valves; refer to page 11-41 for removal instructions.

8. Check the system for excessive leakage due to scored cylinder blocks or pistons in the A- or B-ends. To do this perform the following operations:

a. Increase the clearance between the rollers and cams to allow pressure to build up in the system.

b. Remove the connecting drain pipe between the top of the B-end and the top of the A-end.

c. Install a temporary drain pipe from the B-end to a separate container and check the B-end leakage. If the leakage exceeds 0.5 gallons per minute (hydraulic fluid at 100 degrees, Fahrenheit) a scored B-end piston or cylinder block is indicated. If the B-end will operate at slow speed, but hoist drum rotation is erratic and uneven, a scored piston is indicated. If the B-end leakage is not excessive, a damaged A-end cylinder block or piston is indicated.

Hoist inoperative due to pressure failure when the controls are set for a lowering cycle. Check the following:

1. Powder car failure to lower at either upper or lower unloading station may be caused by the car being blocked by the safety car stop latches.

This may occur if the starting lever is alternately placed in START and STOP positions several times before starting to lower the car. Such improper operation releases and applies the brake each time the starting lever is depressed and may lock the car on the latches. Move the control lever to HOIST to lift the car above the latches before starting to lower.

2. The condition described above may also occur if the car hoist rope has stretched in excess of the two inches provided for by the B-end cams. Improper adjustment of the cams or the loading station limit switches may also be the cause. Take up the car hoist rope slack, or adjust the cams and limit switches.

3. Check for pressure build-up failure when the car is not resting on the safety car stop latches. Check the hoist equipment as described for pressure failure with controls set for hoisting, described on page 11-27.

Stopping inaccurate.

Servo electrical control. When operating in SERVO ELECTRICAL control and the car fails to stop within one inch of the intended stopping position:

1. Verify the starting lever position when the car approaches the loading or upper unloading stations. The starting lever must not be held down. This is improper control by the operator (the starting lever should be released as soon as the car has moved a few inches) and will cause the car to overtravel and strike the buffers.

2. Check the car hoist rope for stretching in excess of the two inches allowed for by the B-end cams. Adjust the cams or, if the cams have been doweled in place, shorten the cable.

3. Check the limit switches for improper adjustment. Readjust the limit switches if necessary.

4. Check the brake adjustment. Readjust the brake to hold the loaded car.

5. Check the condition of the brake band lining for worn, oil saturated, or glazed areas which may allow the brake to slip. Remove and clean, or install a new lining.

Servo mechanical control, or manual control. When operating the hoist in SERVO MECHANICAL or MANUAL control, stopping will not be as accurate as in SERVO ELECTRICAL control. If stopping is not normal, the probable causes will be the same as when using SERVO ELECTRICAL (except for limit switch adjustments). An improperly adjusted latch and vent valve latch and cam assembly can also cause inaccurate stopping. This condition prevents the brake from applying, and the circuit from venting, when the car reaches a stop position.

Ratchet slips when hoisting. Ratchet slip is indicated by a clicking sound in the B-end, while the unit is hoisting or starting to hoist. This condition is caused by slow releasing of the brake. Referring to drawing 325001:

1. Check the brake cylinder piston for too much travel. The end of piston 274318-1 is to be 3.0 inches from the face of the brake cylinder head.

2. Check for insufficient clearance between the brake band and brake drum when the brake is released. Adjust for a clearance of 0.010-inch between brake band and drum.

3. Check the control pump for insufficient pressure. Use a pressure gage to verify control pump pressure of 160 pounds per square inch. See causes of control pump pressure failure on page 11-26.

Slow starting of the hoist. If the hoist requires excessive time to start after the controls are set for hoisting or lowering:

Check for insufficient clearance between the rocker arm rollers and the B-end cams. Refer to adjustment of B-end cam, page 11-31.

Excessive drop of the powder car when the brake is released. When the brake is released, normal drop of the powder car is from 0.50- to 0.75-inch. This is due to the time required for main circuit pressure build up to be sufficient to support the car. If the drop is excessive the probable cause is leakage in the foot valve assembly. Refer to drawing 325001.

1. Check the by-pass valve in the foot valve assembly for improper adjustment. Refer to page 11-36 for instructions to adjust foot valve control linkage.

2. Verify that the check valve in the foot valve assembly is not stuck open. Remove cover 274330-5 to inspect valve.

3. Verify that the relief valve ball is not held off its seat by foreign matter. Remove cover 274330-9 and inspect the valve ball and retainer; clean or replace if necessary.

Excessive heating. If the unit overheats:

1. Check for insufficient hydraulic fluid in the main system. Verify the fluid level in the A-end reservoir.

2. Check for mechanical binding in equipment or powder car. Verify main system pressures, with a gage, at the B-end pressure connections.

Unusual noises and their causes. When operating the hoist in servo electrical or servo mechanical control, the hoist operates with normal noise and vibration. Increase in noise and vibration in manual control operation is caused by failure of the control pump circuit which no longer supercharges the main system. The condition results from pulling air into the hydraulic system; the equipment should be operated as described on page 11-23.

Popping and sputtering. Popping and sputtering are caused by air entering the control pump through the intake lines. This may be caused by leaking gaskets in the pump intake line or a damaged oil seal on the control pump drive shaft.

Grinding. Grinding noises are usually caused by dry bearings or gears, or by foreign matter.

Hydraulic chatter or hammer. Hydraulic chatter or hammer is caused by vibration of a spring loaded valve, long pipe sections not securely clamped, or air in the system.

Squeals. Squeals are caused by the control pump head being fastened too tightly against the pump rotor.

Leakage. When leakage is indicated, inside or outside the system:

1. Check for improperly tightened threaded fittings. Tinning the threads of fittings or pipe plugs will aid in preventing leakage when the parts are correctly aligned.

2. Check for crossed threads in fittings.

3. Check for improperly fitted or torn gaskets.

4. Check for distorted, scored, or worn oil seals, sealing rings, or packing. A single scratch or cut on the working surfaces may cause a slow steady leak.

5. Check for pipe flanges not seating squarely.

6. Check for worn or scored valves.

7. Check for worn or scored pistons in the motor or pump.

8. Check for scored valve plates or cylinder blocks in the A- and B-ends.

9. Check for scored bushings or worn vanes in the control pump.

Adjustments

General. Adjustment of the various powder hoist elements is principally confined to adjustments of the power drives and control linkages, and the interconnection of the latter with the hoist control and interlock system. Adjustment of the car hoist rope attachment, the brake, and the switch actuating cams are apparent from the general arrangement drawings. The positions of parts of the upper door dog locking mechanism, the lower door latch, and latch release are prescribed by design. They should be set as shown on the general arrangement drawings and should subsequently be fitted and adjusted to perform properly. Adjustments of the power units and controls are divided into two stages, preliminary adjustment and detail adjustment. The first stage is only applicable in the installation of a new hoist or a disassembled and reassembled hoist.

Preliminary adjustments. When making preliminary adjustments disconnect the car hoist rope from the hoist drum. Remove the complete cam assembly and cam support from the B-end (until all preliminary adjustments and tests have been completed). Refer to drawing 325001. Proceed as follows:

1. Remove inspection cover 325050-1 from the B-end cam case.

2. Remove locknut 271731-3 and lockwasher 200074-8.

3. Remove cam support 274322-1, with the cams attached.

The B-end may now be operated in a hoisting direction only, and preliminary tests may be made after preliminary adjustments have been completed.

Adjustment of control selector linkage. Proceed as follows:

1. Move the control selector lever to SERVO ELECTRICAL. The latch and vent valve latch should be held out of its notch, and should clear the hoist control linkage cam when the control lever is moved to either HOIST or LOWER.

2. Move the control selector lever to SERVO MECHANICAL. The latch and vent valve latch should drop into the notch on the hoist control linkage cam, when the control lever is at neutral.

Adjustment of venting valve lever. The adjustable rods are set to provide for the proper angular position of the control selector levers at the A end. Refer to drawing 324987. Proceed as follows:

1. Place the control selector lever at SERVO ELECTRICAL.

2. Move the venting valve manually, at the A-end, toward the mechanical position. Release the lever and permit it to return to the electrical' position (by valve spring action).

3. Move the lever one degree farther in the SERVO ELECTRICAL direction. Maintain this position by making necessary adjustments on the adjustable rod.

The lever can be moved farther manually. This additional movement provides lost motion when the venting valve is solenoid-operated during SERVO ELECTRICAL control.

Adjustment of control lever. The connecting rods are adjusted for prcper length to provide correct angular position for the control lever. Refer to drawing 325003. Proceed as follows:

1. Disconnect the adjustable rods 325004-2 from the A-end.

2. Disconnect control rod 325052-2 that connects lever 325005-1 to the B-end.

3. Place the control selector lever at SERVO MECHANICAL. Permit the latch and vent valve latch to engage in the notch of the hoist control linkage cam.

4. Place the servo pump (by-pass valve) operating lever at MANUAL.

5. Adjust the control lever to its neutral position (with the latch in the notch of the linkage cam).

6. Adjust the universal link (which connects the lever on the main control shaft to lever 325005-2) for proper length. This link must hold lever 325005-2 so that its centerline is in line with the centerline of bracket 325004-1. This is determined by measuring the distance from the centerline of shaft 325005-2 to the lower side of the gun girder cap plate. The universal link is adjusted so that the centerline of the end of lever 325005-2 is the same distance (as above) from the lower side of the gun girder cap plate.

7. Adjust the length of rod 325007-3 (for left installation), or of rod 325004-2 (for right installation) to fit exactly between the lever on the control linkage and the lever on the A-end.

8. Adjust control rod 325052-2 which connects lever 325005-1 to lever 325051-4 (refer to drawing 3 25001) to maintain a distance of 1.25-inches between the lower edge of clevis 274253 5 and the top of the B–end base.

Adjustment of servo control valve centering lever and the servo pump operating lever. Proceed as follows:

1. Place the control selector lever at SERVO ELECTRICAL.

2. Place the servo control valve centering lever and the servo pump operating lever at SERVO.

3. Fit the adjustable control rod between the lever on the A-end and the lever on the control selector rocker shaft. The rod adjustment must prevent movement of the lever on the A-end when the control selector lever is at SERVO ELECTRICAL and must permit shifting of the lever when the control selector lever is at SERVO MECHANICAL.

Preliminary tests. The power drive must receive functional tests after it is assembled in the turret and following the preliminary adjustments of the preceding paragraphs. They are slow speed tests to verify correct assembly and are essential to prevent serious malfunctioning. The car hoist rope is to be disconnected from the hoist drum during these tests. Proceed as follows:

Servo mechanical control. Place the control lever in neutral and the starting lever at STOP. Make the following check:

1. Verify that the electric motor can be started by pressing the START button on the electric controller.

2. Verify the direction of electric motor rotation. Rotation must agree with direction arrow on the motor housing.

3. Verify application of the B-end brake.

4. Verify that the safety car stop latches are in the path of the car.

5. Verify that the latch and vent valve latch engages in the notch in the hoist control linkage cam.

With the control lever remaining at neutral, move the starting lever to START. Make the following check:

1. Verify that the latch is withdrawn from the notch in the linkage cam to permit control lever movement.

2. Verify release of the B-end brake.

3. Verify that the safety car stop latches are withdrawn from the path of the car.

4. Verify that the centering plungers in the A-end are retracted to permit pump yoke offset.

5. Move the control lever toward HOIST. Verify that B-end rotation agrees with control lever position.

With the control lever remaining at HOIST, permit the starting lever to return to STOP. Make the following check:

1. Verify that the safety car stop latches are in the path of the car.

2. Verify that the latch has withdrawn from the notch on the linkage cam and the latch rides on the cam.

3. Stop the electric motor.

Servo electrical control. Block the car to give access to all limit switches (to permit manual operation of the switches). With the car hoist rope remaining disconnected place the control selector lever at SERVO ELECTRICAL, the control lever at neutral, and the starting lever at STOP. Open the powder trunk doors. Block switch number 7 open (to simulate car at loading station). Make the following check:

1. Verify that the electric motor can be started.

2. Verify application of the B-end brake.

3. Verify that the safety car stop latches are in the path of the car.

4. Verify that the main system is by-passed. This is indicated by no movement of the hoist drum.

Close the powder trunk doors and verify that there is no change in hoist function from the conditions checked above.

Move the starting lever to START with the control lever remaining at neutral. Make the following check:

1. Verify release of the B-end brake.

2. Verify that the safety car stop latches are withdrawn from the path of the car.

3. Verify that the main system by-pass is closed. This is indicated by slow B-end rotation (because the pump yoke is lightly offset toward hoisting when the control lever is at neutral).

Unlatch and open the trunk lower door. With the control lever at neutral, place the starting lever at START. Make the following check:

1. Verify application of the B-end brake.

2. Verify that the safety car stop latches are in the path of the car.

3. Verify that the main system by-pass is open. This will permit shifting of the control lever slightly toward hoisting without causing B-end rotation.

Close the powder trunk doors. Release switch SW7 to its normally closed position. With the control lever at neutral, place the starting lever at STOP. Make the following check:

1. Verify release of the B-end brake.

2. Verify that the safety car stop latches are in the path of the car.

3. Verify hoist drum rotation by manipulating the control lever to HOIST and LOWER.

4. Verify that the opening of one or all loading or unloading position switches, or the opening of the trunk lower door, will open the main system by-pass and apply the B-end brake.

Detail adjustments.

Adjustment of flight length. Following completion of the preliminary tests, the car hoist rope is attached to the hoist drum. The drum size permits one more loop than is required for maximum lift (56.6 feet). Limit switch car stopping positions, described below, are adjusted without B-end cams assembled, and the car must be operated at slow speeds. Perform the following operations:

To adjust upper limit switch SW9. Proceed as follows:

1. Start the electric motor.

2. Lower the car slowly to the bottom of the hoist trunk and open the lower doors.

3. Block switches SW4 and SW5 closed.

4. Move the starting lever to START and the control lever toward HOIST.

5. Release the starting lever as soon as switch SW7 closes.

6. Hoist the car to contact switch SW9. Verify the car position and adjust the car cam for the desired position (at car movement of 6 inches per second - slow speed).

7. Adjust switch SW9. Limit switches are adjustable for opening or closing by varying the position of the switch operating lever. Adjust as follows:

8. Loosen the locknut on the lever clamp bolt.

9. Turn the clamp bolt until the operating lever is at the desired position.

10. Tighten the locknut.

To adjust lower unloading station switch SW8. After adjusting switch SW9, proceed as follows:

1. Move the starting lever to START.

2. Move the control lever slightly toward LOWER.

3. Release the starting lever after the car has lowered enough to close switch SW9.

4. Verify the car position and adjust the car cam for the desired position.

5. Adjust switch SW8, following the procedure of operations 7 through 10 inclusive of switch SW9 adjustment.

To adjust loading station switch SW7. After adjusting switch SW8, proceed as follows:

1. Move the starting lever to START.

2. Move the control lever slightly toward LOWER.

3. Lower the car slowly to contact switch SW7.

4. Verify the car position and adjust the car cam for the desired position.

5. Adjust switch SW7 to correct any error in stopping, following the procedure of operations 7 through 10 inclusive of switch SW9 adjustment.

Adjustment of B-end cams. B-end cam assembly adjustment involves positioning the components listed below. Before making the adjustments, remove the drain plug at the bottom of the housing and remove the housing cover 325050-1 shown on drawing 325001.

Component	Piece Number
Hoisting acceleration cam	274323-1
Hoisting deceleration cam	274323-3
Lowering acceleration cam	325047-1
Lowering deceleration cam	274324-1
Lowering cam arm	325049-2
Hoisting cam arm	325049-1

These are identical components in all hoists, but have varying arrangements of the cam positions in the cam support and clamping rings with respect to the two cam arms. Cam arms have the same position in all assemblies; cams are positioned according to the height of lift and hoist location. In the left hoists, the cams are reversed from right and center hoist arrangement. There are two objectives to be accomplished in this adjustment:

1. To position the cams in exact synchronization with car stopping positions (as adjusted by limit switches SW7 and SW9).

2. To position the cam arm rollers with respect to the adjusted positions of the cams so that the arms (and control lever) have precise limit of movement from neutral when the cams are at limit stop positions.

To accomplish these objectives the switch-actuating car cam must be properly adjusted, hydraulic fluid must be at normal operating temperature, the system must be full and vented, the shaft linkage must be connected from the control lever to the A-end, and B-end controls accurately positioned from neutral. Excessive friction in the control shafting must be eliminated to make accurate adjustment possible. After attachment to the hoist drum, the car hoist rope must be adjusted at the car to position the car at the loading station as shown in drawing 240889.

Remove the cam support assembly from the cam housing and make scribe marks on the cam outer faces from the profile points indicated below, toward the cam shaft center. (Marks need only be scribed on new cams.) Locations and scribe mark numbers are shown in figure 11-27. Scribe mark locations are as follows:

Mark number 1 is at the high point of the lowering deceleration cam.

Mark number 2 is 0.141-inch beyond mark number 1.

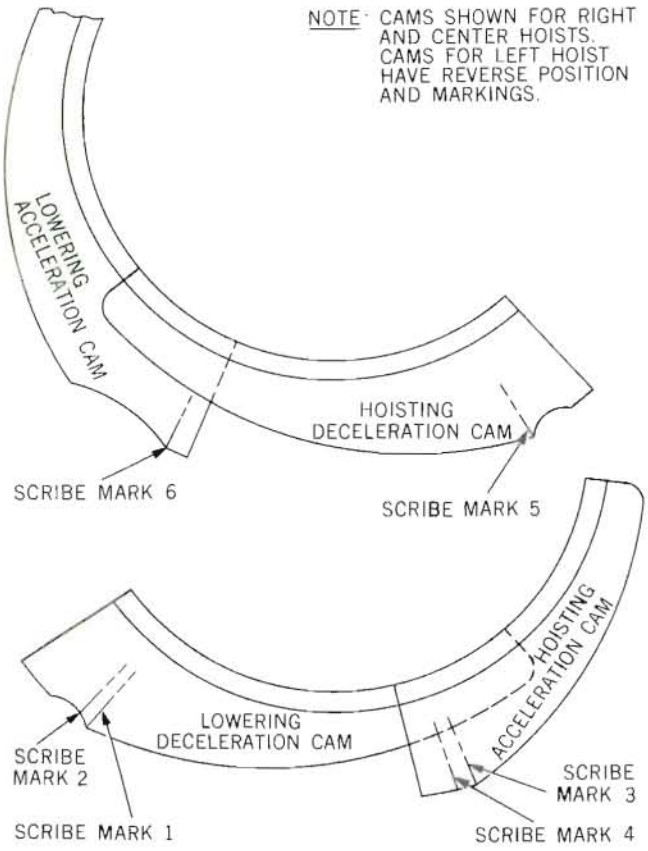


Figure 11-27. Powder Hoist B-end Cams, Locations of Scribe Marks - Adjustment

Mark number 3 is at the high point of the hoisting acceleration cam.

Mark number 4 is 0.141-inch beyond mark number 3.

Mark number 5 is at the high point of the hoisting deceleration cam.

Mark number 6 is at the high point of the lowering acceleration cam and is equivalent to the upper unloading position stop point.

In addition to the scribe marks on the cams, make 12 chalk marks on the outer rim of the hoist drum, spaced 30 degrees apart. These marks are for timing (by stop watch) the slow hoisting speed required in the following adjustment procedure: The distance between chalk marks is equal to approximately 6.0-inches length of the car hoist rope.

After the preceding preparations have been complete, adjust the B-end cams as follows:

1. Start the electric motor.

2. Place the control selector lever at SERVO ELECTRICAL.

3. Move the control lever toward HOIST for slow speed car movement. Stop the car at a point approximately 10 feet up the trunk.

4. Use a stop watch and observe the drum chalk marks. Lower the car at a rate of 6.0-inches per second until the car operates switch SW7 to stop the hoist.

5. Stop the electric motor.

6. Reassemble the cam support unit. Mesh the cam drive gearing so that the lowering deceleration cam is positioned with scribe mark number 1 adjacent to the lowering arm cam roller (fig. 11-28).

7. Verify the exact neutral position of the control lever. Check the control linkage and pump yoke for neutral position by verifying the 1.25-inches dimension is section KK, drawing 325001, sheet one.

8. Unclamp the cams so that they may be positioned by light taps with a copper or lead mallet.

9. Align a steel straightedge from the cam shaft center to the center of the lowering arm cam roller.

10. Move the lowering deceleration cam until mark 1 aligns with the straightedge. Secure the cam.

11. Align the straightedge from the cam shaft center to the center of the hoisting arm cam roller.

12. Move the hoisting acceleration cam until mark 3 aligns with the straightedge. Secure the cam.

13. Use a 0.062-inch feeler gage to verify gap between each roller and cam as positioned. Adjust arms for gap as required (fig. 11-28). Check the hoist controls as in step 7.

14. Start the electric motor.

15. Move the control lever toward HOIST for slow speed car movement. Stop the car at a point about 25 feet up the trunk.

16. Move the control lever toward LOWER (with the dashpot connected and adjusted as described on page 11-36) for full speed car movement into switch 7.

17. Stop the electric motor. Check the hoist controls as in operation 7.

18. Repeat operation 9 and observe position of mark 2. This mark should align with the straightedge. If the mark has overtraveled, the car has overtraveled from switch SW7 and cam deceleration is late. An extremely small advance of the cam will correctly decelerate the car approach to switch SW7. In high speed stop at that station, mark 2 should align precisely with the straightedge. The cam position is essential to permit cam roller starting action (when the control lever is shifted from neutral cam roller should have full bearing in the notch.) Correct positions for left and right hoists is shown in figures 11-28 and 11-30 respectively.

19. Repeat step 11 and observe position of mark 4. This mark should align with the straightedge.

20. Repeat operation 13.

21. Start the electric motor.

22. Move the control lever toward HOIST for slow speed car movement. Time the speed as in operation 4. Hoist until the car is stopped by switch SW9. If operations 13 and 20 have been exact, the hoist will operate at exactly 6.0 inches per second with the control held at the limit of starting movement (0.0625-inch cam roller movement).

23. Start the electric motor with the control lever at neutral.

24. Repeat operation 11.

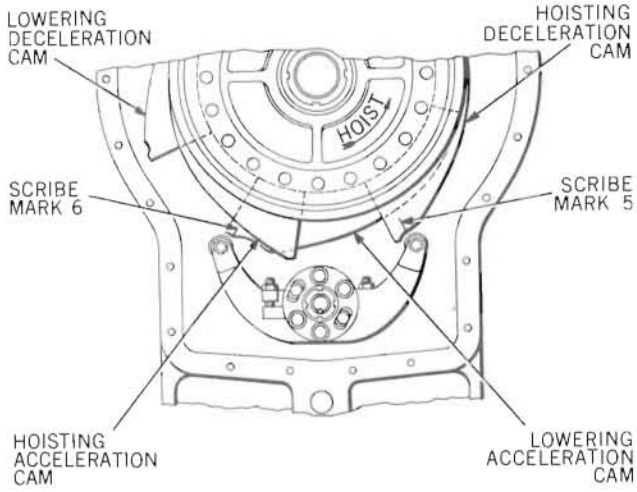


Figure 11-29. B-end Cams, Positions for Left Hoist. Car at Upper Unloading Station. Control Neutral. Adjustment.

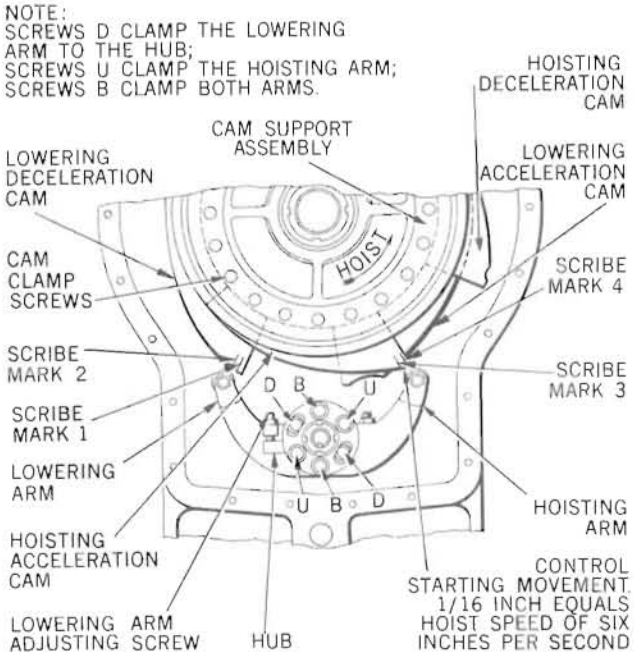


Figure 11-28. B-end Cams, Positions for Left Hoist. Car at Loading Station, Control Neutral. Adjustment.

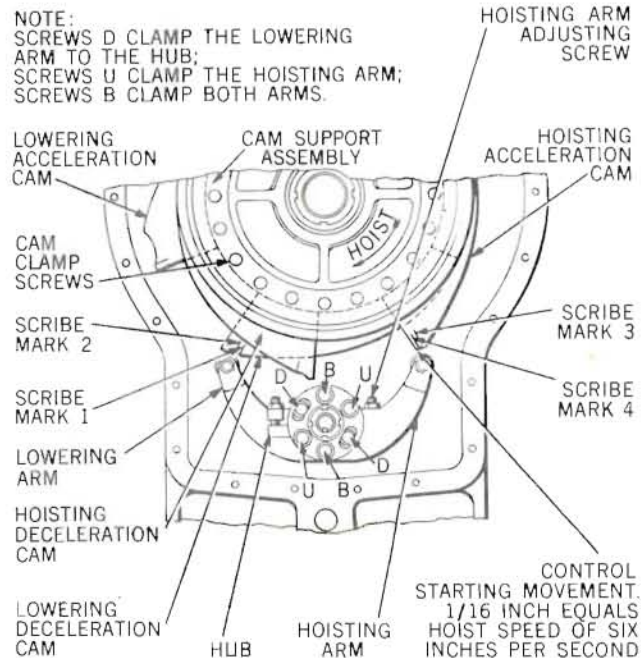


Figure 11-30. B-end Cams, Positions for Right Hoist. Car at Loading Station, Control Neutral. Adjustment.

25. Move the hoisting deceleration cam until mark 5 aligns with the straightedge. Secure the cam.

26. Repeat operation 9.

27. Move the lowering acceleration cam until mark 6 aligns with the straight edge. Secure the cam.

Cam positions obtained by operations 25 and 27 provide high speed synchronization with respect to switches SW9 and SW8. In high speed stopping by action of switch SW9, marks 5 and 6 will overtravel but the car should be at the upper unloading station. See positions of marks 5 and 6 on figures 11-29 and 11-31. If the car is out of position, very slight adjustment of the hoisting deceleration action will give the required stopping position. The lowering acceleration cam must be reset an equal amount.

Adjustment of A-end centering plungers. The centering plunger assemblies have been adjusted at the factory to maintain the pump yoke at slight offset toward hoisting. The pump is offset to supply fluid enough to overcome system leakage and build up enough pressure to retract the centering plungers and to release the brake and operate the safety car stop device. No adjustment is necessary until the equipment has worn enough to permit increased leakage and improper function. Centering plunger adjustment is made by shimming the complete plunger assembly to the desired position. When this is done, control rod 325004-2 or 325007-3 between the control linkage shaft and the A-end control lever must be readjusted. Refer to drawings 325000, 325003, and 325007. Proceed as follows:

1. Remove pipe flanges 271724-4 from both centering plunger housings 274304-1.

2. Remove the six long screws 274340-2 from each assembly and remove the centering plungers.

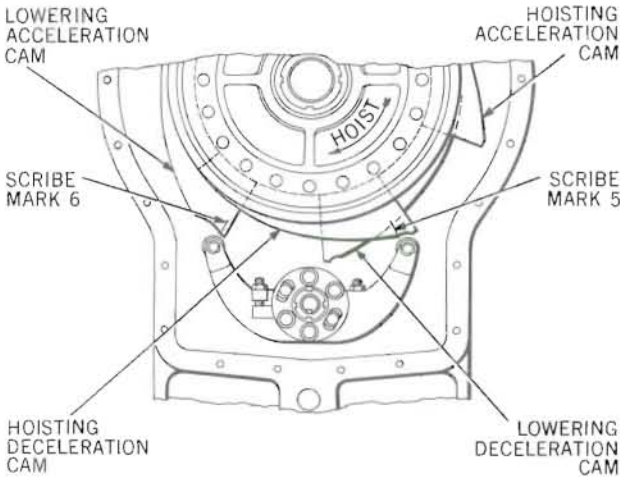


Figure 11-31. B-end Cams, Positions for Right Hoist, Car at Upper Unloading Station, Control Neutral Adjustment.

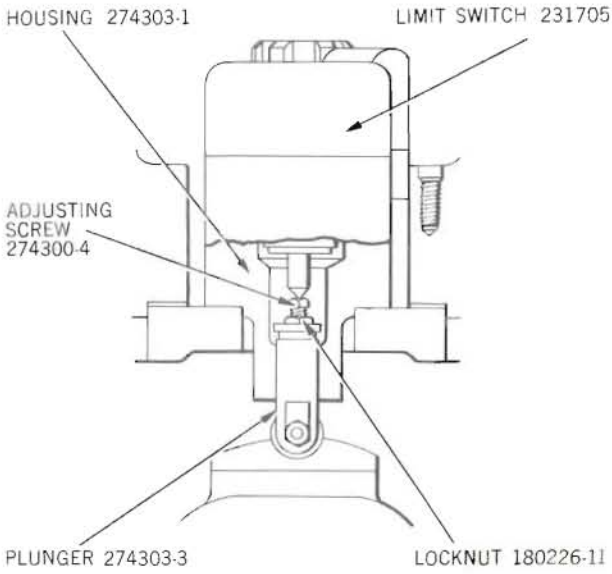


Figure 11-32. A-end Limit Switch, Adjustment.

3. Disconnect clevis 325004-4 from control rod lever 325005-4 and 325007-1.

4. Remove 0.010-inch of shim stock from shim 274305-9 under centering plunger housing (long plunger 274306-1). This will shift the pump yoke farther towards hoisting.

5. Add the same amount of shim stock (as removed in step 4) under the opposite centering plunger.

6. Replace the centering plunger assemblies and the pipe flanges.

7. Adjust the length of control rod 325004-2 or 325007-3 as described in step 7, page

If the 0.010-inch shim adjustment is not enough for proper operation, additional shims may be removed from plunger 274306-1 and added to the other plunger. After the centering plungers have been adjusted, the limit switch may need adjusting. Refer to the next paragraph.

Adjustment of A-end limit switch. The limit switch (fig. 11-32) is factory adjusted to close only when the control lever is at neutral. Centering plunger adjustment may make limit switch readjustment necessary. Refer to drawings 325000 and 231705. Proceed as follows:

1. Disconnect the switch electrical connections.

2. Remove screws 180226-7.

3. Remove the complete assembly of switch 231705 and plunger 274303-3.

4. Remove the two screws 196825-7 from the limit switch.

5. Remove plunger 274303-3 from switch housing 274303-1.

6. Loosen locknut 180226-11.

7. Turn adjusting screw 274300-4 out one-half turn if electric motor would not start (control lever at neutral).

8. Tighten locknut 180226-11.

9. Verify that the motor will start.

Adjustment of control pump relief valve. The control pump relief valve is factory adjusted for a pressure of 160 pounds per square inch. It should not require adjusting unless the valve block is disassembled. Refer to drawing 325030. To adjust, proceed as follows:

1. Remove cap nut 274280-8 and loosen the locknut.

2. Turn adjusting screw 274277-8 in to increase the pressure. Turn the screw out to decrease the pressure.

3. Check the pressure with a gage attached at the pump discharge flange 274289.

4. Adjust pressure to 160 pounds per square inch.

5. Tighten the locknut and replace the cap nut.

Adjustment of main system relief valve (fig. 11-33). The relief valve on the same side of the B-end head-valve plate as the number 1 flange connection, is used in left installations to relieve high pressure. The other relief valve, on the same side as the number 2 flange connection, relieves high pressure in right or center installations. Both valves are factory adjusted to relieve at a pressure of 2100 pounds per square inch. Readjustment is unnecessary unless the head-valve plate is completely disassembled. If adjustment is necessary, the valve in the high pressure line is the only one to be adjusted. The other valve (in the low pressure line) will act as a check valve. Refer to drawing 325001. Proceed as follows:

1. Place the control selector lever at SERVO MECHANICAL.

2. Attach a pressure gage to the air vent on the same side of the head-valve plate as the valve.

3. Start the electric motor.

4. Hold the starting lever at START.

5. Move the control lever toward HOIST and hoist the car until it contacts the upper buffer. In this operation the starting valve (held at start position) prevents venting the main circuit lines.

6. Observe the pressure gage. It indicates the relief valve setting.

7. Remove cap nut 274311-2 and loosen locknut 274319-3.

8. Turn in adjusting screw 274324-5 to increase the pressure setting. Turn out to decrease. An approximate setting can be made by turning in the adjusting screw as far as possible, and backing it out 1.5 turns.

9. Tighten the locknut. Replace the cap nut.

Adjustment of B-end brake. The brake has three types of adjustments to provide for wear of the band, (fig. 11-34). These are made at the brake band ends, at four eccentric stop pins, and at two adjusting stop screws. Refer to drawing 325001. Proceed as follows:

1. Start the electric motor.

2. Place the selector control lever at SERVO ELECTRICAL and the control lever at neutral.

3. Loosen locknuts 274339-4 and back off the upper adjusting nut 206522-3.

4. Tighten the lower adjusting nut 206522-3 until the maximum dimension of 3.0 inches is obtained from the end of brake cylinder piston 274318-1 to the face of cylinder cap 274317-2. The adjustment permits 0.25 inch of piston travel to provide for wear before it is necessary to readjust the brake. The dimension must never be less than 2.75 inches and should be checked frequently.

5. Move the starting lever to START. This releases the brake.

6. Check the clearance between the band and the drum with a 0.010-inch feeler gage.

Maintain this clearance by adjusting stop screw 274328-10 and eccentric stop pins 274307-2. To adjust the stop pins:

7. Remove the cotter pins and loosen (slightly) the castellated nuts 274339-5 on stop pins 274307-2 (sheet 1).

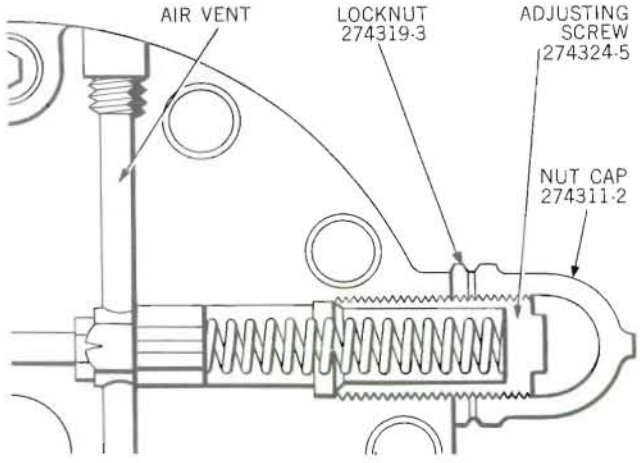


Figure 11-33. Main System Relief Valve, Adjustment.

8. Use a wrench on the stop pin flats. Turn until proper clearance is obtained around the brake band.

9. Hold the stop pins with a wrench, tighten the castellated nuts, and replace the cotter pins.

Adjustment of foot valve control linkage. With the A-end yoke held at center position by the centering plungers and the control rods between the A- and B-ends correctly adjusted, adjust the foot valve control linkage. Refer to drawing 325001. Proceed as follows:

1. Adjust clevis 274334-9 so that the centerline of lever 274335-9 lines up with the centerline of the valve in the foot valve body.

2. Adjust clevis 274335-2 so that there is 0.020- to 0.025-inch deflection of spring 325052-3 when the valve is seated. Make this adjustment when the centerline of lever 274335-9 lines up exactly with the centerline of the valve.

Adjustment of the dashpot. The dashpot assembly is factory adjusted so that the shortest time required for A-end yoke shifting from full hoisting to full lowering (or full lowering to full hoisting) is 2.5 seconds. No adjustment should be necessary unless the dashpot has been completely disassembled. Refer to drawing 325009. To adjust, proceed as follows:

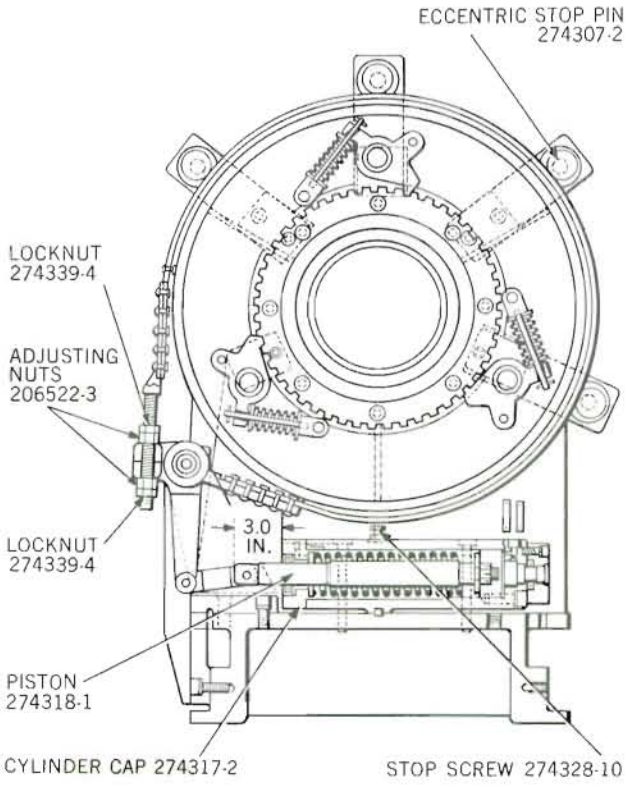


Figure 11-34. B-end Brake. Adjustment.

1. Disconnect the link from lever 325005-2 to permit control lever operation independent of the A- and B-ends.

2. Move the control selector lever to SERVO ELECTRICAL to hold the control shaft latch out of its notch.

3. Adjust clevis 274266-5 to permit full control travel from full hoist to full lower by loosening locknut 274339-9 and screwing in or out on the piston rod 274266-13. Tighten the locknut.

The dashpot assembly needle valves may now be adjusted. Needle valve adjustment number 1 controls speed of piston depression, adjustment number 2 controls speed of piston withdrawal. To adjust:

1. Remove the cap nut, loosen the locknut.

2. Turn adjusting screw in to decrease the piston speed, or out to increase the speed.

3. Tighten the locknut and replace the cap nut after each adjustment (before operating) to prevent air entering while testing.

4. Connect all linkage after adjustment is completed.

Adjustment of latch and vent valve cam. Automatic stopping action in SERVO MECHANICAL operation is obtained (to stop the car at loading and unloading stations) by the venting action of the latch and vent valve. The valve movement is controlled by the adjusted positions of the edges of the notch formed by the two segments of the latch and vent valve adjustable stop. Refer to drawing 240653. Proceed as follows:

1. Position adjustable stop 234036-9 to permit latch movement when mark number 1 (fig. 11-30) is aligned as in step 10, page 11-32.

2. Position adjustable stop 234036-9 to permit latch movement when mark number 5 (fig. 11-31) is aligned as in step 25, page 11-34.

Adjustment of upper powder door closing action. The adjustable bolt which actuates the quick opening valve must be set at a definite position to obtain correct sequence of porting to the dog operating cylinder. Proceed as follows:

1. Unscrew adjusting bolt on powder door, close door.

2. Screw bolt in until contact is made bolt, cam, and valve stem.

3. Turn adjusting bolt 2.25 turns and lock in position.

DISASSEMBLY AND ASSEMBLY

General instructions

Disassembly and assembly of most components of the powder hoist are apparent from the general drawings. No instructions are included for disassembling the hoist doors, door operating mechanisms, or the car and its attachments. However,

the installed positions of the power drive units necessitate their disassembly in order to pass them through the gun girder access hatches. Complete instructions for the disassembly and assembly of A- and B-end mechanisms are included in this chapter. Assembly procedures are omitted if they are the exact reversal of disassembly operations. The equipment drawings and illustrations should be studied carefully before starting operations.

A-end group

Control and supercharge pump. Control and supercharge pump removal, disassembly, and assembly operations are described below. The control pump can be removed without draining the system of fluid. Refer to drawings 274269 and 325000.

Removal of the control pump. Proceed as follows:

1. Remove screws 180226-7 and 220718-2 from the pump intake and discharge flanges.

2. Remove four screws 196825-6 from the pump mounting flange 325029-1.

3. Slip the pump drive shaft out of drive gear 274294-3 by springing the hydraulic tubing slightly.

Disassembly of the control and supercharge pump. After the pump has been removed as described above, proceed as follows:

1. Break the lockwire through screws 274270-2 and remove the screws.

2. Remove the pump head 324926-3.

3. Remove all internal parts except drive shaft 274269-4 and bearing 164474-10.

4. Loosen screws 196780-4 and remove mounting flange 325029-1.

5. Remove the drive shaft and bearing.

Assembly of the control and supercharge pump. Proceed as follows:

1. Wash all parts with solvent Navy Specification P-S-661.

2. Replace the bearing and drive shaft.

3. Replace the mounting flange; tighten screws 196780-4.

4. Replace all internal parts. The vane chamfer must be at the trailing edge.

5. Replace the pump head. Tighten the screws diametrically opposite and rotate the pump shaft while tightening screws 274270-2.

6. Insert a new lockwire through the screws.

Control pumps should be operated in the direction indicated by the arrows on the housing, rotor, and bushings. However, they may be assembled for opposite rotation by reversing the rotor, cam plate, valve plates, and valve plate pin. Direction of pump rotation may be reversed in emergency.

Centering plunger assembly. Centering plunger assembly removal, disassembly, and assembly operations are described below. The assembly can be removed without draining the system of fluid. Refer to drawing 325000.

Removal of the centering plunger assembly. Proceed as follows:

1. Remove screws 196780-4 from pipe flanges 271724-4, which are secured to the assemblies.

2. Remove six screws 274340-2 from each housing and remove the assemblies from the A-end case. When removing, mark the parts to ensure that the centering plunger assembly and mating shim 274305-9 are kept together. The assembly shims are of different thickness to adjust the plungers.

Disassembly of the centering plunger assembly. After the assembly has been removed as described above, proceed as follows:

1. Remove screws 180226-6 and remove cover 274305-8 from the body 274304-1.

2. Using a jackscrew, remove the cover from spring 274305-7.

3. Remove plungers 274306-1 and 274306-4 from the bushings.

Assembly of the centering plunger assembly. Proceed as follows:

1. Wash all parts with solvent Navy Specification P-S-661.

2. Assemble the parts in reverse order of disassembly. Make sure that correct centering plunger assemblies are installed in the bodies and that the same shims are used. If new shims are necessary, refer to adjustment procedure on page 11-34.

Limit switch. Neutral interlock limit switch removal, disassembly, and assembly operations are described below. The switch can be removed without draining the system of fluid. Refer to drawing 325000, sheet 1.

Removal of the limit switch. Proceed as follows:

1. Shut off the electric power supply at the electric controller and disconnect the switch connections.

2. Remove screws 196325-7 and remove the limit switch 231705.

3. Remove screws 180226-7 and remove the plunger assembly from the A-end.

Disassembly and assembly. These operations are apparent. Refer to drawing 231705.

Solenoid. Solenoid removal, disassembly, and assembly operations are described below. Refer to drawing 325030.

1. Open the electric power disconnects.

2. Remove 14 screws 196825-6 from the cover 274277-1. This permits access to the solenoids.

3. Disconnect the solenoid connections and remove screws 206446-3.

4. Remove solenoids 274233 from the case.

Disassembly. Solenoid disassembly and assembly are apparent. Refer to drawing 274233.

Installation. Install solenoids in the same locations they were removed from. Proceed as follows to install a new solenoid:

1. Loosen clamp bolts 196780-4 in the solenoid operating levers 27427-3 and 274273 (see drawing 325030, valve block assembly).

2. Remove the levers.

3. Remove the solenoid housing mounting screws 196780-4.

4. Remove the solenoid housing 274279-1.

5. Remove pipe plugs 196826-9 located in the back of the solenoid housing. Drive out dowel pins 196732-8.

6. Mount the new solenoid in place with its mounting screws.

7. Drill through the solenoid mounting flange, using a 19/64-inch (size M) twist drill. Do not injure the solenoid coils by drilling too deep.

8. Ream the holes for 0.312-inch dowel pins 196732-8; assemble the pins and the pipe plugs 196826-9.

9. Remove the solenoid and reassemble the housing 274279-1 to the valve block cover.

10. Reassemble the solenoid operating levers and both solenoids.

11. Connect solenoid and replace the cover.

Air breather assembly removal. Perform the following operations to remove the air breather assembly (refer to drawing 274286-2).

1. Remove the breather assembly from elbow 206447-4; use a wrench on the lower hexagonal portion of the assembly.

Disassembly of the air breather. To disassemble the air breather, proceed as follows:

1. Place a hexagonal portion of the breather in a vise and remove the cover with a wrench.

Precautions must be taken not to lose the needle valve while disassembling.

Control and supercharge pump gear case assembly. Removal, disassembly, and assembly of the control and supercharge pump gear case assembly are described below. Refer to drawing 325000.

Removal of the control and supercharge pump gear case.

1. Remove the screws from the number 7 pipe flange and disconnect the flange.

2. Remove the flexible coupling between the electric motor and A-end shaft.

3. Remove screws 206829, insert three 3/8-16 NC jackscrews in the screw holes. Turn the jackscrews evenly to remove the assembly. Do not damage oil seal 2745338-7.

Disassembly of the control and supercharge pump gear case. After the control and supercharge pump gear has been removed as described above, proceed as follows:

1. Remove two screws 180226-6 remaining in cover 325042-1.

2. Insert jackscrews in the 3/8-16 NC tapped holes in the cover.

3. Tighten the jackscrews evenly to remove cover from dowel pins.

4. Remove gear 274298-1 from case 274296-1.

5. Remove gear 274298-5 from drive shaft 274300-1.

Assembly of the control pump gear case. Proceed as follows:

1. Wash all parts with solvent Navy Specification P-S-661.

2. Assemble gear 274298-5 on shaft 274300-1.

3. Assemble gear case 274296-1 in position on the A-end.

4. Assemble gear 274298-1 and the two shims 274300-2.

5. Slip oil seal leader 274350-2 over the end of the drive shaft 274300-1. Then slip the oil seal over the end of the leader and replace cover 325042-1.

6. Coat spacer 325042-2 lightly with grease so that it adheres to cover 325042-1 when placed in position. This procedure enables the spacer to be assembled over pins 324919-4.

7. Assemble the cover on the case.

8. Reassemble the pipe flanges and coupling.

Oil filter assembly. Removal, disassembly, and assembly operations of the oil filter assembly are

described below. The system must first be drained of hydraulic fluid. Refer to drawing 325000.

Removal of oil filter assembly. Proceed as follows:

1. Disconnect tubing 274289-2 and tubing 274256-2.

2. Remove screws 196825-11 and remove the oil filter assembly.

Disassembly of the oil filter assembly. Proceed as follows:

1. Remove six screws 180226-6 from each filter container 274303-2.

2. Remove the filter springs 229026-10 and the filter element 274306-3.

3. Remove screws 196780-4 from the oil seal retainer 274296-3 and remove valve 274296-4 from the filter body 325039-1.

4. Drive out pin 27431-5 and lever 274295-4.

5. Remove spring 199993-5 and detent plunger 274297-4.

Assembly of the oil filter assembly. Proceed as follows:

1. Wash all parts with solvent Navy Specification P-S-661.

2. Assemble the parts in reverse order of disassembly. Check the assembly for easy movement of the directional valve.

3. Connect tubing 274289-2 and tubing 274256-2.

Control and supercharge pump by-pass valve. Control and supercharge pump by-pass valve removal, disassembly, and assembly operations are described below. The system must first be drained of hydraulic fluid. Refer to drawings 274256 and 325031.

Removal of control and supercharge pump by-pass valve. Proceed as follows:

1. Disconnect the linkage from lever 325031-1.

2. Disconnect tubing 274256-2 and tubing 274256-4.

3. Remove screws 274340-3 and remove the by-pass valve from the valve block assembly.

Disassembly of the control and supercharge pump by-pass valve. Proceed as follows:

1. Remove clamp bolt 196780-4 from lever 325031-1 and remove the lever from valve 325031-2.

2. Remove key 196716-3 and remove the valve from the body.

3. Drive out pin 274341-6.

4. Remove detent plunger 274257-3 and spring 180233-6.

Assembly of the control and supercharge pump by-pass valve. Proceed as follows:

1. Wash all parts with solvent Navy Specification P-S-661.

2. Assemble the parts in reverse order of disassembly. Check the assembly for easy movement of the valve.

3. Connect tubing 274256-2 and tubing 274256-4.

4. Connect the linkage from lever 325031-1.

Valve block assembly. The removal and the disassembly and assembly operations of the valve block assembly are described below. Before performing these operations, the system must be drained of hydraulic fluid. Remove the air breather assembly, control and supercharge pump gear case assembly (with control and supercharge pump attached), oil filter assembly, and both solenoids as previously described. Refer to drawings 325030 and 325000.

Removal of valve block assembly. Proceed as follows:

1. Disconnect all linkage and tubing from the valve block.

2. Remove pipe plug 274341-11 from the A-end housing 325041-1.

3. Reach into the top opening of the A-end housing and remove slotted nut 274339-2.

4. Remove pin 274273-11. Keep it from turning by inserting large screw driver through the pipe tapped hole in the pump housing.

5. Loosen screws 196825-6 and remove the venting valve control lever shaft 274281-5.

6. Remove clamp bolts 196780-4 from the two solenoid operating levers 274273-3. Remove the levers.

7. Remove the solenoid housing mounting screws 196780-4. Remove the housing.

8. Secure a chain fall (or block and tackle) to the valve block eyebolts. This is essential for ease and safety in handling the very heavy valve block unit.

9. Insert jackscrews in the two 1/2-inch tapped holes in the pump housing. Turn in evenly on both jackscrews.

10. Remove the valve block as it slips off dowel pins 271727-11.

Disassembly of the valve block assembly components. Remove the valve block to a suitable workbench before disassembling. Proceed as follows:

Valve block servo linkage removal.

1. Loosen slotted nut 274339-2 and remove screw 274273-6 from the stroking piston 274280-1.

2. Loosen slotted nut 206513-6 and remove screw 274273-10 from servo valve 274283-1.

3. Turn control lever 274276-2 so that the end of short lever 274276-4 projects out of the block.

4. Remove nut 206513-6 and screw 274252-5.

Stroke control piston removal.

1. Remove the mounting screws 325054-6 from the stroke control piston retainer 325037-1.

2. Remove the piston and retainer from the valve block. Do not damage oil seal 274273-8.

3. When reassembling, insert the piston into the block and then assemble the retainer.

Servo valve removal.

1. Remove the control and supercharge pump by-pass valve as described previously.

2. Remove the servo valve from the valve block.

The servo valve may also be removed from the valve block when the valve block is assembled to the A-end housing. Drain the A-end and remove inspection covers 325043-1. Proceed as follows:

1. Reach into the inspection openings and remove nut 206513-6 and screw 274273-10. Screw 274273-10 secures servo valve 274283-1 to servo control link 274275-3.

2. Remove the control and supercharge pump by-pass valve as described previously.

3. Remove the servo valve and cover 274280-5.

4. Remove the servo valve from the valve block.

When a new servo valve is assembled it must be ground to fit. The valve outside diameter will be 0.010-inch oversize; it must be ground to fit the valve block with a clearance of 0.0005- to 0.0007-inch. The 45 degree chamfer and 0.125-inch side slots are to be ground on the lands of the valve (refer to drawing 274283-1). Determine the lines-of-seal on the valves for each individual valve block as described below:

a. Assemble the valve in the valve block with the control pump by-pass valve in place, and the large end cover off. With the valve installed, turn the cam on the end of the by-pass valve to permit no movement of the valve. Measure the distance from the end valve to the valve block cover face 274280-5 with a depth micrometer.

b. Remove the valve; measure the distance from the valve block face to the inner grooves in the servo valve bore.

c. Determine the seal lines from these dimensions.

d. Scribe the lines for the 45 degree chamfers and the ends of the 0.125-inch wide slots on the valve.

e. Set the valve up in a grinding machine and grind the slots and chamfers to the scribe marks.

By-pass valve removal.

1. Loosen screws 180226-6 from end cover 325036-5; remove the cover.

2. Remove valve 274283-3 from the valve block.

Valve block cover removal.

1. Remove end cover 325036-5 to expose the venting valve.

2. Remove the cover mounting screws and the screws from the servo valve end cover. Insert jackscrews into the two 1/2-13 NC tapped holes in the valve block cover.

3. Remove the valve block cover. The servo valve and venting valve are assembled to the cover and will slip out of the valve block.

4. Remove the valves from the valve block cover by loosening the slotted nuts and removing the screws.

Removal of the venting valve, power failure valve, relief valve, and check valve.

Refer to instructions for valve block cover removal. Further disassembly is apparent.

Assembly of the valve block.

1. Wash all parts with solvent Navy Specification P-S-661.

2. Assemble the parts in reverse order of disassembly.

CAUTION: Do not damage valves assembled to the valve block cover 274280-5 when the cover is replaced on the valve block. Insert the valves into the valve block and push the cover slowly to its mounting face. Verify the installation of check valve 196788-10, spring 196786-3, and relief valve stop washer 274277-9 in the valve block before tightening the cover screws.

Reassembly of new sliding valves - special instructions. When reassembling new sliding valves in the valve block, outside diameters must be fitted to the valve block bores by grinding the 0.010-inch oversize stock off. Grind and polish the valves to a clearance fit of 0.0005- to 0.0007-inch.

Removal of check valve assembly. Check valves 274285 and 274286 (assembled on top of the valve block) may be removed without draining fluid from the A-end. The A-end must be drained before removing check valves 274286 from the intake and discharge flanges 274297-1 of the A-end. Refer to drawing 324999. Proceed as follows:

1. Disconnect the hydraulic tubing from the check valves.

2. Remove the check valve mounting screws.

3. Remove the check valves from the A-end.

A-end pump assembly. Removal, disassembly, and assembly of the A-end pump assembly are described below. The assembly must be drained of hydraulic fluid before these steps are performed. Refer to drawing 325000.

Removal of the A-end pump assembly. Proceed as follows:

1. Disconnect all control linkage from the A-end.

2. Disconnect the coupling to the electric motor; disconnect all hydraulic tubing.

3. Remove the A-end mounting bolts.

4. Slide the A-end under the access opening to provide room for using a chain fall (or block and tackle) to remove heavy components.

5. Remove the control and supercharge pump gear case, the oil filter assembly, the centering plunger assemblies, the neutral interlock switch, and the valve block as described in previous paragraphs.

6. Remove inspection covers 325043-1 from the ends of the A-end tank 325012.

7. Reach into the inspection openings and remove the 21 screws 206513-1. This permits separation of pump housing 325041-1 from pump base 325040-1.

8. Remove the pump housing using the chain fall.

9. Remove gear 274298-5 from drive shaft 274300-1.

10. Remove two keys 200066-6, spacer 274303-7, and split rings 274300-5.

11. Turn the pump housing over, set it on wood blocks so that pump shaft 274300-1 points down.

12. Block the pump yoke in a centered position, remove pipe plug 206701-6, and screw 196780-4 from pump head 274302-1.

13. Remove the pump head mounting screws 206701-7 and 271730-12.

14. Remove the pump head 274302-1.

15. Remove the valve plate 274299-5, cylinder block 274299-1, and universal link assembly.

16. Remove the pump shaft 274300-1 with the pistons and bearings.

17. Remove the pintles 274289-3 from the end of the pump housing.

18. Remove the pump yoke 274301-1.

Pump shaft disassembly. Proceed as follows:

1. Remove screws 271678-4 from piston rod retainers 271692-4. Mark these parts to ensure reassembly in the same positions.

2. Remove piston rods 271690-4 from the shaft.

3. Disassemble the pistons, straighten lockwashers 271691-4, and remove bearing retainers 271690-3.

4. Remove bearing 274337-16 from shaft 274300-1 by tapping on the edge of the inner race of the bearing.

5. Remove bearing 274337-15 from shaft 274300-1. This bearing, a press fit, can be removed only by inserting pins of equal length in the 0.375-inch diameter holes in the shaft piston rod bores, after piston rod bearings 271691-6 have been removed. Place shaft and pins in a press and force the bearing off the shaft.

To replace bearing 274337-15, heat it in an oil bath to 175 degrees fahrenheit. Assemble on shaft 274300-1 (which is to be coated with finely powdered graphite MIL-G-6711 or equivalent) before bearing cools.

6. Remove locking screw 220718-1 and spring retainer 271692-2.

7. Remove universal link retainer 271692-5.

8. Tap out universal link retainer 271691-3 and remove the cylinder bearing pin 274296-5 from the cylinder block.

Assembly of the A-end pump assembly. Proceed as follows:

1. Wash all parts with solvent Navy Specification P-S-661.

2. Assemble the parts in reverse order of disassembly. When assembling the pistons into the cylinder block, tilt the pump yoke to one side and insert the piston and universal link into their bores, one at a time. Verify that all moving parts have freedom of movement. If new oversize pistons are assembled to an old cylinder block, machine the bores true and round. New pistons, 0.010-inch oversize, are ground and polished to fit the bores with a tolerance of 0.0008- to 0.0014-inch.

Replenishing check valve removal. It is not necessary to remove these valves for inspection purposes. Before removing, drain the A-end tank. Refer to drawing 274284. Proceed as follows:

1. Remove inspection covers 325043-1.

2. Reach into inspection opening and remove the cover mounting screws.

3. Remove the cover and valve 274284-7.

Verify that the valve does not bind when reassembled by checking valve movement through an opening in the lower end of the valve body.

B-end group

Cam support assembly. Removal, disassembly, and assembly steps for the cam support assembly are described below. Before performing these operations, remove the large portable plate at the cam end of the power drive compartment and drain the fluid from the cam housing. Refer to drawing 325001.

Removal of the cam support assembly. Proceed as follows:

1. Remove cam housing cover 325050-1.

2. Remove locknut 271731-3 from the end of drive shaft 274313-1, using adjustable spanner wrench 12-Z-715-0118; remove the lockwasher.

3. Mark cam support 274322-1 and gear 274328-9 to ensure reassembly of parts in same locations.

4. Remove the cam support assembly from the drive shaft.

Disassembly of the cam support assembly. Proceed as follows:

1. Loosen the screws which project above the surface of the clamp ring 274323-4. Remove the hoisting cams.

2. Remove screws 220718-2 from clamp ring 274323-2.

3. Remove screw 180226-6 from face of gear 274327-5.

4. Remove the gear from dowel pins 2 06485-14; remove the lowering cams.

Assembly of the cam support assembly. Proceed as follows:

1. Wash all parts in solvent Navy Specifications P-S-661.

2. Assemble the parts in reverse order of disassembly. Adjustment instructions are on page 11-31.

Rocker arm assembly. Removal, disassembly, and assembly steps for the rocker arm assembly are described below. Refer to drawing 325001.

Removal of the rocker arm assembly. Proceed as follows:

1. Loosen locknut 271665-3 and lockwasher 196733-14, using locknut wrench 220720-2.

2. Remove the rocker arm assembly from shaft 325048-3.

Disassembly of the rocker arm assembly. Proceed as follows:

1. Remove screws 220718-2 and 180226-7 which project from the hoisting rocker arm.

2. Remove hoisting rocker arm 325049-1 from hub 325049-3.

3. Remove screws 180226-7 from the lowering rocker arm 325049-2 and remove the arm from hub 325049-3.

Assembly of the rocker arm assembly. Proceed as follows:

1. Wash all parts in solvent Navy Specifications P-S-661.

2. Assemble the parts in reverse order of disassembly. Adjustment instructions are on page 11-31.

Brake band assembly. Removal, disassembly, and assembly steps for the brake band assembly are described below. Refer to drawings 325001 and 274307.

Removal of the brake band assembly. Proceed as follows:

1. Block the powder car at the loading station.

2. Loosen lower locknuts 206522-3 and 274339-4 on the adjustable brake band end 274318-3.

3. Remove the two clamp bolts 196825-9 from the upper bosses of brake support bracket 325048-1.

4. Remove shaft 274331-1 from the brake band end 274320-4, lever 274321-1, and bracket 325048-1.

5. Remove slotted nuts 274339-5 from the four eccentric adjusting screws 274307-2.

6. Turn the adjusting screws so that the flat on the screw heads will slide past the hoisting drum; remove adjusting screws 274307-2.

7. Loosen locknuts 180226-12, located on top of brake cylinder housing 274315-1.

8. Turn adjusting screws 274328-10 in as far as possible.

9. Remove the brake band cam; spring it slightly if necessary.

Removal of the brake cylinder assembly. After removal of the brake band assembly, described above, the brake cylinder assembly may be removed as follows:

1. Disconnect the hydraulic tubing from the brake cylinder.

2. Loosen slotted nut 206513-6 and remove screw 325052-4.

3. Remove lever 274321-1.

4. Loosen brake cylinder mounting screws 274340-9.

5. Lift one end of the brake cylinder assembly until it clears key 274319-7; remove the cylinder.

Disassembly of the brake cylinder assembly. Proceed as follows:

1. Remove slotted nut 206513-6 and screw 325052-4.

2. Remove two cover screws 220806-7 from the flange end of the brake cylinder.

3. Insert jackscrews into the two tapped holes to prevent the spring from forcing the piston out of the housing when all four screws 220806-7 are removed.

Further disassembly is apparent.

Assembly of the brake cylinder. Proceed as follows:

1. Wash all parts in solvent Navy Specifications P-S-661.

2. Assemble the parts in reverse order of disassembly. Slip oil seal leader 274347-4 over the end of piston 274318-1 while the piston is being assembled through oil seal 274338-10.

Assembly of the brake band assembly. Proceed as follows:

1. Assemble the parts in reverse order of disassembly. Adjustment instructions are on page 11-35.

CAUTION: Do not permit oil or grease to get onto the brake band or drum. If this happens, wash all parts as described above.

Relief valve. Removal of the B-end relief valves is described below. Refer to drawing 325001. Proceed as follows:

1. Loosen acorn cap nuts 274311-2 and locknut 274319-3.

2. Remove adjusting screw 274324-5; remove the relief valves and springs, numbers 274312-6 and 274312-3 respectively.

Wash all parts in solvent Navy Specifications P-S-661. Assemble in reverse order of disassembly. Adjustment instructions are on page 11-35.

Cam housing assembly. Removal, disassembly, and assembly of the cam housing assembly are described below. Refer to drawing 325001 and 325046-1.

Removal of the cam housing assembly. Proceed as follows:

1. Block the powder car at the loading station to take the load off the car hoist rope.

2. Remove the cam support assembly as previously described.

3. Loosen locknut 274339-6, using wrench 274346-2, on shaft 274314-1.

4. Remove gear 274328-6 and spacer 274335-6.

5. Remove clamping screw 196825-7 from the upper end of link 274335-8.

6. Remove link pin 274334-8.

7. Loosen locknuts 274339-8 on control rod 325052-2.

8. Remove screw 274252-5 from upper end of link 274253-4.

9. Screw out control rod 325052-2 from clevis 274253-5 at the B-end.

10. Remove the mounting screws 229123-7 from the mounting face of the cam housing 325046-1 and remove the dowel pins 274319-4.

11. Slide the cam housing along the mounting base until it clears the drive shaft; remove the housing with a chain fall.

Disassembly of the cam housing assembly. Proceed as follows:

1. Remove the rocker arm assembly as described on page 11-42.

2. Slip the rocker arm shaft out of bearings 325054-10 and oil seal 274338-10.

3. Remove the small cover 325047-2 and loosen the locknut on shaft 274324-3 using spanner wrench 12-Z-715-0118.

4. Tap shaft 274324-3 out of gear 274327-1 and outer bearing 196827-9.

5. Remove the shaft bearing 196827-9, and gear 274328-9 assembly.

6. Loosen key 200148-6; force the bearing and gear from the shaft.

7. Remove retainer 274334-13.

8. Remove oil seal 274338-8 and bearing 274337-11.

Assembly of the cam housing assembly. Proceed as follows:

1. Wash all parts in solvent Navy Specifications P-S-661.

2. Assemble the parts in reverse order of disassembly. Assemble drive shaft spacer into oil seal 274338-8 and bearing 274337-11 before the cam housing is slipped over the drive shaft. Make sure gasket 274329-4 is in place before housing is assembled to shaft. Adjustment instructions are on page 11-32.

Hoisting drum. Hoisting drum removal, disassembly, and assembly are described below. The cam housing assembly must be removed first. Refer to drawings 325001 and 274325.

Removal of the hoisting drum. Proceed as follows:

1. Remove slotted nut 274339-1 and collar 274328-11.

2. Remove the rope clamps; pull the car hoist rope out of the drum slots.

3. Remove the hoisting drum from shaft 274314-1.

Disassembly of the hoisting drum. Proceed as follows:

1. Remove screws 200075-6.

2. Remove the ratchet from dowel pins 206664-6.

Assembly of the hoisting drum. Assemble the parts in reverse order of disassembly. To assemble the drum on the shaft, proceed as follows:

1. Form wire hooks which will hook over the edge of the brake drum and slip into holes in the ratchet dogs 325048-2 to hold the dogs.

2. Push the drum far enough on the shaft for the dogs to engage, remove the wire hooks and push the drum against its retaining face.

3. Attach the car hoist rope to the hoisting drum.

Brake drum. Brake drum removal, disassembly, and assembly are described below. Refer to drawings 325001 and 274320.

Removal of the brake drum. Proceed as follows:

1. Remove the brake band assembly, cam housing assembly, and hoisting drum as described previously.

2. Slip the brake drum over the end of drive shaft 274314-1.

Disassembly of the brake drum. Proceed as follows:

1. Remove slotted nuts 274339-7.

2. Remove the ratchet dog support pins 274322-2 from the brake drum.

3. Disconnect springs 325052-5 from the ratchet dogs.

Assembly of the brake drum. Proceed as follows:

1. Wash all parts in solvent Navy Specifications P-S-661.

2. Assemble the parts in reverse order of disassembly.

CAUTION: Do not permit oil or grease to get onto the brake band or drum. If this happens, wash all parts as described above.

Oil seal. Removal of the B-end oil seal is described below. Drain the hydraulic fluid from the B-end case by removing drain plugs. Refer to drawings 325001 and 325054-9. Proceed as follows:

1. Remove the cam housing, hoisting drum, and brake drum as previously described.

2. Remove screw 27166 9; remove retainer 325049-4.

3. Remove oil seal 325054-9 from the retainer.

Foot valve control linkage. Removal of the foot valve control linkage is apparent from the reference drawing 325001.

Foot valve assembly. Removal of the foot valve assembly is described below. The assembly can be removed without completely draining the system of fluid if a drip pan is placed under the valve while it is being removed. The system should be completely drained if the units must remain disassembled for any length of time. Refer to drawing 325001.

Removal of the foot valve assembly. Proceed as follows:

1. Disconnect drain flange 274287-6 from the foot valve body.

2. Remove screw 274334-11 to disconnect foot valve clevis 274335-2 to the link of the control linkage.

3. Disconnect supply line flange 274330-1 from the foot valve body 274332-1.

4. Remove mounting screws 274340-10; remove the foot valve.

Disassembly of the foot valve assembly. Any or all of the valves in the foot valve assembly may be removed without removing the assembly from the B-end. For ease of disassembly, it is advisable to remove the assembly.

By-pass valve removal. Refer to drawing 274335-4.

1. Loosen locknut 180247-8; remove clevis 274335-2.

2. Remove the screws from cover 274331-8.

3. Work the by pass valve 274335-4 back and forth and remove the cover, bushing 274334-1, and the valve.

4. Remove cover 274331-6.

5. Tap on the inner face of bushing 274335-7 to remove it, using a rawhide mallet. Remove bushing 274334-12.

Check valve removal. Refer to drawing 274331.

1. Remove the screws from cover 274330-5.

2. Remove the cover, spring 274329-5, and check valve 274331-2.

Foot valve, relief valve, and ball seat removal. Refer to drawing 274341.

1. Remove the screws from lower cover 274330-9.

2. Remove the cover spring 274330-6, spring guide 274330-11, plunger 274331-9, washer 274327-7, and ball 274341-15.

3. Remove cover 274330-9.

4. Remove ball seat 274330-2.

Assembly of the foot valve assembly. Proceed as follows:

1. Wash all parts in solvent Navy Specifications P-S-661.

2. Assemble the parts in reverse order of disassembly.

3. Grind and polish the outside diameter of new by-pass valves to a tolerance fit of 0.0005- to 0.0007-inch with the bushings.

4. Grind new check valves to a tolerance fit of 0.005- to 0.006-inch with the body. Verify that washer 274327-7 and spring guide 274330-11 are in place when the relief valve ball is assembled.

Hydraulic motor assembly. Removal, disassembly, and assembly of the hydraulic motor assembly are described below. Refer to drawing 325001.

Removal of the hydraulic motor assembly. Proceed as follows:

1. Block the powder car in the loading position (to take the load off the car hoist rope) and remove the car hoist rope from the hoisting drum.

2. Drain the B-end of hydraulic fluid.

3. Disconnect all hydraulic tubing and control linkage from the B-end.

4. Remove the B-end from the turret. This operation is necessary to provide a convenient working area with a chain fall to aid in disassembly.

Disassembly of the hydraulic motor assembly. Cylinder block 274312-1 and its associated parts can be removed without completely disassembling the B-end assembly. If shaft 274314-1 is to be removed, the complete B-end must be disassembled. Proceed as follows:

Cylinder block removal. Refer to drawing 274312.

1. Block the B-end assembly securely in a position that places the centerline of the cylinder block and B-end head-valve plate in a vertical plane.

2. Remove the foot valve assembly as previously described.

3. Remove the two screws from the head-valve plate cap.

4. Remove the 12 mounting screws from the head-valve plate 274316-1.

5. Use a chain fall to remove the head-valve plate.

6. Replace small cover 274312-9 and screws 274319-2; clamp a 5-inch length of 0.50-inch square steel stock between the cover and the cylinder bearing pin 274319-1. This provides an attachment for a rope sling for removing the valve plate 274311-1 and cylinder block 274312-1 from the motor housing 274310-1.

7. Remove universal link 274313-6 and link knuckles 274314-4.

8. Remove cover 274312-9. Using a rawhide mallet, tap lightly on the end of the cylinder bearing pin 274319-1 to remove.

9. Remove the universal link retainer from the cylinder block.

10. Remove nuts 274339-3 from the motor housing 274310-1; remove the housing.

11. Remove spring retainer 274329-3.

12. Insert a 1/2-13 NC threaded rod into the tapped hole in universal link retainer 274313-1; remove the retainer from shaft 274314-1.

13. Loosen the screws in the bearing retainers and remove piston rods 274313-8. The bearings, piston rods, and retainers are individually fitted to bores in shaft 274314-1 and must be reassembled in their respective locations.

Drive shaft removal. Refer to drawing 274314-1.

1. Remove the cam housing assembly, hoisting drum, brake drum, brake band assembly, and the foot valve and control linkage as previously described.

2. Remove the cylinder block as described above.

3. Remove the drive shaft 274314-1.

4. Remove bearing 274338-1 from shaft 274314-1. This bearing, a press fit, can be removed only by inserting three pins of equal length in the 0.516-inch diameter holes provided in the bearing bores of the shaft. Place shaft and pins in a press and force bearing 274338-1 off the shaft.

To replace the bearing, heat it in an oil bath to 175 degrees fahrenheit. Assemble on shaft 274314-1 (which is to be coated with finely powdered graphite MIL-G-6711 or equivalent) before bearing cools.

5. Loosen nuts 206522-3.

6. Insert jackscrews in the two 3/4-10 NC tapped holes and turn the screws in evenly to remove the drive shaft housing 274309-1 from dowel pins 274319-4 and key 274312-2.

Further disassembly is apparent from drawing 325001.

Assembly of the hydraulic motor assembly. Proceed as follows:

1. Wash all parts with solvent Navy Specifications P-S-661.

2. Assemble the parts in reverse order of disassembly. Motor housing 274310-1 must be assembled before cylinder block 274312-1 and valve plate 274311-1 are assembled. When assembling the pistons into the cylinder block, tilt the pump yoke to one side and insert the pistons and universal link into their bores one at a time. Verify that all moving parts have freedom of movement. If new oversize pistons are assembled to an old cylinder block, machine the bores true and round. New pistons, 0.010-inch oversize, must be ground and polished to fit the bores with a tolerance of 0.0008- to 0.0015-inch.

After assembly and installation, the assembly must be adjusted and tested as described previously.

Valve assemblies and control linkage

Safety car stop release valve. Removal, disassembly, and assembly operations of the safety car stop release valve are described below. If a drip pan is used, the valve can be removed without draining the system of fluid. Refer to drawing 274260.

Removal of the safety car stop release valve. Proceed as follows:

1. Disconnect all electric wiring.

2. Remove the screws from flanges 274263-1 and 271697-7.

3. Spring the tubing at the number 5 flange connection enough to remove the four valve mounting screws.

4. Remove the valve.

Disassembly of the safety car stop release valve. Proceed as follows:

1. Loosen the switch mounting screws and remove switch 231707.

2. Remove nuts 191000-2; remove handle 274262-1 and link 274262-5.

3. Loosen locknut 220718-7; insert pin in hole in valve 274262-10.

4. Remove clevis 274262-6 from valve 274262-10.

5. Remove the cover screws; remove cover.

6. Remove valve 274262-10 from body 274261-1.

7. Remove the cover screws from the opposite end; remove the cover, washer, and spring 274263-2.

Assembly of the safety car stop release valve. Proceed as follows:

1. Wash all parts with solvent Navy Specification P-S-661.

2. Assemble the parts in reverse order of disassembly. Slip the oil seal leader 274349-2 over the threaded end of the valve 274262-10 to prevent damage when assembling oil seal 274338-3. Verify that all moving parts have freedom of movement.

3. Verify that the valve returns to STOP when lever 274262-1 is released.

Grind and polish new valves (which are 0.010-inch oversize) to fit the body with a tolerance of 0.0004- to 0.0008-inch; stone the sharp edges.

Latch and vent valve. Removal, disassembly, and assembly of the latch and vent valve are described below. If a drip pan is used, the valve can be removed without draining the system of fluid. Refer to drawing 274263.

Removal of the latch and vent valve. Proceed as follows:

1. Remove 190958-3 and 206829-3 from flanges 271697-7 and 274263-1.

2. Spring the tubing at number 6 and 7 flanges to permit removal of the four valve mounting screws.

3. Disconnect the valve linkage.

4. Remove the valve.

Disassembly of the latch and vent valve. Proceed as follows:

1. Remove the four cover screws from the stem end cover of the valve assembly; remove cover 325008-2.

2. Remove valve 274263-4 and bushing 274266-1 from valve body 274264-1.

3. Remove the four screws from the opposite end cover; remove cover 325008-3.

4. Remove washer 196733-1, spring 274265-1, and valve plunger 274265-2.

Assembly of the latch and vent valve. Proceed as follows:

1. Wash all parts in solvent Navy Specification P-S-661.

2. Assemble the parts in reverse order of disassembly. Slip the oil seal leader 274349-2 over the threaded end of the valve 274263-4 to prevent damage when assembling oil seal 274338-3. Verify that all moving parts have freedom of movement.

3. Adjust the latch to hold just clear of its notch when the control selector lever is placed in SERVO ELECTRICAL.

Grind and polish new valves to fit the body with a tolerance of 0.0004- to 0.0008-inch; stone the sharp edges.

Safety car stop device cylinder and lever assembly. Removal, disassembly, and assembly of the safety car stop device cylinder and lever are described below. If a drip pan is used, the assembly can be removed without draining the system of fluid. Refer to drawing 274258.

Removal of the safety car stop device cylinder and lever assembly. Proceed as follows:

1. Remove cover screws 206590-7 from the flange end of the assembly.

2. Remove cover 274259-4 carefully; spring 274260-3 will force piston rod 274259-9 out of the body with a force of approximately 65 pounds.

3. Remove the four cover screws 196825-11 from the opposite end of the assembly; remove cover 274259-10.

4. Remove Garlock packing 274260-2 and retainer 274260-4.

5. Further disassembly is apparent from the reference drawings.

Assembly of the safety car stop device cylinder and lever assembly. Proceed as follows:

1. Wash all parts in solvent Navy Specification P-S-661.

2. Assemble the parts in reverse order of disassembly. Slip the oil seal leader 274349-4 over the end of the piston rod 274259-9, to prevent damage when assembling oil seal 274338-2.

When assembling new Garlock packings 274260-2, fit to hold the piston rod in the oil seal and packing to a maximum pull of 20 pounds on the piston rod. Verify this by holding the valve assembly by the end of the piston rod, which should slide in its packing and oil seal by the weight of the body and its attached parts.

Control linkage assembly. Removal, disassembly, and assembly of the control linkage assembly are described below. Refer to drawing 325003.

Removal of the control linkage assembly. Proceed as follows:

1. Disconnect the control rod from lever 325006-2.

2. Remove screw 274252.

3. Disconnect link 274253-4 to the B-end control rod which passes through the gun girder cap.

4. Remove screw 274252-6 from clevis 274253-6.

5. Remove the four bracket mounting screws.

6. Force the bracket assembly off its dowel pins.

7. Remove from the turret to disassemble.

Disassembly of the control linkage assembly. Proceed as follows:

1. Remove screws 274252-5 and the control rod.

2. Dissassemble link 274253-4.

3. Loosen clamp bolt 220718-2 from inner lever 325005-1; slide the lever along shaft 325006-3.

4. Remove the clamp bolt from one of the end levers; remove the lever and its keys.

5. Force shaft 325005-3, with other lever attached, out of the inner lever and bracket 325005-2. Further disassembly is apparent.

Assembly of the control linkage assembly. Proceed as follows:

1. Wash all parts with solvent Navy Specifications P-S-661.

2. Assemble the parts in reverse order of disassembly. Verify that all moving parts have freedom of movement. Instructions for adjustment are on page 11-29.

Dashpot cylinder assembly. Disassembly and assembly of the dashpot cylinder assembly are described below. Refer to drawing 325009.

Disassembly of the dashpot cylinder assembly. Proceed as follows:

1. Remove filler cap 274266-7 and drain the assembly by turning upside down. Loosen screws 196780-4 and cover 274267-7 to aid in draining.

2. Remove locknut 274399-9 and clevis 274266-5.

3. Insert a pin through the hole in piston rod 274266-13 to prevent the rod from turning.

4. Remove cover 274267-7; push piston rod 274266-13 out of the body 274268-1.

5. Remove screw 180226-6 from the upper cover 325009-1. Remove the cover, washer 274267-5, and packing 274266-10.

6. Remove feed control valves 274267-1 and spring 274267-9.

7. Remove small pipe plugs 196826-9 from ends of body 274268-1; remove ball checks 196701-9, springs 274266-4, and spring retainers 229060-9.

8. Remove acorn nuts 206482-11 and loosen locknuts 274267-10; remove needle valves 274266-11.

Assembly of the dashpot cylinder assembly. Proceed as follows:

1. Wash all parts with solvent Navy Specification P-S-661.

2. Assemble the parts in reverse order of disassembly. Slip the oil seal leader 274349-3 over the threaded end of the piston rod 274266-13 to prevent damage when assembling oil seal 274338-4 and packing 274266-10. Fill the assembly and adjust according to instructions on page 11-36.

Piping disassembly and installation

Refer to the installation and maintenance instructions in chapter 17 for disassembly and installation of hydraulic system pipes.

METHOD OF CHANGING POWER EQUIPMENT FROM RIGHT HAND TO LEFT HAND

General

The steps required to convert a right-hand power drive to a left-hand power drive are described below. Components of the A-end, B-end, control linkage, and safety car stop device must be converted. All other units are assembled identically for right and left installations. Conversion from left hand to right hand is the same as described below except the components above are to be mounted in right hand locations and right hand levers are to be used.

B-end changeover

When the B-end is changed from right hand to left hand, the following changes are made:

The foot valve assembly and its control linkage are assembled on the opposite side of the motor base and B end head-valve plate.

The brake cylinder and brake band are reversed and assembled to the opposite side.

The ratchet dogs and springs are assembled for opposite rotation.

The acceleration and deceleration cams in the B-end are reversed.

Check valve 206639-5 and pipe plug 200075-16 are assembled in the opposite side of the B-end head-valve plate.

Refer to drawing 325001, proceed as follows:

1. Remove the foot valve assembly and its control linkage as described on page 11-44.

2. Remove the cam housing assembly as described on page 11-43.

3. Remove the hoisting drum as described on page 11-43.

4. Remove the brake band and brake cylinder assemblies as described on page 11-42.

5. Remove screws 220806-7 from brake lever bracket 325048-1; drive out dowels 274329-9.

6. Remove the brake lever bracket.

7. Reassemble brake lever bracket 325048-1 on the opposite side of the mounting face.

8. Remove flange 271697-7 from the brake cylinder assembly; remove pipe plug 196826-10 in the flange mounting of the body.

9. Reassemble the pipe plug in the opposite flange mounting.

10. Mount the brake cylinder (after it is altered for left-hand mounting) on the mounting base in the left hand position.

11. Disassemble the three ratchet dogs 325048-2 assembled to brake drum 274320-1 by removing slotted nuts 274339-7 and pins 274322-2.

12. Reverse the ratchet dogs and reassemble with springs 325052-5 hooked over the opposite pins. Remove the brake drum from the drive shaft for convenience in changing the ratchet dogs.

13. Reassemble the brake band 274307 and the brake lever 274321-1 in the left-hand mounting position. Reassemble the brake band stop pins in their respective positions.

14. Assemble the hoisting drum as described on page 11-35.

15. Slide the cam housing over the drive shaft after assembling spacer 274334-13 into bearing 274337-11 and into oil seal 274338-8. Verify that gasket 274329-4 is in place on the drive shaft.

16. Secure the cam housing to the base with the dowels and screws provided.

17. Reassemble spacer 274335-6, gear 274328-6, keys 200148-6, and the bearing, locknuts, and washers to the cam housing.

18. Reassemble the brake cylinder piston to the brake operating lever and the brake band end to the block. Adjustment instructions are on page 11-35.

19. Reposition the acceleration and deceleration cams, before assembling cam support 274322-1, for left-hand rotation.

20. Remove screws 180226-6 and 220718-2 from clamping rings 274323-4 and 274323-2.

21. Remove the cams from the grooves, turn over 180 degrees, and reassemble in the same grooves.

22. Secure in place with the screws and clamping rings; do not tighten the screws until all cam adjustments are made.

23. Reassemble to the drive shaft; secure with washer and bearing locknut. Designation LH will appear on the outside of the cams if they are correctly assembled for left-hand installation.

24. Adjust the cams as described on page 11-32. Replace inspection cover 325050-1 and fill the case with oil.

25. Change the foot valve to a left-hand assembly before reassembling it to its left-hand location on the B-end head-valve plate.

26. Remove the large pipe plug 274334-16 from the bottom of the valve body 274332-1; reassemble it in the opposite side.

27. Remove the two covers 274330-9 from the top and bottom of valve body 274332-1.

28. Remove ball seal 274330-2, spring 274330-6, plunger 274331-9, spring guide 274330-11, sleeve 274334-5, and ball 274341-15.

29. Reassemble these parts in the body on the opposite side. When the foot valve is assembled to the B-end head-valve plate, ball seat 274330-2 should be at the top of valve body 274332-1.

30. Mount the foot valve assembly on the opposite flange of the head-valve plate; secure with four mounting screws 274340-10. Verify installation of neoprene seal 274297-2 between the foot valve and head-valve plate.

31. Reassemble the foot valve control linkage to left hand position. Disconnect link 274335-3 from lever 325051-3.

32. Remove lever 274335-9 by removing the pin and nut.

33. Remove the key in shaft 325047-4. Do not damage the bronze bushing with the key when lever 274335-9 is removed.

34. Slip the bracket off the end of the shaft; reassemble in the opposite way. Refer to drawing 325002. Verify that all moving parts have freedom of movement.

35. Connect the control linkage to the foot valve clevis 274335-2 and to the B-end control lever 325052-1. Adjust the linkage as described on page 11-36.

36. Change check valve 206639-5 (in the B-end head-valve plate) for left-hand installation. Remove the two 0.75-inch pipe plugs 196826-11, located below the relief valve cap nuts.

37. Remove spacer 274312-5, spring 206639-1, and check valve 206639-5. Reassemble these parts in the opposite side; replace the two 0.75-inch pipe plugs.

38. Remove the 0.50-inch pipe plug 196826-10 from the end of the B-end head-valve plate. One hole is plugged with a 0.375-inch pipe plug 200075-16. Remove it and replace it in the other 0.375-inch tapped hole.

39. Replace both 0.50-inch pipe plugs.

A-end changeover

For A-end changeover from right-hand assembly to left-hand assembly, refer to drawing 325000.

The right-hand assembly is identical to the left-hand assembly except for the three levers mounted on the valve block assembly.

1. Remove the clamp bolts of all three levers; remove the levers.

2. Replace with the levers shown in drawing 325000.

Control linkage changeover

For control linkage changeover from right-hand to left-hand, refer to drawings 325003 and 325007.

The control linkage is identical for right- and left-hand installations except for the control rods and lever which connect it to the A-end.

1. Remove clamp bolt 220718-2; remove lever 325005-4 on the right-hand assembly; remove control rod 325004-3.

2. Put lever 325007-1 on control rod 325007-3. This is the left-hand control rod assembly.

Safety car stop device cylinder changeover

For safety car stop device cylinder changeover from right-hand to left-hand, refer to drawing 274258.

Identical assemblies are used for right-hand and left-hand installations, except for pipe flange 274259-2.

1. Remove flange 274259-2.

2. Remove pipe plug 196826-9 from the side of the cylinder to which the flange is to be mounted.

3. Put the pipe plug in the opposite side.

4. Mount flange 274259 for left-hand assembly.

Chapter 12

FIRE CONTROL

The general arrangement of turret fire control equipment, shown in figure 12-1, is the same in all turrets, with the exception of turret I, from which the rangefinder has been removed, together with the projecting hoods.

Each installation governs turret operation under three basic methods of control: primary, secondary, and local. Each method of control does not employ all of the equipment.

For a detailed description of the main battery fire control system, see OP 856.

Ship fire control system

The ship fire control system enables turret operation in each of the three basic methods of control, as described below.

Primary control. Primary control is turret control by a main battery director in combination with main battery plotting room equipment. It has two types of operation: "Automatic" and "Indicating." In "Automatic" control the turret and its guns are automatically positioned by the receiver-regulators through signals received from plot. In "Indicating" control the turret and its guns are positioned by the turret crew in the follow-the-pointer operation. The firing station in both types of control is normally the stable vertical in either plotting room.

Secondary control. In secondary control a turret acts as a controlling director, in combination with main battery plotting room equipment, to control either or both of the other turrets and their guns. This is an auxiliary method of director control, and has two types of operation: "Automatic" and "Indicating," which are identical to the similar types of primary control.

Local control. Local control is independent turret control deriving target bearing and range locally by visual estimate. It is control in which the sight control stations, rangefinder, and auxiliary computer control the turret and gun positions.

GENERAL DESCRIPTION

Turret fire control circuits

The turret fire control circuits consist of electrical circuits through which fire control orders are transmitted for loading, positioning, and firing the guns, and for turret communications. The circuits are listed below and described in the following paragraphs.

Gun-laying control
Gun-firing control
Interlocks and indicators
Interior communications systems

Gun-laying control. Gun-laying and turret train are controlled through circuits designated GE and GEP.

Circuit GE. Shown in figures 12-2 and 12-4, circuit GE connects electrical elements of the following fire control instruments:

Turret officer's transfer switchboard
Multiple turret train indicator
Auxiliary computer
Sight setter's indicator
Gun elevation order transmitter
Gun elevation indicator
Turret train indicator and transmitter
Rangefinder

The general arrangements and functions of these instruments are described in following paragraphs. They operate together to control gunlaying and turret train by "indication" in primary, secondary, or local control through signals provided by the directors, the other turrets, or the local turret. In addition, range and train angle data may be transmitted to either plotting room and to the other turrets.

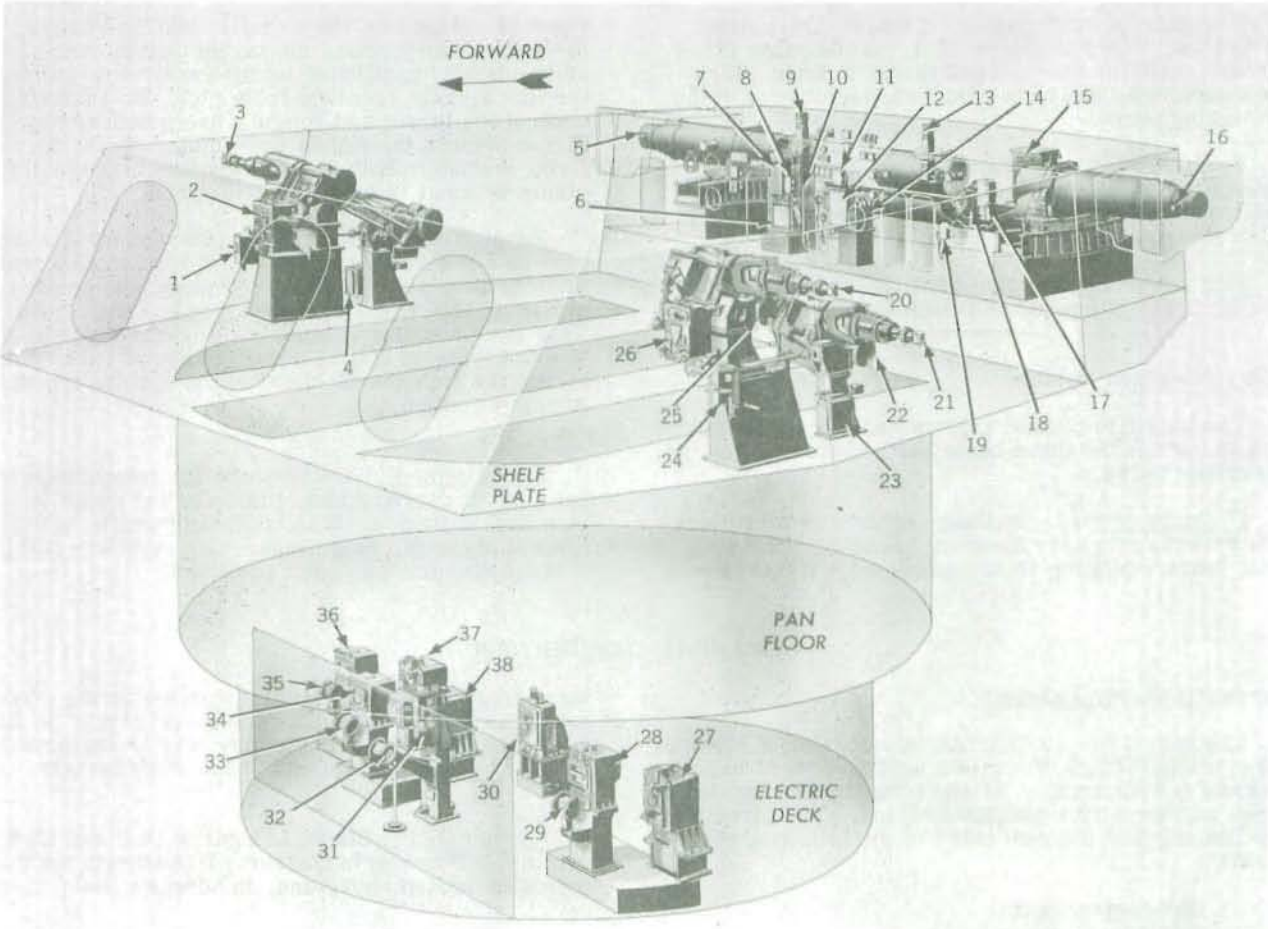
Circuit GEP. Shown in figures 12-3 and 12-5, circuit GEP connects the same fire control instruments identified above and, in addition, the following:

Elevation receiver-regulator
Train receiver-regulator

The general arrangement and function of these instruments are described in chapters 5 and 6. They automatically control gun-laying and turret train in primary, secondary, or local control through signals provided by the directors, the other turrets, or the local turret.

Gun-firing control. The gun-firing control circuits, shown in figure 12-6, are 1PA, 1R, 1VB, and 1U.

Circuit 1PA. Circuit 1PA, the electric gun-firing circuit, extends from the directors and plotting rooms to the turrets. Through circuit 1PA the guns are fired either individually or in salvo from the directors or the plotting rooms, or from one or more stations within the turret. The entire system is a ground-return, series-arranged circuit with three alternative power sources, the forward and after main battery plotting rooms (120-volt, 60-cycle), and an emergency source within the turret (24-volt storage battery).



1. SIGHT ANGLE SYNCHRONIZING CLUTCH AND INTERLOCK
2. RIGHT SIGHT SETTER'S INDICATOR
3. RIGHT SIGHT TRAINER'S TELESCOPE
4. GUN ELEVATION ORDER TRANSMITTER
5. RANGEFINDER SIGHT
6. MULTIPLE TURRET TRAIN INDICATOR
7. TURRET OFFICER'S INDICATOR PANEL
8. TURRET OFFICER'S SELECTIVE SWITCH
9. TURRET OFFICER'S PERISCOPE
10. TURRET OFFICER'S TRANSFER SWITCHBOARD
11. REPRODUCER
12. TRANSMITTER CONTROL BOX
13. TURRET CAPTAIN'S PERISCOPE
14. AUXILIARY COMPUTER
15. RANGEFINDER STABILIZER CONTROL PANEL
16. RANGEFINDER SIGHT
17. TURRET CAPTAIN'S INDICATOR PANEL
18. RANGEFINDER STABILIZER
19. SHIP'S SERVICE TELEPHONE
20. LEFT SIGHT TRAINER'S TELESCOPE
21. LEFT SIGHT POINTER'S TELESCOPE
22. LEFT SIGHT POINTER'S HANDWHEELS
23. GUN ELEVATION ORDER TRANSMITTER
24. SIGHT ANGLE SYNCHRONIZING CLUTCH AND INTERLOCK
25. LEFT SIGHT TRAINER'S HANDWHEELS
26. SIGHT SETTER'S INDICATOR
27. LEFT GUN ELEVATION RECEIVER-REGULATOR
28. LEFT GUN ELEVATION INDICATOR
29. LEFT GUN LAYER'S HANDWHEELS
30. TRAIN RECEIVER-REGULATOR
31. TURRET TRAIN INDICATOR AND TRANSMITTER
32. TRAIN OPERATOR'S HANDWHEELS
33. CENTER GUN LAYER'S HANDWHEELS
34. CENTER GUN ELEVATION INDICATOR
35. RIGHT GUN LAYER'S HANDWHEELS
36. RIGHT GUN ELEVATION INDICATOR
37. RIGHT GUN ELEVATION RECEIVER-REGULATOR
38. CENTER GUN ELEVATION RECEIVER-REGULATOR

Figure 12-1. Turret Fire Control Installation, General Arrangement

Circuit 1R. Circuit 1R, the main battery ready light circuit, includes an arrangement of indicator dials located at turret control stations. It also includes foot-operated switches and manually operated switches, as well as a system of relays, solenoids, and limit switches at various locations. The 1R circuit is interconnected with the turret officer's transfer switchboard and selective switch, and with ready switches at the gun captain's, gun layer's, trainer's, and sight setter's stations. This circuit serves to coordinate loading and gun-laying operations by indicating the readiness of each station with indicator lights. In addition, the 1R circuit includes a safety interlocking arrangement which prevents lowering the cradle and opening the powder unloading door at any but the proper time during the gun-loading sequence. The general arrangement and function of the elements of this circuit are described in detail in chapter 15.

Circuit 1VB. Circuit 1VB, the salvo signal circuit, is an arrangement of appropriately located buzzer-type horns. The circuit is interconnected with local contact makers at the turret officer's station and at the right and left sight pointer's stations. Salvo signals, which indicate to turret personnel when guns are to be fired, originate at remote principal fire control stations or the local stations.

Circuit 1U. Circuit 1U, the cease firing signal circuit, powers a bell mounted in the left rear corner of the turret officer's compartment. The bell is operated to indicate "cease firing" by closing a contact maker at any of the remote principal fire control stations. It cannot be operated by turret personnel.

Interlocks and indicators. The interlock and indicator circuits are designated: CS, CP, RP, QE, Q, QB, and QC.

Circuit CS. Circuit CS, the sight setter's clutch indicator and interlock circuit, supplies power to interlock solenoids and two-dial indicators located at the sight setters' stations. Alternate legs of the circuit are energized by clutch-operated microswitches so that the relative positions of the sight setters' clutches are indicated by dial lights. The clutches are interlocked, so that only one can be engaged at a time, by solenoids energized through the microswitches.

Circuit CP. Circuit CP, the sight pointer's clutch indicator circuit illuminates one-dial indicators located at the sight pointer's stations. The circuit is interconnected with a clutch-actuated switch so that when either sight pointer is clutched in, the indicator is illuminated to warn the other sight pointer not to engage his clutch.

Circuit RP. Circuit RP, the projectile ring ready light circuit, includes three-dial indicators located on the projectile flats at the right operators' stations. Identical circuits on each flat are interconnected with three contact makers, one located at each projectile hoist operator's station. Illumination of the indicators notifies the ring operator when the ring may be rotated. The projectile hoist loading crews may also order ring rotation.

Circuit QE. Circuit QE, the projectile hoist interlock circuit, includes an arrangement of three interlock solenoids, two located at each hoist control handle and one at the function control and shut-off valve handle. An identical circuit for each projectile hoist is interconnected with two neutral start interlock and eight door and shutter interlock switches.

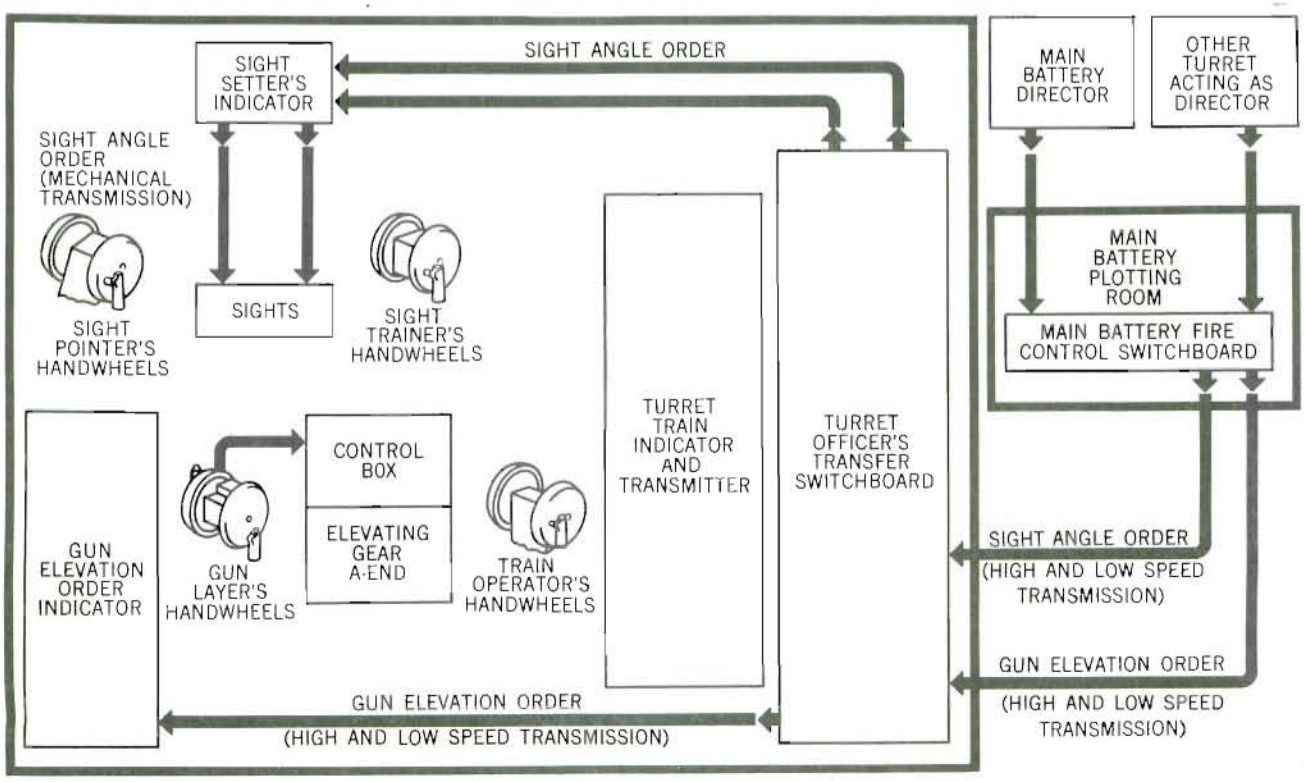


Figure 12-2. Gun Elevation Control - Circuit GE - Functional Diagram

Through circuit QE, movement of the function control and shut-off valve is blocked and the power drive motor cannot be started unless the hoist control handles are both at neutral. The hoist control handles cannot be moved from neutral unless all door and shutter switches are closed.

Circuit Q. Circuit Q, the projectile hoist control handle interlock circuit, is an arrangement of a five-dial indicator, a gong, and two solenoids located at each projectile hoist operator's station. The circuit is interconnected with a gong relay and with switches at the function control and shut-off valve, the projectile indicator lever, and the projectile latch. Circuit Q prevents hoisting or limits control handle movement under certain conditions. In addition, it provides the hoist control operator with visual and audible signals of the hoist cycles.

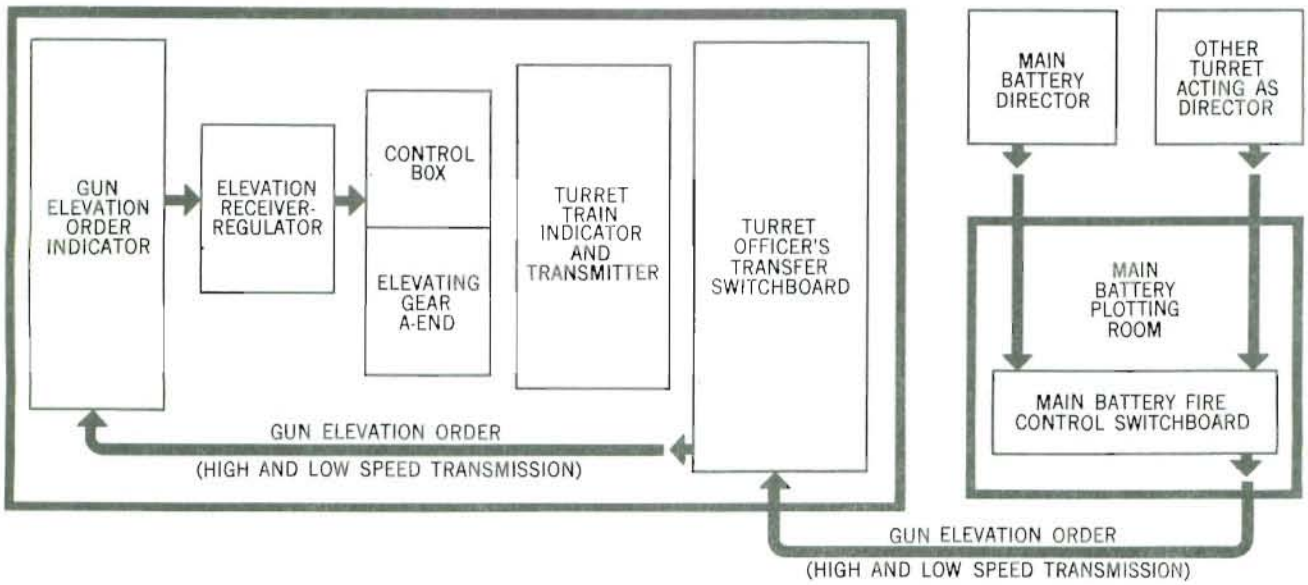


Figure 12-3. Gun Elevation Control - Circuit GEP - Functional Diagram

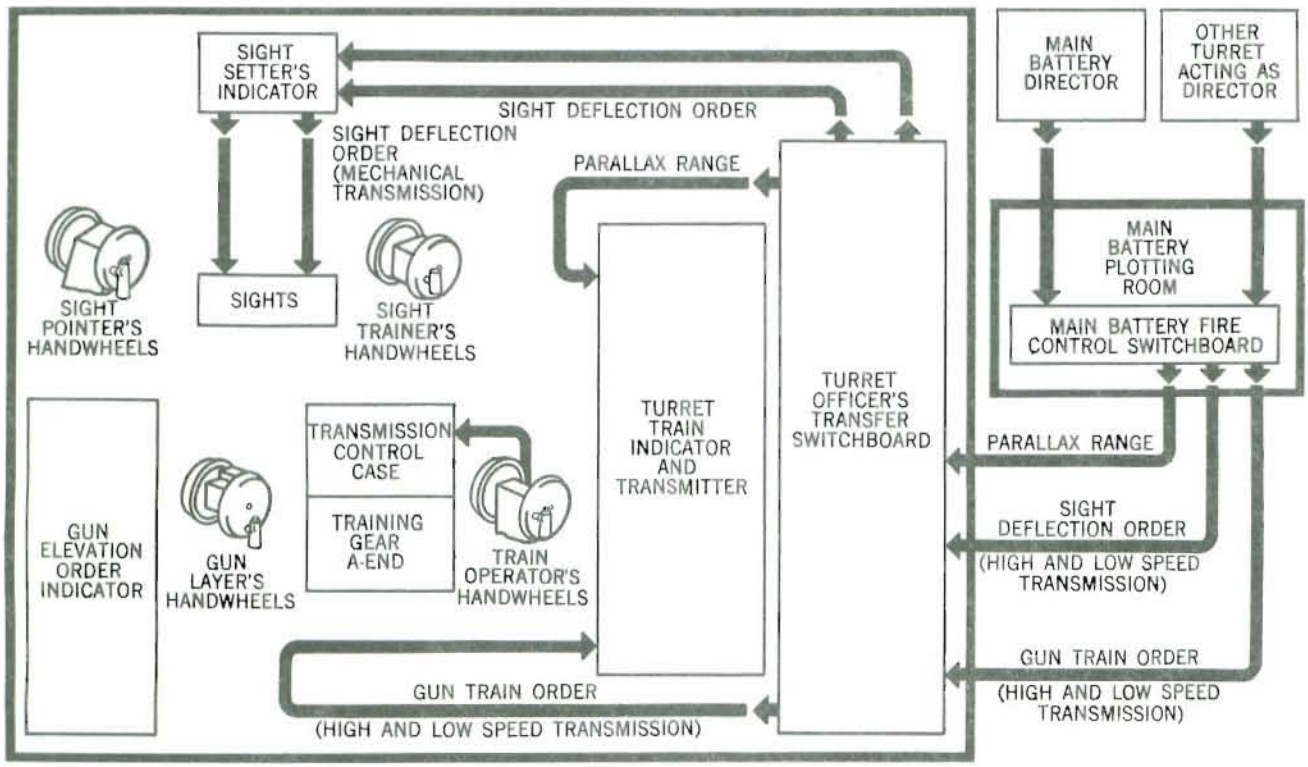


Figure 12-4. Turret Train Control - Circuit GE - Functional Diagram

Circuit QB. Circuit QB, the projectile latch indicator circuit, is an arrangement of a one-dial indicator located at each projectile hoist operator's station and shared with circuit Q. The circuit is interconnected with a switch mounted on the top of the hoist operating cylinder. Circuit QB provides the hoist control operator with a visual signal when the hoist has completed a hoisting stroke.

Circuit QC. Circuit QC, the powder hoist interlock circuit, energizes two solenoids located at the hoist starting lever and the venting valve. The circuit is interconnected with nine switches which energize or de-energize the solenoids to coordinate powder hoist operations. Circuit QC vents the hydraulic drive and sets a brake to hold the powder car at a loading or unloading level. In addition it prevents powder car movement when either door of the hoist trunk is open or undogged.

Interior communications systems. The interior communications systems are the circuits designated DS, RA, TW, MC, JA, XJ, J, and E.

Circuit DS. Circuit DS, the depression and train stop signal circuit, includes an arrangement of a three-dial and three one-dial indicators located at the train operator's and gun-layer's stations respectively. The circuit is interconnected with six switches which are located as described on page 6-19, chapter 6. Circuit DS opens the firing circuit of individual guns, and warns (by indicator lights) when a gun's line of fire approaches the ship's superstructure.

Circuit RA. Circuit RA, the emergency alarm circuit within the turret, energizes nine sirens located as follows: one in the turret officer's compartment, one in each gun room compartment, one on the electric deck, one on each projectile flat, and one each in the powder handling room and the powder passing space. The circuit is interconnected with identical locking type contact makers at each siren and additional contact makers (all normally open) in the powder handling room and powder passing space. An additional non-locking contact maker, in the turret officer's compartment is normally closed. Circuit RA sounds the alarm sirens when any one of the locking contact makers is closed. The circuit can be opened by holding the non-locking contact maker open.

Circuit TW. Circuit TW, the train warning signal circuit, operates a bell mounted under the turret overhang. The circuit is interconnected with a normally open push button located at the turret officer's station. Circuit TW provides an audible warning to personnel outside the turret when it is about to train.

Circuit MC. Circuit MC, the turret announcing circuit, connects 16 reproducers at various locations in the turret. The circuit is interconnected with an amplifier, a transmitter control box, and a turret officer's microphone. Circuit MC allows the turret officer and turret captain to communicate with any or all turret stations. The circuit also provides transmission for general alarm and chemical attack signals.

Circuit JA. Circuit JA, the battle telephone circuit, is an arrangement of five branch circuits each of which connect with the forward and after main battery plotting rooms. These circuits are designated as follows:

Control circuit JD - Turret officer to plotting room and associated director and control station.

Sight setter's circuit JE - Local computer, left and right sight setters, and train operator to associated computer, director, and control station.

Fuze setter's circuit JK - Fuze setter to secondary battery computer fuze follow-up operator.

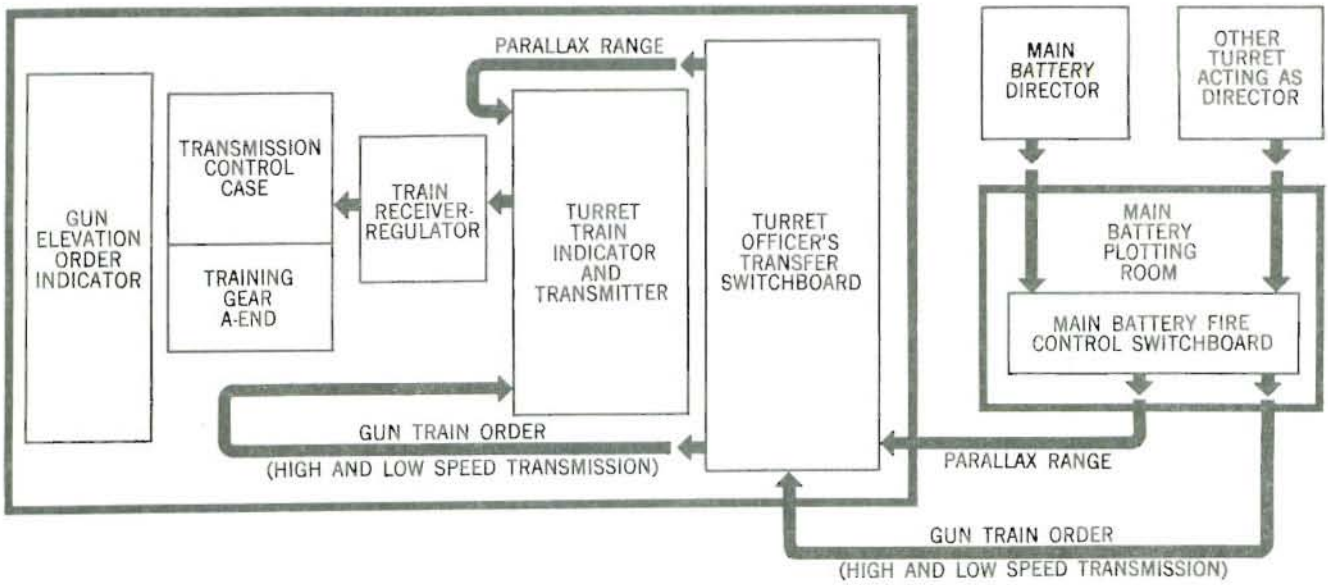


Figure 12-5. Turret Train Control - Circuit GEP - Functional Diagram

Rangefinder operator's circuit JW - Local rangefinder and local computer to graphic plot operator and range receiver operator in associated plotting room and director.

Spotter's circuit JB - Local computer to associated plotting room, control station, director and combat information center (CIC).

The circuit tie switches are in a telephone switch box adjacent to the turret officer's transfer switchboard. In event of casualty to either the forward or after section, the damaged section may be isolated by opening switches designated TIE in the switch box.

Circuit XJ. Circuit XJ, the turret officer's telephone circuit (fig. 12-14), is an arrangement of six supplementary local turret circuits designated as follows: Pointer's circuit X101J, ammunition circuit X102J, subcaliber circuit X103J, right powder hoist circuit X104J, center powder hoist circuit X105J, and left powder hoist circuit X106J.

The above designations are for turret I, the designations for turret II are X201J to X206J inclusive. The designations for turret III are X301J to X306J inclusive.

Circuit XJ provides communication within the turret between stations of the above circuits and the turret officer.

Circuit J. Circuit J, the ship's service telephone circuit, is an arrangement of dial-type telephones installed in the turret officer's compartment and the electric deck. These connect through a central automatic switchboard to any similar dial telephone in the ship.

Circuit E. Circuit E, the sound-powered telephone and call bell circuit is an audible call system which parallels the supplementary local XJ circuits and most voice tubes. It is an arrangement of bells and buzzers at various turret locations which parallel the voice tubes and telephones respectively, except for a call bell for circuit X102J from the electric deck to the turret officer's compartment. The circuit is interconnected with single or multiple push buttons. Circuit E provides an audible signal system to call personnel to circuit XJ telephones or to voice tubes.

Turret fire control station equipment

The turret fire control stations, interconnected by the circuits described previously, are equipped with the units described in following paragraphs.

Turret officer's station. The turret officer's station is at the right side of the turret officer's compartment shown in figures 12-7 and 12-8. His position at the turret transfer switchboard provides ready access to the nearby equipment described below.

Turret officer's periscope and mount. The turret officer's periscope is mounted in the roof plate above the turret officer's station as shown in figure 12-7. Periscope Mk 29 is supported by Periscope Mount Mk 5 Mod 10 and is located in turret I. Periscope Mk 28 is supported by Periscope Mount Mk 5 Mod 11 and is located in turrets II and III. Periscopes Mk 28 and 29 are "quick tilt" periscopes of the prismatic fixed-power (12x) type. Their major apparent difference lies in the length, Periscope Mk 28 being the longer of the two. Other differences are described in detail in OP 1338, the instruction book for these periscopes. The main supporting member of the periscope mount is a base ring secured to the underside of the roof plate. The base ring is provided with an azimuth index, roller bearing supports for the periscope holder, and a fixed internal ring gear which meshes with the train handwheel gearing supported by the periscope holder. The periscope holder, a tubular casting with an integral external rimmed spider, supports the periscope through pressure blocks and an azimuth locking pin. The periscope holder also supports the deflection offset knob and dial, training handwheel assembly and azimuth index. The periscope collar, a tubular steel casting, is mounted on top of the roof plate to provide both a rigid vertical alignment and a watertight seal for the periscope. The only differences between these periscope mounts, and Periscope Mount Mk 5 Mod 9, described in detail in OP 810 for Gun Director Mk 38, lie in the differing heights of the various periscope collars and the mounting spacers for the base ring as required by the different lengths of the periscopes and thicknesses of the roof plates of director and turrets.

Turret transfer switchboard. The turret transfer switchboard (fig. 12-9) is mounted in the turret officer's compartment as shown in figure 12-8. With 16 rectangular panels arranged across its front, the switchboard has 21 rotary disc-type switches mounted in 14 panels. The remaining two panels, horizontally aligned in the lower right corner, serve miscellaneous purposes. The transfer switchboard provides ON - OFF and transfer switching facilities for most of the turret fire control circuits.

Multiple turret train indicator. The multiple turret train indicator (fig. 12-10) is mounted in the turret officer's compartment as shown in figure 12-7. An electrical receiver, the instrument has one-speed and 36-speed synchros operating calibrated dials. One dial indicates modified turret train response, the other (a zero reader) indicates the difference between train order and modified turret train response. The instrument indicates whether the turrets are following gun train orders in addition to indicating modified turret train response (turret train response from which correction for horizontal parallax has been removed). A complete description of these instruments is provided in OP 1309.

Turret officer's selective switch. The turret officer's selective switch (fig. 12-11) is mounted in the turret officer's compartment as shown in figure 12-7. It comprises a pair of rotary switches housed in a watertight case. Controlled by a pointer-type knob, the upper switch has three positions, labeled DIRECTOR - OFF - LOCAL. The lower, operated by a pointer-handle, also has three positions, labeled AC SUPPLY - OFF - BATTERY. Through the selective switch the turret officer selects the character of fire, either director or local, and the source of power, either alternating current supply or battery, to energize the firing circuit. Battery power can be used only for local turret firing (see fig. 15-37).

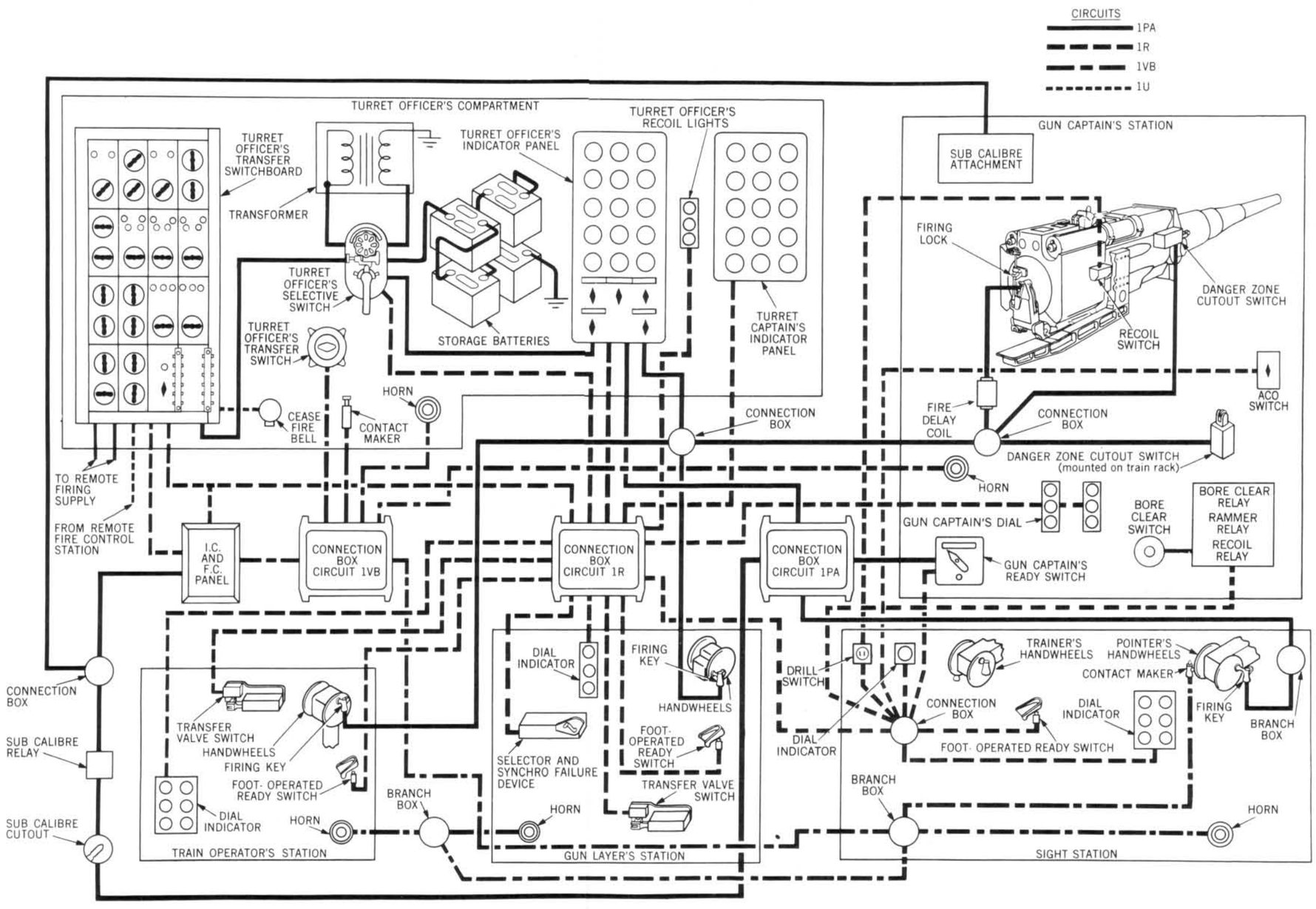


Figure 12-6. Gun Firing Control System Arrangement For Circuits 1PA, 1R, 1VB, and 1U

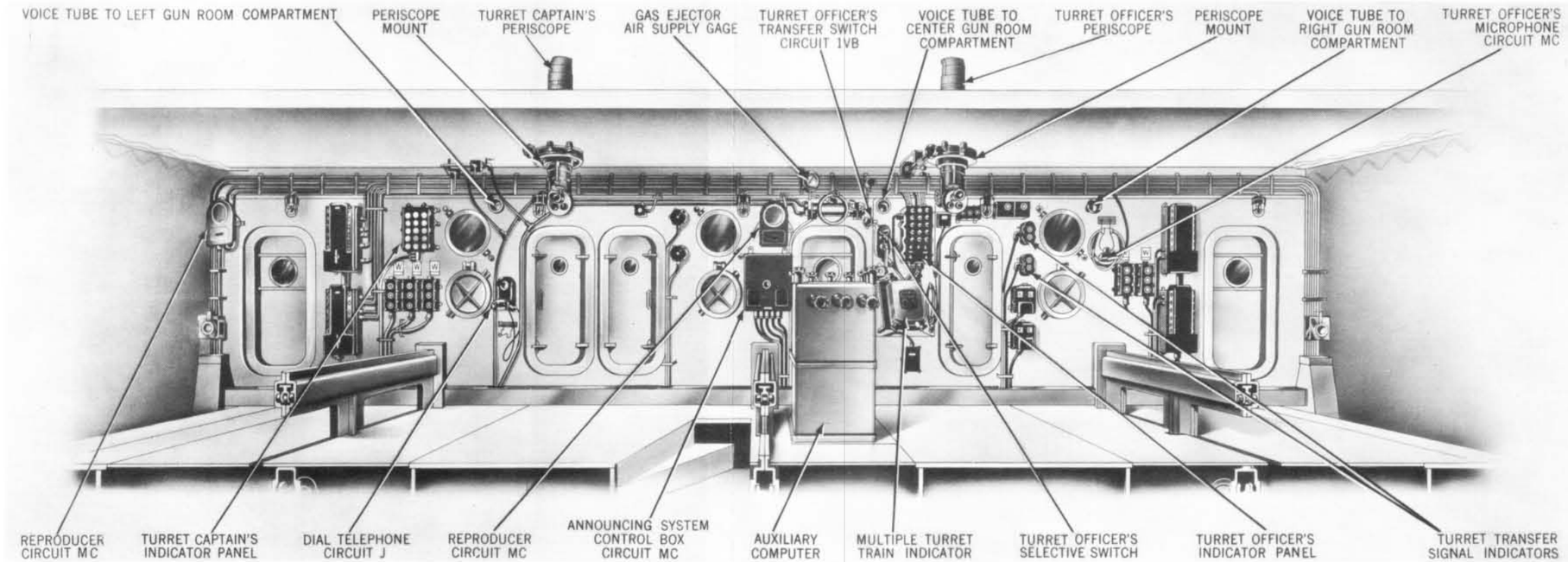


Figure 12-7. Turret Officer's Booth Fire Control Arrangement, Looking Forward

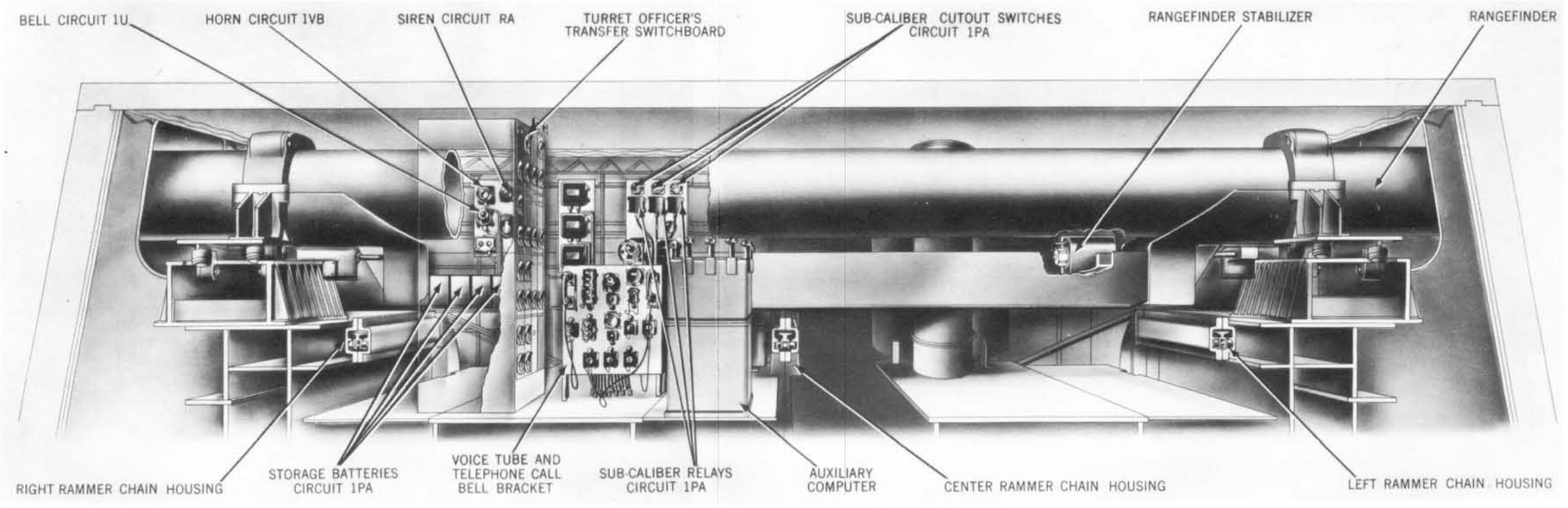


Figure 12-8. Turret Officer's Booth Fire Control Arrangement, Looking Aft

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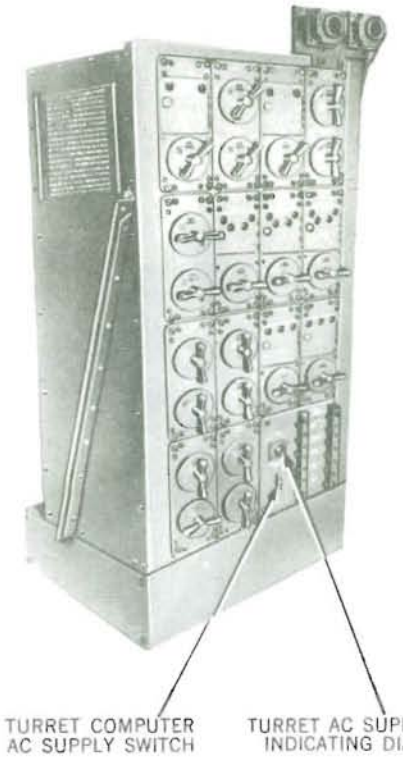

SWITCH NUMBER AND NAME

	1 TRAIN INDICATOR		2 TURRET I MULTIPLE TURRET TRAIN INDICATOR
3 TRAIN TRANSMITTER	4 GUN TRAIN RECEIVER–REGULATOR	5 TURRET COMPUTER TRAIN RECEIVER	6 TURRET II MULTIPLE TURRET TRAIN INDICATOR
7 ELEVATION INDICATOR SELECTOR			
8 ELEVATION RECEIVER–REGULATOR SELECTOR	9 LEFT GUN INDICATOR AND RECEIVER–REGULATOR	10 CENTER GUN INDICATOR AND RECEIVER–REGULATOR	11 RIGHT GUN INDICATOR AND RECEIVER–REGULATOR
12 ELEVATION TRANSMITTER SELECTOR	13 SIGHT ANGLE TRANSFER		
14 ELEVATION TRANSMITTER TRANSFER	15 SIGHT DEFLECTION TRANSFER	16 LEFT SIGHT SETTER'S INDICATOR	17 RIGHT SIGHT SETTER'S INDICATOR
18 RANGE TRANSMITTER	19 PARALLAX RANGE RECEIVER		
20 IC CIRCUIT TRANSFER	21 OWN SHIP'S COURSE AND OWN SHIP'S SPEED		

Figure 12-9. Turret Officer's Transfer Switchboard - Turret II - General Arrangement

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Salvo signal control. When the turret is in local control operation of the salvo signal horns (circuit 1VB) is controlled by the portable contact maker located adjacent to the multiple turret train indicator shown in figure 12-7. The device is a normally-open, button-actuated switch mounted in a cylindrical grip-type handle.

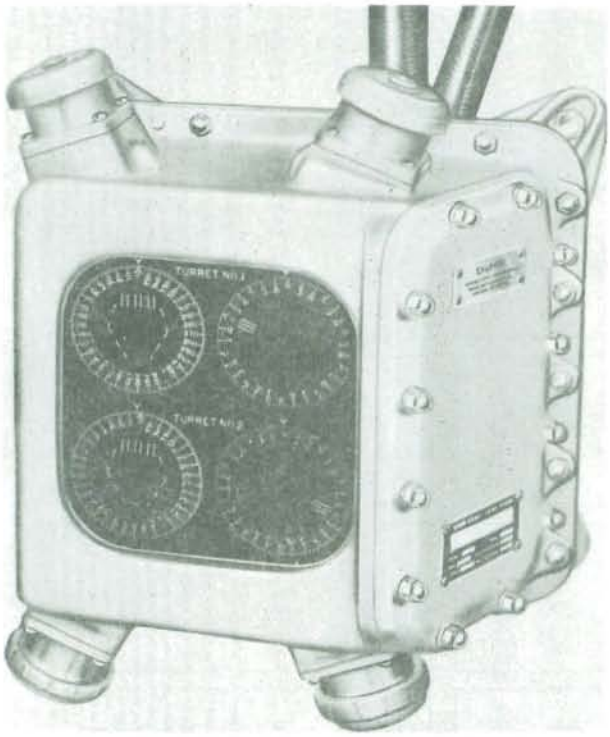

Figure 12-10. Multiple Turret Train Indicator Mk 12 Mod 7

Cease firing contact maker. Cease firing contact makers (circuit 1V) are located at several remote fire control stations outside the turret. They indicate "cease firing" and cannot be operated by turret personnel.

Turret officer's indicator panel. The turret officer's indicator panel (circuit 1R) is mounted in the turret officer's compartment as shown in figure 12-7. Except for the addition of five rotary snap switches arranged in two horizontal rows at the bottom, and three amber recoil lights arranged in a horizontal row at the top, this indicator panel is identical with the turret captain's indicator panel (fig. 12-12) described on page 12-9. In addition to dial light indications, this panel provides the turret officer with individual firing key cutout and cut-in switch facilities.

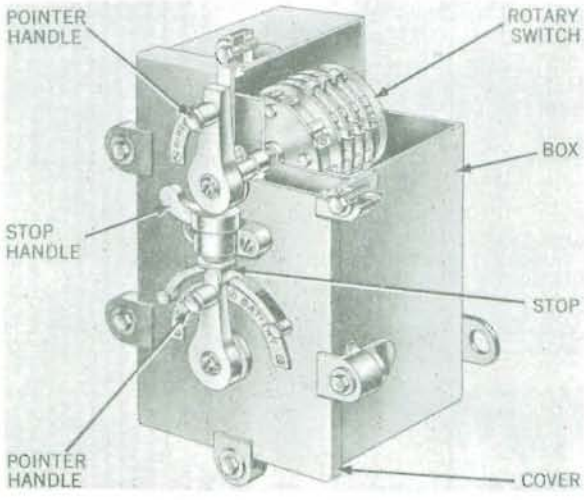

Figure 12-11. Turret Officer's Selective Switch

Figure 12-12. Turret Captain's Indicator Panel

Turret transfer signal indicator. The turret transfer signal indicator (circuit GE) is mounted in the turret officer's compartment as shown in figure 12-7. It is a two-dial indicator with the dials marked F and A for the forward or after plotting room respectively. It indicates the selected position for transfer switches through which control circuits are actuated from either plotting room.

Danger sector indicator. The danger sector indicator (circuit DS) is mounted in the turret officer's compartment as shown in figure 12-7. It is a three-dial indicator with the dials marked STOP LEFT GUN, STOP CENTER GUN, and STOP RIGHT GUN. The dials are illuminated to indicate an obstructed line of fire as the respective elevation and train danger zone switches (described on page 6-19, chapter 6) are closed.

Turret officer's microphone (MC). The turret officer's microphone (circuit MC) is attached by a 20-foot length of cord to the transmitter control box. The breast-plate mounted microphone is supported by a strap and has a press-to-talk button. It is a portable means of communicating over the reproducer circuit.

Transmitter control box (MC). The transmitter control box (circuit MC) is mounted in the turret officer's compartment as shown in figure 12-7. The control box switches control the circuit amplifier. In addition there is a group of key-type switches with which any combination of talk-back reproducers may be tied into the circuit. Cutout switches permit any combination of reproducers to be cut out of the circuit in event of trouble in an individual circuit.

Reproducer (MC). Reproducers (circuit MC) are mounted in the turret officer's compartment as shown in figure 12-7. These are permanent magnet, non-talk-back type.

Telephones (J, XJ, JA). Three turret telephone circuits (circuits J, XJ, and JA described on pages 12-5 and 12-6) are available to the turret officer at his station.

Circuit J comprises the dial-type telephone mounted on the transverse bulkhead as shown in figure 12-7.

Circuit XJ connections and circuit JA connections are at the instrument panel shown in figure 12-8.

Call bell buttons (circuit E). The turret officer's call bell circuit (circuit E described on page has push buttons with which the turret officer may call either sight control station, any of the gun-layers, or the train operator. These buttons are arranged on the instrument panel shown in figure 12-8.

Turret captain's station. The turret captain's station, shown in figure 12-7, is equipped with controls that partially duplicate those of the turret officers station. The turret captain's station is equipped with a periscope indicator panel, emergency alarm contact maker, train warning push button and communications as described in following paragraphs.

Turret captain's periscope and mount. The turret captain's periscope is mounted in the turret roof plate above the turret captain's station as shown in figure 12-7. The turret officer's and turret captain's periscope installations in any one turret are identical.

Turret captain's indicator panel. Mounted in the turret officer's compartment (fig. 12-7), the turret captain's indicator panel is a watertight indicator assembly comprising fifteen dials marked as shown in figure 12-12. Arranged in five horizontal rows of three in each row, the dials are colored as follows: Top row, yellow; second row (from left to right), red, clear, and green; third row, yellow; fourth row, clear; bottom row, clear. The panel dials indicate the loading or firing readiness of the local turret, the firing readiness of all turrets, and the readiness of the plotting room in control.

Emergency alarm contact maker. The emergency alarm contact maker is mounted in the turret captain's compartment as shown in figure 12-7. It is a non-locking type contact maker, normally closed, that can be held open by hand against a spring return. When held open, the alarm sirens are stilled and instructions and order may be transmitted to turret personnel through other communication circuits.

Train warning push button. The train warning push button is located at the turret captain's station. Of watertight design, the push button is normally open and must be held closed to sound the train warning bell.

Communications. Telephone and call bell units at the turret captain's station provide battle telephone communications to turret control and operating stations. This arrangement can be tied in to any other station through a telephone switch box at the turret officer's station. In addition, the dial-type telephone (circuit J) is located at the turret captain's station.

Computer's station. The computer's station, shown in figures 12-7 and 12-8, is equipped with fire control equipment consisting of an auxiliary computer and telephone communication units. This equipment provides the turret with local means for receiving and computing the various fire control data required for generating values of sight angle and sight deflection, and for transmitting these values orally to the sight setters.

Auxiliary Computer Mark 3 Mod 2. The auxiliary computer (fig. 12-13) is mounted in the turret officer's compartment as shown in figure 12-7. Computer Mk 3 Mod 2 is a computing and indicating mechanism used by the computer operator and talker to solve fire control problems. It generates indicated values of sight angle and sight deflection based upon three electrical inputs and 13 manual inputs. Complete information on this instrument is contained in OP 1290.

Communications. Range information is received and sight angle and sight deflection orders are transmitted over the telephone facilities at the computer's station. These comprise battle telephone (circuit JA) and supplementary turret officer's telephone (circuit XJ) tie-in arrangements which connect the computer

talker with the sight pointers and trainers, sightsetters, gun-layers, train operator, range finder, plotting rooms, and directors.

Gun captain's station equipment. The gun captain's station, shown in figure 12-15, has fire control equipment consisting of two 3-dial indicators, synchro power on indicator, elevating motor STOP button, projectile hoist pushbutton, bore clear switch pushbutton, action cutout switch for 1R circuit, drill switch, turret alarm contact maker, and communications. Each gun captain's station is similarly equipped.

Gun captain's ready switch. Mounted on the post at each gun captain's station is a gun captain's ready switch (circuit 1R). This switch is a two-position, spring return lever-operated, rotary-type unit, and has an integral unlocking solenoid which prevents the lever from being shifted to the opposite position until this solenoid is energized. One position of the lever is SAFE (meaning "safe to load"), and the other position is READY (meaning "ready to fire"). This lever is spring-returned to the SAFE position when the unlocking solenoid is energized. A manual PULL TO RELEASE button is also located on the switch. This release button can be pulled out to release the lever if the unlocking solenoid should fail to function. When positioned at SAFE, the switch illuminates dials marked LOAD at the gun captain's and gun layer's indicators; in addition, with this switch at SAFE, a device at the elevation receiver-regulator causes the gun to move to its loading position (in automatic control). When positioned at READY the switch illuminates red dials at the gun captain's and gun layer's indicators; in addition, with the switch at READY, a device at the elevation receiver-regulator causes the gun to match the gun elevation order signal (in automatic control). The gun captain's ready switch also functions in a safety interlocking electrical circuit to prevent lowering the cradle and opening the powder unloading door until the switch lever is positioned to SAFE and other operations have taken place during the loading sequence. See chapter 15 for details.

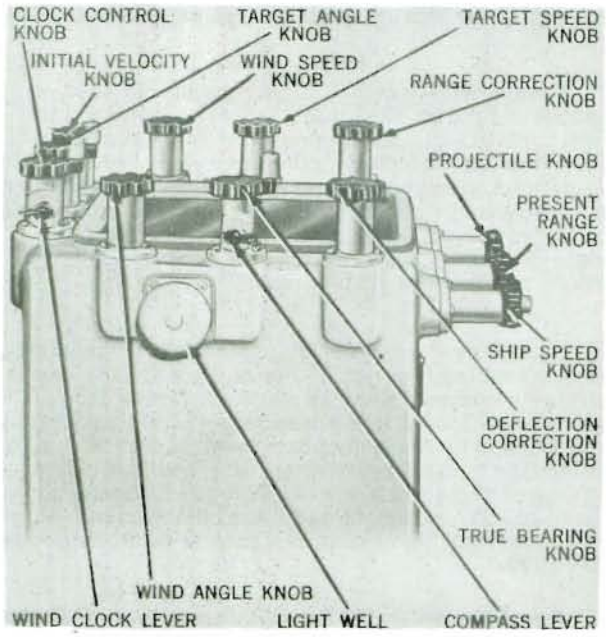

Figure 12-13. Auxiliary Computer - General Arrangement

Gun elevation ready, gun ready, and load indicators. Located at each gun captain's station, these three-dial indicator lights indicate, from top to bottom, respectively: gun captain ready, gun elevation ready, and load. The indicators for the left gun captain's station are marked, from top to bottom, L, L, and LOAD. Similarly, indicators for the center gun captain's station are marked C, C, and LOAD; and for the right gun captain's station, R, R, and LOAD. The lower (LOAD) dial is illuminated (with the gun captain's ready switch at SAFE, through interlocking relays) during the loading cycle, and goes OFF when the gun is ready to fire. It remains OFF during firing and recoil, until the gun is back in battery; then it goes on again. In other words, the LOAD light indicates to the gun captain that this portion of his ready light circuit is in operation and that the gun is to be moved to, or is at, the loading angle.

The upper (red) light is illuminated when the gun captain's ready switch is positioned to READY. These lights indicate to the gun captain that his signal circuit is functioning. The middle (blue) dial is illuminated by the gun layer, through his foot-operated ready switch (described on page 12-13). This indicates to the gun captain that the gun elevation is matched with the gun order.

Breech closed, recoil, and bore clear indicators. A second three-dial indicator is located at each gun captain's station, mounted directly above the gun elevation ready, gun ready, and load indicator lights. These dials are illuminated when the actions they identify occur during the loading and firing cycle.

Action cutout switch. Located at each gun captain's station, mounted on the post and below the gun captain's ready switch, is the action cutout switch. This is a snap switch with on-off-on-off action, and serves to turn off the power supply to the indicator lights, switches, and control relays of the ready light circuit. Before the gun can go through the loading sequence, this switch must be in an ON position.

Drill switch. Located at each gun captain's station, mounted on the post and below the action cutout switch, is the drill switch. This is a single receptacle which requires the insertion of a plug to close the circuit. This switch is only used during gun drill and serves to by-pass the recoil switch (ch. 15) so that, without firing the gun, the sequences of the loading and firing operations can be rehearsed while the gun is in battery. It permits the normal functioning of the safety interlocking arrangement in the ready light circuit (1R) without the need for having the gun go through recoil.

Bore clear switch. Located forward and to one side of each gun captain's station, on the longitudinal

bulkhead, is the bore clear switch (fig. 15-25A). This switch is a momentary contact unit with a spring-loaded pushbutton. The main body of the switch is mounted on the opposite side of the bulkhead, and only the mushroom head of the pushbutton extends through to the gun captain's station. With the gun captain's ready switch at SAFE, momentarily depressing the bore clear switch pushbutton (done after ascertaining the condition of the bore) will illuminate the bore clear indicator light and will initiate the relay circuit which releases the cradle for lowering.

Synchro power on indicator. A one-dial indicator marked SYNCHRO POWER ON is located at the gun captain's station. When illuminated, it indicates that synchro power is available for the related elevation receiver-regulator.

Elevating motor STOP button. The elevating motor STOP button is mounted adjacent to the gun ready switch. It is a normally closed, single pushbutton switch which, when pressed to open, stops the elevating motor and brings the gun to a quick stop.

Projectile hoist pushbutton. The projectile hoist pushbutton is mounted on the transverse bulkhead at the gun captain's station. It is a lever-operated switch with two pushbuttons labeled START EMERG and STOP. The projectile hoist motor is started or stopped from the gun captain's station by this switch.

Turret alarm contact maker. The turret alarm contact maker is mounted on the transerve bulkhead adjacent to the projectile hoist pushbutton. It is a normally open, double contact, lever-operated, locking type. When closed, the contact maker sounds all the sirens in the turret emergency alarm circuit (circuit RA).

Communications. The gun captain's communication facilities include a talk-back type reproducer (circuit MC), turret officer's telephone (circuit XJ), and call bell (circuit E) circuits. The circuit arrangements enable the gun captain to communicate with the turret officer, or with the powder hoist and projectile hoist control stations.

Right and left sight stations. The right and left sight stations have similar fire control equipment which includes a sight setter's indicator, gun elevation and train ready indicator, train ready indicator, foot operated ready switch, firing key, sight setter's clutch indicator, pointer's clutch indicator, gun elevation order transmitter, and communications.

Sight setter's indicator. Mounted on the forward side of the sight trainer's handwheel pedestal, the sight setter's indicator (fig. 12-16) is enclosed in a square case. It has two hand cranks, three dials, and two output shafts. Sight angle and sight deflection received electrically by the indicator synchros from the plotting rooms operate the indicator dials. These are "follow-the-pointer" dials with calibrated ring dials (hand crank operated) which are matched with the calibrated inner dials (synchro operated). Hand crank rotation is transmitted to the trainer's and pointer's sights through output shafts to correct the sights for deflection and angle respectively. This instrument is described in detail in OP 880.

Gun elevation and train ready indicator. Located at the sight pointer's station, this is a four-dial indicator with the dials marked L, C, and R (for respective left, center, and right guns), and TRAIN READY. When illuminated the dials indicate to the sight pointer that the gun and turret positions are matched with gun and train order signals.

Train ready indicator. Located at the sight trainer's station, this is a one-dial indicator (circuit 1R) marked TRAIN READY. When illuminated (by closing the foot-operated ready switch) it indicates to the sight trainer that his signal circuit is functioning.

Foot-operated ready switch. Located at the sight trainer's station, this is a normally open, bridge-type switch (circuit 1R). When closed by foot pressure it illuminates TRAIN READY dials at the turret officer's, turret captain's, train operator's, and the sight station indicators.

Firing key. Firing Key Mk 16 Mod 8 is mounted on the sight pointer's handwheels. It is a pistol grip design with spring-loaded trigger-type contact maker. The design includes a latch to hold the trigger closed for director fire. Connected in

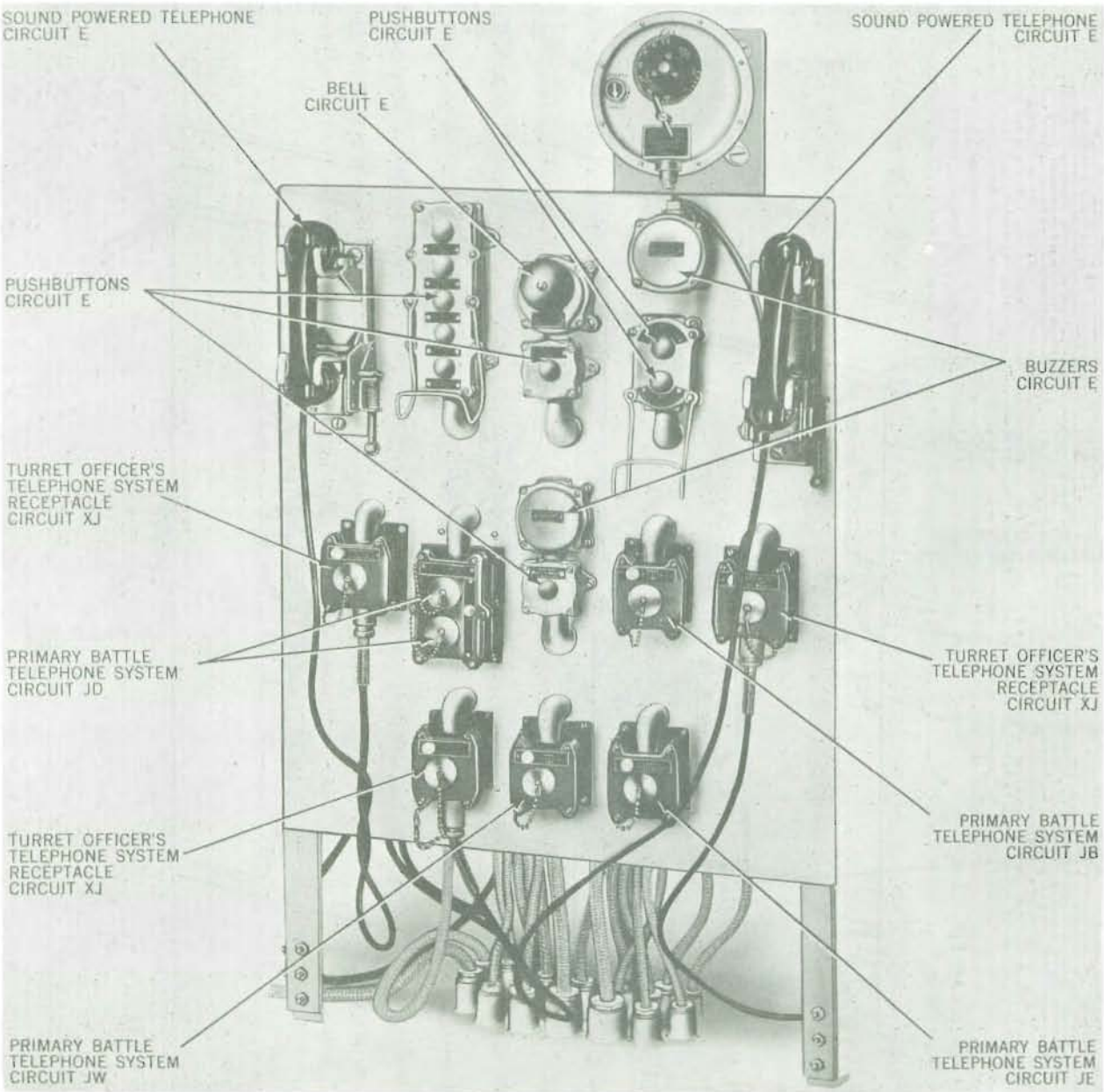

Figure 12-14. Voice and Telephone Call Bell Bracket

circuit 1PA, the firing keys can be individually closed to fire the guns (through switches on the turret officer's indicator panel) when in local control (as described on page 12-8.

Sight setter's clutch indicator. The sight setter's clutch indicator (circuit CS), is a two-dial type with red and green dials. Depending on which dial is illuminated, the relative positions of both sight setter's clutches are indicated. Red indicates that the opposite sight setter's clutch is engaged. Green indicates that neither clutch is engaged.

Pointer's clutch indicator. The pointer's clutch indicator (circuit CP) is a one-dial type with a red dial labeled CLUTCH WARNING LIGHT. Illuminated by either sight pointer as he engages his clutch, it warns the opposite sight pointer to remain disengaged.

Gun Elevation Order Transmitter Mk 2 Mods 0 and 1. Mounted on the sight pointer's handwheel pedestal, the case-enclosed transmitter (figs. 17 and 19) is designated Transmitter Mk 2 Mod 0 at the right station, and Transmitter Mk 2 Mod 1 at the left. It is an electrical transmitter with 2-speed and 36-speed synchros operating calibrated transmitter dials for adjustment purposes. With the pointer's sight acting as a local director, the instrument transmits gun elevation orders to related synchros in the elevation indicator. This instrument is described in detail in OP 1308.

Communications. Sight station communication facilities include battle telephone (circuit JE), turret officer's telephone (circuit XJ), and call bell (circuit E) circuits. These arrangements enable the turret officer to communicate with the sight stations and also connect the sight stations with the main battery directors.

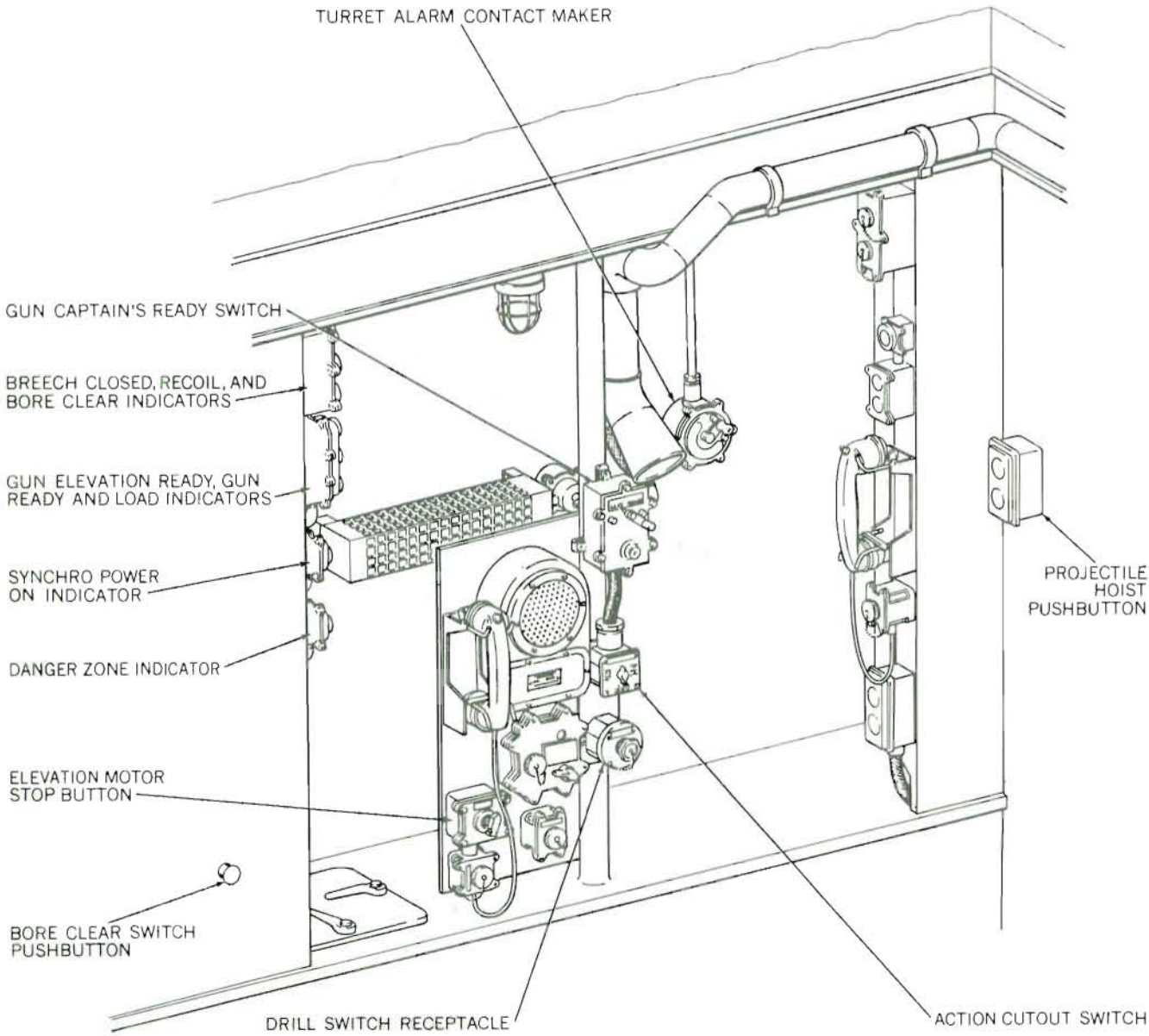

Figure 12-15. Gun Captain's Station - General Arrangement.

Gun-layers' stations. The gun-layers' stations (fig. 12-18) have similar fire control equipment which includes a gun elevation indicator, synchro power-on indicator, firing key, gun elevation ready and gun ready indicator, foot-operated ready switch, and communications.

Gun Elevation Indicator Mk 33 Mods 3 and 4. Mounted on the gun-layer's handwheel pedestal, the case-enclosed indicator (fig. 12-18) is designated Indicator Mk 33 Mod 3 at the right and center stations, and Indicator Mk 33 Mod 4 at the left station. There are six dials arranged in three horizontal rows on the indicator face. In the top row there are 2-speed and 36-speed synchro operated dials which are the zero reader and follow-the-pointer dials respectively. These provide gun elevation orders which are matched by the gun-layer in "indicating" control. In the middle row there are also zero reader and follow-the-pointer dials. These are mechanically operated at 2- and 36-speeds through shafting from the sight pointer's handwheels. They provide gun elevation orders which are matched by the gun-layer in "local" control. In the bottom row there are velocity loss and angle reader dials. The velocity loss dial mechanically indicates correction for difference in equivalent service rounds fired. This correction is based on the quantities "sight angle" and "difference in velocity loss" and is set manually through knobs. The angle reader dial is mechanically operated through shafting from the sight setters' indicators. This instrument is completely described in OP 854.

Synchro power-on indicator. Located at the gun-layer's station, this indicator is a one-dial type marked SYNCHRO POWER ON. When illuminated it indicates that synchro power is available for the related elevation receiver-regulator.

Firing key. Mounted on each of the gun-layer's handwheels, this key is identical in designation, arrangement, and function to the sight pointer's firing key described on page 12-11.

Gun elevation ready and gun ready indicator. Located at each gun-layer's station, this indicator is a three-dial type with the two upper dials marked L, C, or R (for respective left, center, or right stations) and the lower dial marked LOAD. The lower dial is illuminated when the gun captain's ready switch is positioned to SAFE and the middle dial is illuminated when the switch is positioned to READY: These lights indicate to the gun-layer when the gun is being loaded and when the gun position may be matched with the gun order signal. The upper dial is illuminated by the gun-layer through his foot-operated ready switch. This indicates to the gun-layer that his signal circuit is functioning.

Foot-operated ready switch. Located at each gun-layer's station, this switch is a normally open, bridge-type (circuit 1R). When closed by foot pressure it illuminates dials marked L, C, or R (for respective left, center, or right stations) at the turret officers, turret captain's, trainer's, gun captain's, and the sight station's indicators to indicate that the gun is ready.

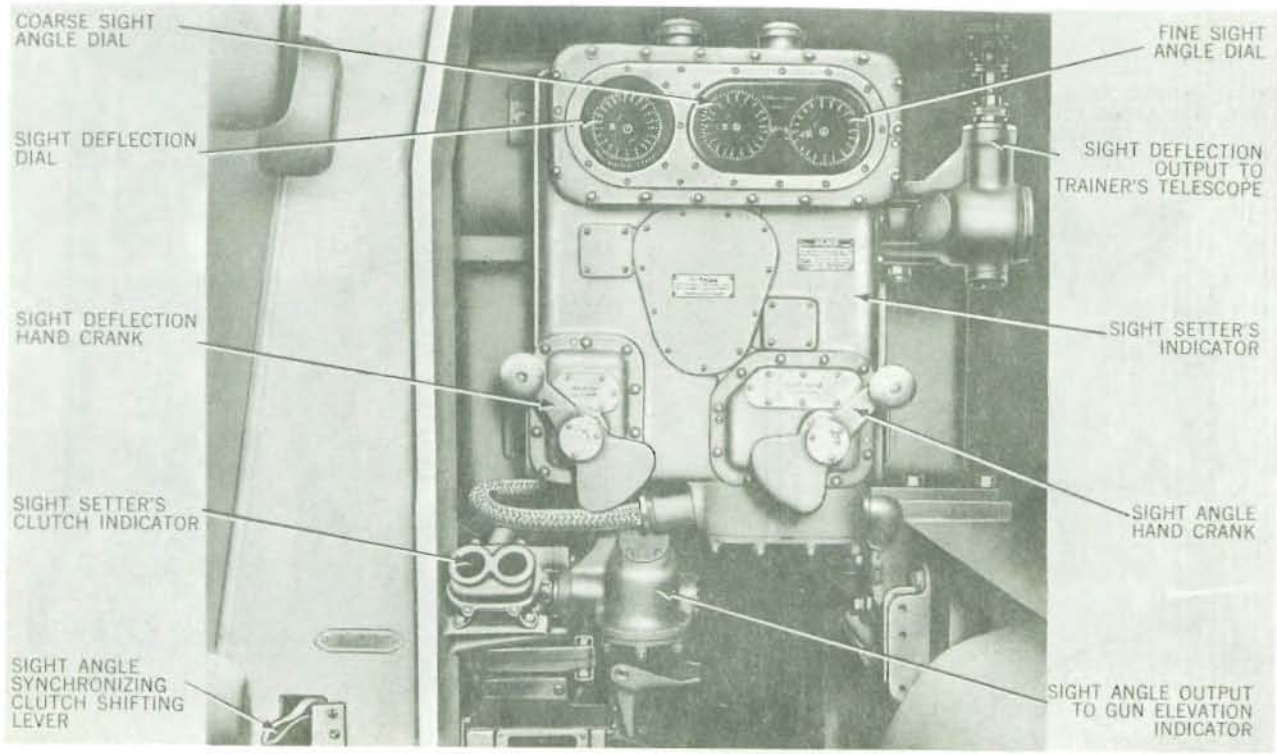

Figure 12-16. Sight Setter's Station - Fire Control Arrangement

Communications. Gun-layer communication facilities include a talk-back type reproducer (circuit MC), turret officer's telephone (circuit XJ), and call bell (circuit E) circuits. These arrangements provide communications between the gun-layer and the turret officer.

Trainer's station. The trainer's (train operator's), station has fire control equipment which includes a turret train indicator and transmitter, firing key, gun elevation and train ready indicator, foot-operated ready switch and communications.

Turret Train Indicator and Transmitter Mark 37 Mods 4, 5, and 6. Mounted on the trainer's handwheel pedestal, the case-enclosed Indicator and Transmitter is designated Mk 37 Mods 4, 5, and 6 for turrets I, II and III respectively. As an indicator, the instrument shows four quantities on dials: gun train order, modified turret train response, parallax-range order, and parallax range in terms of range in yards. As a transmitter, the instrument sends modified turret train response (electrically) to other stations throughout the ship, and parallax range (mechanically) to the train receiver-regulator. The instrument is used by the train operator who rotates his handwheels to match pointers on the dials. The train operator also turns the parallax-range handcrank to match pointers on the range dials. This instrument is completely described in OP 851.

Firing key. Mounted on the trainer's handwheels, this key is identical in designation, arrangement, and function to the sight pointer's firing key described on page 12-11.

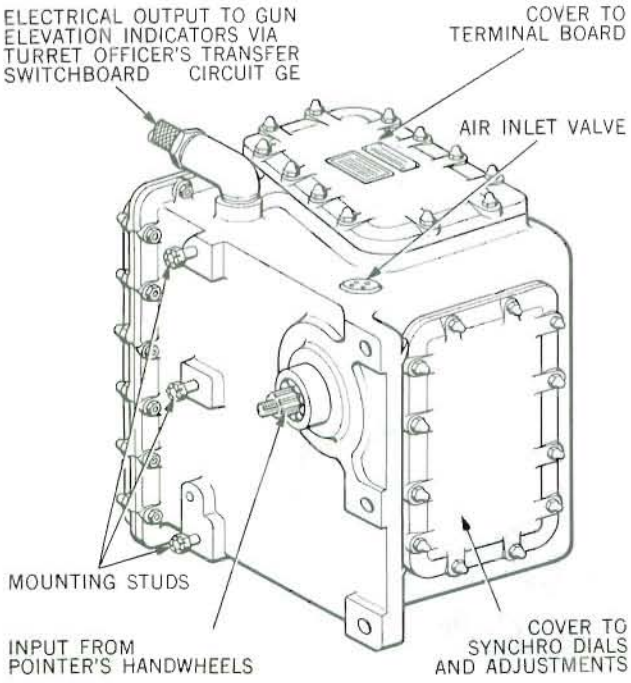

Figure 12-17. Gun Elevation Order Transmitter

Gun elevation and train ready indicator. Located at the trainer's station, this is a four-dial indicator (circuit 1R) with the dials marked L, C, and R (for respective left, center, and right guns), and TRAIN READY. When illuminated, the dials marked L, C, and R indicate that the gun positions are matched with the gun order signals. TRAIN READY indicate to the trainer that his signal circuit is functioning.

Foot-operated ready switch. Located at the trainer's station, this is a normally open, bridge-type switch (circuit 1R). When closed by foot pressure it illuminates dials marked TRAIN READY at the turret officer's, turret captain's, trainer's, and the sight station indicators.

Communications. Trainer communication facilities include a talk-back type reproducer (circuit MC), battle telephone (circuit JE), turret officer's telephone (circuit XJ), and call bell (circuit E) circuits. These arrangements provide communications between the trainer and the turret officer and main battery directors.

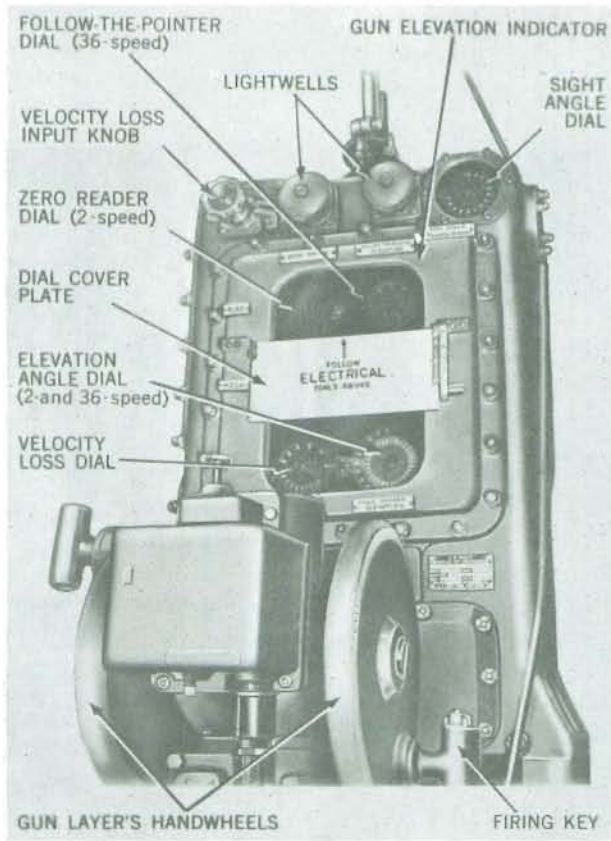

Figure 12-18. Gun Layer's Station - Fire Control Arrangement

Rangefinder operator's station. The rangefinder operator's station in turrets II and III has fire control equipment which includes the rangefinder, the rangefinder stabilizer, and communications.

Rangefinder. The rangefinder Mk 52, stereoscopic type, is mounted transversely at the rear of the turret as shown in figure 12-8. It provides target ranges during "secondary" or "local" control operation. This instrument is described in detail in OP 1573.

Rangefinder Stabilizer Mk 4 Mod 1. Mounted on the rear of the rangefinder stand, the stabilizer is an electric motor-driven assembly automatically controlled by a gyroscope. The stabilizer keeps the rangefinder line of sight horizontal, as described in chapter 14.

Communications. Rangefinder communication facilities include battle telephone (circuit JA), and the turret officer's compartment non-talk-back type reproducer. These arrangements provide communication between the rangefinder operator and local computer, graphic plot operator, and associated plotting room and director.

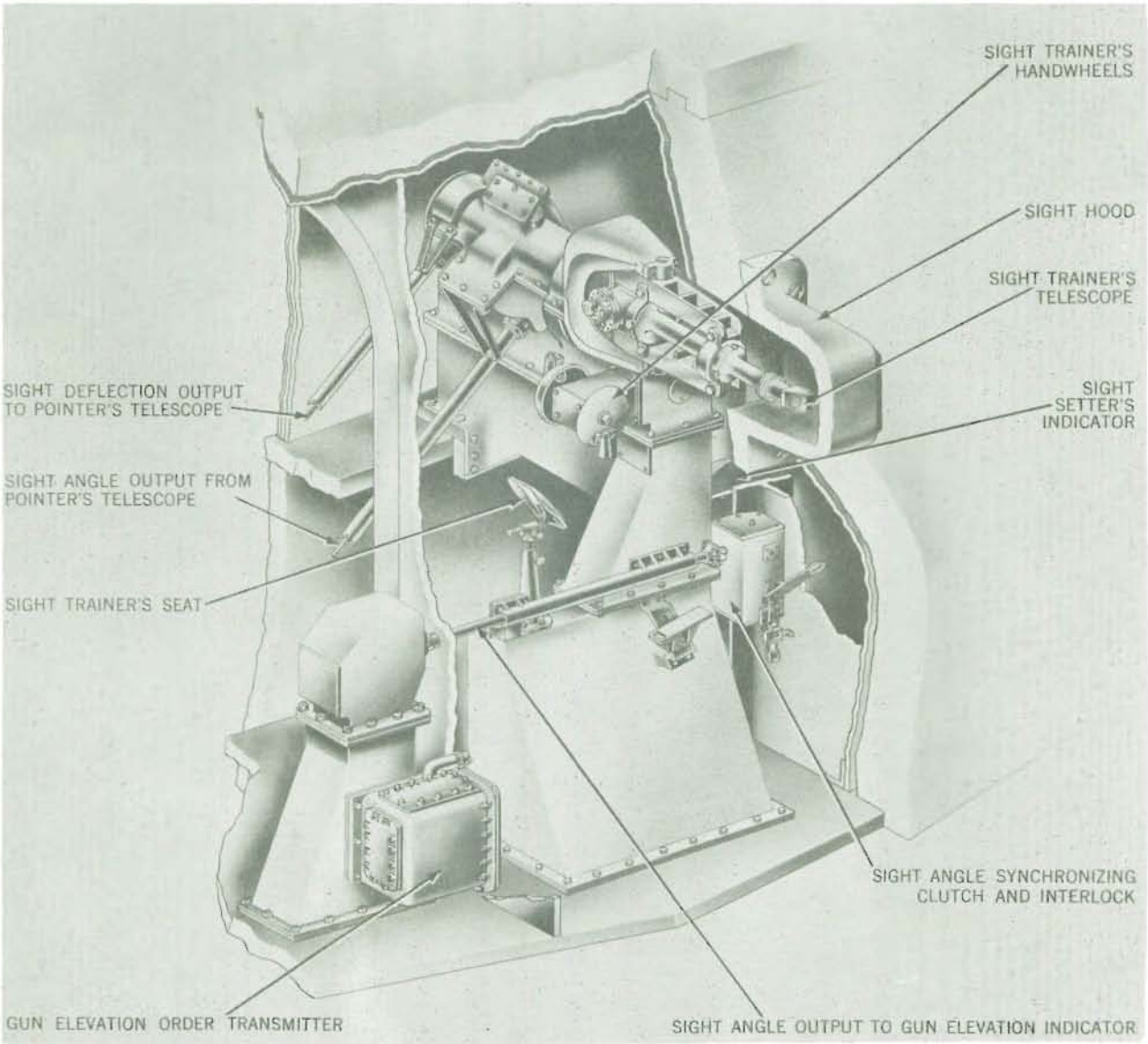

Figure 12-19. Sight Trainer's Station - Fire Control Arrangement

Chapter 13

SIGHT ASSEMBLIES

16-inch Sight Mark 4 Mods 2 and 3

GENERAL DESCRIPTION

Turret local fire control arrangements comprise two interconnected sight assemblies and attached or associated instruments. The installations are identical in all turrets.

Type

The design is a carriage sight arrangement which functions as a directing type fire control assembly. Control may be selectively arranged to direct gun laying and turret train from either of two stations. These stations are designated 16-inch Sight Mk 4 Mod 2, in the right side of the gun house, and 16-inch Sight Mk 4 Mod 3, in the left side.

General arrangements of sight stations and components

The arrangement of the sight stations and associated instruments is shown in figure 13-1. Each station is a pedestal and bracket mounted arrangement of a sight trainer's and sight pointer's line-of-sight optic with a sight setter's indicator.

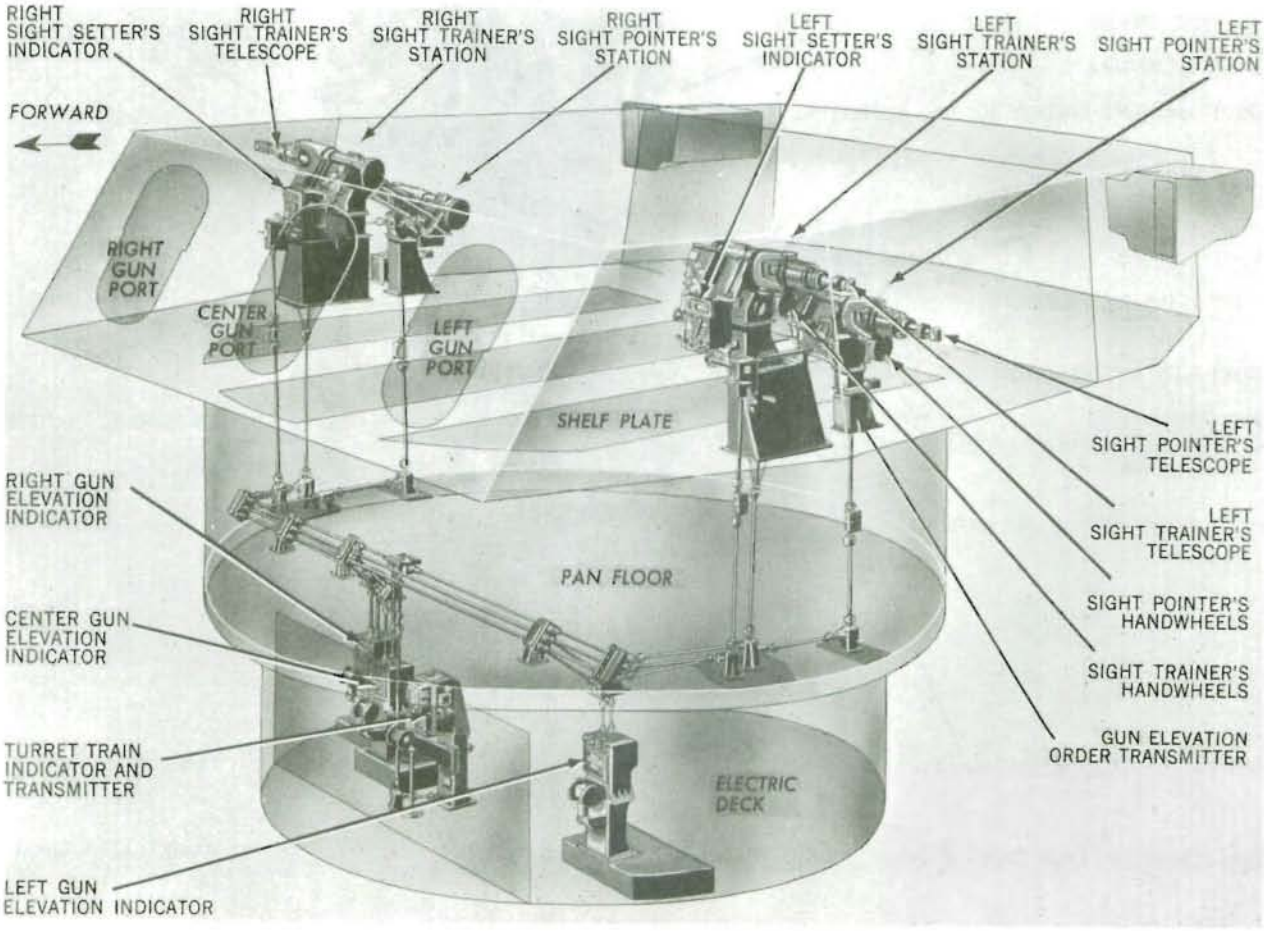

Figure 13-1. Sight and Gun Attachments, General Arrangement

The lines of sight are mechanically connected for simultaneous offset in deflection and sight angle from the sight setter's input. All lines of sight move together in response to the sight pointer's handwheel movement as the controlling sight pointer manipulates his handwheels to hold his telescope on the target. However, the sight trainer's telescopes may be unlatched from the sight angle and sight pointer's inputs. Sight angle and sight pointer's movements are transmitted to instrument dials at the gun layer's stations. They are gun order directing movements and do not position the gun laying controls; sight train is selectively arranged so that the sight trainer's handwheel may be clutched to the servo control of the training gear speed gear. The mechanical system of gun order transmission extends transversely between the two sight stations and connects line-of-sight and sight setter outputs of both stations to all indicating instruments. The interconnection is arranged with manually operated, interlocked, synchronized selectors. By this means either sight station can quickly assume control of gun direction in response to the turret officer's designation of the controlling sight. Turret train control selectors (for LOCAL) are manually positioned clutches located at the train operator's station. Either sight trainer may be given control from this station when the operator unclutches his speed gear control.

Functional arrangements

The fire control system utilizing the above described arrangements is supplementary to two other basic systems, designated PRIMARY and SECONDARY. They are director control systems which use a portion of the sight facilities described below.

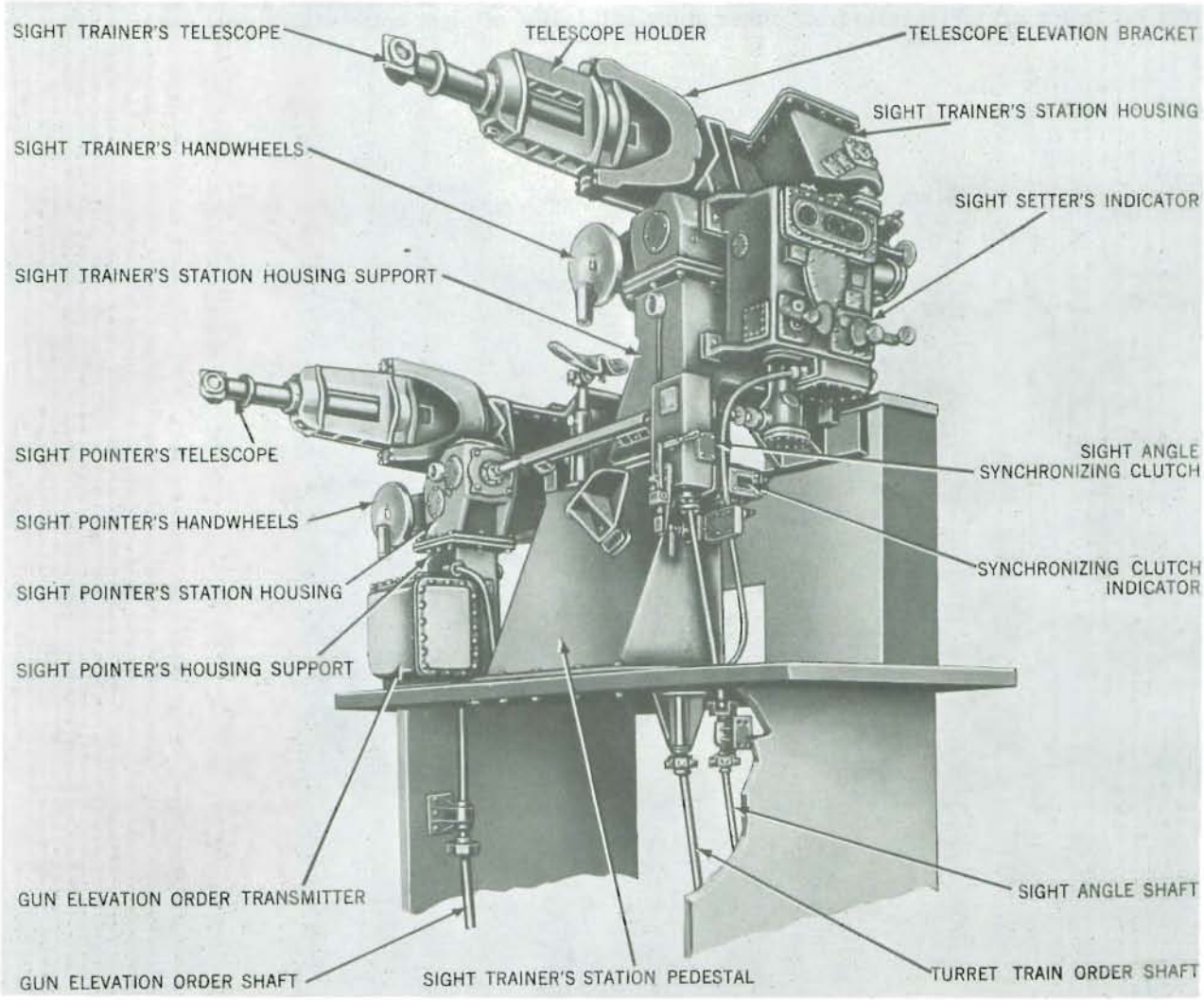

Figure 13-2. 16-Inch Sight Mk 4 Mod 2

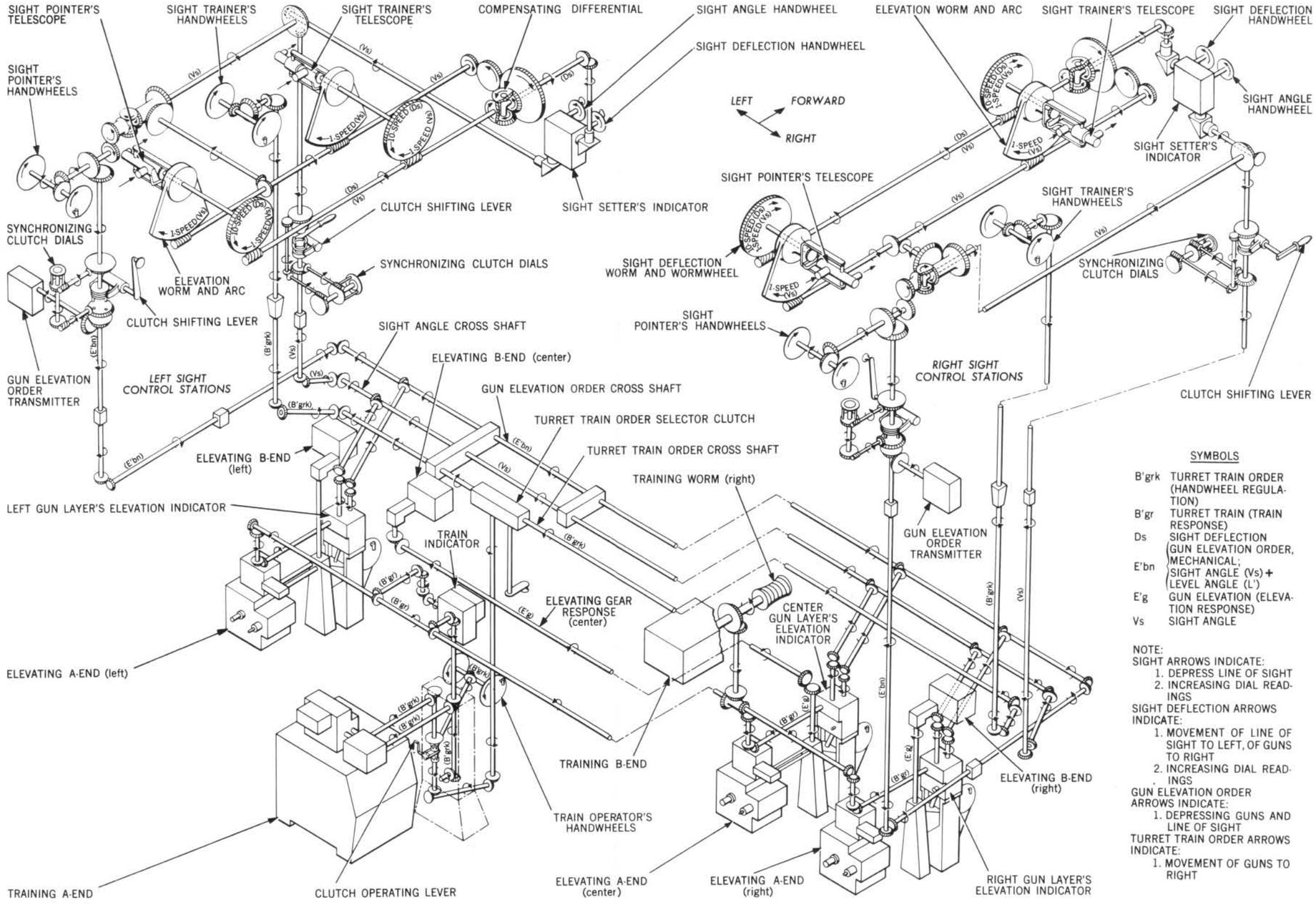

Figure 13-3. 16-Inch Sight Mk 4, Mods 2 and 3, Schematic Arrangement

PRIMARY control. In PRIMARY control the main battery fire control director system operates to position the guns "automatically" or by "indicating." In either case, gun orders are generated by the rangekeeper in the forward or aft plotting room from signals received from either the forward or aft main director. In "automatic" PRIMARY control, the orders are transmitted to the gun and turret drive receiver-regulators, providing remote control of all gun positioning movements. PRIMARY "indicating" control transmits orders to dials of the indicators at the gun layer and turret train operator stations. Both methods require continuous operation of one sight setter's indicator in order that sight angle corrections for erosion may be entered in each gun elevation indicator.

SECONDARY control. SECONDARY control is an auxiliary method of director fire control in which gun orders originate in one turret (as a controlling director) and are transmitted to the other turrets. The system provides "automatic" and "indicating" control in the same manner as PRIMARY control, requiring similar operation of one sight setter's indicator.

Local control instruments

The instruments listed below are directly associated with the operation of the sights, but are not part of the sight assembly. Details of their arrangement with respect to the sight assemblies are given in the description of the sight. A more complete description occurs later in this chapter. The electrical circuit arrangements, illumination, and fire control system selector connections are described in chapter 15. The instruments are as follows:

Telescope Mk 66 Mod 0
Sight Setter's Indicator Mk 3 Mods 2 and 3 or 4 and 5
Gun Elevation Indicator Mk 33 Mods 3 and 4
Turret Train Indicator and Transmitter Mk 37 Mods 4, 5, or 6
Gun Elevation Order Transmitter Mk 2 Mods 0 and 1
Multiple Turret Train Indicator Mk 12 Mods 5 or 6
Battle Order Indicator Mk 28
Train Receiver-Regulator Mk 18 Mods 5, 6, or 7
Elevation Receiver-Regulator Mk 10 Mod 0

DETAILED DESCRIPTION

Sight

16-inch Sight Mk 4 Mod 2 comprises the right sight station assembly and the elements of the shaft system of brackets, gearing, shafts, clutches, and connected parts that extend across the turret to the left sight station and to the machinery floor. 16-inch Sight Mk 4 Mod 3 comprises the left sight station assembly. The two sight station assemblies are approximately symmetrical about the longitudinal center line of the turret.

Location and subassemblies. The elements and arrangement of the right sight station are illustrated in figure 13-2. This is typical of both stations except for the right and left positions of parts. Shafts from the two stations extend through the shelf plate to brackets on the circular girder above the pan floor, then obliquely forward to cross shafts running transversely through the turret to connect the two sight assemblies. From cross shaft brackets other shafts extend into the gun layer's and turret train operator's compartments to connect to elevation indicators and the turret train operator's handwheel bracket. See figure 13-3 for the schematic arrangement of the system.

Components. The components of the sights are as follows:

Left and right sight pointer's stations
Left and right sight trainer's stations
Shaft and gear box transmitting system
Sight hoods

Line-of-sight data.

Sight positions in plan:

Sight pointer's telescope objective, right and left of longitudinal centerline of turret, inches	239.50
Sight pointer's telescope objective, rear of transverse centerline of turret, inches	20.0
Sight trainer's telescope objective, right and left of longitudinal centerline of turret, inches	233.50
Sight trainer's telescope objective, forward of transverse centerline of turret, inches	36.0

Sight positions above plane of gun trunnion axis:

Sight pointer's telescope objective, inches	5.5
Sight trainer's telescope objective, inches	36.5

Sight positions above plane of shelf plate:

Sight pointer's telescope objective, inches	54.5
Sight trainer's telescope objective, inches	85.5

Line-of-sight movement limits:

Depression of line of sight (includes 20° of roll), deg.	50
Elevation of line of sight (for 20° of roll), deg.	20
Left deflection of line of sight, mils	100
Right deflection of line of sight, mils	175

Pointer's station. The principal components of each sight pointer's station (figs. 13-4 and 13-5) are described below.

Telescope holder. The telescope holder (fig. 13-5) holds the telescope, rotates with the elevation bracket for sight angle input, and provides vertical trunnions for deflection movement of the telescope. A sector gear, mounted on the inboard end of the casting, is driven by a pinion to move the telescope holder in deflection.

Deflection gear sector and pinion. Telescope deflection is accomplished through the deflection gear sector and pinion (fig. 13-5). Sight deflection input from the sight setter's handwheel turns the pinion to rotate the telescope holder about its vertical trunnions.

Deflection worm and worm wheel. The sight deflection worm and worm wheel (fig. 13-5) are part of the gear train between the sight deflection handwheel and the telescope holder. The worm is on a shaft extension from the sight trainer's station deflection input, so that both stations receive identical sight deflection input.

Elevation bracket. The elevation bracket supports the telescope holder and supplies elevation input. The hollow inboard shaft section of the bracket mounts the elevation worm arc which is driven by sight angle and elevation handwheel inputs. This portion of the bracket also encloses and supports the deflection pinion shaft.

Elevation worm and arc. The sight elevation worm and worm arc drive the elevation bracket in elevation. The worm is driven by the sight angle bevel gears which transmit combined sight angle and pointer's handwheel input from the pointer's station differential. A shaft from the worm also connects through an adjustable coupling to the sight trainer's station elevation worm.

Sight pointer's station differential. The sight pointer's station differential consists of a planetary arrangement of a spider, two idler bevel gears, a combination bevel gear, and a combination spur and bevel gear. These elements combine sight setter's sight angle and sight pointer's handwheel elevation to position the telescopes in elevation.

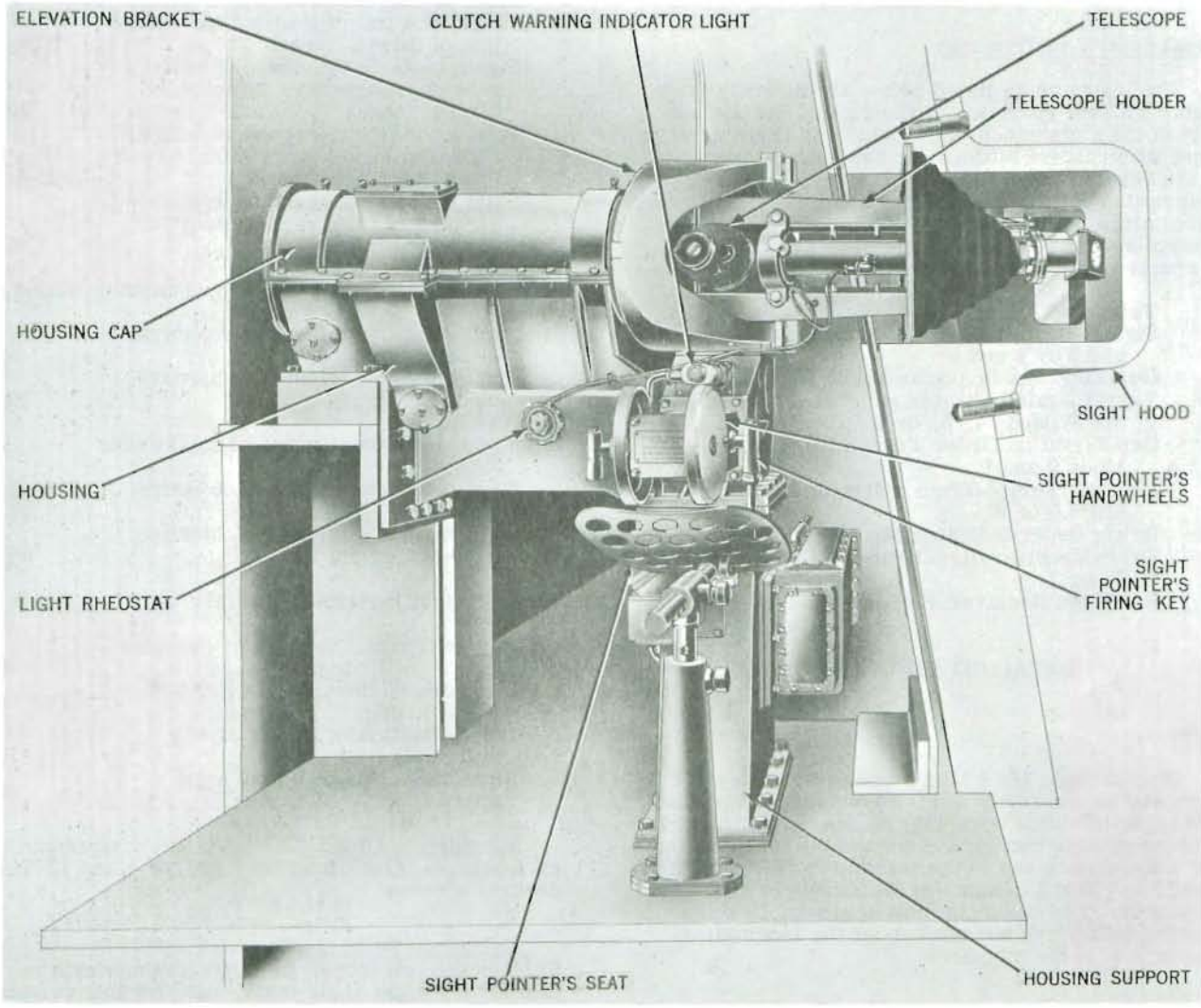

Figure 13-4. Sight Pointer's Station, 16-inch Sight Mk 4, Mod 2 or 3, General Arrangement

Handwheel and order shaft gearing. The handwheel and order shaft gearing is composed of two bevel gears at the handwheel shaft, a pair of bevel gears that connect the handwheel shaft to the elevation order shaft, and a spur gear that connects the handwheel shaft to the spur bevel gear of the differential. These gears and shafts, as well as all others in the sight, are ball bearing mounted. The elevation order shaft is connected from the handwheels to the lower bearing sleeve by the synchronizing clutch and its related indicator gearing.

Synchronizing clutch assembly. The sight pointer's station synchronizing clutch, clutch dials, and clutch gearing comprise a device for synchronizing the sight station (sight pointer's handwheels) with the gun elevation indicators at the gun layer's stations. When the dials are matched, the clutch may be engaged. The clutch upper jaw is located on the splined section of the elevation order shaft just below the upper synchronizing dial bevel gear. The clutch lower jaw is a combination jaw, containing holes to receive and match the different diameter pins of the upper jaw and a double bevel gear. One side of the double bevel gear is for the synchronizing dial mechanism and the other side is for the gun elevation order transmitter. The matching dial bevel gears are shaft-connected to worms and wormwheels which rotate their respective matching dials of the synchronizing clutch matching dials. These dials are enclosed by the synchronizing dial housing. Each clutch is arranged with an indicator light and a switch in an electrical warning light circuit (see chapter 15). The indicator light and switch are mounted on the handwheel bracket.

Synchronizing dial housing. The synchronizing dial housing is attached to the station housing support. It contains elements for the support and enclosure of the synchronizing dial mechanism.

Handwheel bracket. The handwheel bracket (fig. 13-4) supports the handwheel shaft and the handwheel bevel and spur gear shaft. The bracket is attached to the station housing; it has a cover to enable inspection and assembly of the enclosed mechanisms.

Housing cap. The housing cap (fig. 13-4) encloses the telescope elevation bracket, sight deflection gearing, and sight elevation gearing. The cap is bolted to the top of the cap.

Housing. The housing contains elements for the support and enclosure of the handwheel, deflection, elevation, and sight angle shafts and gearing. Attached to the housing are the housing cap, housing support, and various covers used in connection with the support, inspection, and lubrication of the enclosed mechanism.

Housing support. The housing support supports the housing, the synchronizing dial housing, and the gun elevation order transmitter. It encloses the clutch, gun elevation order shaft bearings, elevation order transmitter gears, and synchronizing dial gears. An inspection cover provides access for service.

Trainer's station. The principal components of each sight trainer's station are described below.

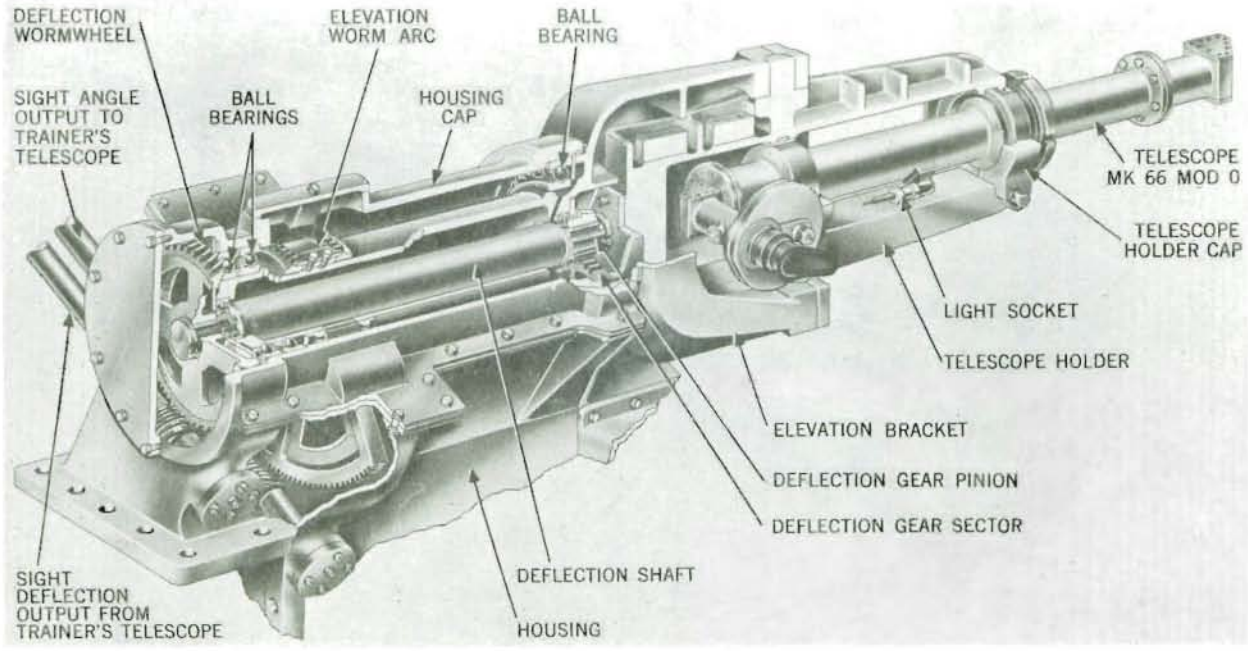

Figure 13-5. Sight Pointer's Telescope and Telescope Holder - Sectional View

Telescope holder. The telescope holder, figure 13-6, is similar to the sight pointer's station telescope holder except that there is provision for the telescope to rotate within the holder about its longitudinal axis. This rotation is limited by two stops on the holder and can be prevented by a locking pin mounted on the holder cap. The holder is driven through a sector by a pinion on the deflection worm-wheel shaft. Supported by the elevation bracket, the holder provides a ball bearing mount for the telescope (line-of-sight elevating movement).

Elevation bracket. The elevation bracket differs from the pointer's station elevation bracket only in the shape of the arm skirt and in the length of the shaft portion of the bracket. The skirt is cut away to permit motion of the telescope in elevation independent of the elevation bracket motion.

Deflection and elevation movement mechanisms. The deflection pinion and sector, the sight deflection worm wheel, and the sight elevation arc are virtually identical with the same parts of the sight pointer's station.

Sight trainer's station differential. The compensating differential (fig. 13-3) compensates for deflection movement of the telescope caused by rotary movement of the deflection gear sector around its pinion in response to sight angle input.

Handwheel and order shaft gearing. The handwheel and order shaft gearing, enclosed and supported by the handwheel bracket, connects the handwheels to the train order shaft. The gear system consists of two sets of bevel gears with a handwheel and connecting shaft, ball-bearing mounted on the handwheel bracket.

Housing assembly. The housing cap, housing, housing support, pedestal, and shaft enclose and support the various elements of the sight trainer's station, synchronizing clutch, and sight setter's indicator. These parts are arranged in the order mentioned from top to bottom of the sight trainer's station. The shaft guard fastens to the housing and to the pedestal by means of a bracket. The seat pedestal and foot rests are also attached to the pedestal.

Sight angle synchronizing clutch assembly. The sight angle synchronizing clutch (fig. 13-2), located at each sight setter's station, enables either station to be clutched into correct engagement with the sight angle cross-shaft system. Electrical interlocks described in chapter 15 prevent simultaneous engagement of both clutches. Each clutch is a 180 degree engagement, positive jaw type. The gearing arrangement is shown in figure 13-3.

Shaft and gear box transmitting systems. Starting at the two sight stations, shaft systems (fig. 13-3) extend down through the shelf plate and transversely across the turret through all gun girders. These shafts transmit gun laying and turret train orders and sight angle movements into a series of gear brackets mounted on the gun girders. Outputs from these extend down to connect with the indicators at the gun layer and turret train operator's stations and to the receiver-regulators of the gun and turret drives.

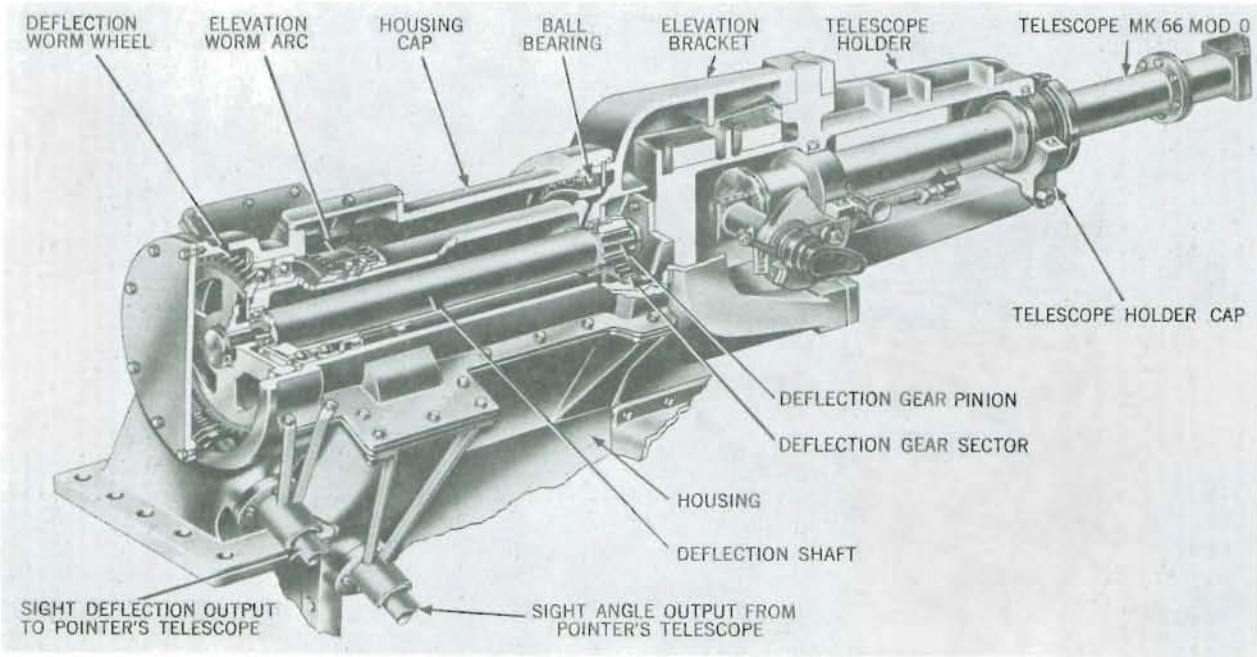

Figure 13-6. Sight Trainer's Telescope and Telescope Holder, Sectional View

System arrangement. The extent of the shafting and the locations and mountings of the gear housings are as follows:

Gun elevation from each sight pointer's handwheels is transmitted by shafting down through bearing brackets to gun elevation order bevel gear brackets, mounted on the circular girder of the pan floor. From here, shafting runs forward to the two sight angle, gun elevation, and turret train order bevel gear housings. Each housing is mounted, right and left respectively, on the outboard gun girder. The gun elevation order cross shaft passes transversely across the turret between these housings and through three sight angle and gun elevation cross shaft brackets. These brackets are mounted on a beam above the pan floor. Vertical shafts from these brackets transmit gun elevation orders to the input shafts of the three gun elevation indicators.

A vertical shaft transmits turret train orders from each sight trainer's handwheels down through bearing brackets to turret train order upper bevel gear brackets mounted on the circular girder of the pan floor. From this point a horizontal shaft transmits motion forward to the sight angle, gun elevation, and turret train order bevel gear housings. The turret train order cross shaft extends transversely across the turret between these housings. At the center of the shaft, the turret train order selector clutch is mounted on a beam above the pan floor. From this clutch, shafting extends down through bearing brackets to the turret train order lower gear bracket. A shaft runs horizontally from this gear bracket to the turret train indicator and transmitter.

Sight angle is transmitted from each sight setter's indicator through bearing brackets to sight angle bevel gear brackets, mounted on the circular girder.

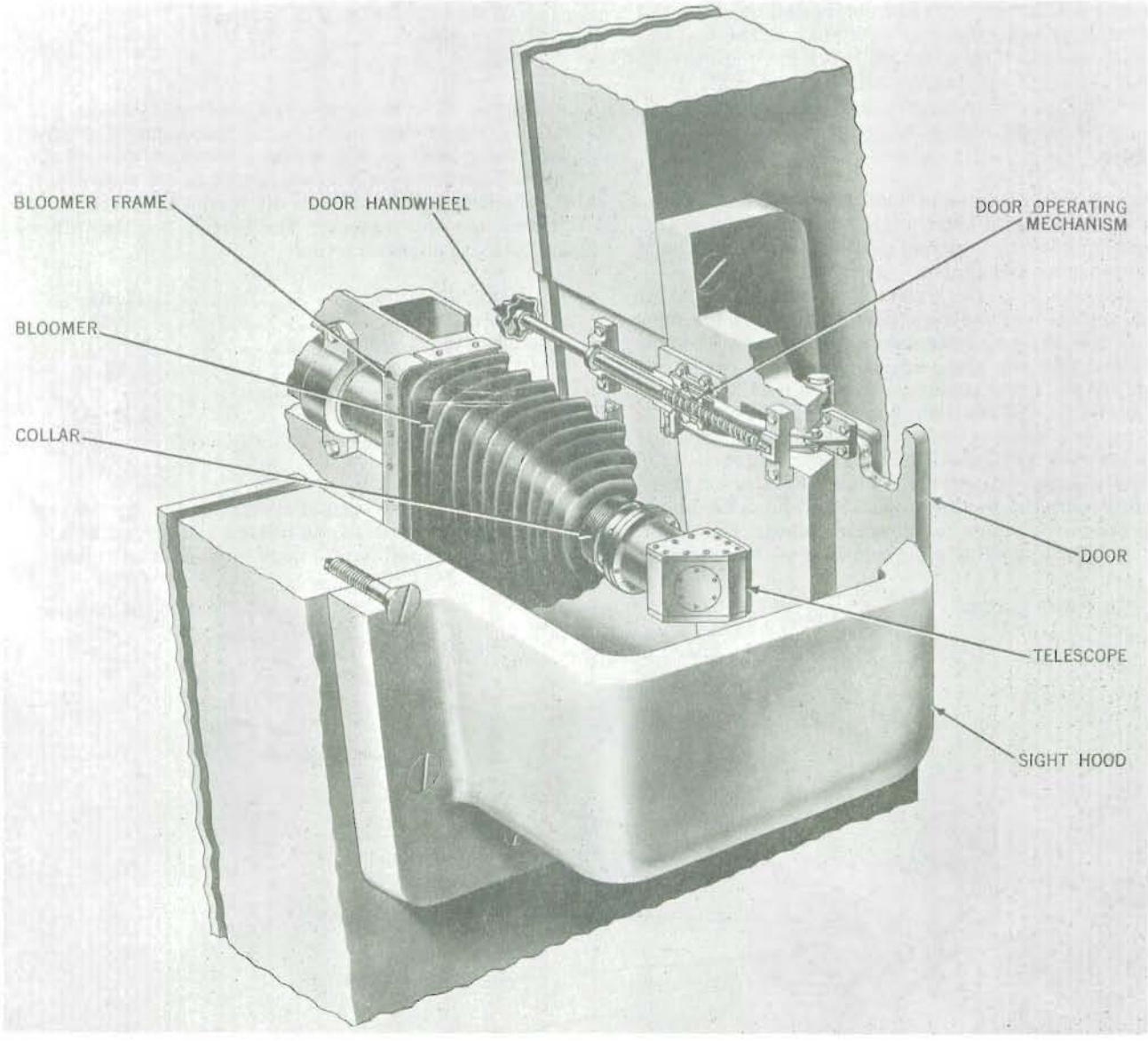

Figure 13-7. Sight Pointer's Sight Hood, Sectional View

From this point shafting extends forward to the two sight angle, gun elevation, and turret train order bevel gear housings. The sight angle cross shaft extends trasversely across the turret between these housings and through the three sight angle and gun elevation cross shaft brackets. Vertical shafts transmit motion from these brackets to the three gun elevation indicators.

Turret train order selector clutch. The turret train order selector clutch is a combination of two jaw-type clutches and a bevel gear arrangement which provides a means for selecting control from either the right or left sight trainer's station. The jaw-type clutches are each composed of a movable jaw, spline-mounted on its train order cross shaft, and a combination jaw and bevel gear, bearing-mounted on this same train order shaft and geared to the shaft from the turret train order lower gear bracket. The two movable jaws are fork positioned, the forks being connected and controlled together by a sector gear and spur gear on a shaft. The unit is manually operated by a control lever located overhead at the train operator's station. The control shaft, positioned by a lever and detent, provides adjustment for the clutch by means of an adjustable coupling.

Sight hoods. The sight hood assembly (fig. 13-7) comprises the sight hood, sight hood door and seal assembly, bloomer, bloomer collar and frame, and door operating mechanism. All sight hood assemblies are similar. Each sight hood is mounted on the turret armor over the sight port. Hinged to the sight hood is a bullet-proof steel door operated by a double screw and link operating mechanism which opens and closes the door and secures it in either position. The inside face of the sight hood door is recessed and a rubber weather seal cemented in the groove. When the door is closed, the seal bears against the sight hood face, effectively sealing the interior of the hood from the weather. The sight hood bloomer is secured by a frame to the armor plate. A collar and lashing secures it to the telescope. The bloomer provides a gas and weather seal for the opening and has a slit to permit wiping of the telescope objective lens.

Instruments

The sight optical and instrument assemblies attached and associated with the sights are the Ordnance designated units listed on page 13-3. Their arrangement and features are described below and in the references mentioned.

Telescope. Telescope Mk 66 Mod 0, figure 13-8, is installed in the telscope holders of all sight stations.

Components. Each telescope consists of the following:

Optical system
Body tube and prism housings
Eyepiece
Color filter housing

Optics. The telescope is a prismatic, fixed power, single eyepiece type, containing a 90 degree adjustable head prism, a compound objective lens, a crossline lens (in the focal plane of the objective), an erecting lens system, a 90 degree eyepiece prism, and an eyepiece. The system has the following optical characteristics:

Magnification	11.8X
True field	$4^{O}15'$
Exit pupil mm	5.0
Eye distance, mm	32.0
Eyepiece adjustment limits, diopters	+2 to -4
Weight, pounds	60

Structure. The optical system excluding the eye piece and color filters, is housed and sealed within an airtight assembly of a body tube and two prism

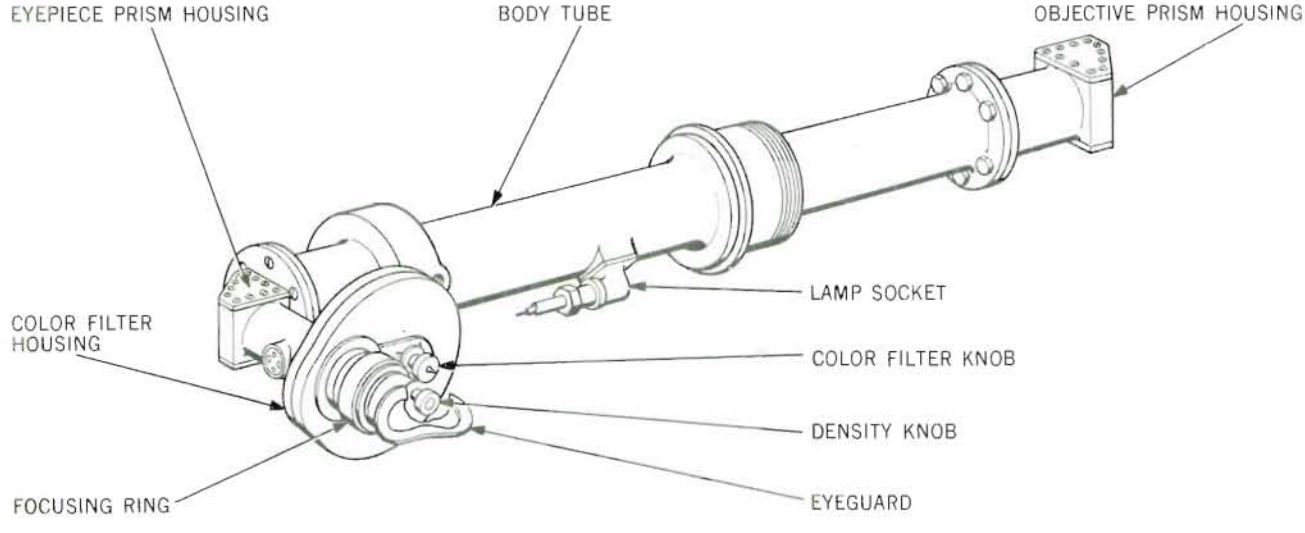

Figure 13-8. Telescope Mk 66, Mod 0, Rear View - Trainers Station

housings (fig. 13-8). Two concentric cylindrical seats are provided for mounting the telescope in the telescope holder. The objective lens is mounted on a double eccentric so that the optical axis of the telescope may be adjusted to correspond with the axis of the bearings.

Illumination. The crossline lens is illuminated by an electric lamp mounted in Lamp Socket Mk 9 Mod 0. Correct illumination requires a two candlepower six- to eight-volt lamp.

Color filter. The color filter housing comprises a manually operated arrangement of four color filter selections, designated CLEAR, RED, YELLOW, and POLARIZER. They are rotated into position by two knobs, the "ray filter" knob and the "density" knob (fig. 13-8). The latter permits any desired degree of light transmission when the "ray filter" knob is turned to "POLARIZER."

References. Additional data and information concerning the telescopes and their care are published in OP482, First Revision, Turret Sight Optical Instruments.

Sight setter's indicator. Sight Setter's Indicators Mk 3 Mod 2 or 4 (right hand) and Mk 3 Mod 3 or 5 (left hand) are located on the forward side of the respective sight trainer's stations (fig. 13-2). The instruments are described in OP880. Each indicator receives sight angle, sight deflection, and battle orders electrically from the main battery fire control systems, and transmits sight angle and sight deflection mechanically to the sight pointer's station, the sight trainer's station, and gun elevation indicators. The instrument receives sight angle and sight deflection from the plotting room computer and battle orders from the plotting room battle order transmitter. The instrument is provided with handcranks for setting values of sight angle and deflection into the sights. Dials indicate sight angle, deflection, and battle orders. Dial graduations and limits are: sight angle, 2000 to 4800 minutes; deflection, 350 to 600 mils. Mil calibrations are spaced at two mils. Zero sight angle is 2000 minutes; zero deflection is 500 mils.

Sight setter's clutch warning and interlock system. Each sight setter's synchronizing clutch is equipped with a clutch position indicator and interlock system. This is an electrical circuit arrangement of two switches and two signal lights which indicate to each sight setter the position of the other sight setter's sight angle synchronizing clutch. Each switch is mounted on the clutch case with a plunger in the way of and actuated by the clutch control lever. Two other switches and two solenoids are arranged to actuate and control interlocking mechanisms at each clutch. These systems are further described in chapter 15.

Flexible adjustable coupling assembly and shaft. The flexible adjustable coupling assembly and shaft are located adjacent to the sight setter's indicators. They provide a means of adjusting the lines of sight in deflection relative to the indicators.

Gun elevation indicator. A gun elevation indicator is located at each gun layer's station. These instruments, Gun Elevation Indicator Mk 33 Mod 3 at the right and center gun controls and Mk 33 Mod 4 at the left gun control, are functionally identical. They operate to give orders for the gun layer and provide correction to the gun response before it is indicated as elevation on the dials. Each receives gun elevation orders electrically from the controlling director or from the sight pointer's gun elevation order transmitter. When the turret is operating in LOCAL control each also receives gun elevation orders mechanically from the sight pointer's stations. For further details, refer to chapter 12 and to OP 854, Fire Control Equipment, Gun Elevation Indicators Mk 33 and Mk 33 Mods 1 and 4; Description.

Gun elevation order transmitter. Gun Elevation Order Transmitter Mk 2 (right hand) and Mk 2 Mod 1 (left hand) are located at the sight pointer's stations. In LOCAL fire control, one instrument transmits gun elevation order electrically to the three gun elevation indicators. The order is equal to the depression of the sight pointer's sight which, in turn, equals the sight angle set plus a selected value of level (director correction). Thus the sight pointer's sight acts as a local director transmitting gun elevation order to the gun layer's gun elevation indicator. In SECONDARY control, the local gun elevation order transmitter in any selected turret can be switched to transmit gun elevation order to other turrets. Further details are given in chapter 12.

Turret train indicator and transmitter. Turret Train Indicator and Transmitter Mk 37 Mod 4, 5, or 6 is located at the turret train operator's station in each turret. The instrument indicates train order and shows, by a zero reader, when turret train (corrected for parallax) is the same as train order. It transmits corrected train angle and supplies the necessary correction to turret train to give the correct train angle. It also indicates the actual turret train with parallax subtracted and transmits these values for use in multiple turret train indicators. In SECONDARY control, these values are transmitted for direction of other turrets. Further details are contained in chapter 12 and in OP 851, Turret Train Indicator and Transmitter Mk 37 Mods 0 and 1.

Multiple turret train indicators. Multiple Turret Train Indicators Mk 12 Mod 5 (turrets I and II) and Mk 12 Mod 6 (turret III) are located in the turret officer's compartment. They indicate as a direct reader and also as a zero reader that the turret has been trained in accordance with orders received. In turrets I and II, the indicators show the train angle of both turrets so that the turret officer can control train and elevation to prevent interference between the guns of the two turrets. The direct reader dial indicates the train of the turret. The zero reader dial, when pointing to zero (vertical position), indicates that the turret is trained on the same target as the controlling director. Refer to chapter 12 for further details.

Battle order indicator. A Battle Order Indicator Mk 28 Mod 0 is located in each turret officer's compartment. The instrument indicates range, deflection, and battle orders transmitted by the battle order transmitter in the plotting room computer.

Turret train receiver-regulator. Train Receiver-Regulator Mk 18 Mod 5 (turret I), Mod 6 (turret II), and Mod 7 (turret III) provide automatic control of turret train. For a detailed description of this instrument refer to chapter 6.

Gun elevation receiver-regulator. All gun elevating gears are equipped with Elevation Receiver-Regulator Mk 10 Mod 0. This instrument provides automatic control of gun laying. Refer to chapter 5 for further details.

OPERATION

Personnel, stations

The personnel primarily concerned in the operation of the sights are, in each right and left station, the sight setter, the sight trainer, and the sight pointer. The sight stations are located in the forward corners of the turret. The sight setter, at his position in front of the sight, stands facing aft. Seated on the trainer's station pedestal is the sight trainer, the sight pointer sits, also facing forward.

LOCAL control

The relation of the sight to other fire control equipment is defined by its function in LOCAL control. Starting with values of true compass course, speed, own ship's target bearing, target angle, target speed, wind angle, wind speed, present range, range spot, deflection spot, nominal velocity, and initial velocity, the auxiliary computer supplies values of sight angle and sight deflection by oral order to the sight setter. The sight setter (in either station), by setting dials on the sight setter's indicator, transmits sight angle and sight deflection mechanically to his respective sight pointer's and sight trainer's stations. The sight pointer and the sight trainer, in laying their sights on the target, develop gun elevation order and turret train order, respectively. The sight trainer directly controls the turret training gear to train the turret. The sight pointer transmits elevation orders, electrically by means of gun elevation order transmitters or mechanically through shafts and gears, to the gun elevation indicator of each of the three gun layers. At the gun elevation indicators, factors are added for erosion correction, roller path compensation, and elevation screw angularity to indicate elevation order and gun elevation on follow-the-pointer dials. Each gun layer then operates the elevating gear control to lay the gun by matching dials (gun elevation indicator).

PRIMARY and SECONDARY control sight operation

The sights are not employed in PRIMARY and SECONDARY fire control methods except for one sight setter. This sight setter receives orders electrically and operates the indicator to supply sight angle correction for gun erosion. The guns are controlled in elevation by the gun layers and controlled in train by the turret train operator in INDICATING control. All operate by matching pointers in their respective indicators. The sight pointers and sight trainers "stand by." In AUTOMATIC operation, the gun layers and the train operator also "stand by."

Alternative sight operations

The sight function can be accomplished in three ways: by the sight setter, the sight pointer, and the sight trainer on the same side of the turret; by combinations using the sight stations on both sides of the turret; or by the sight stations in one turret acting through transmitters and indicators to direct other turrets. When using the sight stations on either side of the turret, the sight setter, sight pointer, and sight trainer on one side perform the sight function entirely independent of the other side. The sight pointer can either follow the target continuously, causing the sight trainer's telescope to follow his telescope in elevation, or fire on selected level, making it necessary for the sight trainer to unlatch his telescope and use his handgear to position his telescope in elevation. The sight pointer on one side can operate with the sole purpose of keeping his sight trainer on the target in elevation while the sight pointer on the other side is fixed in elevation for selected level firing. Any telescopes not being used in the sight operation can be used for checking. However, in all combinations where both sides are used, both sight setter's indicators must be in operation. Under "director" control from one turret to other turrets, the sights of the controlling turret are used as in LOCAL control; gun elevation orders and turret train orders are transmitted to all turrets by the controlling turret's sight station elevation order transmitter and turret train transmitter. All of these various selections and combinations of sight control operation are made by use of the synchronizing clutches (sight angle and sight pointer's elevation order), the turret train order selector clutch, the turret train operator's selector clutch, and the turret officer's selectors (chap. 15). There is a synchronizing dial in connection with each synchronizing clutch which must be matched before engagement of the clutch. It is not intended to have two synchronizing clutches of the same system engaged during operation. All clutch engagement combinations are evident from the operation. However, note that sight angle is supplied to the elevation indicators by the sight setter on the side where the sight pointer is firing, in all combinations.

Operation of the sight station differentials

The differential at the sight pointer's station (fig. 13-3) combines the sight pointer's handwheel and sight angle line of sight inputs to elevate and depress the telescope line of sight. The differential at the sight trainer's station compensates for movement of the telescope in deflection due to the planetary rotation of the deflection sector around the pinion when the telescope is rotated in elevation.

INSTRUCTIONS

General maintenance

Mechanisms of the class of the sights and gun attachments require high mechanical accuracy and must have exacting care. The designs include ample provision for precise alignment adjustments and for retaining the adjusted position of all elements. The designs have virtually no backlash and are capable of long service without appreciable increase in lost motion. These features have been attained by exceedingly high standards of manufacture. They provide accurate signal transmission and parallelism

of the lines of sight throughout the full range of movement. All elements have been verified by test installation,* collimation of the optical instruments, and check of the complete assemblies before acceptance and mounting in the turret. Misalignments and mechanical errors (larger than those accepted at manufacture) will not develop if the assemblies are correctly operated; if they are not deranged or otherwise damaged by misuse of shafts, brackets, and any other exposed parts; and if they are constantly serviced as prescribed by these instructions and the regulations of the Bureau of Ordnance Manual.

Inspection.

1. Keep all bracket bolts tight. Inspect for looseness after firing and at least once monthly.

2. Prevent vibration stress, which will occur while underway, by setting up the slide securing devices and by seating the centering pins.

3. Perform bore sight alignment check at least once quarterly and always before and after firing.

Exercise operations. Exercise all elements of the sights, training gun attachments, and elevation gun attachments through the full range of movements at least once weekly.

Lubrication.

1. Lubricate the assemblies with the lubricants and according to the periodic frequency prescribed by the lubrication charts.

2. All points of shaft support, all gear brackets, all gearing, and all moving elements of signal transmission and optical instruments have been provided with means for lubrication. In many instances, correct lubrication is obtained only with the use of lubricants prescribed on the charts. This is particularly important with respect to the internal mechanisms of the housings at the sight pointer's and sight trainer's stations. Oil is required at certain fittings; grease must not be substituted. Lubricants should be applied sparingly, but regularly.

Preservation.

1. When stowing, dry out and ventilate the sight hoods; dry the objectives; secure the movements at zero sight angle and deflection positions; close and secure the hood shutters.

2. Maintain a complete record in the turret journal of all sight misalignments and shaft errors together with data as to shimming, fitting, and adjustment.

3. Observe the following instructions as to care of the optics.

Operating precautions

The sight, gun attachments, and associated instruments are to be operated in accordance with the regulations of the Bureau of Ordnance Manual and the instructions below.

Sight.

1. Ascertain that all parts of the signal transmission system are properly lubricated and that all shafts operate without binding or lost motion.

2. Make sure that the sight hood doors are fully open to permit the full visual range of the telescopes.

3. When preparing for operation, operate the sight pointer's and sight trainer's hand cranks through the full range of movement.

4. The sight setter's indicator hand crank mechanisms include limit stop devices. Never attempt to force any crank if a restriction is encountered; check the dial and output positions and adjust to operate within the limit stops.

Gun attachments. Make certain that all shafting is properly lubricated and operates without binding and lost motion.

Instruments.

1. Be sure that all instrument dials are properly illuminated to facilitate dial readings.

2. Train the turret and elevate and depress the guns before firing to verify the adjusted settings of turret train, parallax, and sight angle inputs at the roller path tilt correctors, gun erosion corrections, and parallax mechanisms of the indicators and regulators.

3. Never operate the sights and gun attachments after coupling an uncoupled shaft until the dials and shaft transmitters have been synchronized.

Installation care

Telescopes. Instructions as to the care of telescopes for turret sights are contained in OP 482. This pamphlet includes instructions for the guidance of optical repair ship personnel as to maintenance and adjustment of optical systems. The following extracts are for care of the instruments by turret personnel.

1. Telescopes should be treated with the greatest possible care, should not be handled unnecessarily, and should be kept clean, dry, and covered (door closed) except when in use.

*A report of these tests, including data of accepted backlash, is provided with each turret assembly; compare with recorded data for all subsequent dial accuracy and sight alignment checks. It is of extreme importance that the shafting and brackets should not be disturbed. Any deformation may alter the adjusted positions of the lines of sight. An assembly that performs satisfactorily should not be disturbed. Refer all lubrication, adjustment, and servicing of interior elements of the elevation, train, and sight setter's indicators to fire control equipment maintenance personnel. These instruments must not be opened by turret personnel. Maintenance care of the sights and gun attachments includes the instructions prescribed on this page.

2. The object glass and the eye lens must be kept dry. Never touch them with the fingers. When necessary, clean them with drops of alcohol and lens paper.

3. Great care must be observed to prevent deformation of the bearing rings of the telescope bearings; keep these surfaces clean, free from paint, coated lightly with the prescribed lubricant, and use no emery cloth or other abrasive. Always make bore sight sight alignment check after mounting a telescope.

4. Cleaning of exterior surfaces of the telescopes should be performed with a dry, clean cloth. Never use solvents, detergents, or abrasives.

5. Eye shields should not be exposed to the sun's rays, to extremes of temperatures, nor to perspiration. Remove perspiration, oil, or grease as soon as possible, with a clean cloth soaked in gasoline. Rust should be removed by washing the shield in soapy water and rinsing in fresh water; such washing at frequent intervals will delay deterioration. Eye shields can be made pliable by steeping them in warm water.

6. Small dust particles in the field of view (interior optical surfaces) should be tolerated, unless such dirt, fogging, or other similar defect seriously interferes with efficient use of the instrument. Cleaning, drying out, or other correction is to be performed exclusively by optical repair ship personnel.

Shafts, couplings, and gears.

1. Shafts, couplings, and critical spiral bevel gears are fitted and punch marked to designate correct position at assembly. After removal of any such parts for repair or other purposes these reference marks must be matched when reinstalling.

2. When installing new shafts or couplings, fit the splines by dressing them down with a fine file to obtain a slip fit.

3. Shafts should be installed with clearance between the ends of the shafts to prevent abutments.

4. Coupling bolts should be properly secured to prevent lost motion from developing in service.

5. After final adjustments have been made on an adjustable coupling, secure the clamp screw to preserve the adjustment.

Adjustments

Sight alignment. The sights and gun attachments require periodic check and adjustment to correct for deviations of the line of sight and for elimination or compensation of lost motion. Verification of alignment and test of dial accuracy must always be performed before and after firing the guns. The necessity for such checks, the reasons for structural and other changes affecting alignment, and the theory and method of alignment operations are fully discussed in OP762, Alignment of Ordnance Installation on Board Ship; General Instructions.

General instructions. When an alignment check is made, each gun must be bore sighted. When dials are checked and synchronized, each gun and the turret must be trammed as well as bore sighted. Alignment of the guns and sights by bore sighting has the following objectives:

1. To position the telescopes so that all instruments, when at zero sight angle, zero deflection, and zero gun elevation, have their lines of sight parallel to the gun bores and to each other (or, for short ranges, converge to a point at a designated range).

2. To elevate and depress the lines of sight from the position described in (1), in planes perpendicular to the gun trunnion axis.

3. To deflect the lines of sight from the position described in (1), in planes parallel to the gun trunnion axis.

4. To obtain indicator readings corresponding to all gun and line-of-sight positions as in (1), (2), and (3), and to synchronize them with the electrical and mechanical transmitters and receivers.

Bore sight equipment. The bore sight equipment used is a 16-inch Bore Sight Mk 2 Mod 0 (figure 13-9). It comprises a telescope, a telescope holder, and a muzzle disc. The telescope is either Telescope Mk 75 Mod 0 or Telescope Mk 8 Mod 6. The telescope holder is a steel bar approximately 32 inches long. A hole at each end of the bar provides a means of fastening it to the gun and a hole in the center is provided for insertion of the telescope. The aluminum muzzle disc, approximately 16 inches in diameter, has a 1/16-inch hole bored through its center.

Preparations for bore sighting. Any convenient target may be used for bore sighting, such as the horizon, a star, or a specially prepared target. When in port, many targets on shore are available. When dry-docked, a batten board target should be used for precise survey and verification of all line-of-sight motions. The batten board should be substantially constructed, with horizontal and vertical lines or wires for each line of sight and bore sight. Small targets should be provided for zero positions in elevation and deflection for each line of sight and scales equivalent to each minute of error should be calibrated adjacent to each target. The structure should be adjusted so that the vertical and horizontal lines are respectively perpendicular and parallel

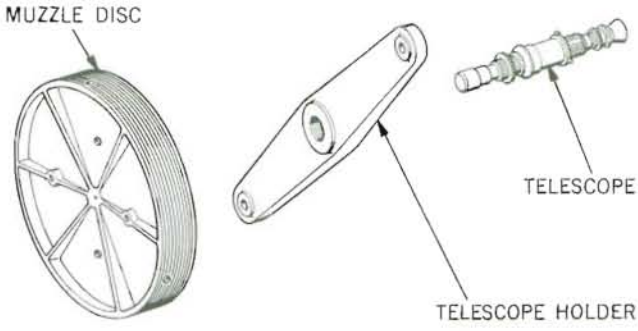

Figure 13-9. 16-Inch Bore Sight Mk 2 Mod 0, General Arrangement

to the plane of the roller path, the turret being trained on the batten with any roller path errors compensated for as prescribed in OP 762. These arrangements should be on the basis of a batten emplacement located at least 200 feet from the gun muzzle. The batten board target should establish that sight angle movements follow traces that are normal to the gun slide trunnion axes throughout the full range of gun and sight movements and that dial indications are without excessive lost motion errors, that is, that they do not indicate errors greater than those listed in the sight test acceptance report. A chase-mounted batten (center gun) is a convenient alternative device for proving the sight angle movements.

Before bore sighting, it is essential to inspect, test, service, and exercise the assemblies as follows:

1. Examine the telescopes to see that they are clean, properly focused, free from parallax, and that the crosslines are clearly visible and in horizontal and vertical positions.

2. Run the sights, at one station, through full arcs in elevation and deflection to see that they work freely and are properly lubricated; shift the clutch controls to the other station and repeat.

3. Verify that the telescope holder (bore sight) is true, that it has not been bent or damaged.

4. Inspect the bore sight telescope.

The installed arrangement of the bore sight is shown in figure 13-10. Installation procedure is as follows:

1. Insert the muzzle disc in the gun muzzle with the position marked TOP uppermost.

2. Attach the telescope holder to the gun by means of two bolts passed through the holes in the ends of the holder and screwed into the threaded holes provided in the screw box liner face.

3. Insert the telescope in the telescope holder.

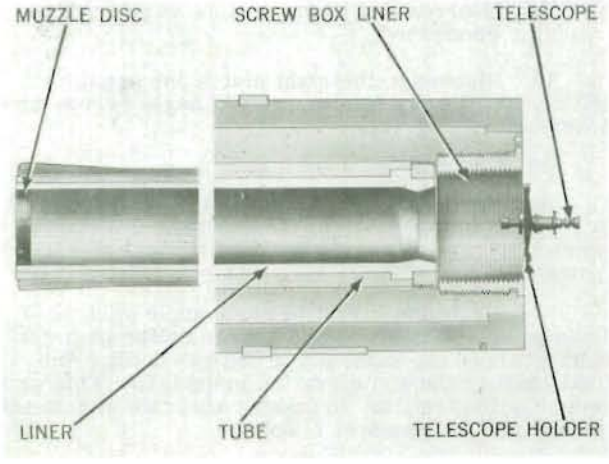

Figure 13-10. 16-Inch Bore Sight Mk 2 Mod 0, Installed in Gun

Bore sighting procedure. The procedure described below is initiated by bore sighting the center gun on the selected target, verifying parallelism of each telescope line of sight by bringing it on the same target, and checking for deviation of dial indications from the desired readings of 2000-minute sight angle and 500-mil sight deflection. This procedure is repeated for each of the two wing guns. (Deviations of triple gun bore alignment are averaged as explained in OP 762.) The operations prove alignment or error for zero sight angle and sight deflection only and enable sight system adjustment of dial indications and lines of sight to agree with the gun bore at that position only. These purposes are accomplished as follows:

Man the sight pointers' and sight trainers' telescopes. (Normally the turret officer takes the station at the bore sight telescope with the regular personnel at their stations.) Set the sights at 2000-minute sight angle and 500-mil deflection. Using one sight station, check one set of lines (horizontal or vertical) and then the other. This checking is done by the officer or man at the bore sight telescope calling out "Mark!" when on the target, with the others observing differences. Right, left, and vertical errors of the sight telescopes are then separately adjusted at their shaft inputs until they are on the target when "Mark" is given. When the adjustments are complete it is good practice for the sight pointer and sight trainer to call "Mark," separately, so that the bore sight observer can see the effect of their adjustments. The procedure is then repeated using the other sight station. Vertical and horizontal adjustments of the lines of sight established by this means are made as described in the following paragraphs.

Sight movement adjustments. Inaccuracies and errors revealed by the bore sight and dial checks are adjustable at the sight mountings and shaft inputs and outputs. The sight mountings are adjusted by refitting and shimming the sight station pedestal brackets and the shaft inputs and outputs by the adjustable couplings provided. Telescope holder bearings and elevation brackets are not adjustable and must not be altered. Refitting and shimming operations are authorized only when sight errors are confirmed by precise survey (batten board bore sighting in drydock). Following any adjustments of the sight system pedestals or shafts or both, the entire assemblies must be accurately rechecked and the elevation indicators reset. The adjustments of the indicators are described below. These include all operations incident to coupling a new installation; readjustment operations for installed units, to correct dial inaccuracies, are apparent from the routine.

Gun elevation indicator adjustments. The following instructions refer only to mechanical alignment with the sight assembly; see OP 854 for adjustment of other elements. When installing the gun elevation indicators, the units must be coupled and adjusted in the sequence of operations described in the routine below, particularly observing the precautions specified.

Coupling the elevation response shaft. This shaft receives its drive from the elevating gear B-end. It operates a cam in the instrument which compensates for the lack of proportion between the travel of the elevation lead screw and the travel of the gun, so that the dials will give true elevation of the gun before additional correction is added for velocity loss and roller path compensation.

Before coupling the instrument to the response gear, the following is necessary:

1. Elevate the gun to 2000 minutes (zero elevation).

2. Turn the velocity loss knob until the velocity loss dial reads zero foot-seconds velocity loss.

3. Lock the velocity loss knob.

4. Turn the elevation response shaft by hand until the angle reader dial is exactly 2000 minutes. The shaft should turn freely.

5. Remove the lower side cover. Check the scribed line on the cam for coincidence with the fixed index when the angle reader dials are exactly at 2000 minutes.

6. With the gun at 2000 minutes and the indicator set at 2000 minutes, the response shaft from the hydraulic unit may be coupled to the response shaft of the indicators. A micrometer is provided to permit coupling the shafts together in their proper relation.

7. After connections have been made, the dial should be rechecked for 2000 minutes, the indices should be checked for matching, the gun retrammed for 2000-minute positions.

8. The depression stops for guns of turret II should be set at 2000 minutes to prevent damage to the periscope located in turret I.

Coupling the sight angle input shaft. This shaft receives its drive from the sight setter's indicator through connecting gearing and shafting. The sight angle input shaft drives through a worm to a carriage which operates a multiplying mechanism. If this input shaft is turned so that the sight angle dial reading is greater than 4800 minutes, serious damage to the mechanism of the instrument will result. Therefore, before connecting the shafts:

1. Set all three gun elevation indicators in the turret so that all sight angle dials in the upper right-hand corner of the instruments read similarly at some angle between 2300 and 3000 minutes. For purposes of description, it is assumed that all dials will be set at 2500 minutes.

2. Operate the right sight setter's sight angle handle, turning it to the 2000-minute dial position, and set the index pointer on the switch carrier of the clutch synchronizing mechanism at the equivalent position shown on drawing number 343418. Match the index pointer on the cam carrier with the index on the switch carrier. Engage the right sight angle synchronizing clutch (the left clutch being disengaged and locked out by the solenoid plunger). Operate the sight angle handle until the sight angle dial reads 2500 minutes.

3. Connect all sight angle shafting between the right sight setter's indicator and the three gun elevation indicators, the latter instruments being positioned as in step (1). If necessary, fine adjustments may be made at the micrometer coupling located in the sight angle shaft leading to each elevation indicator, but not at the micrometer coupling located in the right gun pocket on the transverse sight angle shaft.

4. Check that the right sight setter's synchronizing clutch is engaged. (The left station should be disengaged and the shafts uncoupled.) Check that the right sight setter's indicator sight angle dial and the sight angle dial in each of the gun elevation indicators read 2500 minutes accurately.

5. Disengage the synchronizing clutch at the right sight setter's station.

6. Operate the left sight setter's sight angle handle, turning it to the 2000-minute dial position, and set the index pointer on the switch carrier of the clutch synchronizing mechanism at the equivalent position shown on drawing 343736. Match the index pointer on the cam carrier with the index on the switch carrier. Engage the left sight angle synchronizing clutch.

7. Operate the sight angle handle until the sight angle reads approximately 2500 minutes.

8. Connect the remaining sight angle shafting from the left clutch to the micrometer coupling in the left gun pocket and the elevation indicators.

9. Operate the sight angle handle at the left sight setter's indicator to give exactly 2500 minute dial reading.

10. By means of the micrometer coupling in the left gun pocket, simultaneously set all three gun elevation indicator sight angle dials accurately at 2500 minutes.

11. Verify sight angle indications as follows:

a. Disengage the left clutch and engage the right clutch.

b. Set 2000 minutes sight angle and check at each gun elevation indicator.

c. Set 4700 minutes sight angle and check at each gun elevation indicator.

d. Return to 2000 minutes sight angle; any variation of the elevation indicator readings is indicative of lost motion. If it exceeds plus or minus 2 minutes, inspect all gear brackets and gear housings. Interchanged or incorrect assembly of left and right gear elements of the gear train will result in accumulation of error and cause serious damage to the indicator concerned.

12. Disengage the right clutch and engage the left clutch. Verify minimum sight angle errors as described in step (11).

Coupling the train angle input and adjusting roller path tilt compensation. Connect the shafting between the training gear A-end and the gun elevation indicator.

1. Train the turret to some angle such as 0 degrees or 180 degrees and set the roller path azimuth scale to the same angle before coupling the final shaft to the gun elevation indicators. This procedure will save time in making accurate adjustment through the micrometer couplings.

2. After all train angle shafts have been coupled, the gun elevation indicator roller path azimuth scale should be checked in all three indicators to see that they agree with the train indicator.

3. When delivered for initial installation, all gun elevation indicators have the roller path azimuth scale set at zero (zero index matching "C," fixed index), the tilt scale set at zero (the adjustable "A" index set on zero of the fixed scale), and the high point set at 180 degrees on the 0 to 360 degree graduated dial. When the high point and the amount of tilt have been determined for the turret roller path (refer to OP 762), adjustments are made according to the following steps.

4. Remove the rectangular cover below the dial cover. Use the special spanner wrench provided with the gun elevation indicators to remove the slotted nuts.

5. Loosen, but do not remove, the two bolts (158337-7) which clamp the tilt scale mechanism to the azimuth scale (315964).

6. By turning the worm, rotate the "B" index to the desired high point on the azimuth scale. After this adjustment is made, tighten the tilt scale bolts.

7. To adjust the tilt scale, turn the screw (158338-8) and match graduations on scale "A" with the index. It is not necessary to loosen the clamping guides when adjusting the tilt scale.

8. For simplicity in making the adjustments in steps (5) and (6), the train drive shaft may be disconnected at the coupling where it enters the instrument. This makes it possible to turn the azimuth scale without rotating the turret. After all adjustments have been effected, reset the roller path azimuth scale by observing the angle of train on the train indicator.

Coupling the gun elevation order input (mechanical). Before coupling the input, it is first necessary to set the sight trainer's and sight pointer's telescopes at zero sight angle (2000 minutes). If this position has not been predetermined, it may be accomplished by bore sighting or by placing battens on the guns. (See New York Navy Yard Sketch #A-1376).

1. After the sight pointer's and sight trainer's sights have been established, start at the right station and recheck the setting of sight angle and deflection on the sight setter's indicator for zero.

2. Engage the clutch at the right sight pointer's station. The clutch in the left sight pointer's station must be in neutral.

3. Connect the shafting to the gun elevation indicator from the right station only.

4. With all guns and sight on 2000 minutes, turn all three mechanical gun elevation order input shafts on the gun elevation indicators so that the mechanical follow-the-pointer and zero-reader dials read 2000 minutes.

5. Set the gun elevation order dials by removing the front cover and, using a dial wrench, reset the zero-reader and the high speed mechanical follow-the-pointer inner dial. Do not disturb the setting of the outer mechanical elevation order dial.

6. Disengage the clutch at the right sight pointer's station. Do not disturb the sights or shafting until the final settings in the left sight pointer's station have been accomplished.

7. Engage the clutch at the left sight pointer's station.

8. Check the sight setter's indicator for 2000-minute reading of the sight angle dial and for zero deflection on the deflection dial.

9. Couple the shafting from the left sight pointer's station to the gun elevation indicators without disturbing the gun elevation order dial settings.

10. By turning the micrometer coupling on the shaft running behind and parallel with the sight pointer's sight mount (120-speed sight angle shaft, dr. no. 235200), bring the sight pointer's and sight trainer's telescopes simultaneously to 2000 minutes.

11. Verify that all settings for mechanical gun elevation order are as follows: Right sight pointer's station clutch in neutral, sight pointer's and sight trainer's telescopes on 2000 minutes. Sight setter's indicator (right station) at 2000 minutes sight angle and 500 mils deflection. Left sight pointer's station clutch engaged and sight pointer's and sight trainer's telescopes on 2000 minutes. Sight setter's indicator (left station) at 2000 minutes sight angle and 500 mils deflection. Elevation order dials at each gun elevation indicator set at 2000 minutes. Elevation angle dials at each gun elevation indicator set at 2000 minutes.

12. Check the gun order movements by operating to full limits in both directions from each station. If lost motion errors exceed plus or minus two minutes, examine the gear train for incorrect assembly.

DISASSEMBLY AND ASSEMBLY

General instructions

The positions of all telescope mounts, gear housings, gun attachment brackets, bearing brackets, shafting and couplings, and attached instruments are fixed by design. All were established at ship's installation by tests and bore sight alignments. Alteration of relative position of these parts may not be made. They are to be reassembled in the same positions after any repair or disassembly work. Dismantling of any of the elements of the sight, gun attachments, and associated instruments is to be discouraged. It must never be attempted except under supervision of the gunnery officer, experienced fire control men, or home yard staff. Instruments attached to the assemblies may be dismantled only by authorized personnel familiar with such optical and fire control equipment. Disassembly and reassembly of most parts of the sight mechanism and gun attachments are apparent from the illustrations of this text and the general arrangement and design detail drawings. It is particulary important to observe the assembled positions of deflection and elevating sectors and worms, and bevel and spur gears. These are lap-fitted parts. All such mating parts should be punch marked and tagged as removed.

Chapter 14

RANGEFINDER MOUNT ASSEMBLIES

Rangefinder Stand Mark 52 Mod 0

Rangefinder Stabilizer Mark 4 Mod 1

GENERAL DESCRIPTION

Turrets II and III are equipped with rangefinder mount equipment located and arranged at the rear of the turret. All installations are identical. The equipment is adapted to mounting 46-foot base length instruments of either stereoscopic or coincidence type, the objectives of both types being identically housed in shuttered hoods with port openings. These hoods permit limited deflection and elevation movement of the lines of sight. Stereoscopic Rangefinder Mk 52 Mod 0 is installed in the mount.

Components

Each rangefinder mount assembly comprises two assemblies:

Rangefinder Stand Mk 52 Mod 0
Rangefinder Stabilizer Mk 4 Mod 1

Functional arrangements

The stand supports the rangefinder horizontally in a carriage which pivots the instrument for both elevation and azimuth movements. The instrument rotates in carriage bearings for elevation of the lines of sight (movement counter to roll of ship). For azimuth movement, the entire carriage and instrument pivot in deflection through slight arcs centered at the mid-point of the carriage beam. Elevating movement is automatically stabilized by the rangefinder stabilizer or may be manually operated by hand gear. The azimuth movement is manually operated.

Limits of movement

The stand and stabilizer designs include limit stop arrangements which limit instrument movement as follows:

Elevation: - 30 degrees; 15 degrees on each side of the horizontal line of sight.

Azimuth: - 12 degrees; 6 degrees on left and right.

Stand and stabilizer emplacements

The stand and the stabilizer assemblies have structural support arrangements in the turret officer's compartment. The stand is mounted on pedestals, the two roller path elements, right and left, being rigidly secured to these structures. The arrangements locate the rangefinder carriage transversely at the rear of the compartment in line with large ports in the side armor plates. These two rangefinder ports are enclosed by hoods bolted to the shield armor plate at the top rear corners of the turret. The entire stabilizer assembly is located in the compartment. Three elements, a control panel, a motor-amplidyne set, and a motor-alternator set are mounted on step brackets behind the rangefinder. A fourth element, the stabilizing unit, is secured to the rangefinder stand carriage.

DETAIL DESCRIPTION

Stand

Components. Each rangefinder stand (fig. 14-1) comprises the elements listed below; they are described in this chapter in the order given.

Rail and guide brackets
Carriage assembly
Right and left bearing assemblies
Connecting carriage beam
Altitude mechanism
Deflection gear
Locking devices

Rail and guide brackets. The rail and guide brackets are large, cast steel, arc-shaped tracks machined to provide a horizontal roller path upon which the bearing assemblies are guided in their azimuth motion. The left bracket is shown in figure 14-2. They are bolted at opposite sides of the compartment to structural foundations which are built in the turret. An integral, annular rack segment on each bracket provides a fixed gear for the movement of 12 degrees in azimuth. Each bracket has two concentric roller paths on rails machined in a common plane on the top of the casting. These rails are arranged with "holding-down" roller paths on the underside of the inner rail, beneath the rack. Integral positive stops which limit movement of the bearing assembly are in the outer rail spaced in the way of a stop bolt.

Carriage assembly. The carriage assembly comprises a carriage beam, right and left bearing brackets, two roller brackets, two bearing caps, bearing rollers, and azimuth rollers. With these are assembled the azimuth gear, the altitude mechanism, and the locking gear.

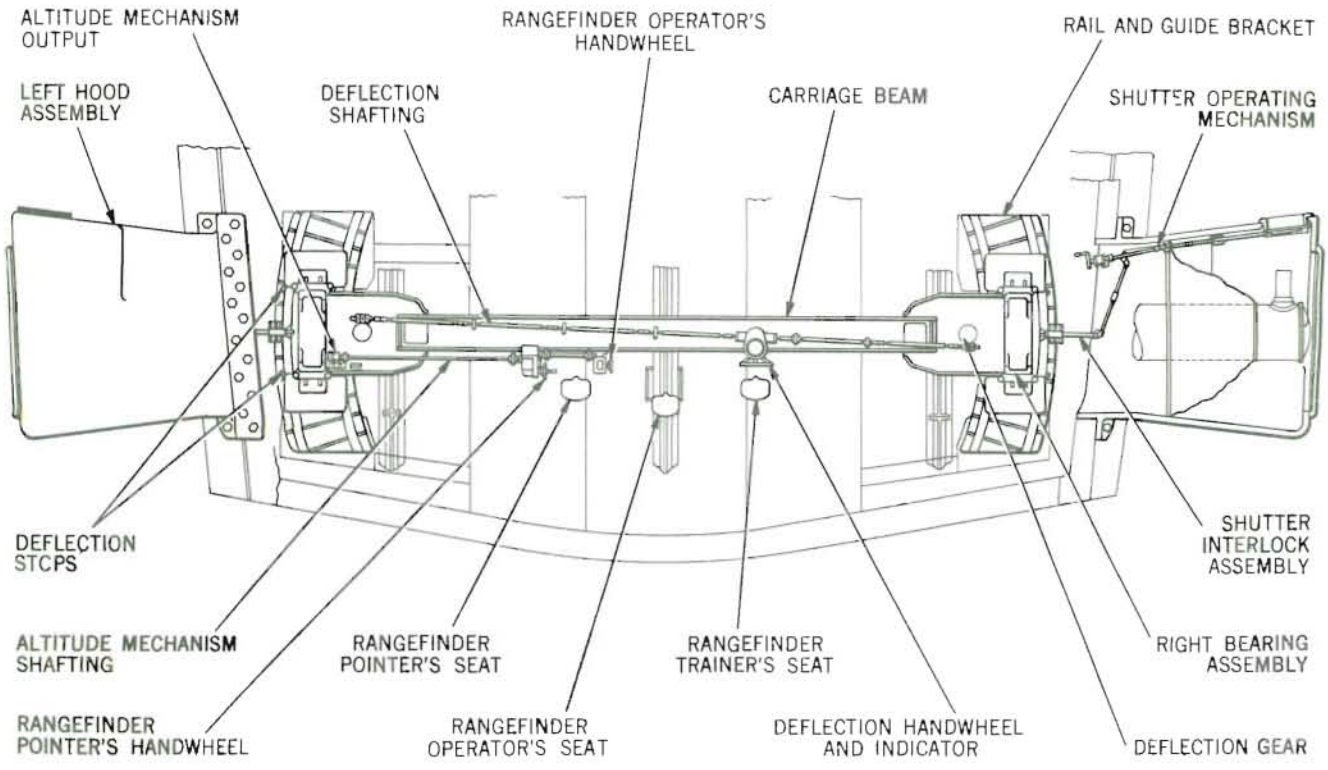

Figure 14-1. Rangefinder Stand Mk 52 Mod 0, General Arrangement

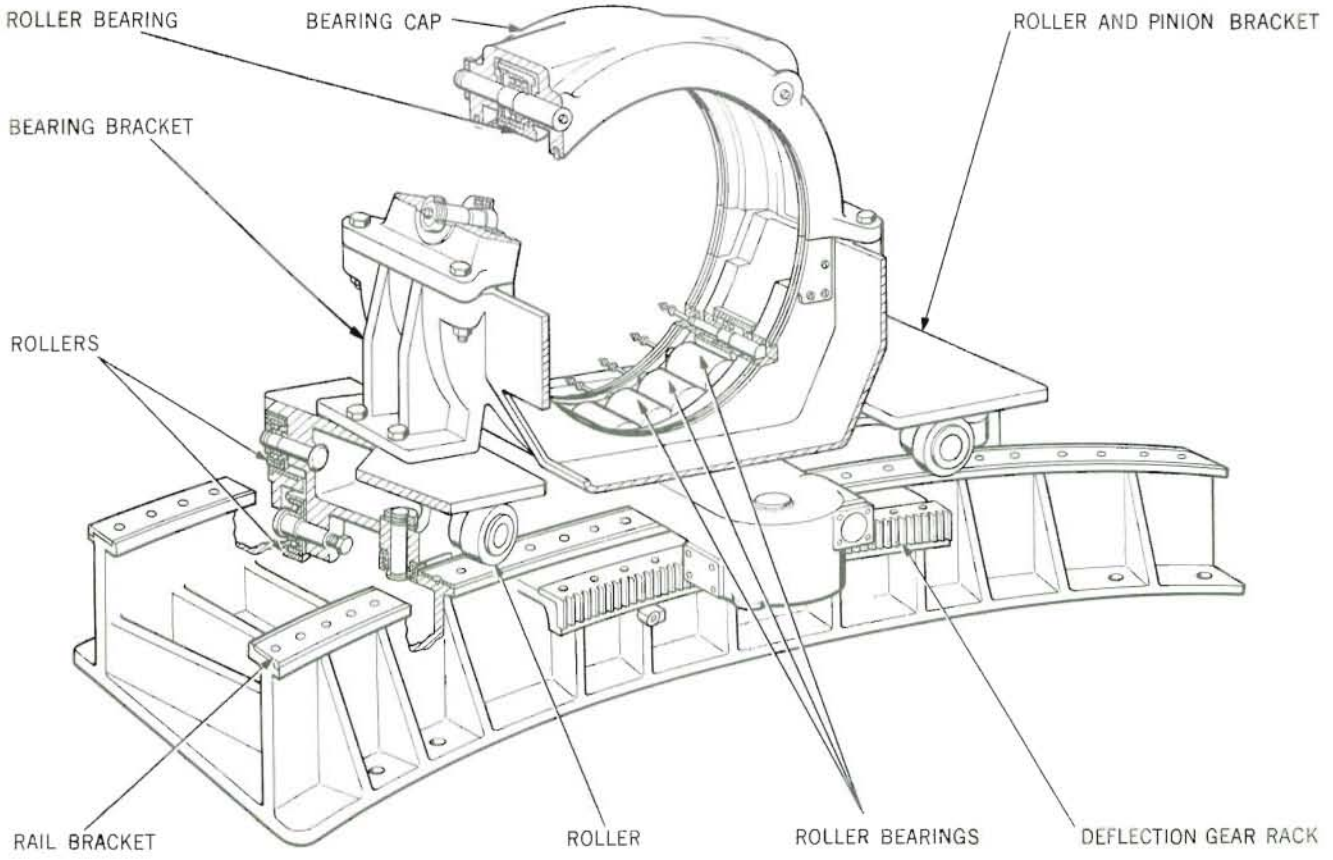

Figure 14-2. Left Rail Bracket and Bearing Assembly, Sectional View.

Right and left bearing assemblies. The right and left bearing assemblies provide roller bearing support for the rangefinder. Each assembly has eight rollers located in the bottom arc of the instrument bearing and two rollers equally spaced in the bearing cap. Thus, when mounted in the bearings, the rangefinder is supported and restrained in each bearing but is capable of frictionless rotation about its axis. The rangefinder bearings are rigidly attached to the bearing bracket by means of angle brackets.

Connecting carriage beam. The carriage beam is a welded steel, box-section beam approximately 20 feet long. It is attached to the right and left bearing brackets. The deflection shafting and the deflection drive are mounted in the beam. The deflection handwheel and indicator are mounted on the right rear side. The altitude mechanism differential, the two altitude mechanism handwheels, and the stabilizing unit of the stabilizer are secured to the left rear side.

Altitude mechanism. Line-of-sight elevating and depressing motion (to follow the roll of the ship), is produced manually through an altitude mechanism or automatically through a stabilizer.

Manual drive. The manual mechanism, figure 14-3, comprises rangefinder pointer's and rangefinder operator's handwheels connected by gearing and shafting to a pinion and rack. The pinion is enclosed in a bracket mounted on the left bearing bracket. The rack attaches to the rangefinder.

Automatic drive. Elevation movement of the rangefinder by means of the stabilizer is described later in this chapter.

Deflection gear. At the center of the carriage beam is a handwheel-operated deflection setting and indicator assembly, figure 14-4. It consists of a bevel gear and shaft drive from the handwheel to each of two deflection drive pinions meshed with the respective racks of the rail and guide brackets. The deflection gear provides equal simultaneous traverse for the two bearings, the movement being centered at the midpoint of the beam.

Locking devices. Altitude mechanism and deflection gear locking devices are provided for securing the carriage and rangefinder when not in use.

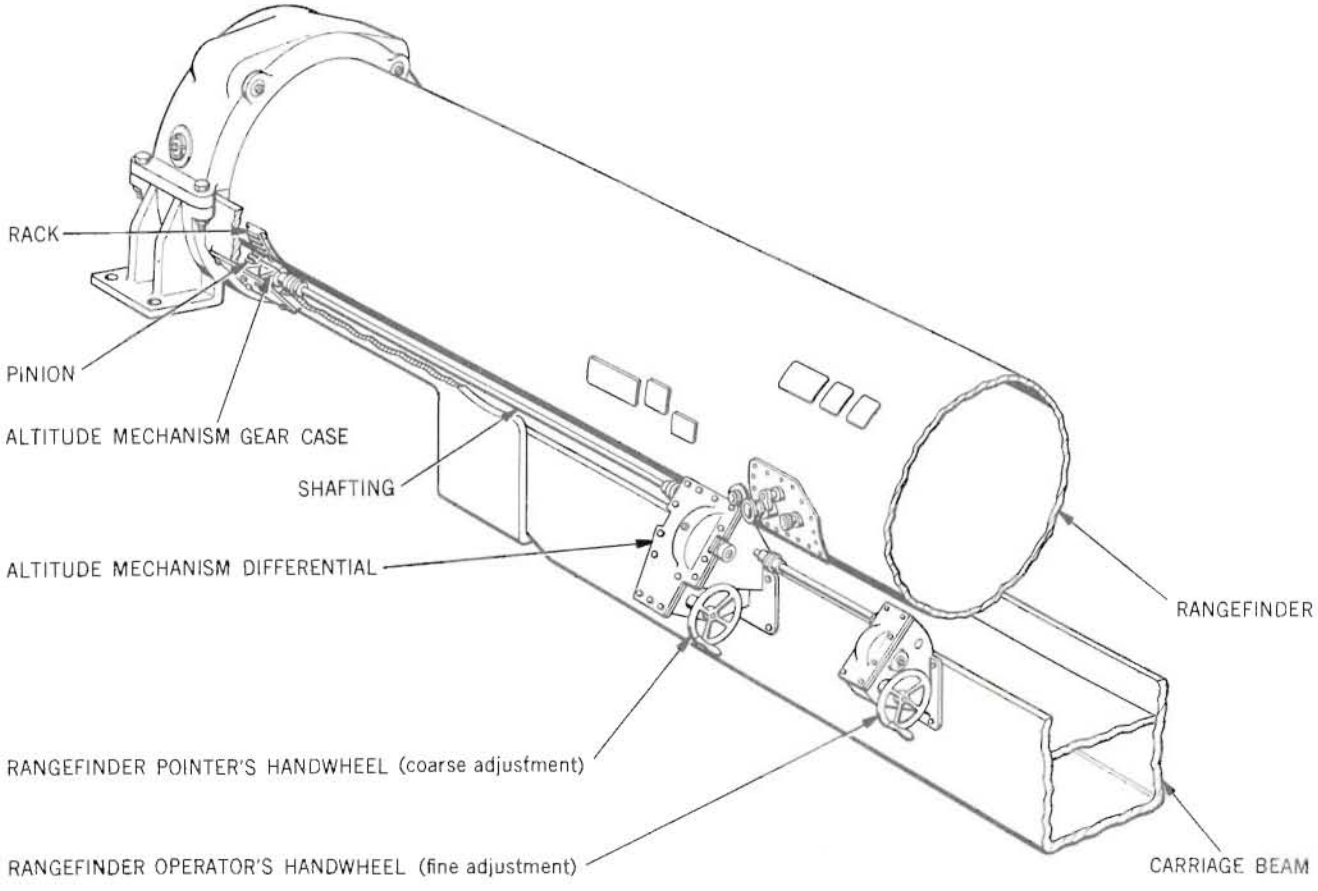

Figure 14-3. Altitude Mechanism, General Arrangement

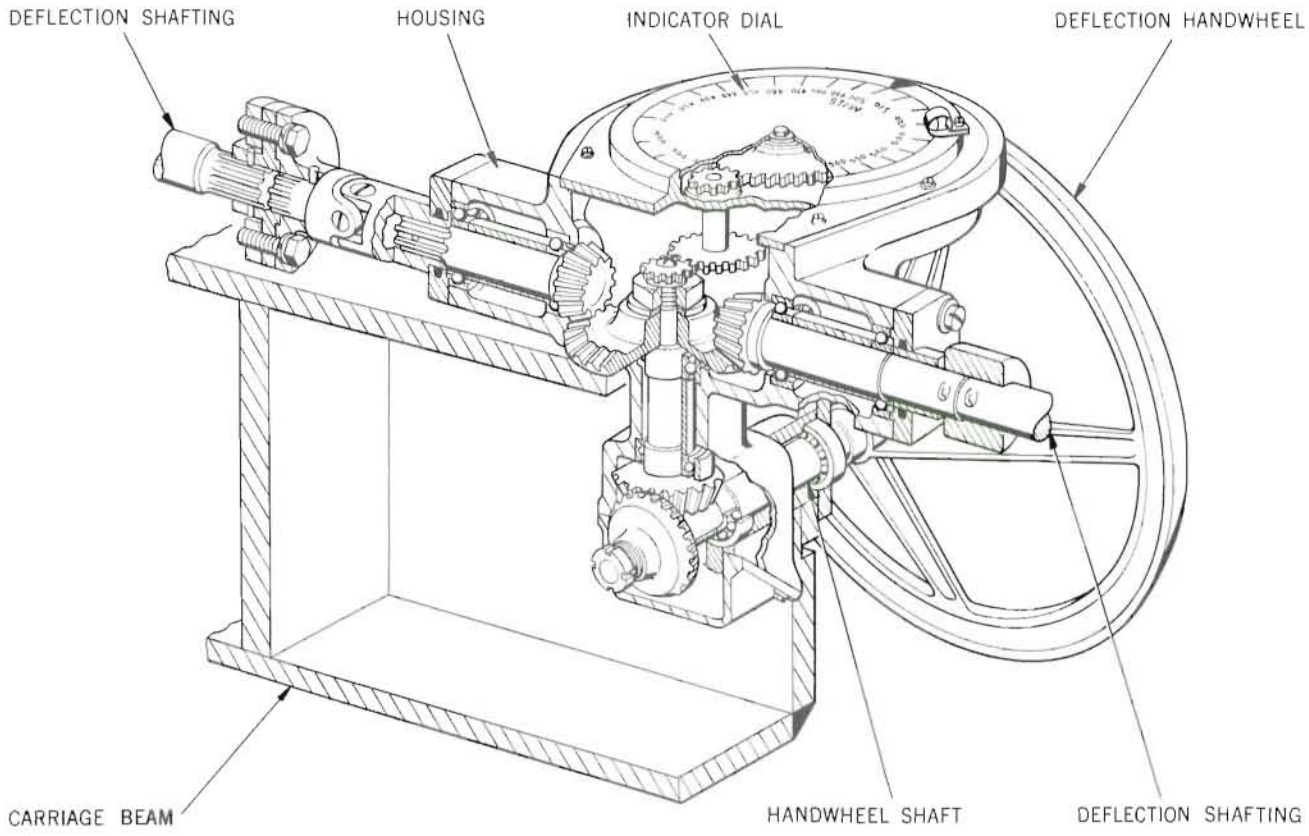

Figure 14-4. Deflection and Deflection Indicator Drive, Sectional View

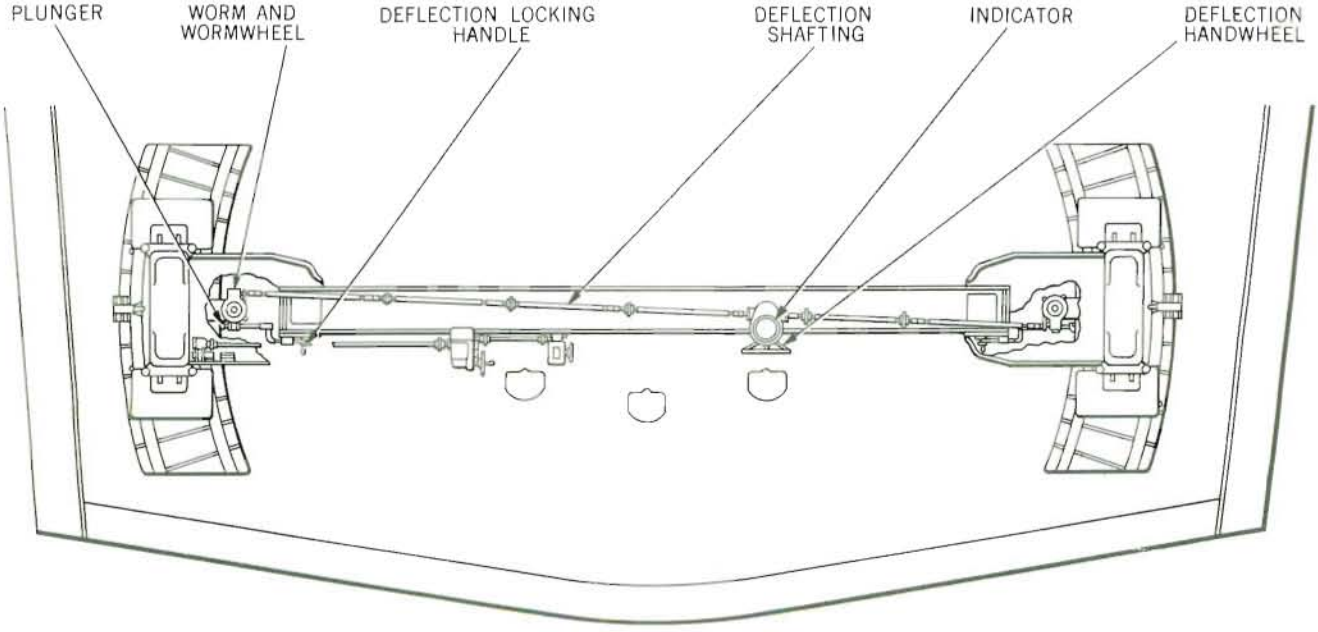

Figure 14-5. Deflection Drive and Deflection Drive and Deflection Locking Mechanism

Altitude mechanism. The rangefinder stand does not include provision for locking the altitude movement but the attached stabilizer assembly operates to prevent movement of the instrument in the bearings when the stabilizer is secured.

Deflection gear. The deflection gear locking device (fig. 14-5) is a hand-crank mechanism with eccentrics and locking shafts. At zero deflection, these elements can be operated to thrust a plunger shaft, located in each bearing bracket, into an aligned hole in each rail bracket.

Hoods. Each hood assembly, as shown in figure 14-6, comprises a cast steel hood, cover plate, shutter frame, and a bronze shutter with a shaft and screw mechanism operated by a handcrank. Fitted fabric sleeves secured to the rangefinder close the hood apertures against the admission of gas and weather.

Stabilizer

Purpose. Rangefinder Stabilizer Mk 4 Mod 1 is an automatic assembly, controlled by a gyroscope and driven by an electric motor, which holds the rangefinder lines of sight horizontal.

Type. The stabilizer is a self-contained assembly of commercial manufacture with functional arrangement of its parts as shown in figure 14-7. Electrical circuit arrangements and details of electric equipment are given in chapter 15 and in paragraphs below.

Components. The stabilizer assembly comprises five principal units designated as follows:

Stabilizing unit
Rangefinder drive
Amplifier control panel
Motor-amplidyne generator set
Motor-alternator set

Stabilizing unit. The stabilizing unit consists of a gyroscope unit and a power drive. It is a large enclosed case, mounted on the left side of the carriage beam, with an external flange-mounted power motor and an "AUTO-HAND" manual selector. Two manual input shafts, designated "hand drive" and "added hand input," are located on one side; an output shaft, common to power and hand drive, is located on the opposite side.

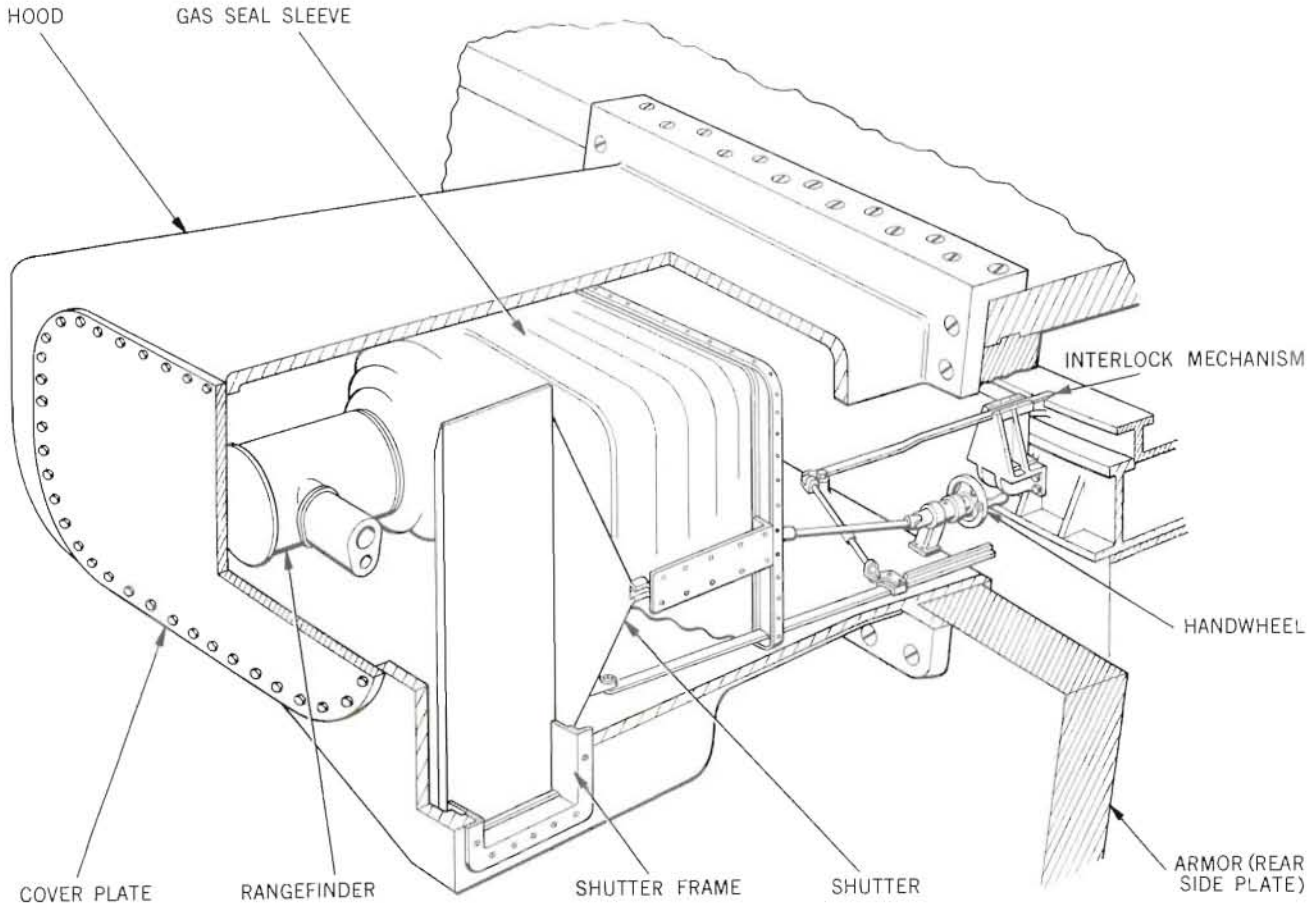

Figure 14-6. Hood Shutter Operating Mechanism and Interlock

Gyroscope unit. The gyroscope unit consists of a gyroscope, gimbal, erecting magnet, ring gear, an exciting coil, and a pick-up coil.

Gyroscope. The gyroscope has a balanced rotor with considerable inertia, with a conducting disc fastened to the lower end. It receives power from the 24-volt, 230-cycle output of the motor-alternator, rotating at a speed of approximately 13,600 revolutions per minute. The gyroscope is non-pendulous and is erected to a vertical position by means of an averaging pendulum coupled electro-magnetically to the gyroscope but not physically connected to it. The conducting disc is a shell (formed of iron over which is spun a thin sheet of copper) in the form of a segment of a sphere.

Gimbal. The gyroscope is pivoted in the gyroscope gimbal which, in turn, is pivoted in the pendulum gimbal. The pendulum bail, to which the erecting magnet is attached, also pivots in the pendulum gimbal. The pendulum gimbal is pivoted about a fixed axis in the case, perpendicular to the line of sight and parallel to the deck. The pendulum gimbal swings in a plane through the line of sight normal to the deck, in response to acceleration of roll or pitch. The mean position of the electro-magnet is then in a vertical plane normal to the line of sight. The gyroscope gimbal pivots about an axis perpendicular to the line of sight and parallel to the deck, and establishes a plane which is maintained parallel to the line of sight.

Erecting magnet. The erecting magnet is mounted on the pendulum bail and excited with 100 volts alternating current. If the pendulum is displaced by any amount from the gyroscope axis, the rotation of the conducting disc in the field produced by the magnet causes eddy currents to flow in the conducting disc. The interaction of these currents with the magnetic field produces a force on the disc which tends to precess the gyroscope into line with the pendulum. The magnitude of this torque depends on the displacement between the gyroscope and pendulum, on the strength of the magnetic field, and on the speed of the disc (constant in this instance). As a result of this torque, the gyroscope precesses toward the pendulum in a dead beat manner without spiralling. Thus the gyroscope tends to assume the average direction of magnetization of the electro-magnet. So long as the gyroscope axis coincides with the average position of the erecting magnet the gyroscope is acted upon by torques of short period, of which the time integral is zero and which exercise a negligible effect upon it. However, if the gyroscope departs from this position the pendulum exerts on it a torque, increasing with the magnitude of departure, which does not average to zero but which causes precession into the mean position of the pendulum.

Ring gear. The ring gear is mounted on the gyroscope gimbal shaft. Attached to the ring gear is a light leaf spring. This spring, when coming to rest against one of the two eccentric stops located on one side of the gyroscope unit, exerts a pressure on the ring gear teeth tending to reengage the gears when the detent area is reached.

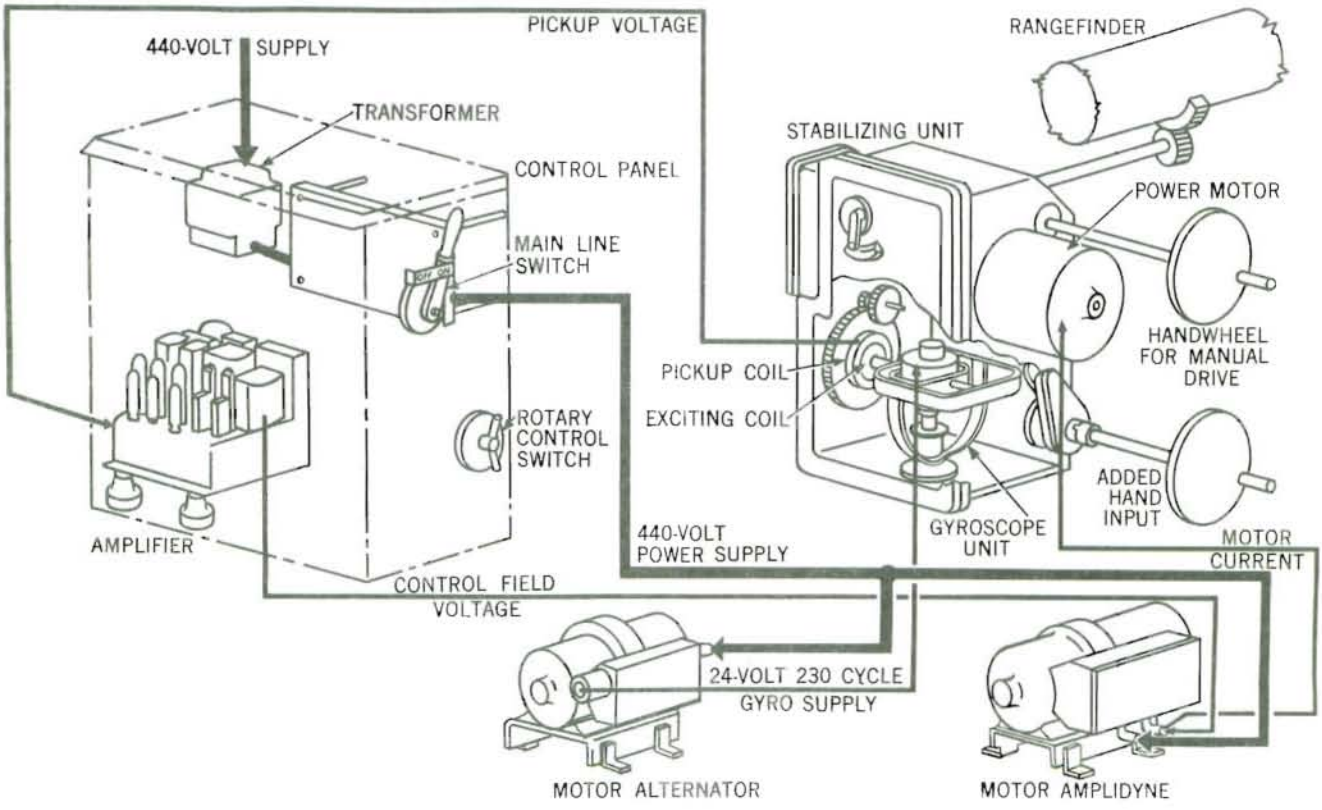

Figure 14-7. Rangefinder Stabilizer Mk 4 Mod 1, Schematic Arrangement

Exciting and pick-up coils. Secured to the pivot shaft of the gyroscope level bail and constrained to rotate with the bail is a cylindrical exciting coil excited with 100 volts alternating current. Concentric with the exciting coil is a pick-up coil, mounted in the ring gear, in which a voltage is induced proportional to the angular displacement between the axes of the two coils. This voltage is the input signal to the vacuum tube amplifier located in the control panel. The output of the amplifier is fed to the control fields of the amplidyne generator which in turn controls the power motor located in the stabilizing unit. The voltage induced in the pick-up coil depends upon the direction and the magnitude of the rotation of the exciting coil. Thus, if the exciting coil is rotated with respect to the cylindrical pick-up coil, the voltage in the pick-up coil can be reduced to zero by moving it the same amount and direction that the exciting coil has been moved. By suitable gearing, the power motor rotates the pick-up coil into correspondence with the exciting coil, thereby measuring and transmitting to the rangefinder the rotation of the gyro level bail relative to the case.

Power drive. The power drive drives the rangefinder through an adjustable friction clutch and through a gear train in the upper part of the stabilizer.

Electric motor. The power motor is externally flange-mounted against the right side of the stabilizing unit.

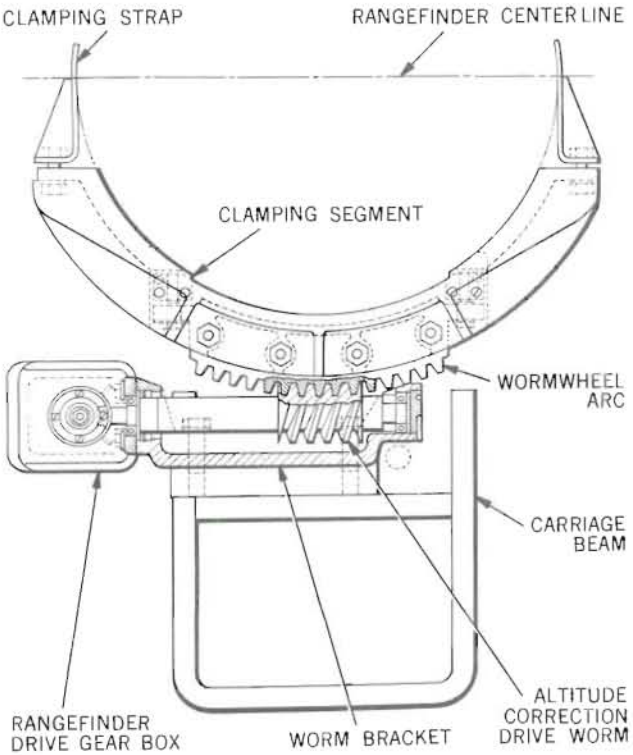

Figure 14-8. Rangefinder Stabilizer Drive

Motor data:

Type	Permanent magnet field
Design features	Horizontally mounted, direct drive, waterproof enclosure, natural draft ventilation
Horsepower	1/6
R.P.M.	1725
Rotation	Reversible
Voltage	0.75
Ambient temperature, C	50
Weight, lbs	42
Manufacturer	General Electric Co.
Manufacturer's designation	5BBY47AB10
Drawing	351101

Adjustable friction clutch. The adjustable friction clutch permits the power motor to reach operating speed before starting to drive the gear train. It comprises a disc, clutch plate, gear, spring, and nut. The clutch is adjusted by varying the tension of the spring, which is held in place by the nut.

Gear train. The gear train includes a clutch shifting mechanism, a clutch switch, a limit stop mechanism, and the "added hand input" shaft.

Clutch shifting mechanism. The clutch shifting lever has two positions, AUTO and HAND. When the lever is moved to HAND, a shifting fork disengages a gear from the power motor gear train and meshes it with the auxiliary hand drive gear train.

Clutch switch. The clutch switch is operated by an arm attached to the shaft of the clutch shifting lever. When the lever is turned to HAND, the switch de-energizes the system.

Limit stop mechanism. The limit stop mechanism is of the travelling nut stop type. The travelling stop is guided by a rod which rides in a rubber bushing in the travelling stop. When the rangefinder reaches its limits of elevation or depression, a pin on the stop strikes a dog at the end of the threaded shaft. The rubber bushing lessens the shock.

"Added hand input" shaft. The power motor is geared to a 1-speed ring gear through one side of a differential; the other side of the differential is geared to the "added hand input" shaft. This shaft permits correction of the line-of-sight when considerably below or above level. A friction brake, arranged to drag on a small drum, prevents the shaft from turning when not in use.

Rangefinder drive. Figure 14-8 illustrates the drive attachment of the stabilizing unit output shaft by which the altitude movement of the rangefinder is controlled. It comprises a worm bracket element mounted on the carriage beam and a meshed wormwheel arc element clamped on the instrument. The speed ration of this drive, worm to instrument, is 56 to 1.

Amplifier control panel. The control panel unit is a waterproof enclosure which contains a supply

transformer, a line switch, an amplifier unit, a selenium rectifier, a selector switch, and protective fuses. It is mounted behind the rangefinder on the rear armor plate bulkhead of the gun house.

Arrangements. The line switch (fig. 14-9) controls the 440-volt supply to the motor elements of the two generator sets described below and to the supply transformer. The selector switch is a 3-position type with the positions designated OFF, START GYRO AND STAND BY, and AUTO. The amplifier is an electronic assembly which includes power, grid, filament, and plate transformers, power supply and stabilizing filter capacitors, limit relays, and six vacuum tubes. The unit picks up gyroscope oscillation signals, amplifies the signals, and transmits them to the field coils of the amplidyne. These control-field voltage inputs unbalance the generator field and provide amplidyne power output to the power motor as indicated below.

Motor-amplidyne generator set. The motor-amplidyne generator set generates the power outputs for driving the power motor of the stabilizing unit. It comprises a 3/4 horsepower, 440-volt, 3-phase, 60-cycle motor driving a 1.5-ampere, 250-volt, 375-watt direct current amplidyne generator at 3450 revolutions per minute. It is mounted on the rear armor plate bulkhead of the gun house. The unit is a 2-bearing horizontal assembly (both armatures on a common shaft). The set operates (fig. 14-7) to vary power-motor input in response to control-field voltage changes of polarity and magnitude, the field changes being derived from the amplified pick-up coil signals. It thus produces motor-driving current to level the rangefinder whenever the gyroscope gimbal moves in response to motion of the hull.

Data.

Type	Squirrel cage, induction
Design features	Horizontally mounted, direct drive, semi-enclosed natural draft ventilated
Horsepower	3/4
R.P.M. synchronous	3600
R.P.M. full load	3450
Speed class	Constant
Voltage	440
Phases	3
Cycles	60
Ambient temperature, C	50°
Torque class	Normal
Weight, lb	80*
Manufacturer	General Electric Co.
Manufacturer's designation, motor	5K47LC14
Drawing	351102

* Includes entire motor amplidyne

The generator has field windings for control (separately excited), quadrature, compensating, and demagnetizing and is rated as follows:

Volts (D.C.)	250
Amperes	1.5
Watts	375

Motor-alternator set. The motor-alternator set generates the high-frequency current which drives the gyro (fig. 14-7). It is mounted on the rear armor plate bulkhead of the gun house.

Data.

Type	Squirrel cage, induction
Design features	Horizontally mounted, direct drive, semi-enclosed natural draft ventilated
Horsepower	1/4
R.P.M. synchronous	3600
R.P.M. full load	3450
Speed class	Constant
Voltage	440
Phases	3
Cycles	60
Ambient temperature, C	40°
Weight, lb	60*
Manufacturer	General Electric Co.
Manufacturer's designation	5K36HD31
Drawing	351103

* Includes entire motor-alternator

The alternator is of the permanent magnet excited type and is rated as follows:

Volts	24
Cycles	230
Watts	100

Controls and interlocks

Rangefinder controls. The rangefinder stand and stabilizer provide the means of moving the rangefinder in deflection (azimuth movement) and altitude (elevating movement).

Deflection gear (azimuth movement). The rangefinder trainer, seated to the right of the rangefinder operator, operates the deflection gear handwheel

Manual control. The deflection handwheel is mounted on the right rear side of the carriage beam. Turning the wheel provides a maximum movement of 6 degrees on each side of a line normal to the turret fore-and-aft centerline. Mil graduations on the indicator dial, directly above the handwheel, show the direction and amount of deflection setting.

Altitude mechanism (elevating movement). Elevation or depression of the rangefinder is accomplished manually by handwheels or automatically by the stabilizer.

Manual control. The handwheels permit rapid altitude setting and fine adjustment between the limits of 15 degrees elevation and 15 degrees depression. This motion is limited to 15 degrees by the stabilizer element with positive stops at 16 degrees in the rangefinder stand.

Pointer's handwheel. The pointer's handwheel, mounted on the carriage beam to the left of the pointer's seat, permits rapid movement of the rangefinder in elevation.

Rangefinder operator's handwheel. The rangefinder operator's handwheel, located to the left of the rangefinder operator's seat, provides a means of fine adjustment after the pointer has set the rangefinder in elevation.

CONTROL PANEL

RECTIFIER

Q	SELENIUM	STACK SH4AM4

STABILIZING UNIT

RESISTOR	OHMS	WATT
R31	1,000	1
R32	THYRITE	

AMPLIFIER

CAPACITORS	MFD	VOLTS
C1	0.1	600
C2	0.25	600
C3	1.0	600
C4	1.0	600
C5	0.1	1000
C6	0.1	1000
C7	0.1	1000
C8	0.1	1000
C9	10.0	1000
C10	4.0	1000
C11	10.0	1000

TUBES	TYPE
V1	6N7
V2	6N7
V3	5T4
V4	6L6
V5	6L6
V6	6SN7-GT

AMPLIFIER

RESISTOR	OHMS	WATT
*R1	25,000	2
R2	500,000	1
R3	560	1
R4	30,000	2
R5	100,000	1
R6	500,000	1
R7	560	1
R8	25,000	2
R9	10,000	2
R10	25,000	1
R11	100,000	1
R12	2,000	1
*R13	2,500	25
R14	25,000	1
R15	25,000	1
R16	600	4.8
R17	350	4.8
R18	6,900	12
R19	2 500	4.8
R20	10,000	2
R21	10,000	2
R22	200	20
R23	200	20
R24	100,000	1
*R25	5,000	25
*R26	5,000	25
*R27	5,000	25
*R28	5,000	25
*R29	100,000	2

RELAYS

K1	3 N.C. 115 V.A.C. COIL
K2	3 N.C. 115 V.A.C. COIL

*THESE ITEMS ARE POTENTIOMETERS

TRANSFORMERS		RATING
T1	68G418	60 ∿ – 132/110/83V. PRI. 46/23 V.O.C. 46/23 V.O.C. SEC. 75 KV INS.
T2	68G384	60 ∿ – .014 KVA – 115V. PRI. 300/150V. 300/150V. SEC. 75 KV INS.
T3	68G81	60 ∿ – .090 KVA – 115V. PRI. 800/400V – 212 SEC.
T4	68G82	60 ∿ – 101 HENRYS – 1 AMP. D.C. – D.C. RES. 200 OHMS
T5	68G79	60 ∿ – .049 KVA – 115V. PRI. 6.3-6.3-6.3-6.3-6.0-5.0/2.5 SEG. 75 KV INS.
T6	68G692	60 ∿ – .300 KVA – 440V. PRI. 115/100V. SEC.

SYMBOLS

R	RESISTOR, DESIGNATED BY "R" NUMBER. RESISTANCE VALUE STAMPED ON RESISTOR.
R	POTENTIOMETER, DESIGNATED BY "R" NUMBER STAMPED ON CHASSIS BY POTENTIOMETER. RESISTANCE VALUE STAMPED ON POTENTIOMETER.
C	CAPACITOR, DESIGNATED BY "C" NUMBER. CAPACITANCE VALUE STAMPED ON CAPACITOR.
T	TRANSFORMER, DESIGNATED BY "T" NUMBER STAMPED ON CHASSIS BY TRANSFORMER TERMINALS. TRANSFORMER RATING ON NAMEPLATE ON TOP OF TRANSFORMER.
V	TUBE, DESIGNATED BY "V" NUMBER STAMPED ON CHASSIS BY TUBE SOCKET TERMINALS. TUBE TYPE STAMPED ON TOP OF CHASSIS BY TUBE.
K	RELAY COIL, DESIGNATED BY "K" NUMBER STAMPED ON CHASSIS BY RELAY SOCKET TERMINALS. RELAY K- STAMPED ON TOP OF CHASSIS BY RELAY.
K	RELAY CONTACT, NORMALLY OPEN, DESIGNATED BY "K" NUMBER TO SHOW WHICH RELAY COIL ACTUATES THE CONTACT.
K	RELAY CONTACT NORMALLY CLOSED.
Q	DRY DISK SELENIUM RECTIFIER, DESIGNATED BY "Q". DIRECTION OF CURRENT FLOW DESIGNATED BY DIRECTION OF ARROW ON RECTIFIER. CURRENT FLOWS FROM YELLOW TERMINAL TO RED TERMINAL. RECTIFIER NUMBER STAMPED ON RECTIFIER.

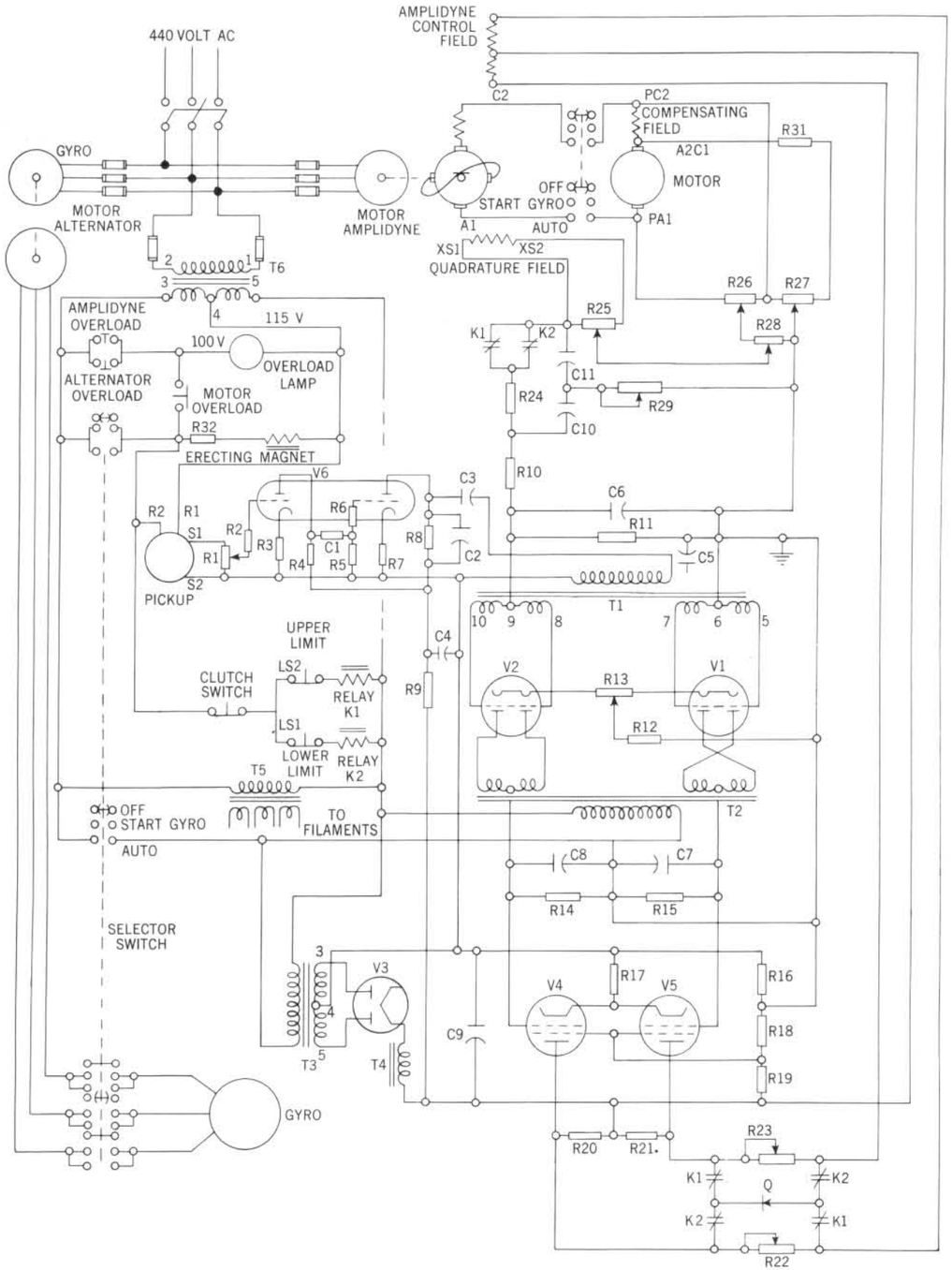

Figure 14-9. Stabilizer Circuit, Wiring Diagram

14-8A/B

Automatic control. Under automatic control the stabilizer unit keeps the rangefinder line of sight in a horizontal position.

Control panel selector switch. The control panel selector switch has two operating positions, START GYRO AND STAND BY and AUTO. In the START GYRO AND STAND BY position, the gyro and the erecting magnet are energized. When thrown to the AUTO position, the power motor is connected to receive power from the amplidyne and the plate supply of the amplifier is energized.

Start-stop control. Closing the line switch, referred to as the start-stop control, starts the motor-amplidyne generator set and the motor-alternator set.

Stabilizing unit manual selector. The stabilizing unit manual selector has two positions, AUTO and HAND. In the AUTO position, the power motor is connected to the rangefinder drive and in the HAND position, the power motor is disengaged and the handwheel for manual drive is made operative.

Handwheel for manual drive. This handwheel provides a means of emergency operation in the event of a breakdown.

"Added hand input" handwheel. By means of this handwheel, a vernier correction may be made to bring the line of sight to the desired position.

Interlocks. There are three interlocks in the stand and stabilizer: the shutter mechanism interlock, the stabilizing unit clutch shifting lever interlock, and the stabilizing unit limit stop interlock.

Shutter mechanism interlock. Each shutter mechanism includes an interlock device which locks the rangefinder stand at neutral position until the shutters are opened. When the shutter handwheel is turned, opening the shutter, a connecting rod and bell crank assembly retracts a locking bar, permitting the carriage to move in deflection.

Clutch shifting lever interlock, stabilizing unit. When the clutch shifting lever is turned to HAND, the auxiliary hand drive is made operative. The clutch switch is also operated and the system is de-energized.

Limit stop interlock, stabilizing unit. Two adjustable hex-headed posts are attached to and extend from each side of the travelling limit stop. Each post actuates a limit switch. When the limit stop strikes the dog at the end of its travel, the limit switch actuated by one of the posts reverses the power motor and backs the rangefinder out of the blind spot.

OPERATION

General

The rangefinder is operated manually in deflection and either manually or automatically in elevation. Normally, the elevating movement should be used automatically. However, if failure of any kind makes the use of hand drive necessary, it is preferable to completely shut down the equipment until repairs can be made.

Manual control

In manual control, the rangefinder trainer, operating the deflection handwheel, keeps the rangefinder on target in azimuth. The rangefinder pointer, using the pointer's handwheel, makes the rapid adjustment necessary to elevate or depress the rangefinder line of sight. The rangefinder operator then makes a fine adjustment in elevation through the handwheel at his station.

Automatic control

Before starting the stabilizer, the control panel selector switch must be in the OFF position. The line switch is turned to ON, starting the motor-amplidyne generator and the motor-alternator. The selector switch is then moved to START GYRO AND STAND BY. After the gyro has come up to speed, the stabilizing unit clutch shifting lever is moved to AUTO. The control panel selector switch is turned to AUTO. (It requires approximately two minutes for the gyro to erect itself; however, the selector switch may be turned to AUTO almost immediately after the gyro is energized. The rangefinder will wander in elevation until the gyro has reached full speed.) If the rangefinder is not exactly on level or on target the rangefinder operator turns the "added hand input" handwheel to bring the line of sight to the desired position.

WARNING

Do not attempt to move the stabilizing unit clutch shifting lever to HAND while the rangefinder is in motion. Before shifting gears, the control panel selector switch must be in the START GYRO AND STAND BY position. If the gears do not mesh easily, work the manual drive handwheel back and forth until they slide in smoothly.

To stop the stabilizer, the control panel selector switch is turned to START GYRO AND STAND BY or to OFF. If the stabilizer is to be operated immediately thereafter, the switch should be left at START GYRO AND STAND BY. This procedure eliminates the necessity of the two-minute warm-up period.

WARNING

Never stop the stabilizer by moving the stabilizing unit clutch shifting lever from AUTO to HAND.

INSTRUCTIONS

General maintenance

The rangefinder stand should be thoroughly cleaned, inspected, and exercised at least once weekly.

Before any operation, operate the locking gear, the shutter mechanism, deflection gear, and altitude mechanism through a complete cycle. Check that all parts have normal movement and adequate lubrication. Perform the lubricating schedule as prescribed in chapter 18. Lubrication of the stabilizer assembly is to be performed only by authorized and experienced fire control equipment maintenance personnel. It should be checked every six months or before any period of heavy use.

Adjustment of stabilizing unit clutch switch

The toggle arm, rigidly attached to the clutch shaft, has a screw and locknut on its end, perpendicular to the axis of the clutch shaft. Adjustment is made by turning the clutch switch to AUTO, loosening the locknut, and moving the screw until it actuates the clutch switch. Secure the screw in position by tightening the locknut.

DISASSEMBLY AND ASSEMBLY

General instructions

All parts of the rangefinder stand may be readily disassembled and assembled by reference to the general arrangement and detail drawings. When disassembling, mark all gears, shafts, bearings, and pinions for reassembly in their proper places. Dismantling of the stabilizing unit is to be discouraged. It should only be attempted under supervision of the gunnery officer, experienced fire control equipment maintenance personnel, or home yard staff.

Chapter 15

TURRET ELECTRICAL INSTALLATIONS

Ordnance Power Equipment

Fire Control Elements

Firing Circuit Mark 3

Lighting Circuit Mark 3

Bureau of Ships Electrical Systems

GENERAL DESCRIPTION

Turret electrical installations consist of the equipment and transmission facilities for power, heat, ventilation, illumination, sprinkling, communication, and fire control. Installations vary in detail between various ships of the class but all facilities in all turrets are of like arrangement, purpose, and capacity. Power equipment, fire control devices, portions of the firing circuit, and the battle lighting system are elements of Ordnance cognizance. All other wiring systems and attached fixtures and devices are elements of Bureau of Ships cognizance. Detailed descriptions of equipment, the arrangements of circuits, and instructions for maintenance are contained in the text and illustrations of this chapter.

Electrical systems

Turret electrical installations comprise six main systems, which are described in the following sequence:

Power system
Fire control system
Interior communication system
Lighting system
Magazine sprinkling system
Turret ventilating equipment

Turret structural arrangements

The mounting arrangements and supply services for the equipment of the six electrical systems include special turret structural details. They are structural brackets, foundation platforms, and other elements that secure motors, panels, and cabinets in correct alignment or protect them from shock vibration or other causes of trouble. They are also structural and installation details that protect units from drippings and from chafing, and that seal, or isolate, or support equipment and its wire leads, so that trouble-free service will be assured. The principal unit of such structural arrangements is the turret central column, described below. This column and its upper and lower wiring recess facilities are service lead-in arrangements that are common to all six electrical systems.

Turret central column. The central column provides a means for routing and supporting the feeder cables of the power system and other electrical circuits between their fixed structure sources and their rotating structure connections.

Cables within the column are flexible. They attach to ships' wiring at connection boxes located in a wiring trunk below the pivot casting at the base of the column, and are routed upward to a wiring recess at the top of the column. These arrangements are shown in figure 15-1.

All cables are suspended and separated in the column by an arrangement of drilled plates. These are the column top and bottom plates and the circular spacer blocks (fig. 15-1). The intermediate spacer blocks are of smaller diameter than the inside of the column. They are supported by clamps attached to the heavy feeder cables of the power system, as shown in figure 15-2. This arrangement permits limited revolving movement of the blocks within the column and, at the same time, prevents entanglement as the cables twist.

The cable holes of the fixed plate at the base of the center column, and those of the spacer blocks, are counter-bored to form holes of hour-glass shape. They are large enough to permit free sliding of the cables through the holes, as shown in figure 15-2. Sufficient slack is provided at the base of the column to allow for twisting and flexing of the cables when the turret is rotated through its training arc.

Each cable is supported at the top by means of a woven-wire cable grip and supporting hooks, arranged beneath the top plate. This arrangement is shown in figure 15-3.

Above the cable grip, each cable passes through the top plate in a stuffing tube which is a specially packed fitting. Another stuffing tube is fitted at the exit hole from the wiring recess. Both stuffing units are similar to the ones illustrated in figure 15-4. The cable terminal tubes and packing details of this illustration are characteristic of all terminal fittings at power panels, controllers, switches, and other electrical elements of the turret. They provide a vaporproof, watertight enclosure for each such unit and, in this instance, seal the wiring recess in a similar manner. Packing of the top plate stuffing tubes is not accomplished until after each cable is supported by its cable grip.

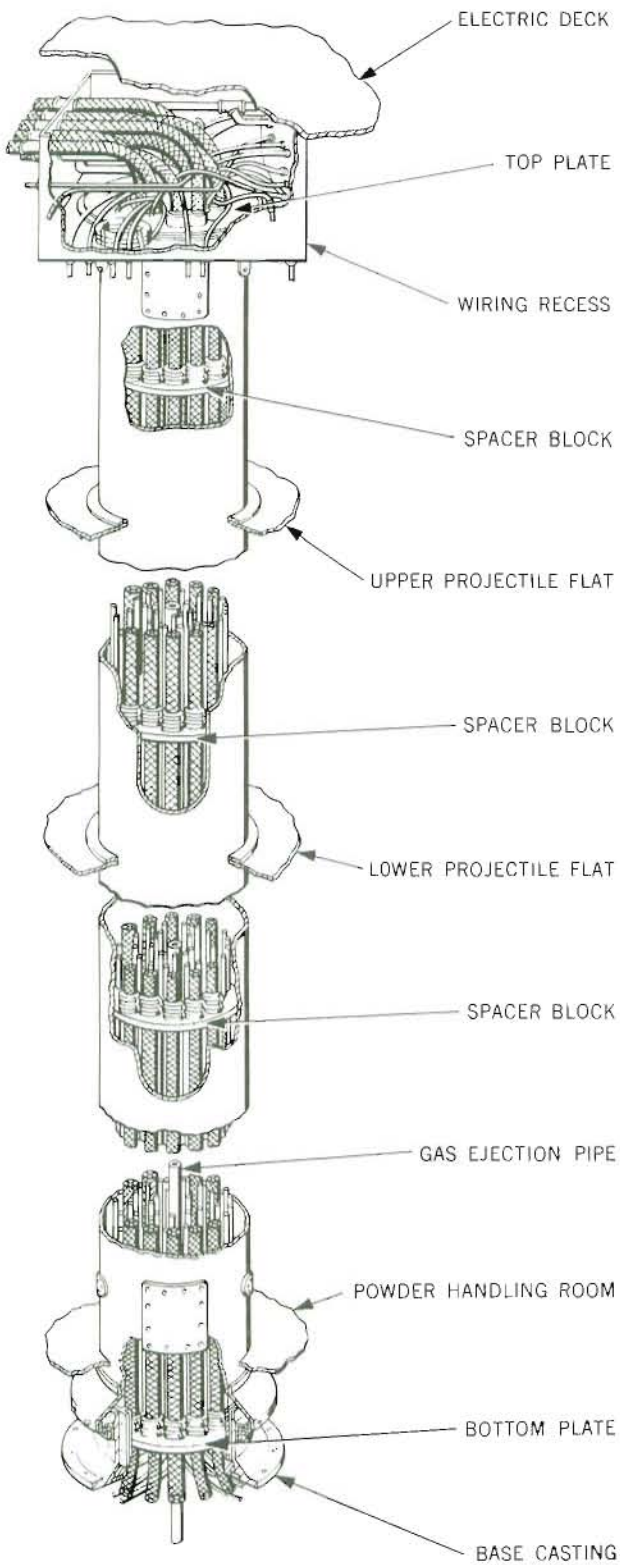

Figure 15-1. Base Casting and Central Column Wiring Tube Arrangements

Cable and conductor details. Turret wiring radiating from the central column comprises an elaborate system of electrical cables of different sizes and capacities. Each cable consists of one or more insulated conductors enclosed within an outer covering of tough, flexible insulation, or within an insulating material sheathed by an armor covering of woven metal.

The flexible cables are utilized principally in the central column. Armored cables are installed throughout the rest of the turret, except when connections are required to moving elements, in which case flexible cables are used.

Cables of both types vary in outside diameter according to the number of individual conductors, the extent of the internal insulation, and the thickness of the external covering. All cables are resistant to moisture, heat, and flame. Some are also especially resistant to oil and abrasion.

Cables in central column. Forty-one electrical cables are suspended in the central column. Of this total, 39 are active and two are spares. They comprise four highly flexible types which are not readily damaged by repeated twisting and bending. The four types, and the principal characteristics indicated by their designations are:

Cable Type	Principal Characteristics
TCOP	Triple conductor, oil resistant, portable
MHFF	Multiple conductor, heat and flame resistant, flexible
TTHFF	Twisted pair, telephone, heat and flame resistant, flexible
MCOS	Multiple conductor, oil resistant, shielded

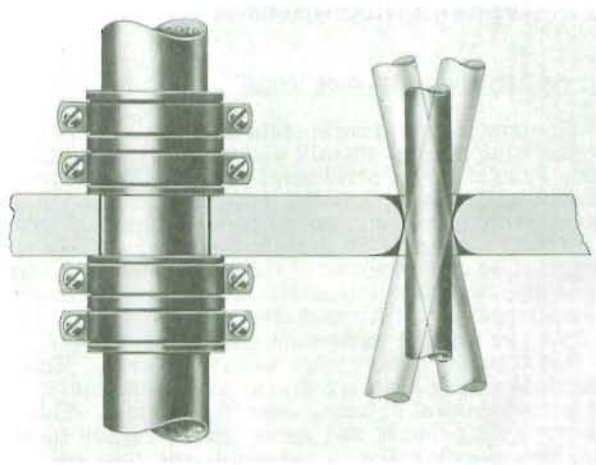

Figure 15-2. Spacer Block Arrangement for Fixed and Free Cables

DETAIL DESCRIPTION

Power system

The power system consists of the electric motors, controllers, push-button stations, and power supply equipment for the turret installations listed below:

Gun elevating gear (3)
Turret training gear
Rammers (3)
Projectile ring drives (2)
Parbuckling gear drives (2)
Projectile hoists (3)
Powder hoists (3)
Rangefinder stabilizer
Ventilating fan units (8)

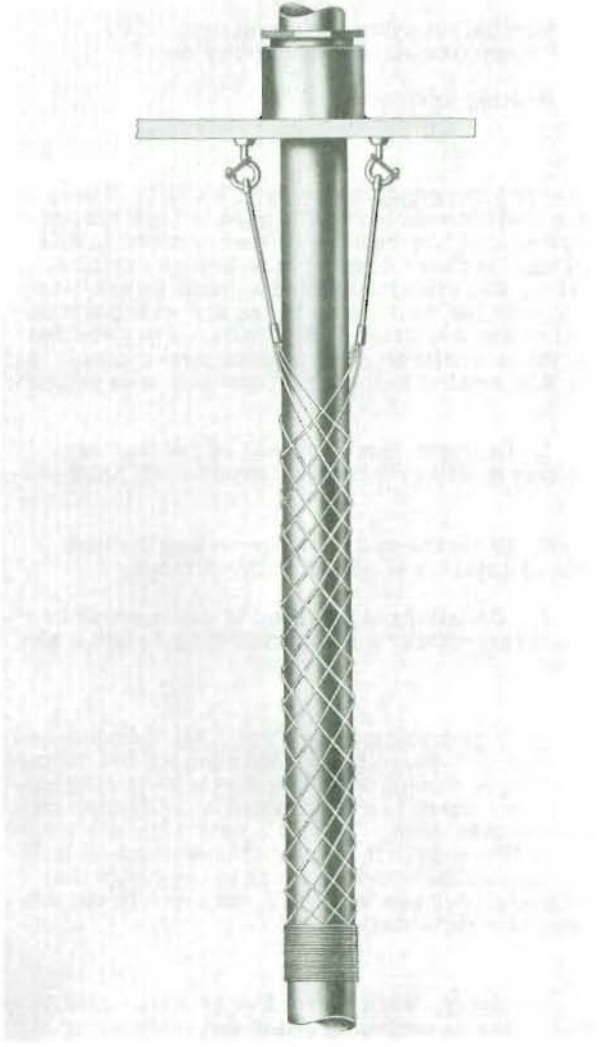

Figure 15-3. Cable Supporting Arrangement

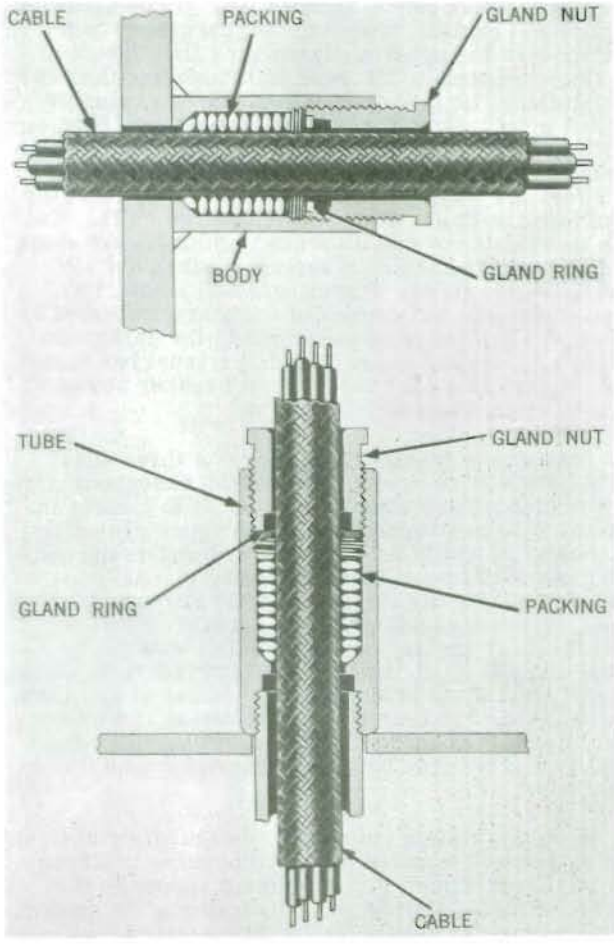

Figure 15-4. Stuffing Tubes. Typical Designs Sectioned

The power system also includes 15 Calrod type T heaters* and supply circuits for Normal and Emergency power to the turret's Interior Communication and Fire Control (IC and FC) Power Panel.* These power units and their respective control and supply sources are indicated in figure 15-5.

Main power supply. Power is supplied to each turret from the ship's main 440-volt, 3-phase, 60-cycle, twin turbo-generator units.

Normal and alternate. Each turret has two sources of supply, normal and alternate, from two of the four ship's turbo-generator units, as indicated in the table below. Bus tie connections at the main switchboards make possible a rearrangement of these sources of supply.

	Main Switchboard and Generator	
Turret	Normal	Alternate
I	1	2
II	2	1
III	4	3

*Bureau of Ships cognizance

Manual bus transfer panel. Power supply selection of either of the two sources is made at the manual bus transfer panel, figure 15-6. It comprises a large steel cabinet located in the machinery compartment of the upper shell handling flat, mounted on floor brackets to the rear of, and facing the central column. It houses 2000-ampere bus transfer switch mechanisms for manual changeover from NORMAL to ALTERNATE. Two interlocked switch elements, each with an external handle, are utilized to effect the transfer. Each is so arranged that the load must be disconnected from one before the other can be closed. A small opening, immediately above each operating handle, reveals a mechanical ON and OFF indicator. Power available on the two supply circuits and connected loads are indicated by a 3-dial light indicator described in the paragraph following. Power is fed from the manual bus transfer panel to five ACB type circuit breaker power panels which are described below.

Manual bus transfer indicator. A three-dial light indicator is used to indicate the energized main power feeders and connected load. It is located in the machinery compartment of the upper projectile handling flat and is mounted at eye level on the center gun powder hoist trunk, near the manual bus transfer panel. Its three vertically aligned glass dials are marked and colored NORMAL POWER AVAILABLE (green), ALTERNATE POWER AVAILABLE (red), and LOAD CONNECTED (white). These dials show which source of power is available for operating the turret's power system and whether that supply is connected to the turret's load. The indicator is a triple bull's-eye assembly in a watertight case.

Power available indicator. Two single dial light indicators are mounted on the transverse bulkhead in the turret officer's compartment, opposite the turret officer's station. One indicates when the normal main power supply feeder is energized, the other when alternate power is available.

Gun equipment power panels. Three ACB type circuit breaker power panels, designated as gun equipment power panels, figure 15-7, are fed by the manual bus transfer panel. Each serves to supply power to the following assemblies of the respective guns:

Elevating gear
Rammer
Projectile hoist
Powder hoist
Gun chamber ventilating system

All three panels are located on the machinery deck in a forward compartment formed by bulkhead extensions of the left gun girder box. These panels automatically disconnect their respective branches of the power system upon prolonged or excessive overload. Each is set to trip when the currecnt rises to 600 ampers. A switch lever in each unit permits manual cutoff of power. A small circular window in the front cover immediately above the switch-operating handle reveals a mechanical indicator plate to show whether the circuit breaker is open or closed. In addition, an electrical indicator, consisting of a lamp with a blue glass bull's-eye, located adjacent to the handle, indicates when the circuit breaker is closed.

Training gear power panel. The training gear power panel is of the same type as the gun equipment power panels, but is set to trip at 400 amperes. It is fed from the manual bus transfer panel and supplies the training gear system. The panel is located in the machinery compartment of the upper shell handling flat on a longitudinal bulkhead to the left and forward of the central column.

Miscellaneous equipment power panel. The miscellaneous equipment panel is fed from the manual bus transfer panel. It is of the same type as the gun equipment panels and the training gear equipment panel previously described, but is adjusted to cut out at a load of 300 amperes. The panel is located in the machinery deck, rear center sector, on the circular bulkhead. It serves to supply power to the following assemblies:

Sump pump motors (elevating and training gear)

Projectile ring drives (upper and lower)

Parbuckling gear (upper and lower)

Rangefinder stabilizer

Ventilation systems (turret officer's compartment and machinery deck)

Heating system

Feeder distribution box Type XXXIII. Three feeder distribution boxes are used to feed respective groups of five heaters (fifteen heaters in all). Each has six fused single-phase branch circuits, including a spare circuit, and a cutoff switch interlocked with the door. The boxes are watertight enclosures and are rated at 500 volts. They are fed from the miscellaneous equipment power panel. All three are located in the turret gun house as follows:

1. On right-hand bulkhead of passageway from turret officer's compartment to left sight station.

2. In center gun chamber on longitudinal bulkhead adjacent to gun captain's station.

3. On left-hand bulkhead of passageway between turret officer's compartment and right sight station.

Feeder distribution box Type NNN. An unfused, two-branch, 3-phase feeder distribution box is used in the supply circuit from the miscellaneous equipment power panel to the two ventilation groups on the machinery deck. This is a watertight enclosure rated at 500 volts. It is located on a diagonal bulkhead, immediately over a hatch in the top of the right gun girder box weldment, adjacent to the center gun captain's station.

Controllers. Each turret has 17 motor controllers. These serve to control starting and stopping of the various hydraulic and mechanical power drive motors. All controllers are housed in watertight steel cabinets.

MOTOR CONTROLLERS:

1	RIGHT ELEVATING GEAR
2	RIGHT RAMMER
3	RIGHT PROJECTILE HOIST
4	VENTILATING SYSTEM (RIGHT GUN CHAMBER)
5	RIGHT POWDER HOIST
6	CENTER ELEVATING GEAR
7	CENTER RAMMER
8	CENTER PROJECTILE HOIST
9	VENTILATING SYSTEM (CENTER GUN CHAMBER)
10	CENTER POWDER HOIST
11	LEFT ELEVATING GEAR
12	LEFT RAMMER
13	LEFT PROJECTILE HOIST
14	VENTILATING SYSTEM (LEFT GUN CHAMBER)
15	LEFT POWDER HOIST
16	TRAINING GEAR
17	AUTOTRANSFORMER
18	LUBRICATION PUMP
19	ELEVATION AND TRAIN SUMP PUMPS
20	VENTILATING SYSTEM (ELECTRIC DECK)
21	LOWER PARBUCKLING GEAR
22	LOWER PROJECTILE RING
23	UPPER PROJECTILE RING
24	UPPER PARBUCKLING GEAR
25	VENTILATING SYSTEM (TURRET OFFICER'S BOOTH)
26	RANGEFINDER STABILIZER

ACB	AIR CIRCUIT BREAKER
NS	NEUTRAL START INTERLOCK
	BRAKE SOLENOID
FS	FLOAT SWITCH
	1000-WATT HEATER AND SWITCH
	MANUAL TRANSFER SWITCH
2 L	FEEDER DISTRIBUTION BOX (UNFUSED)
6 J	FEEDER DISTRIBUTION BOX (WITH SWITCH, FUSED)
	FEEDER CONNECTION BOX
	INDICATING LIGHT
	BRANCH BOX
M	MOTOR
	PUSH-BUTTON STATION
	PROJECTILE HOIST BRAKE
	TRANSFORMER

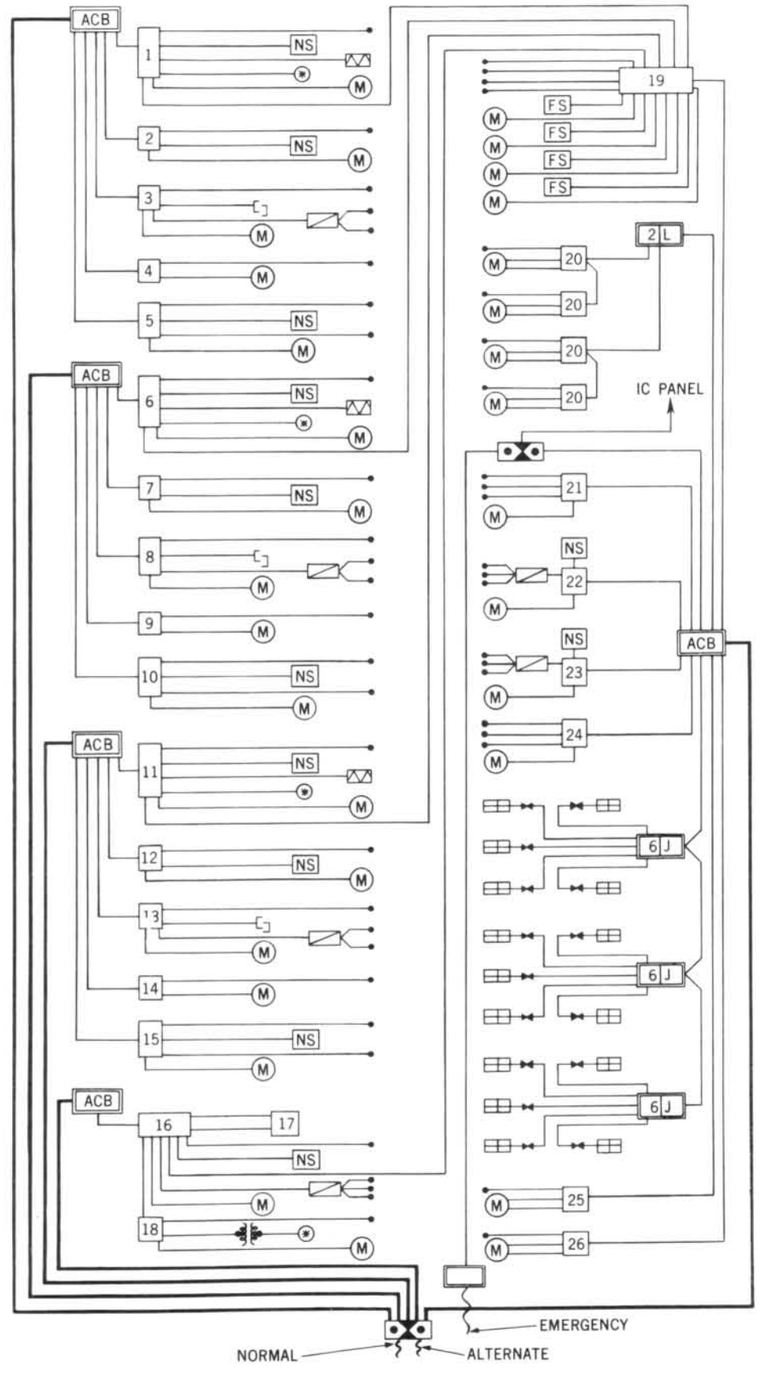

Figure 15-5. Power System Elementary Wiring Diagram

All but the training gear controller are magnetic type, across-the-line starters. The training gear controller is of the autotransformer type. All have overload, undervoltage, and short-circuit protection. For safety, each controller has an external handle-operated disconnect device, consisting of either a circuit breaker or switch, interlocked with the door so that the door can be opened only after the handle has been positioned at "OFF."

Controller data. Data and references for all Bureau of Ordnance controllers are given in the following tabulation:

TABLE 15-1. ELECTRIC CONTROLLER DATA

Controller for	BB Nos.	Ampere rating, full load	Overload Protection		Short circuit protection	Undervoltage Protection		Shock rating	Weight lbs.	Manufacturer	Drawing No.
			Adjustable range	Normal setting		Drop-out voltage	Sealing voltage				
Elevating gear	61/64	60	80/95	90	675 amp circuit breaker	44	374	50	165	Cutler-Hammer	365736
Training gear	61/64	355	360/440	400	None	220	372	2000	1400	Ward Leonard	318740
Rammer	61/64	83.5	78/95	92	675 amp circuit breaker	44	352	50	165	Cutler-Hammer	273545
Projectile ring	61/62	48	59.1/71.0	60	400 amp fuses	110	374	50	130	Ward Leonard	231756
	63/64	48	47.5/58.1	52.8	250 amp fuses	110	374	2000	150	Ward Leonard	293881
Parbuckling gear	61/64	19.9	23.6/28.3	25	800 amp fuses	110	374	150	110	Ward Leonard	231774
Projectile hoist	61/64	95	99.5/134.5	113.5	AQB	50	370	150	235	Westinghouse	268589
Powder hoist	61/64	126	125.8/170.2	128.5	1800 amp circuit breaker	50	370	150	235	Westinghouse	274360

Push-button stations. The push-button station and starting circuit arrangements function the same in most installations. (Interlocks are part of the starting circuits of elevating, training, rammer, projectile ring, projectile hoist, and powder hoist starting circuits.) With the safety switch closed (assuming all interlocks are correctly positioned), a motor may be started by pushing the START-EMERG button. In all magnetic type across-the-line controllers, this action closes the line contactor magnetic circuit and connects the motor directly across the line. In the autotransformer type of controller, for the training gear motor, momentary pressing of the START-EMERG button energizes an auxiliary line contactor circuit which closes to energize a "start" solenoid contactor. The start contactor then closes and connects the motor to the line through the reduced voltage tap of the autotransformer. The start contactor, upon closing, starts a mechanical mercury timer, adjustable from 2 to 15 seconds, which closes to energize a second auxiliary contactor. Upon closing, the second auxiliary contactor energizes the "run" contactor which then connects the motor directly across the line.

Momentary pressing of the STOP button of all controllers opens the line contactor magnetic circuit and immediately disconnects the motor from the line. The controllers of the elevating gear, training gear, parbuckling gear, projectile ring, and the powder and projectile hoists are provided also with emergency STOP switch station which function to stop their respective drive systems from one or more remote secondary control points. All push-button master control station START-EMERG buttons may also be used for EMERGENCY RUN in the event of a sustained overload sufficient to trip the overload relay mechanism. By holding closed the START-EMERG button, the overload relay system is bypassed and the motor will continue to run as long as the button is held closed.

Controller design arrangements. The specific function, design features, and location of the various controllers and their related push-button stations and interlock arrangements are described and illustrated in the following paragraphs:

Elevating gear motor controllers. The wiring arrangements of the elevating gear motor controller are shown in figure 15-8. Each is a conventional, magnetic, across-the-line type arranged with a manually operated disconnect switch and devices protecting the controlled motor. Each controller controls the starting and stopping of an elevating gear power motor.

The controllers for the right and center gun elevating gear motors are located in the machinery space of the upper shell handling flat, on the rear sector of the circular bulkhead. The controller for the left gun elevating gear motor is located on the left rear sector of the circular bulkhead, in the machinery space of the upper shell handling flat.

A circuit-breaker with a non-adjustable trip point of 675 amperes provides short-circuit protection. For other pertinent data, refer to chapter 5 and to the controller data table of this chapter.

The master push-button switch for each elevating motor controller is located at the respective gun layer's station on the machinery deck. Each unit is a watertight assembly which includes the START-EMERG and STOP switch mechanism, a transformer, and a pilot light. The transformer primary is wound for a 440-volt input; the secondary delivers a 6-volt supply to a type TS52, 1.5-candlepower, 6-volt lamp of the pilot light.

An emergency STOP switch is located at each gun captain's station to provide a means of bringing the gun to a quick stop to prevent damage to equipment or personnel. The switch is a single, normally closed, push-button type. Two series-connected neutral start interlock switches, in the starting circuit of the elevating motor controller, function to

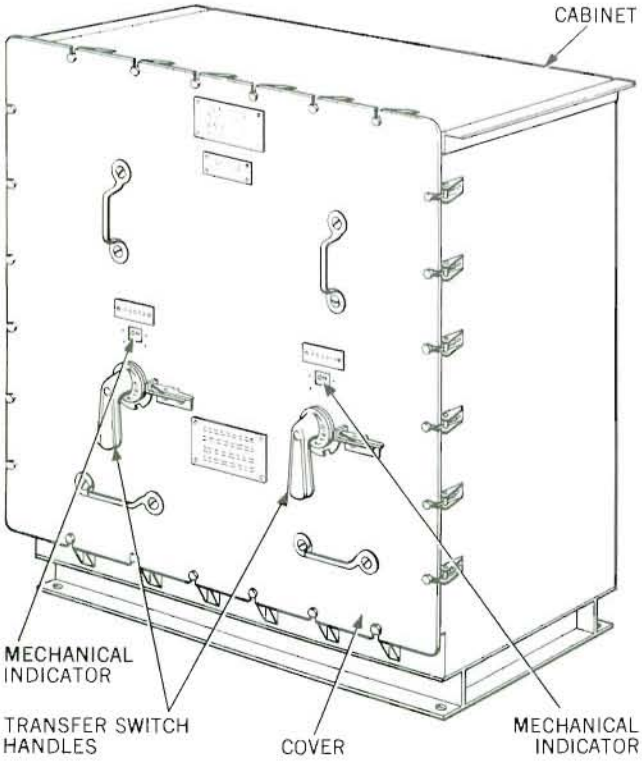

Figure 15-6. Manual Bus Transfer Panel

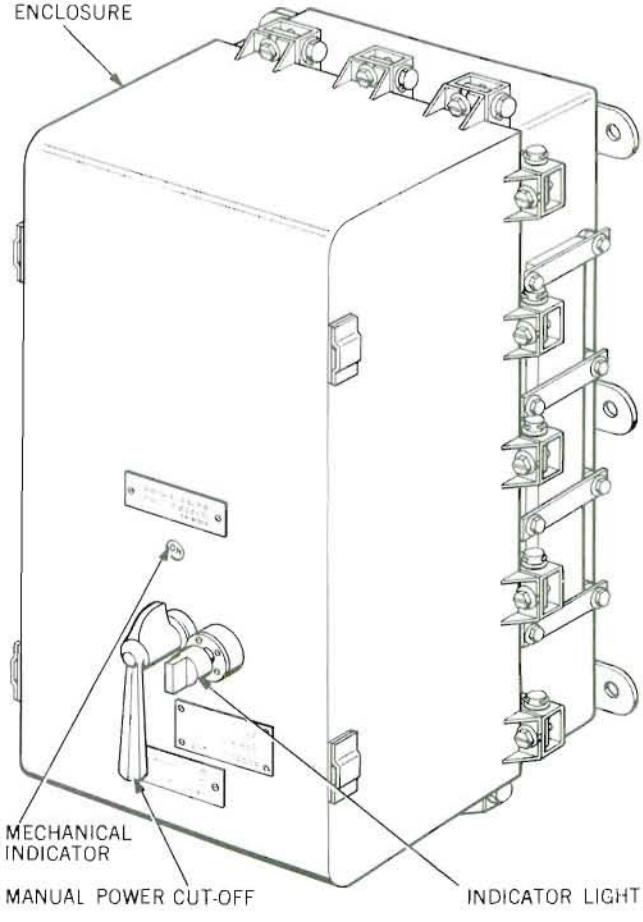

Figure 15-7. Gun Equipment Power Panel

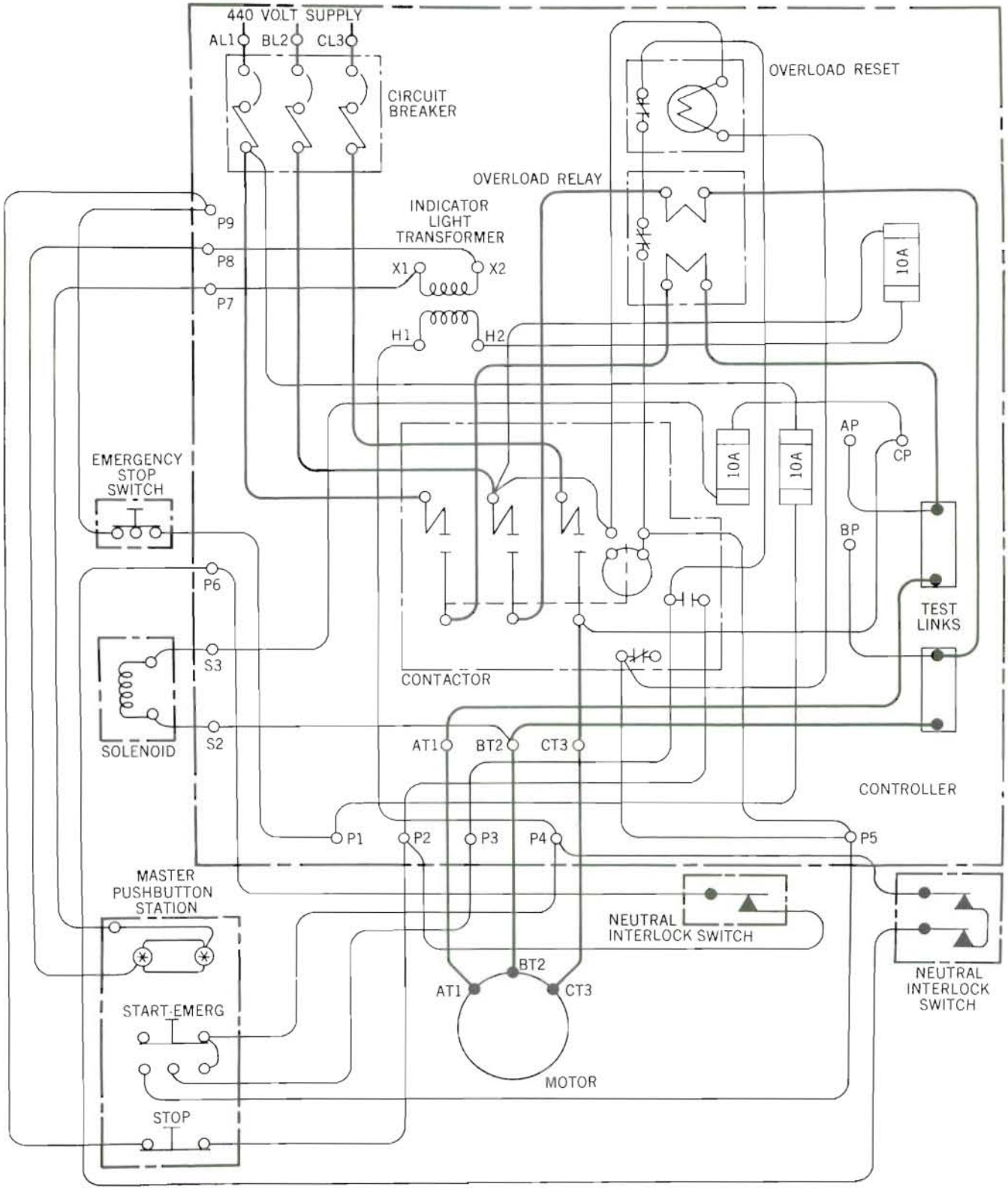

Figure 15-8. Elevating Gear Motor Controller. Practical Wiring Diagram

prevent starting when either or both the tilting box and the control valve are off center. The tilting box neutral interlock switch is located on top of the A-end assembly immediately forward of the neutral return hand lever. The control valve neutral interlock switch likewise is located on top of the A-end assembly, but farther forward. Both switches are watertight, commercial type units.

A spring-loaded power failure solenoid, located on the forward face of the A-end assembly, acts when power fails to position a blocking valve in the hydraulic system to bring gun movement to a sudden stop. The solenoid is energized by 440 volts, single-phase, tapped from two leads of the 3-phase supply to the power motor.

Training gear motor controller. The training gear motor controller is located in the machinery compartment of the lower projectile handling flat, mounted on floor brackets rearward of and facing the central column. Short-circuit protection is not included in the controller but is provided by the ACB type training gear power panel which supplies it (see previous description). The wiring arrangement of the controller is shown in figure 15-9. For reference data, refer to the controller data table and to chapter 6.

The autotransformer associated with the training gear controller is in a separate watertight enclosure, mounted on the circular bulkhead, rearward of the controller.

The master push-button switch for the training gear controller is located at the train operator's station on the machinery deck. It is a watertight unit, identical with the master switch assemblies of the elevating gear control system described above.

Two series-connected neutral start interlock switches, in the starting circuit of the training gear motor controller, prevent starting when either or both of their respective A-end actuating mechanisms are off neutral. These switches are the tilting box neutral interlock switch, located on the left side of the A-end housing, and the servo pilot valve twin micro switch assembly, located on the rear face of the control valve block at the top of the A-end assembly. The tilting box switch is a commercial unit. The servo control valve switch assembly comprises a pair of micro switches designed and arranged so that both are closed only during an extremely limited portion of the servo control valve movement at the center of its stroke.

A spring-loaded power-off solenoid, upon power cut-off, functions through a hydraulic valve to set spring-actuated brakes on the training pinions. The solenoid is normally energized from the single-phase contro circuit supply of the controller. It is located in the center gun pocket on the transverse bulkhead, immediately forward of the center oscillating bearing.

Rammer motor controllers. The rammer motor controllers are magnetic across-the-line type starters, with a short-circuit trip set at 675 amperes. The wiring arrangement is shown in figure 15-10. For further details, refer to chapter 10 and to the controller data table of this chapter.

The rammer motor controllers for the right and center rammers are mounted in the machinery space of the lower projectile handling flat, on the rear sector of the circular bulkhead. The controller for the left rammer is installed on the center powder hoist trunk in the lower shell handling flat.

The master push-button switch for each rammer controller is located at the respective rammer operator's station at the rear of each gun chamber. Each is a watertight, two-button type (START-EMERG and STOP) switch.

A neutral start interlock switch in each rammer controller starting circuit functions through a cam arrangement in the power drive A-end to prevent starting when the tilting box is off neutral. The switch is located on the left side of the A-assembly the right rammer and on the respective right side of the center and left rammer (see fig. 10-6). Each switch is housed in a watertight case.

Projectile ring motor controllers. The two projectile ring motor controllers, figure 15-11, are magnetic across-the-line type starters, with short-circuit protection provided by 400-ampere fuses. The wiring arrangements are illustrated in figure 15-12. Other data is given in the controller data table of this chapter and in chapter 7.

The controller for the lower projectile ring drive is installed on the center powder hoist trunk. The controller for the upper projectile ring drive is mounted on the right rear sector of the circular bulkhead enclosing the machinery space in the upper projectile handling flat.

The master push-button switch for each projectile ring controller is of the conventional two-button watertight design and in each case is located on the center projectile hoist at the respective upper and lower projectile handling flats. Two emergency STOP switches are provided for each controller. They are located one on each side of the projectile handling platforms of both the upper and lower projectile handling flats. The switches are single-button, normally closed type.

Parbuckling gear motor controllers. The two parbuckling gear motor controllers, figure 15-13, are magnetic across-the-line type starters with short-circuit protection provided by 80-ampere fuses. Figure 15-14 illustrates the wiring arrangement. Specification data are included in chapter 8 and in the controller data table of this chapter.

The lower parbuckling gear motor controller is located on the right powder hoist trunk, in the lower projectile handling flat, the upper parbuckling gear motor controller on the right powder hoist trunk, in the upper projectile handling flat.

The master push-button switch for each controller is a conventional two-button type. It is located on the center projectile hoist assembly at its respective projectile handling flat. Three emergency STOP single push-button switches are included in the control circuits of each parbuckling gear motor controller. These are located on their respective lower and upper projectile handling flats at the following points: one on the left and one on the right projectile hoist assemblies, and one adjacent to the parbuckling gear motor controller in the machinery compartment.

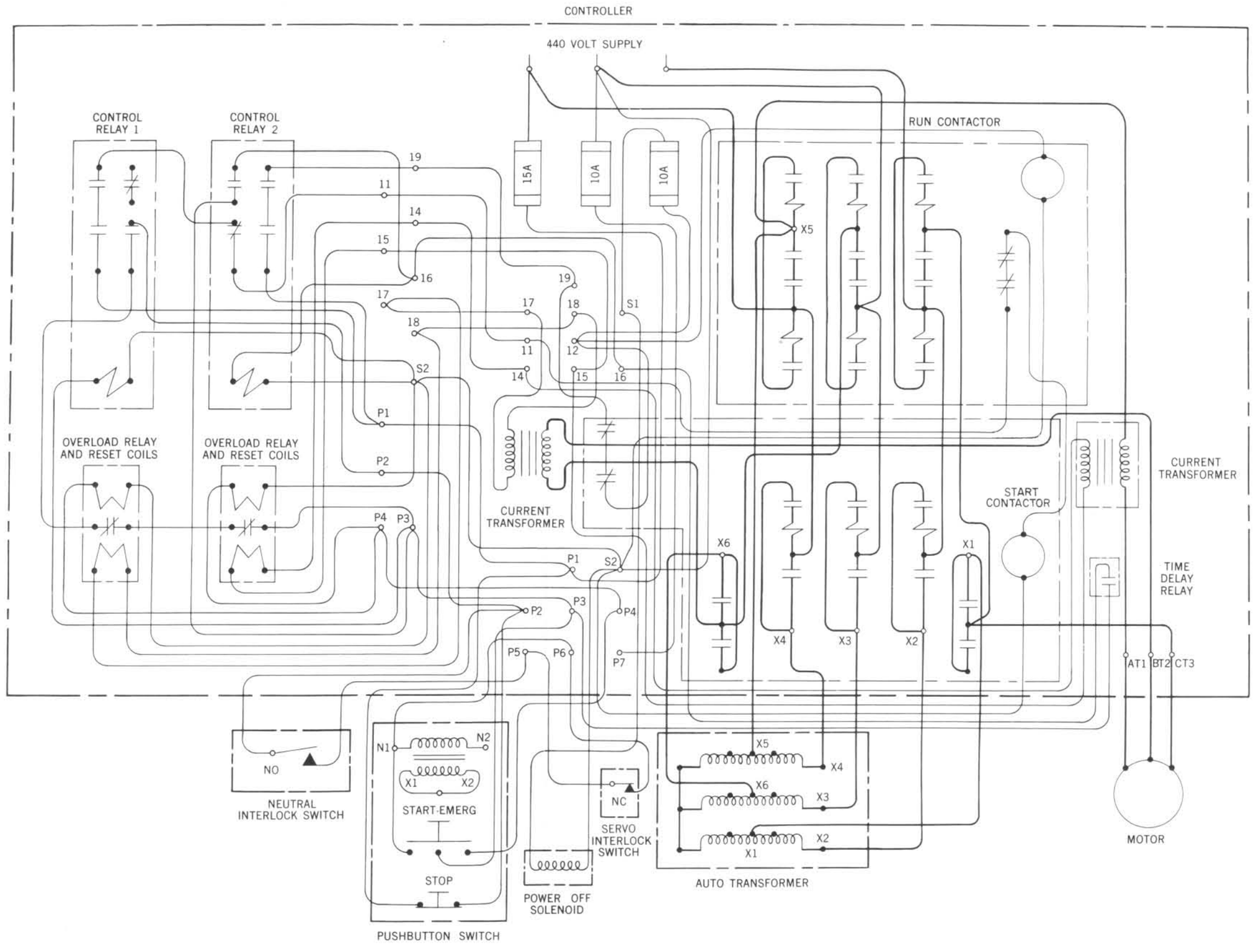

Figure 15-9. Training Gear Motor Controller, Schematic Wiring Diagram

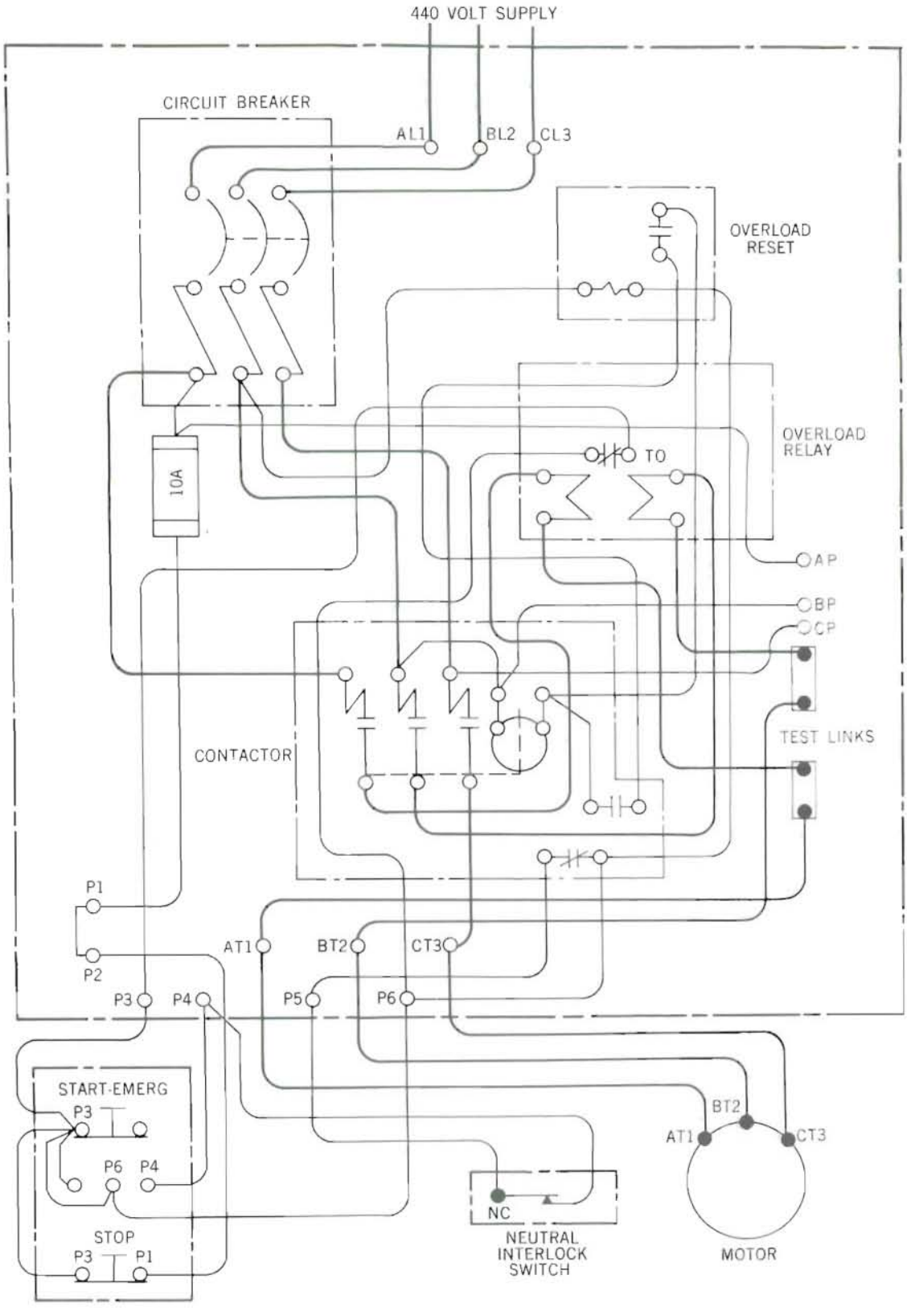

Figure 15-10. Rammer Motor Controller. Schematic Wiring Diagram

Projectile hoist motor controllers. The three projectile hoist motor controllers serve to control starting and stopping of their respective projectile hoist motors. They are mounted on the forward c circular bulkhead in the machinery space of the lower projectile handling flat. Short-circuit protection is provided by a circuit breaker with trip set for instant release at 1350 amperes. Further data is included in chapter 9 and in the controller data table of this chapter.

The master push-button switch for each controller is installed at the rear of each respective gun chamber. These switches are of the watertight, lever-operated type. Two emergency stop switches are provided for each hoist assembly. They are of the normally closed, lever-operated type. They are located one at each of the lower and upper loading stations of their related hoist assemblies. Projectile hoist interlock circuit QE is described later in this chapter. Its wiring arrangements are shown in figure 15-15.

Powder hoist motor controllers. The three powder hoist motor controllers, figure 15-16, are similar to the projectile hoist controllers. Each serves to control starting and stopping for its respective powder hoist motor. The three controllers are mounted forward on the circular bulkhead in the machinery compartment of the upper projectile handling flat. The wiring arrangements are shown in figure 15-17. Further information is included in chapter 11 and the controller data table of this chapter.

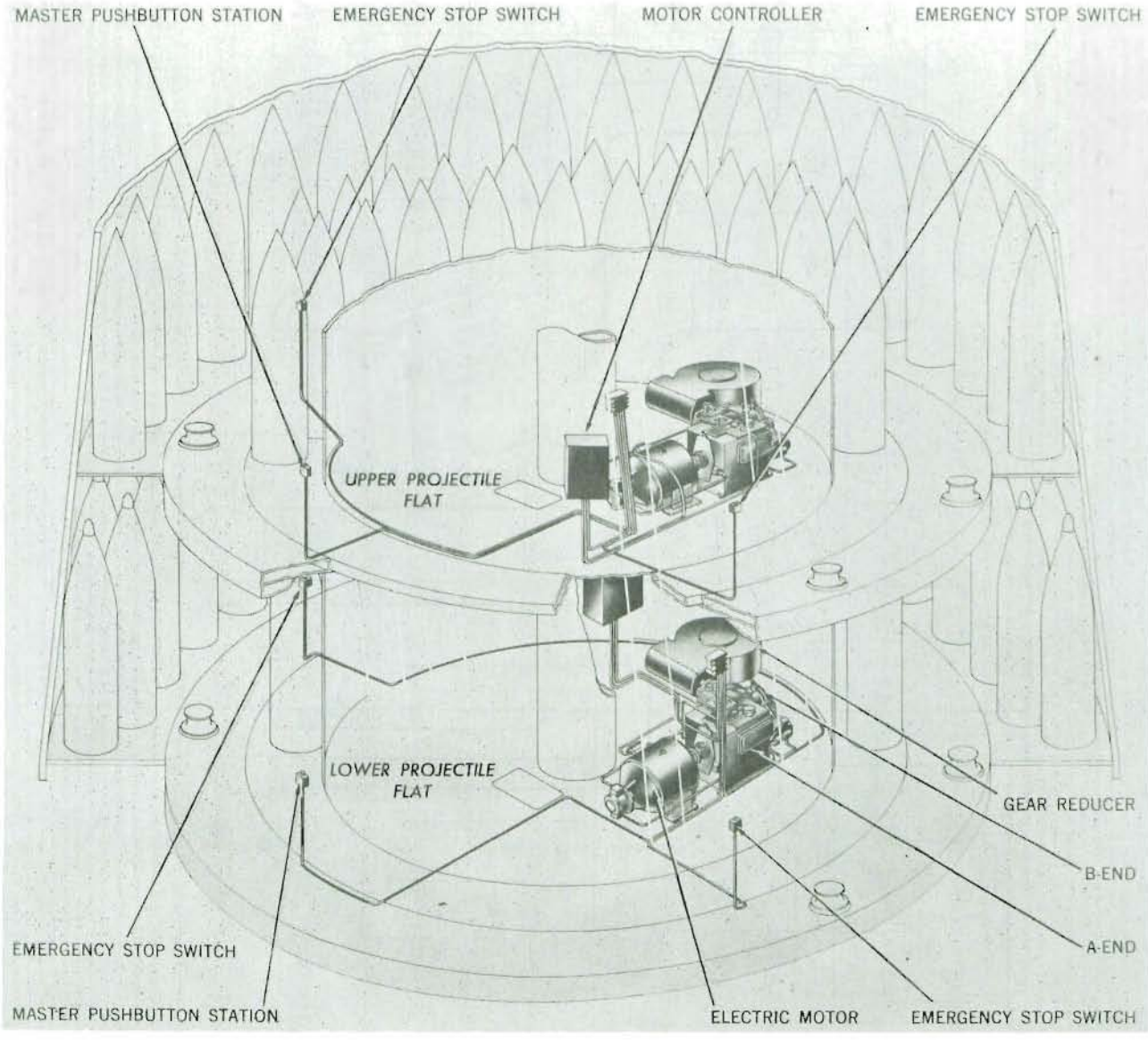

Figure 15-11. 16-inch Projectile Ring Mk 2 Mod 0 Electrical Installation

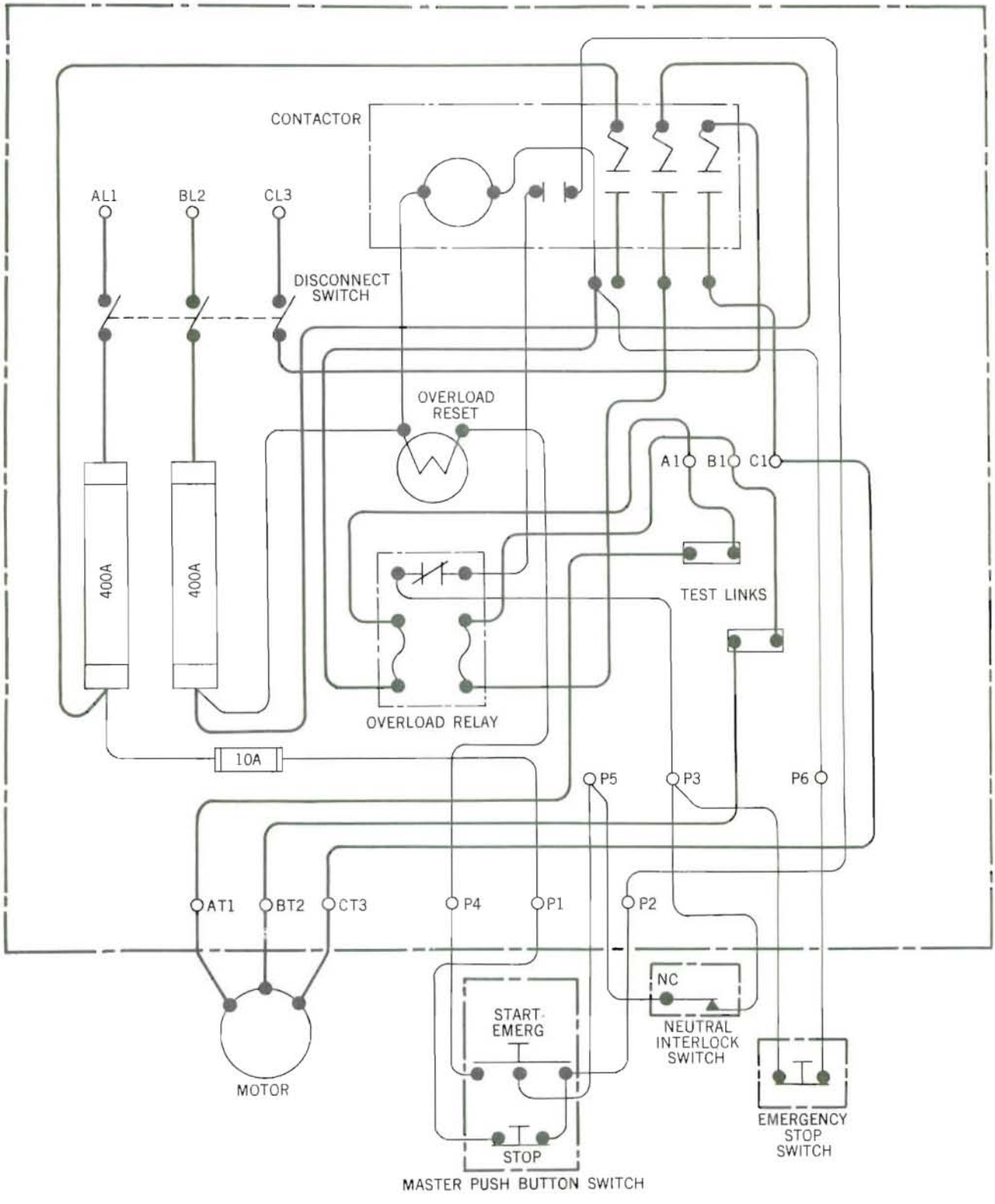

Figure 15-12. Projectile Ring Motor Controller, BB 61-62. Schematic Wiring Diagram

The master push-button switches are the lever-operated type. Each is located at the hoist operator's station, powder trunk upper end. A STOP switch, normally closed, is located at each hoist trunk lower end, at the door operator's station. The interlock arrangements of the powder hoist system are described on page 15-35.

Power motors. The power system of each turret includes 20 motors of Bureau of Ordnance cognizance and nine motors of Bureau of Ships cognizance. Motors of Bureau of Ordnance cognizance consist of three elevating gear motors, three elevating screw lubricating motors, one training gear motor, three rammer motors, two projectile ring motors, two parbuckling gear motors, three projectile hoist motors, and three powder hoist motors. Motors of Bureau of Ships cognizance consist of eight ventilating fan motors and the training gear lubrication motor.

All motors of the power systems are of the 440-volt, 3-phase, 60-cycle, squirrel-cage induction type. They are of normal torque with low starting current characteristics. The ambient temperature rating of each is 40 degrees centigrade. Each motor is provided with a waterproof enclosure and is designed to withstand shocks of high impact. Cooling is provided either by an integral fan or by natural draft.

Elevating gear motors. These motors are horizontally mounted and logitudinally aligned on the machinery floor. The left gun motor is near the left side, the center gun motor in the rear sector, and the right gun motor near the right side.

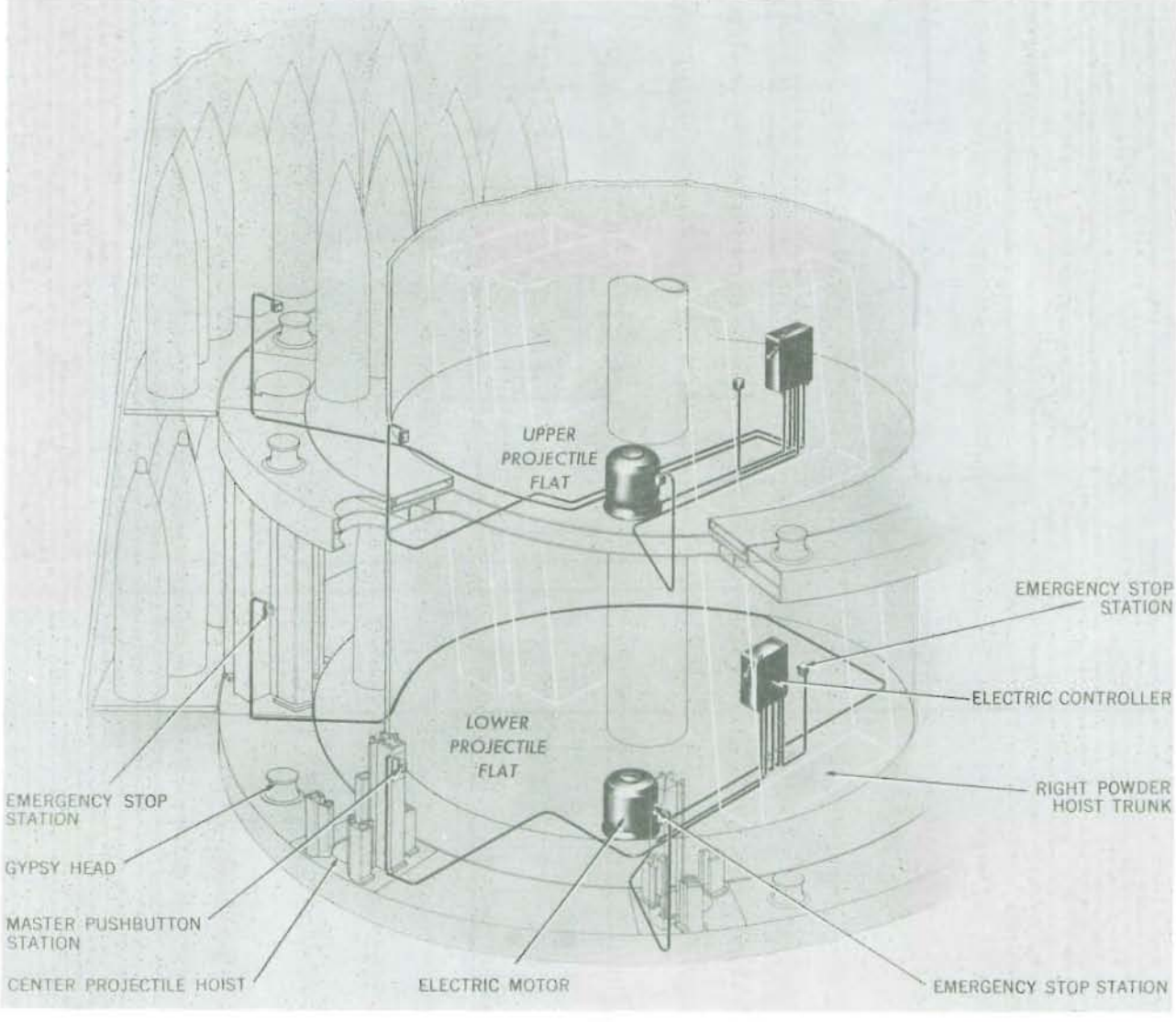

Figure 15-13. Parbuckling Gear Electric Installations, General Arrangement

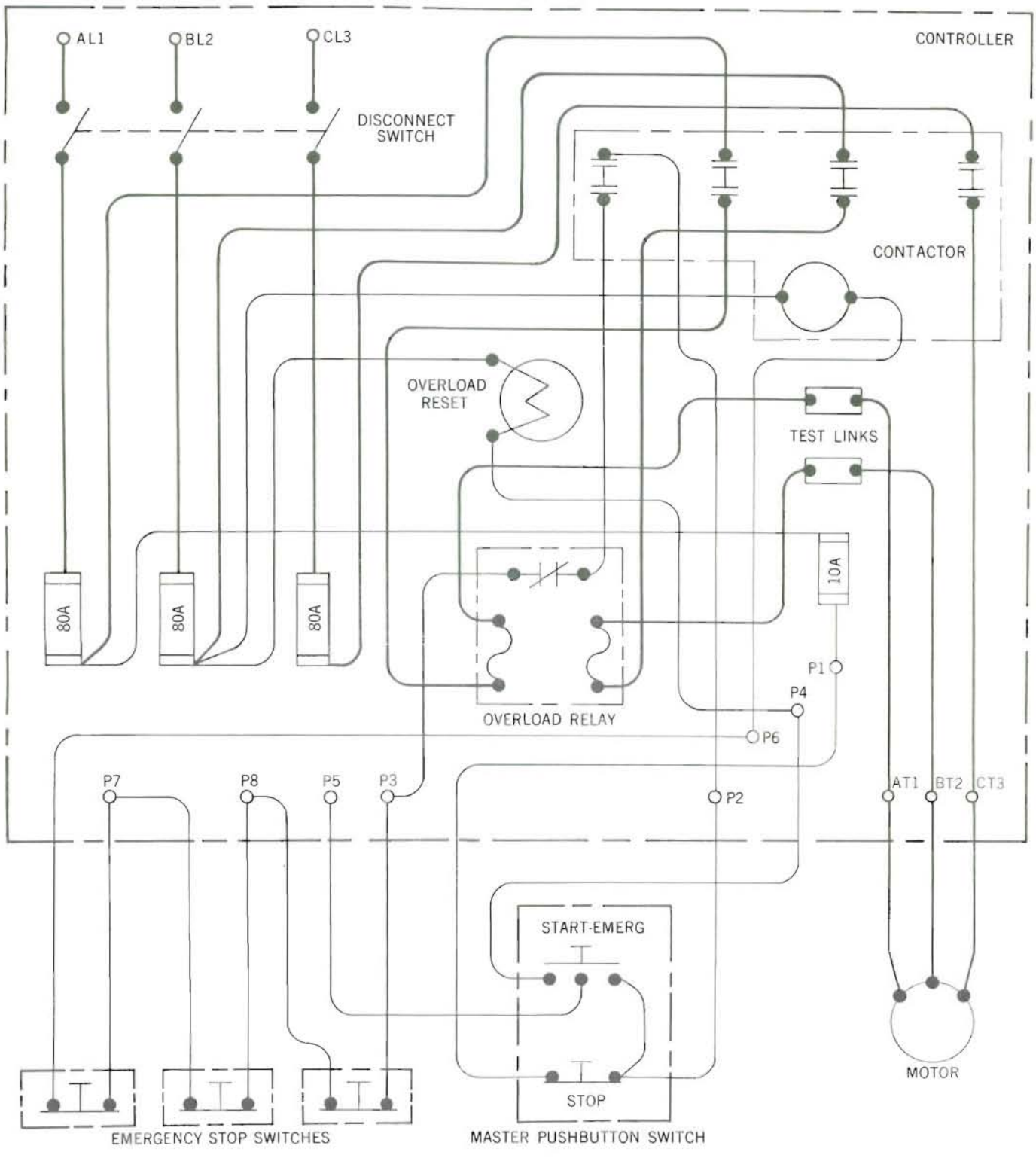

Figure 15-14. Parbuckling Gear Motor Controller, Practical Wiring Diagram

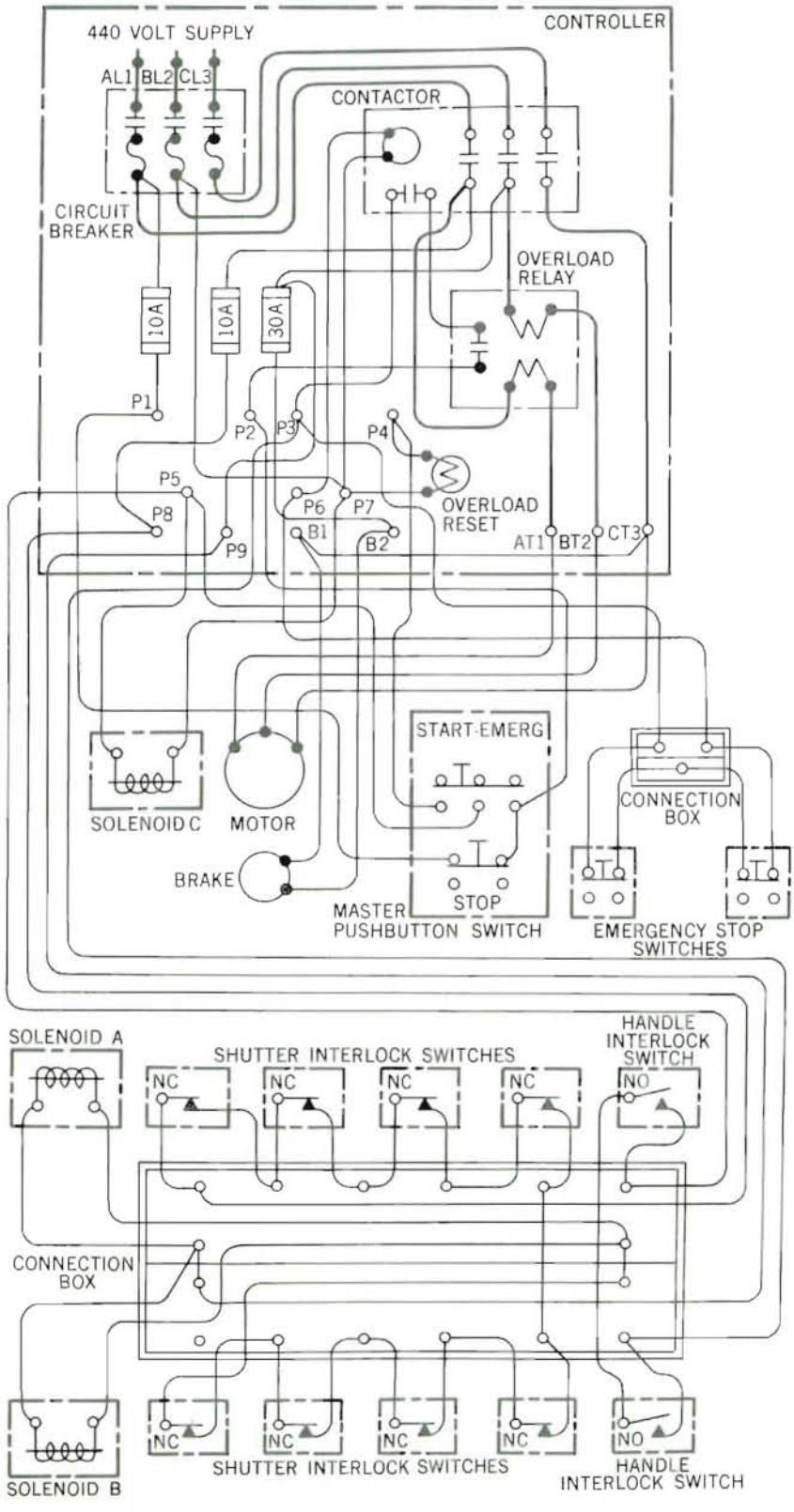

Figure 15-15. Projectile Hoist Motor Controller. Schematic Wiring Diagram

Training gear motor. The training gear motor is horizontally mounted and longitudinally aligned near the rear center of the machinery floor.

Rammer motors. Each of the rammer motors is horizontally mounted and longitudinally aligned immediately adjacent to its respective rammer chain housing under the turret officer's compartment in the overhang.

Projectile ring motors. The projectile ring motors are located in their respective machinery compartments of the lower and upper projectile handling flat machinery compartment. In both cases they are horizontally mounted adjacent to the left side of the right powder hoist trunk.

Parbuckling gear motors. The parbuckling gear motors are located in their respective machinery compartments of the lower and upper projectile handling flats. In each case they are vertically positioned and flange mounted at floor level near the left rear end of the right powder hoist trunk.

Projectile hoist motors. The projectile hoist motors are horizontally mounted on the machinery floor level. The left hoist motor is longitudinally aligned near the left side, the center hoist motor diagonally aligned in the left rear sector, and the right hoist motor longitudinally aligned near the right side.

Powder hoist motors. The powder hoist motors are vertically positioned and flange-mounted in the spaces formed by the upper extensions of the gun girder box weldment and are immediately forward of the upper ends of their respective powder hoist trunks.

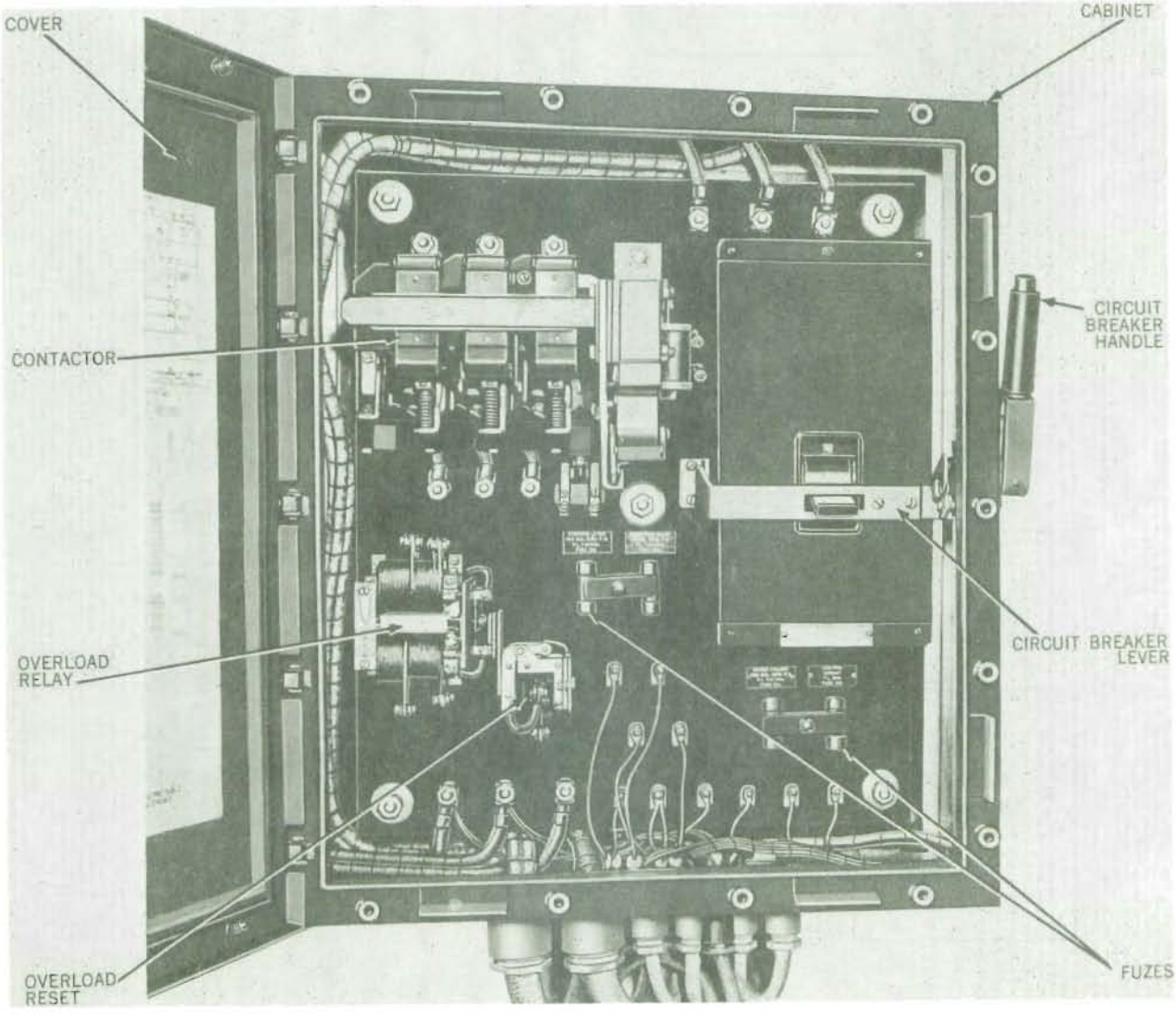

Figure 15-16. Powder Hoist Motor Controller. General Arrangement

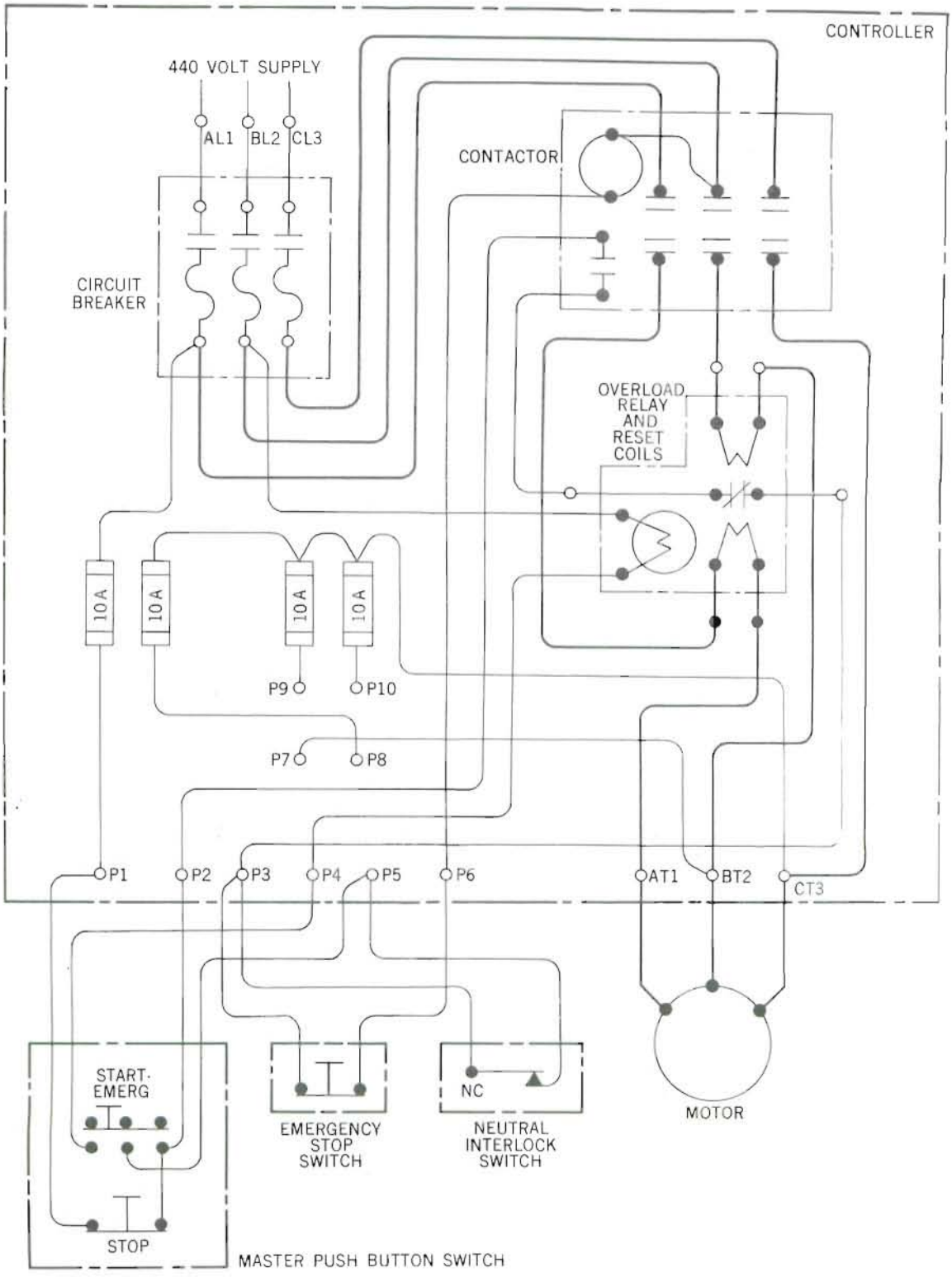

Figure 15-17. Powder Hoist Motor Controller. Practical Wiring Diagram

Fire control system

The fire control system in each turret comprises electrical arrangements through which gun orders are received and transmitted and by means of which guns are positioned and fired, together with related protective interlock circuits.

Circuits. Fire control circuits, figure 15-18, and their designating symbols are listed below and are described in subsequent paragraphs and in chapter 12.

Fire Control Circuits

Symbol	Circuit Name
GE	Gun control system
GEP	Gun remote control system
1PA	Gun firing system
1R	Ready light
1VB	Salvo signal
1U	Cease firing signal
CS	Sight setter's clutch indicator
CP	Sight pointer's clutch indicator
RP	Projectile ring ready light
QE	Projectile hoist interlock
Q	Projectile hoist control interlock
QB	Shell latch indicator
QC	Powder hoist interlock
--	Rangefinder stabilizer

Power supply. Four sources of power are available for operation of the firing circuit in the turret. Two are 120-volt, 60-cycle sources, one from the forward and one from the after main battery control switchboard. The third is an emergency supply from a 24-volt, 100-ampere hour batteries in series source, located in the turret. The fourth source of power is for the operation of the cradle control and powder hoist door solenoids, and is a 117-volt, single-phase, alternating current, from a 1 KVA transformer and does not go through the turret officer's control panel.

The first and second (forward and after) power supplies are duplicate systems, each in turn comprising two divisions with a common return; one, a normally energized supply for local (turret) firing, and the other, a normally open circuit which is energized only upon momentary closing of "director fire" contact makers. Selection of these supplies through the forward or after switchboards is made by a switch on the turret transfer switchboard. To utilize either division of the main 120-volt supply, the turret transfer switch must be positioned to AFT or FWD and the turret officer's selective switch lever turned to A. C. SUPPLY. Choice of DIRECTOR or LOCAL fire is effected by the turret officer's selective switch knob with pointer. Thus, by means of these switches, the guns may be fired by director fire through either the forward or after main battery control switchboards, or they may be fired locally by the normally energized supply from either of these fore or aft sources.

The third supply of the firing circuit, for emergency use only, is from the 24-volt storage battery located in the turret officer's booth. Selection of this supply is made by turning the turret officer's selective switch to BATTERY. On battery supply, gun firing can be effected only from the firing keys in the turret.

The fourth power supply, for the operation of the cradle control and powder hoist door solenoids, is from a 1 KVA 440/117-volt, single-phase transformer on the intercommunication panel, located on the upper projectile flat.

Components of fire control circuits.

Multiple turret train indicator (2GE). The turret officer's instrument for advising as to the position of own turret and other turrets is a standard type of multiple turret train indicator. The instrument not only shows modified turret train response (turret train response from which the connection for horizontal parallax has been removed), but also shows whether the turrets are following gun train orders. In turrets I and II, the indicators show the train angle of both turrets so that the turret officer can control train and elevation to present interference between the guns of the two turrets.

These instruments are electrical receivers with one-speed and 36-speed synchros. Each operates a calibrated dial; one to show modified turret train response and the other, a zero reader, to show the difference between the train order and modified turret train response. Signals received originate in own turret gun train indicator, other turret gun train indicators, and gun train order transmitters in the rangekeeper or computer of the controlling plotting room.

One-speed train signals are routed locally to provide the turret position indication in all methods of control. But the signals used to drive the zero

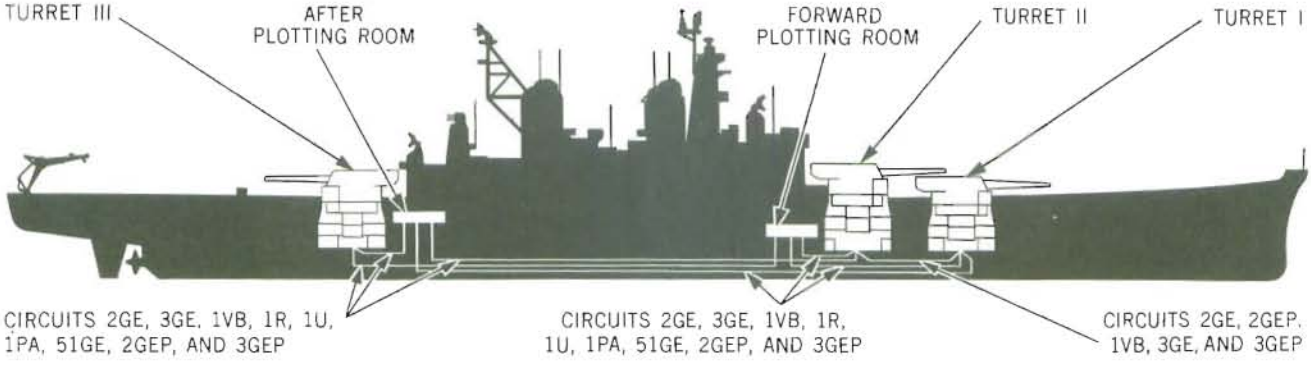

Figure 15-18. Fire Control Circuits. Plotting Room - Turret Connections

reader dials are routed to the turret from the controlling plotting room. The latter signals are separate signals, separately received from the turret officer's transfer switchboard and "mixed" in the 36-speed differential synchro receivers.

These instruments function in the same way in all methods of turret control, provided communications are available.

Turret transfer signal indicator (51GE). Circuit 51GE provides visual signals for positioning the transfer switches which select control circuits from the forward or after plotting rooms. These visual signals comprise two 2-dial indicators, as shown in figure 15-19, located in the turret officer's compartment. They are mounted on the transverse bulkhead to the right of the right powder hoist station door. Supply for the system derives from the 120-volt, 60-cycle current at the forward or after IC switchboard and is controlled from either the forward or after main battery control transfer signal switch panel in the respective main battery plotting room.

Auxiliary computer (GE). Auxiliary Computer Mk 3 Mod 2 is a computing and indicating mechanism used by the computer operator and his talker to solve fire control problems. It generates indicated values of sight angle and sight deflection, based upon three electrical inputs and 13 manual inputs.

Inputs of own ship speed, own ship course, and turret train are received electrically in the instrument. These inputs are routed to the computer through the turret officer's transfer switchboard. Inputs of own ship course and own ship speed are derived through controlling plot from the master gyro compasses and the underwater log transmitter, respectively. The turret train input is received from the gun train indicator.

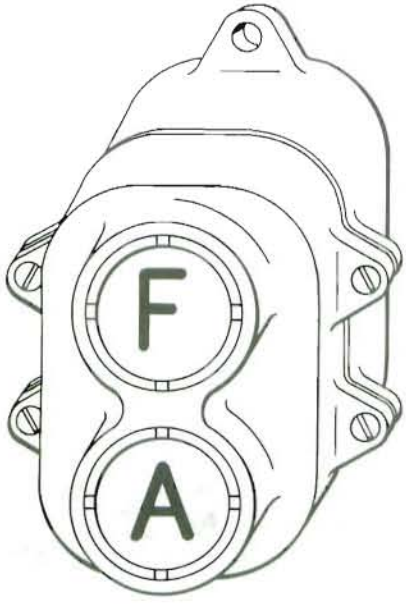

Figure 15-19. Fire Control Transfer Signal Indicator

Thirteen inputs to the computer may be introduced manually by the thirteen control knobs located on the instrument. Three of the manual inputs duplicate corresponding electrical inputs to provide an emergency source for these input components. These are true bearing (in lieu of own ship course), own ship speed, and turret train. Other inputs are: time, target angle, initial velocity, wind speed, target speed, range correction, projectile, present range, deflection correction, and wind angle.

Outputs of the computer are sight angle and sight deflection. These values are indicated on counters of the instrument dial face and are transmitted by telephone from the computer talker to the sight setter.

Gun elevation order transmitter (3GE). Gun elevation signals may originate at a director or at the sight pointer's stations in own turret or in other turrets. The gun elevation order transmitters (page 13 - 9) transmit the signals originated in turret throught the turret transfer switchboard to gun elevation indicators located at the left, center, and right gun layer's stations.

Gun elevation indicators (3GE). Gun elevation indicators, located at each gun layer's station, receive gun elevation orders from the controlling director or from one of the sight pointer's gun elevation order transmitters.

Turret train indicator and transmitter (2GE). The turret train indicator and transmitter, located at the train operator's station in each turret, receives train order signals from either the forward or after plotting rooms or from other turrets. It transmits parallax range and modified turret train response signals to the train receiver-regulator.

Turret officer's indicator panel (1PA) (1R). The turret officer's indicator panel, figure 15-21, is located in the turret officer's compartment in a recess of the transverse bulkhead opposite the turret officer's station. The panel has 15 indicator lights (circuit 1R) and five control switches (circuit 1PA).

Turret officer's selective switch (1PA) (1R). The turret officer's selective switch, figure 15-20, comprises two rotary switch assemblies. The upper switch assembly, controlled by a handle with a pointer, is labeled DIRECTOR-OFF-LOCAL. The lower switch assembly, controlled by a handle with a pointer, is labeled A.C. SUPPLY-OFF-BATTERY. By rotating these switches to their respective positions, the turret officer may select either director or local fire and the source of power for energizing the gun firing circuit.

Turret captain's indicator panel (1PA) (1R). An indicator panel, connected in parallel with the turret officer's indicator panel, is provided at the turret captain's station. It has no switches but otherwise is identical to the turret officer's indicator panel, figure 15-21.

Gun captain's ready switch (1PA) (1R). Located at each gun captain's station is a gun captain's ready switch (fig. 15-22). This switch is a two-position, spring return lever-operated, rotary-type unit housed in a watertight case. It has an integral unlocking solenoid (wired into circuit 1R) which prevents the lever from being shifted to the opposite position until this solenoid is energized, and this can only occur when the gun is in battery and the breech is closed. One position of the lever is SAFE (meaning "safe to load"), and the other position is READY (meaning "ready to fire"). This lever is spring-returned to the SAFE position when the unlocking solenoid is energized. A manual PULL TO RELEASE button, located on the switch, can be pulled out to release the lever if the unlocking solenoid should fail to function. The gun captain's ready switch is arranged in circuit 1PA with the firing key circuit and with the control circuit. In circuit 1R the switch is arranged 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 switch also causes the gun to return to loading position when it is turned to SAFE.

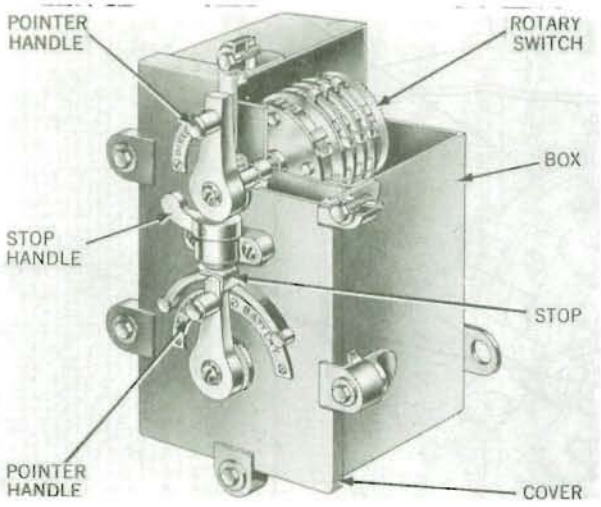

Figure 15-20. Turret Officer's Selective Switch

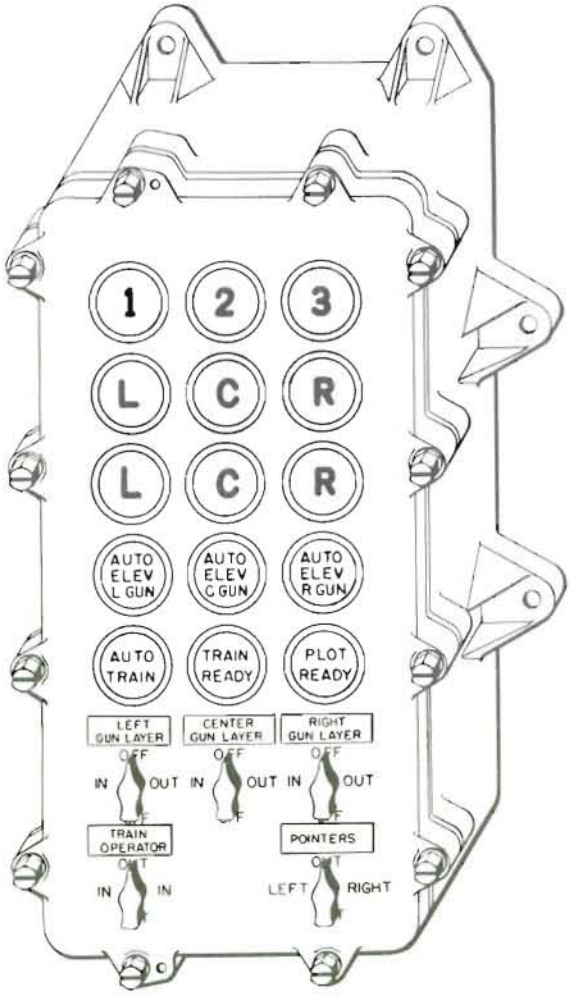

Figure 15-21. Turret Officer's Indicator Panel

Gun elevation ready, gun captain ready, and load indicators (1PA) (1R). A three-dial indicator light is located at each gun captain's station and each gun layer's station. These indicate, from top to bottom, respectively, gun captain ready, gun elevation ready, and load. The indicators are watertight enclosures with three glass window discs, behind each of which are pairs of illuminating lamps. The indicator for the left gun layer's or left gun captain's station is shown in figure 15-23. The top, center, and lower dials for indicators at the center gun layer's and gun captain's stations are marked C, C, and LOAD, respectively. Similarly, for indicators at the right gun layer's and gun captain's stations they are marked R, R, and LOAD. From top to bottom, the dials of the gun captain's indicators are colored as follows:

Left gun captain's indicator	- Red, blue, clear
Center gun captain's indicator	- Red, blue, clear
Right gun captain's indicator	- Red, blue, clear

The dials of the gun layer's indicators are colored as follows:

Left gun layer's indicator	- Blue, red, clear
Center gun layer's indicator	- Blue, white, clear
Right gun layer's indicator	- Blue, green, clear

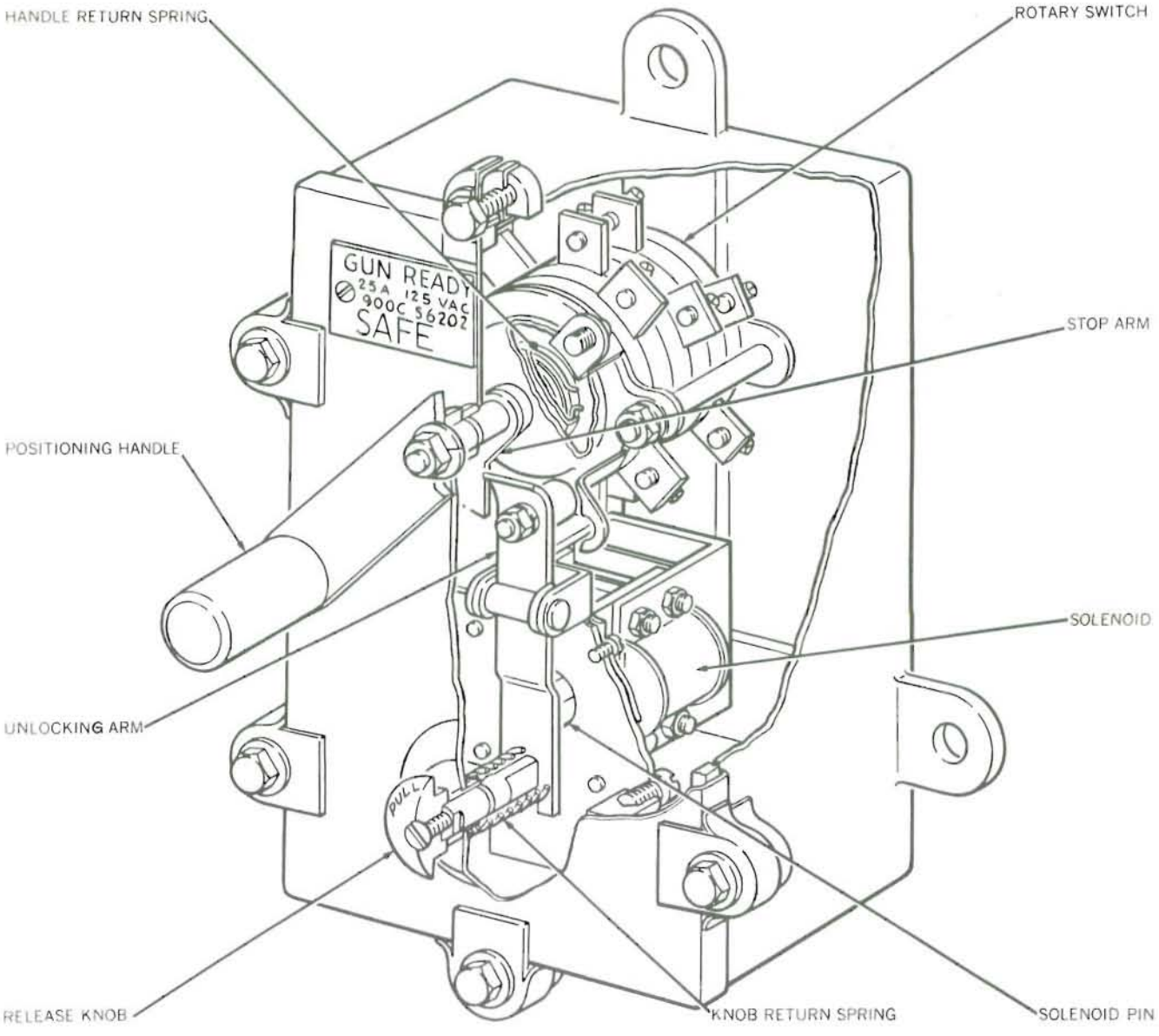

Figure 15-22. Gun Captain's Ready Switch

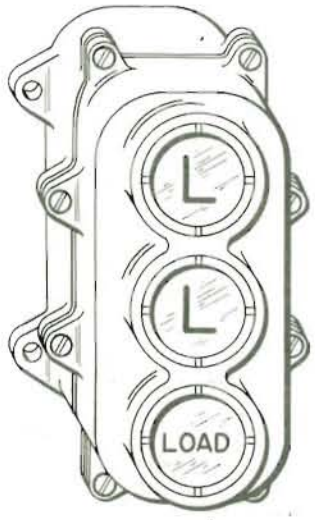

Figure 15-23. Gun Elevation Ready and Gun Ready Indicator

Breech closed, recoil, and bore clear indicators (1R). A second three-dial indicator light is located at each gun captain's station. These dials are illuminated when the actions they identify occur during the loading and firing cycle. A three-dial recoil indicator is also located in the turret officer's booth to indicate when each gun is in recoil. The dials of these indicators are colored as follows:

At each gun captain's station:

Breech closed	- White
Recoil	- Amber
Bore clear	- Green

At the turret officer's booth:

Recoil, left gun	- Amber
Recoil, center gun	- Amber
Recoil, right gun	- Amber

Gun elevation and train ready indicators (1R). Gun elevation and train ready indicators are four-dial light indicators located at the left sight pointer's, right sight pointer's, and train operator's stations. Each is a watertight enclosure with dial lights arranged and marked as shown in figure 15-25.

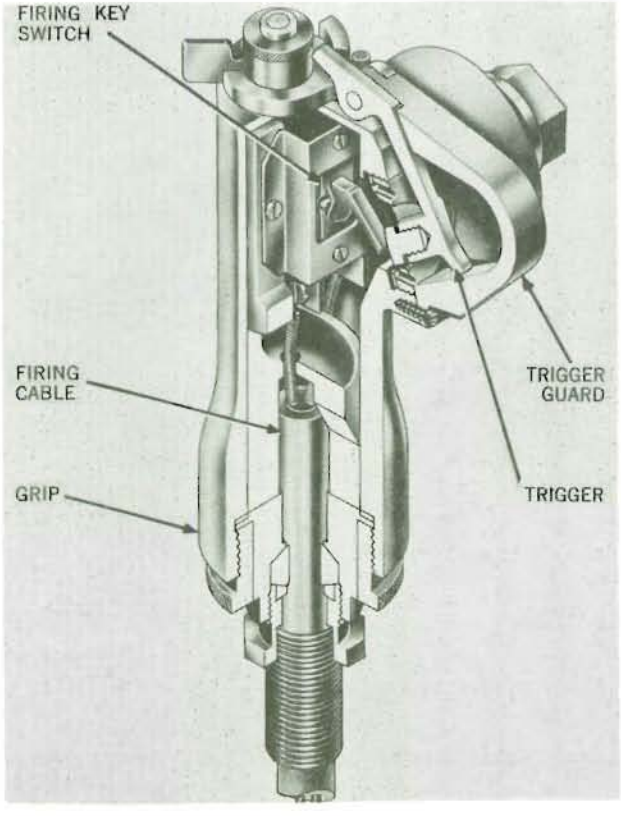

Figure 15-24. Firing Key Mk 16 Mod 8

Firing key (1PA). A Firing Key Mk 16 Mod 8 (fig. 15-24) is located at each sight pointer's, at each gun layer's, and at the train operator's station. The key serves as a means of closing the firing circuit to fire the guns when control is given to a particular station. The keys are designed in pistol-grip form with a spring-loaded, trigger-type contact maker. Each key is waterproof with the path of trigger movement protected by a flexible leather diaphragm. A latch is provided to hold the trigger closed for director-controlled fire.

Sight setter's indicator. A sight setter's indicator is located at each sight station in each turret. Each indicator functions to receive sight angle, sight deflection, and battle orders electrically through circuit GE. It transmits sight angle and

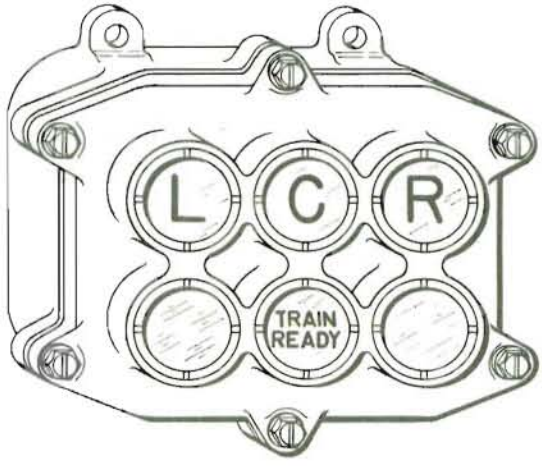

Figure 15-25. Gun Elevation and Train Ready Indicator

sight deflection mechanically to the sight pointer's station, sight trainer's station, and gun elevation indicators.

Train ready indicator. A train ready indicator, figure 15-26, is located at each right and left sight trainer's station. The indicators are illuminated by the foot-operated ready switches of the sight trainers and the train operator.

Bore clear switch (1R). The bore clear switch (fig. 15-25A) is a momentary contact unit, with a spring-loaded pushbutton, located within reach of each gun captain. The main body of the switch is mounted on the opposite side of the bulkhead, and only the mushroom head of the button extends through to the gun captain's station. The bore clear switch is arranged in the 1R circuit to manually, initially energize the bore clear relay, and to light the gun captain's bore clear light; but it can close this relay circuit only after the gun captain has positioned his ready switch to SAFE. After this condition has been met, then, when the gun captain has verified the bore clear condition of the gun barrel, the bore clear switch is depressed momentarily to energize the bore clear relay, thereby releasing the cradle for lowering.

Foot-operated ready switch (1R). Figure 15-27 illustrates a foot-operated switch, six of which are arranged in circuit 1R at the following stations:

Left gun layer
Center gun layer
Right gun layer
Left sight trainer
Right sight trainer
Train operator

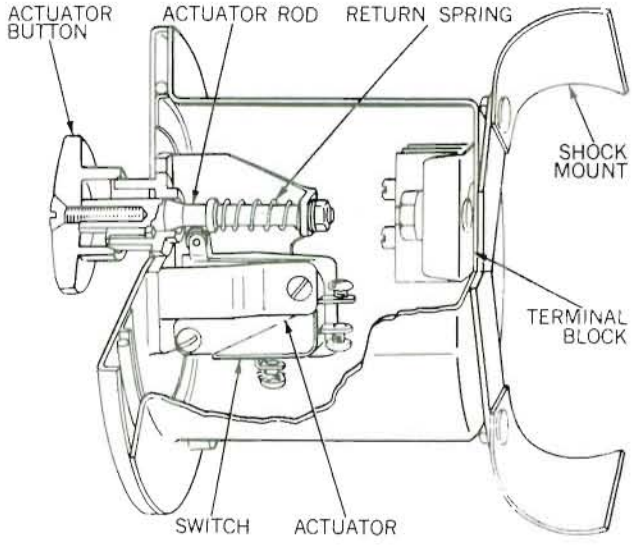

Figure 15-25A. Bore Clear Switch. Cutaway View.

These switches illuminate GUN ELEVATION READY and TRAIN READY indicators, respectively, at various stations.

Salvo signal control (1VB). Salvo signal control, circuit 1VB, consists of buzzer-type horns and contact makers. It provides a warning to turret personnel when the guns are to be fired.

Turret officer's transfer switch (1VB). The turret officer's transfer switch, figure 15-28, is a single pole, double throw, snap switch. It is mounted in the turret officer's compartment over the door to the center gun chamber. The switch has two positions, LOCAL and DIRECTOR, providing selection of salvo signal source.

Cease firing contact maker (1U). The cease firing signal circuit can only be closed from a director station outside the turret. The five contact makers used in the circuit are located in the forward and after plotting rooms, the forward and after main battery directors, and in the fire control station.

Figure 15-26. Train Ready Indicator

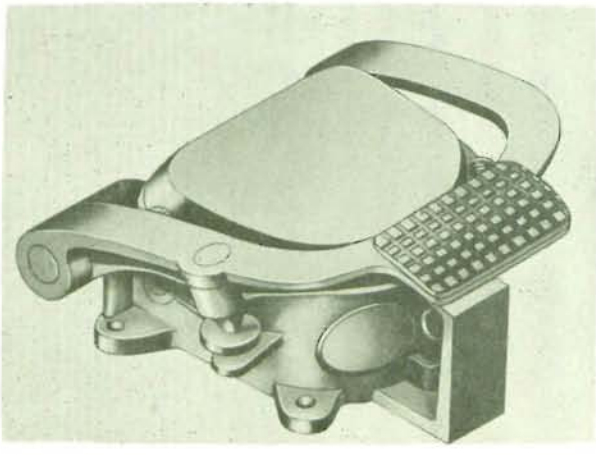

Figure 15-27. Ready Switch, Foot-Operated

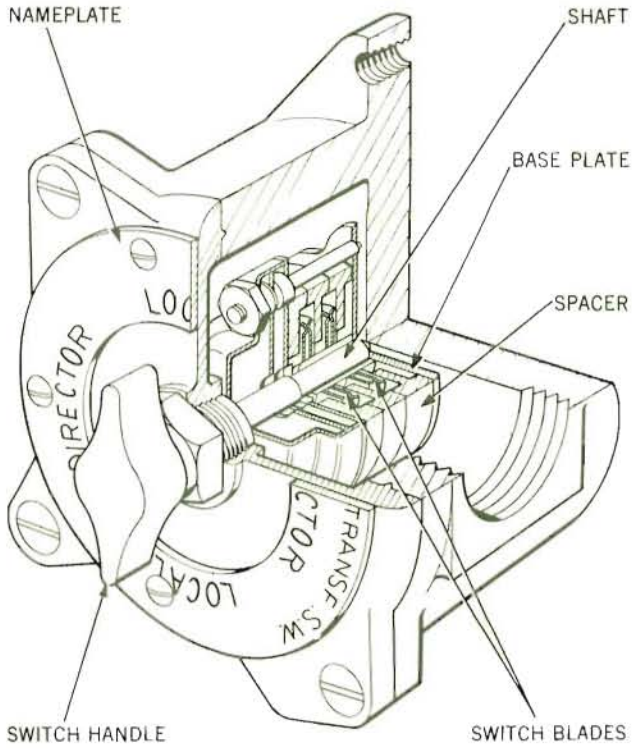

Figure 15-28. Turret Officer's Transfer Switch

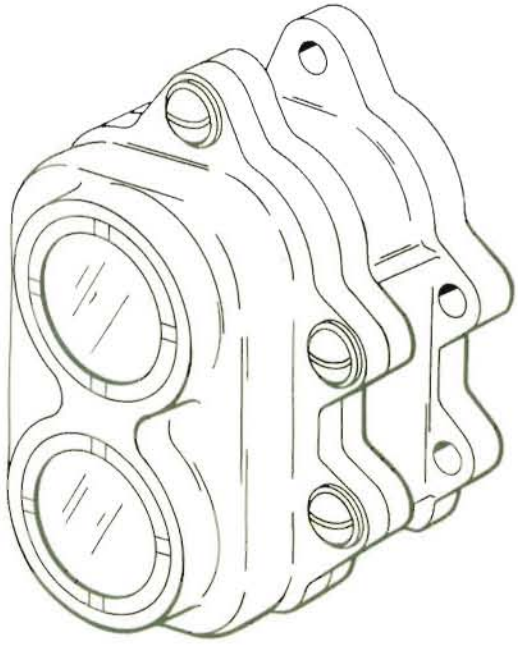

Figure 15-29. Sight Setter's Clutch Warning Indicator

THIS ILLUSTRATION WILL BE SUPPLIED AT A LATER DATE.

Figure 15-30. Turret Fire Control Circuit GE. Isometric Diagram

Danger sector indicator (DS). A danger sector indicator, circuit DS, is located at each gun captain's station and in the turret officer's compartment. These indicators are illuminated whenever a gun's line of fire closely approaches own ship's structure.

Sight setter's clutch indicator (CS). The sight setter's clutch indicator, figure 15-29, is a two-dial indicator with red and green glass dials. The indicators, mounted at each sight setter's station, show the relative positions of both sight setter's clutches.

Pointer's clutch indicator (CP). The pointer's clutch indicator is a single-dial indicator with red glass dial, marked CLUTCH WARNING LIGHT. It provides a warning to the operator when the opposite sight pointer's clutch is engaged.

Emergency alarm contact maker. Emergency alarm contact makers are located throughout the turret. They function to operate sirens which warn turret personnel of danger or serious damage in the turret.

Circuit GE. Circuit GE is the turret indicating control circuit that functions to transmit electric signals that indicate gun orders. Its extent within each turret is shown by the diagram of figure 15-30.

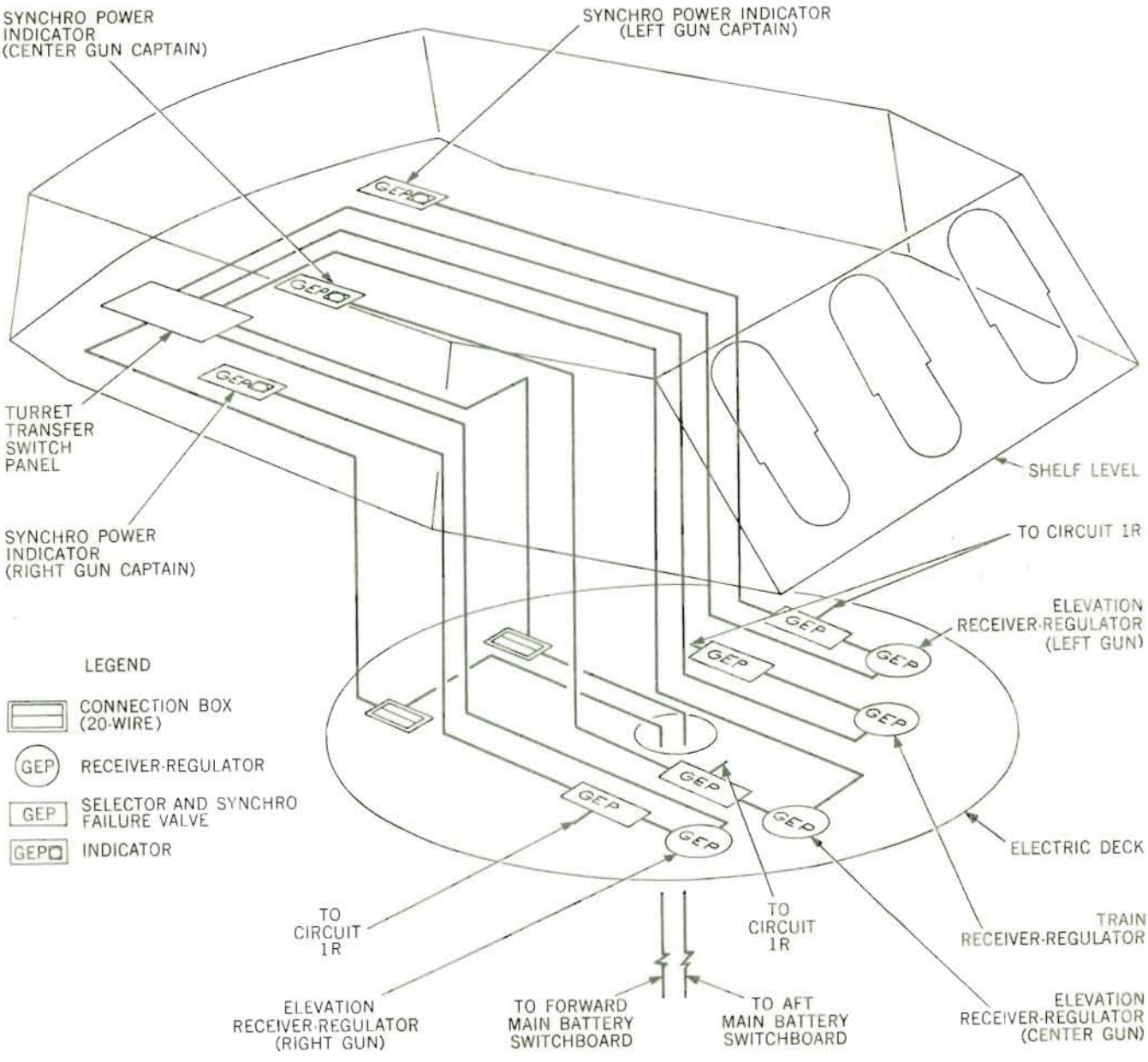

Figure 15-31. Turret Fire Control Circuit GEP. Isometric Diagram

This circuit connects the electrical elements of the following fire control instruments.

Auxiliary computer
Multiple turret train indicator
Gun elevation order transmitter
Sight setter's indicator
Gun elevation indicator
Turret train indicator and transmitter
Rangefinder range transmitter

OSC and OSS signals. Own ship's course and own ship's speed signals energize indicating synchros in the auxiliary computer in the turret officer's compartment. Rotary transfer switch 14B on the turret transfer panel provides selection of signal source from the forward or after plotting room.

Range signals. Range signals are fed to the parallax range receiver-indicator synchro in the train indicator and transmitter through turret transfer switch 14A. Circuits for the range mark contact maker, the observed rnage synchro, and the range plotted signal (turret rangefinder) are routed through switch 13A in the turret transfer panel.

Elevation (indicating) signals. Gun elevation order signals are fed through turret transfer switches to the indicating synchros of the gun elevation indicators located at the left, center, and right gun layer's stations, and from the local sight elevation synchros of the gun elevation transmitters at the left and right sight stations. The signals to the gun elevation indicators have their energizing supply from the forward or after main battery switchboards or from either of the other turrets. Selection is controlled by transfer switch 7A. Energizing supply for the transmitted signals from the synchros of both sight pointer's gun elevation transmitters are selected by switch 12 for operation via either or both of the other turrets.

Gun train order signals. Train order signal switching is more complex than required for previously described circuits since provision is made to connect the output signal of the turret train transmitter to either the forward or after plotting room, to either or both of the other turrets in combination with own turret auxiliary computer, or to own turret auxiliary computer alone. Selection is made through switch 3 on the turret transfer switchboard. The energizing signals for the indicating synchros of the turret train indicator can be selected from any of four sources, forward or after main battery switchboards or either of the other turrets, selection being made by turret transfer switch 1. The train receiver synchro signals of the auxiliary computer can be selected from any turret by switch 5 on the turret transfer switchboard.

Sight angle and deflection signals. Sight angle and deflection signals are transmitted to indicating synchros in both the right and left sight setter's stations from either the forward or after plotting room through switches 13 and 15 on the turret transfer switchboard. Additional switching facilities provide for paralleling the similar synchros of both sight setter's indicators.

Multiple turret train indicator signals. Multiple turret train indicator signals are routed through turret transfer switches 2 and 6 in turrets I and II; they are selected by switch 4 in turret III.

Control transfer signals. Control transfer signals are given by the turret transfer signal indicator. The indicating lights show which plotting room is in control. The circuits are controlled in the plotting rooms.

Circuit GEP. Circuit GEP is the ship's main battery automatic control circuit. Its extent within the turret is shown in figure 15-31. The circuit comprises the branch circuits and the selective switching arrangements through which the synchro motors of the receiver-regulators are energized. All turret wires and terminal connections are identified in figure 15-32.

Gun elevation order signals. Gun elevation order signals are fed through a turret transfer switch 5B from the forward or after plotting rooms, from either of the other turrets or from own turret gun elevation transmitter.

Train order signals. Train order signal switching arrangements provide for energizing the supply to the turret train receiver-regulator synchro from the forward or after plotting room, or from either of the other turrets.

Firing circuit (1PA). Circuit 1PA is the electric gun firing system. It is an extensive system consisting of Bureau of Ships and Bureau of Ordnance installations or components. It extends from the plotting rooms and directors to the turrets as indicated in figure 15-33.

Circuit description. Circuit 1PA provides a means for firing the guns electrically, either individually or in salvo, and either from one of the directors or locally from one of the stations within the turret. It is a series type, ground return system with firing keys, a delay coil, switches, firing transformer, storage battery, sub-caliber relays, and appropriate wiring. The circuit components are elements of several of the switches and panels described in preceding text together with other Bureau of Ships equipment and subassemblies of Firing Circuit Mk 3 Mod 0, all as listed below.

Turret officer's selective switch
Turret officer's indicator panel
Firing transformer
Storage battery
Firing keys
Firing delay coil
Danger sector switches
Sub-caliber relays
Gun captain's ready switch

Turret officer's selective switch. The upper switch assembly of the turret officer's selective switch (page 15-18) provides a choice of either DIRECTOR or LOCAL fire control. The lower switch assembly permits the selection of A.C. SUPPLY or BATTERY to energize the gun firing circuit.

THIS ILLUSTRATION WILL BE SUPPLIED AT A LATER DATE.

Figure 15-32. Turret Fire Control Circuit GEP. Elementary Wiring Diagram

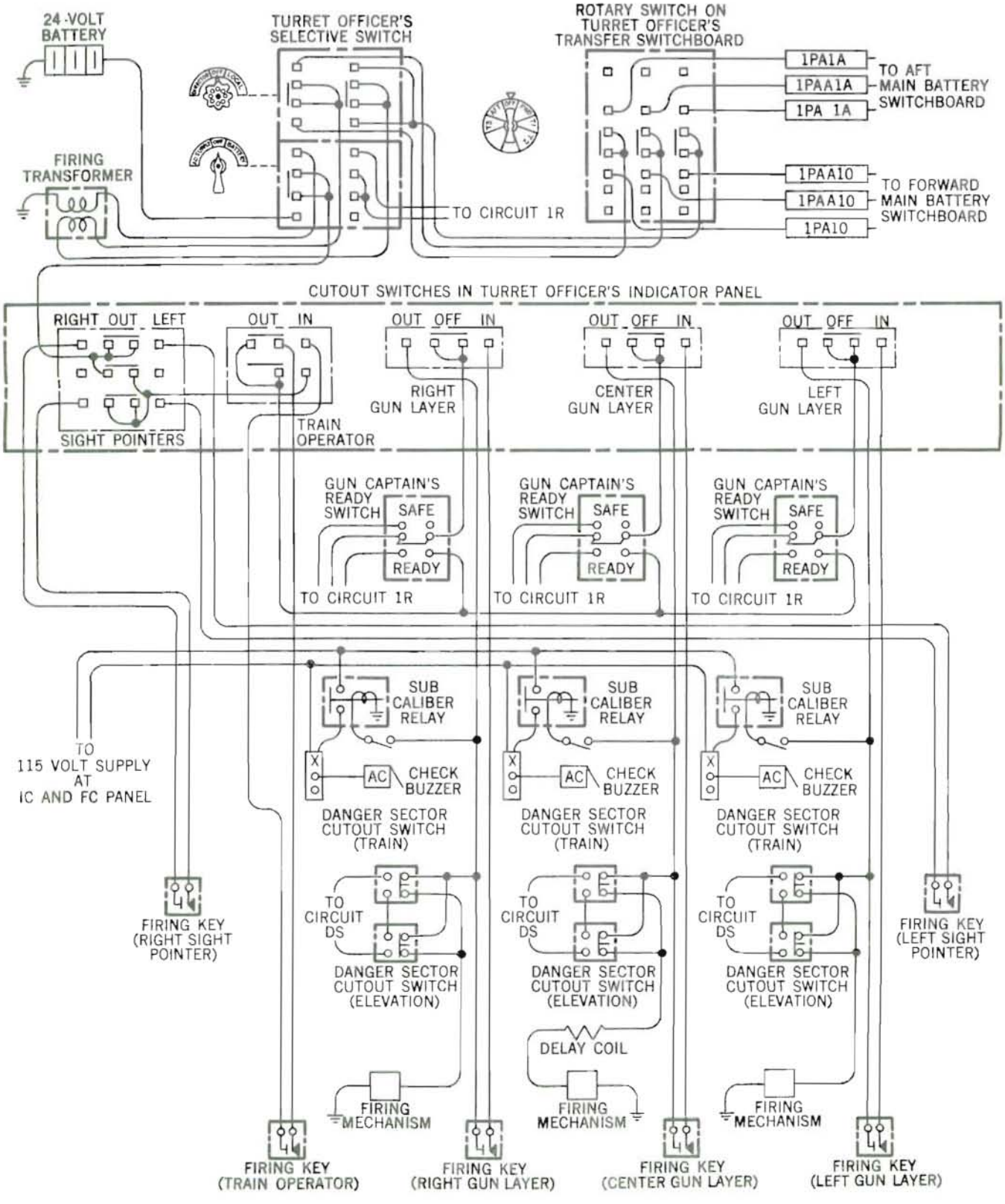

Figure 15-33. 16-Inch Firing Circuit Mk 3 and Associated Equipment. Elementary Wiring Diagram

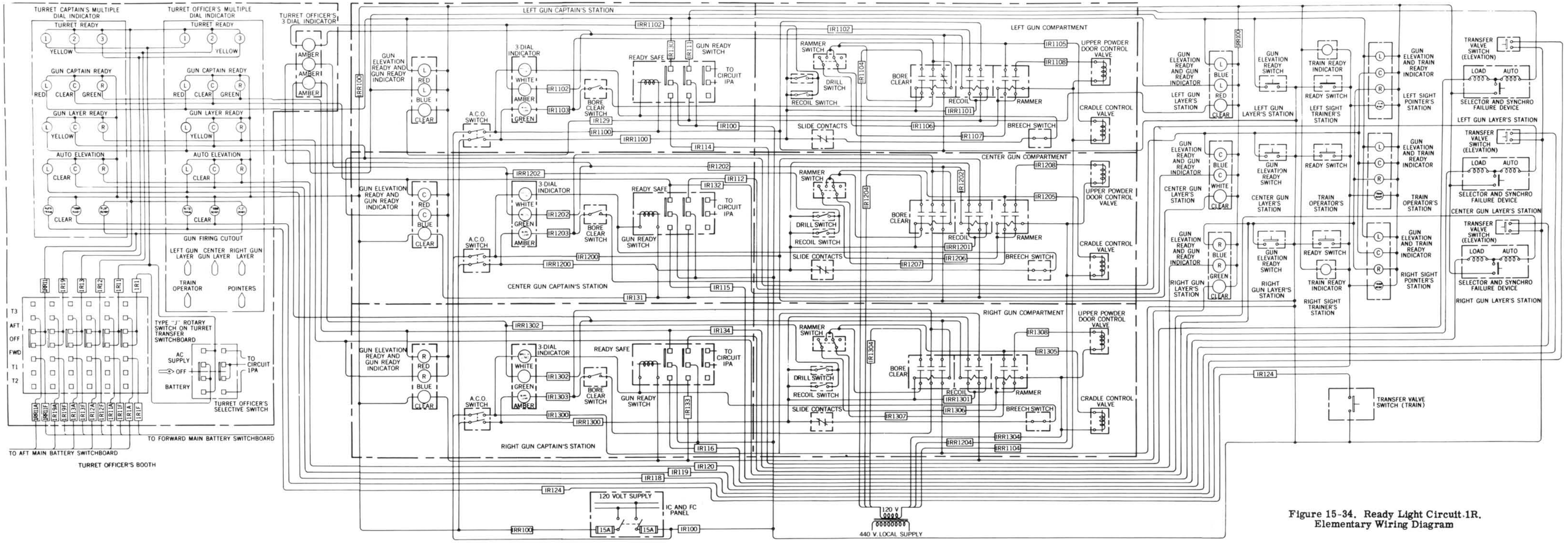

Figure 15-34. Ready Light Circuit 1R. Elementary Wiring Diagram

15-26A/B

Turret officer's indicator panel. The five control switches on the turret officer's indicator panel provide the turret officer with individual firing key "cut out" or "cut in" switching facilities. By means of these switches, he may by-pass all turret firing keys for director firing or any individual key or combination of keys in the event of damage to firing key circuits.

Firing transformer. The firing transformer is located in the turret officer's compartment just above floor level in a recess of the transverse bulkhead. It is a 200-volt-ampere watertight encased unit with a 120-volt primary and 20-volt secondary.

Storage battery. Four 6-volt, 100-ampere-hour storage batteries are used. All are located in the turret officer's compartment on a platform transversely aligned near the right end of the rear armor plate. These batteries are connected in series to provide a 24-volt supply for gun firing in an emergency.

Firing keys. The firing keys (page 15-20) serve as a means of closing the firing circuit when control is given to a particular station.

Firing delay coil. A firing delay coil is used to retard the firing time of the center gun, thus preventing "kissing" of the projectiles in flight. The coil is housed in a watertight case. It contains a non-inductive resistance of 17.10 ohms which retards the firing time of the center gun approximately 1/17 second behind the outboard guns.

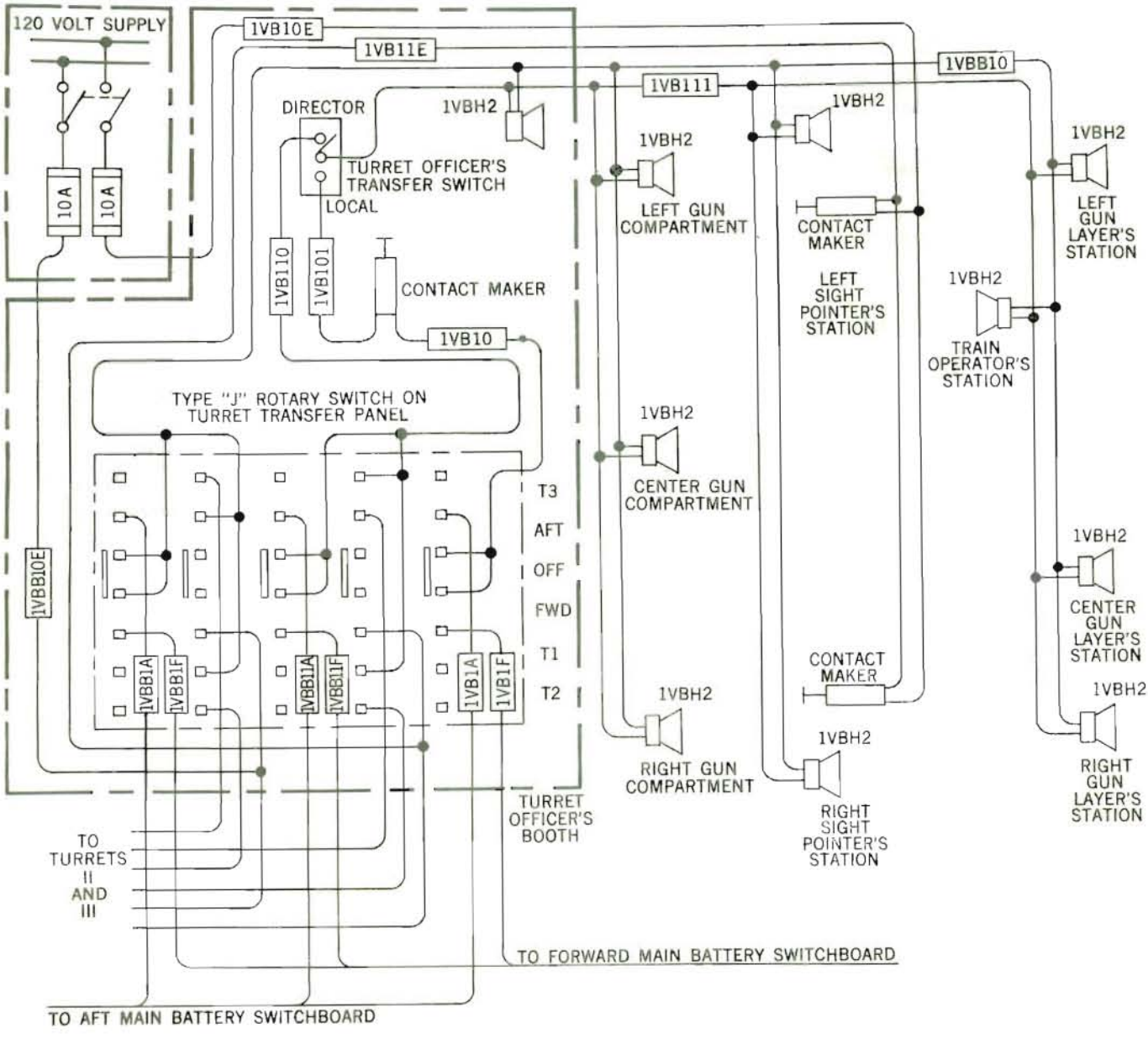

Figure 15-35. Salvo Signal Circuit 1VB. Elementary Wiring Diagram