Chapter 11

POWDER HOIST

16-Inch Powder Hoist Mark 9 and Mark 9 Mods 1 to 8, Inclusive

GENERAL DESCRIPTION

The turret powder hoist installation for each gun is similar to the arrangement shown in figure 11-1. The right, center, and left installations, designated 16-inch Powder Hoist Mk 9 Mod 0 and Mk 9 Mods 1 to 8 inclusive, are installed in turrets of the IOWA class battleships as tabulated below.

The 16-inch Powder Hoist Mk 9 is a car type vertical lift, electric-hydraulically driven, arranged for selective servo or manual control. All hoists are of the same general design and have identical power drives and controls.

Each powder hoist is a functionally independent assembly. It delivers a full service powder charge of six powder bags to a gun during each hoisting cycle.

Turret installation

Powder hoist installations, according to ship, turret, and position of each assembly are tabulated below.

Emplacement			Powder Hoist	
Ship	Turret	Gun	Mark	Mod
Iowa,	I	Right	9	0
	I	Center	9	1
New Jersey,	I	Left	9	2
	II	Right	9	3
Missouri,	II	Center	9	4
	II	Left	9	5
and	III	Right	9	6
	III	Center	9	7
Wisconsin	III	Left	9	8

Components

Each powder hoist assembly consists of the following components which are described in the following paragraphs:

Power drive
Powder hoist trunk
Trunk lower door assembly
Trunk upper door assembly
Powder car
Controls and interlocks

Component locations

Component locations, shown in figure 11-1, are similar for the three turret assemblies. Power drive units are located forward of the hoist trunks, above and within the gun girder box spaces, except for certain controls. The electric controllers are located in the machinery space of the upper projectile flat.

The powder hoist trunks extend from the powder handling room to the gun house roof. Left and center trunks are enclosed within the left gun girder box, the right trunk is similarly enclosed within the right gun girder box.

Powder hoist trunks are equipped with door assemblies arranged at the lower and upper ends. The lower door opens into the powder handling room and the upper door opens into the respective gun room compartment.

The powder car, mounted on rails, moves vertically within the hoist trunk between the lower and upper door assemblies.

Powder car and door actions are coordinated by a system of control and interlock devices located in the hoist trunk, on the powder car, and at the power drive units. The ON-OFF master pushbutton control is at the hoist operator's station.

Functional arrangements

Each powder hoist assembly is operated and controlled independently of the other powder hoists within the turret. Its power drive, an electrically driven hydraulic transmission, raises or lowers a powder car which is confined within the spaces of a trunk. The car is loaded through the trunk lower doors and is unloaded through the trunk upper door. The power drive controls automatically stop the car at the loading and unloading stations.

The trunk lower door arrangements provide for loading both powder car trays simultaneously from the powder handling room. The trunk upper door arrangements provide for unloading each car tray singly at two unloading stations. The upper door is hydraulically operated by pressure from an auxiliary pump mounted on the electric motor.

The arrangement of power drive operating controls is selective and provides for both servo and manual control of the hoist. Pressure for servo operation is derived from a control and supercharge pump mounted on the A-end assembly.

Design features

The turret powder hoist assemblies, independently controlled by separate hoist operators, have no interconnection. The assemblies have the same speeds and degrees of selective control.

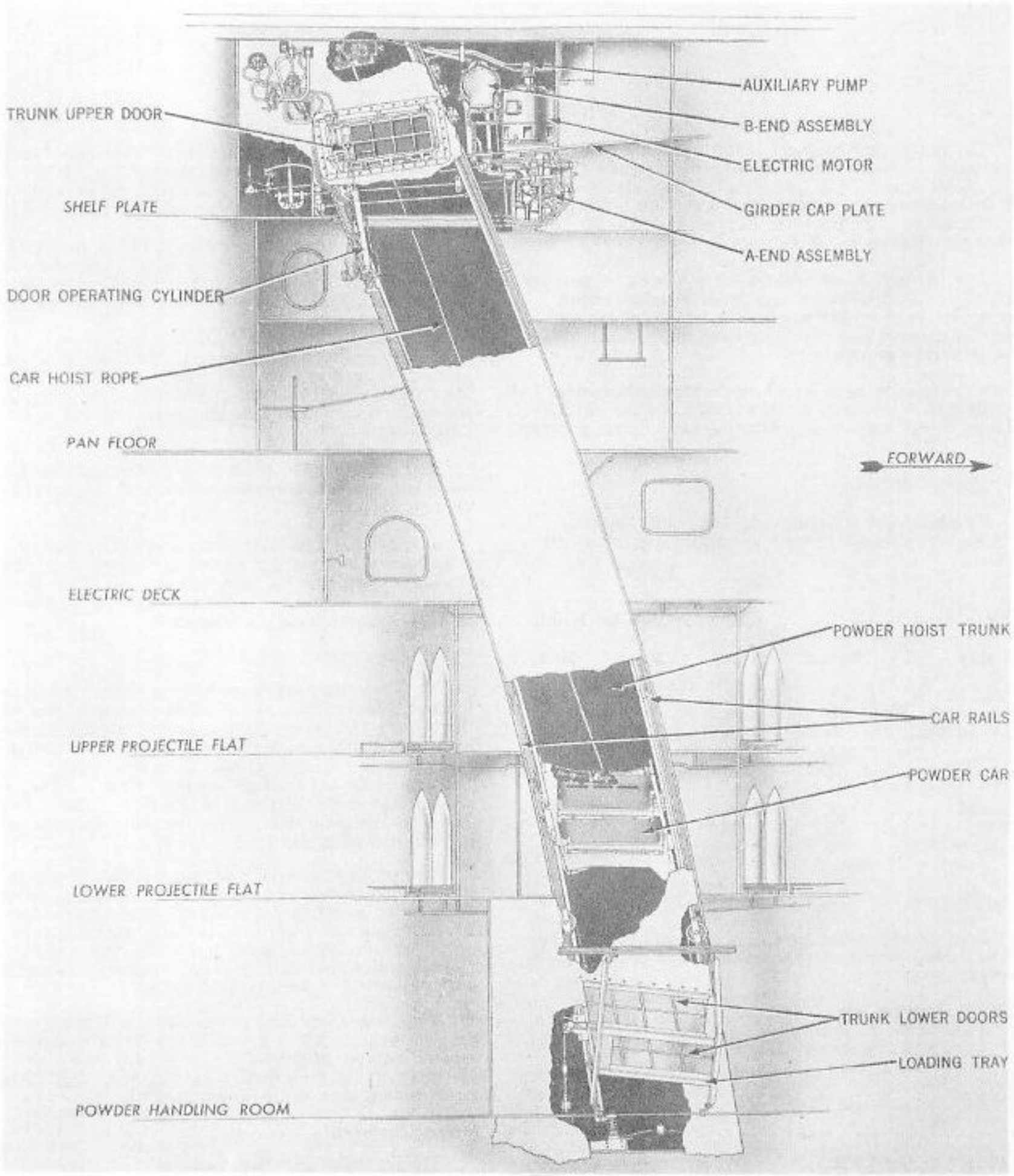


Figure 11-1. 16-Inch Powder Hoist Mk 9 Mod 0 - General Arrangement within Turret

The powder car, trunk lower and upper door assemblies, and the starting lever are interlocked. This arrangement prevents simultaneous opening of both doors, locks the starting lever at neutral (except when both doors are closed or when unloading the car at the upper station), and blocks opening of either door until the car arrives at that station.

Selective hoist controls provide for either servo or manual operation of the hoist.

The trunk upper door is operated by the rammer operator in the gun room.

Design differences

Turret powder hoist assemblies are of virtually identical design. The hoist vertical lift, tabulated below, varies according to its location. Power drive assemblies for right and center hoists are identical. They differ from the left hoist power drive assembly in that the B-end rotation is opposite due to its left hand installation. Powder cars for right and center installations are loaded and unloaded from the right side. The powder car for the left installations are loaded and unloaded from the right side. The powder car for the left installation is loaded and unloaded from the left side. Lower and upper door assemblies and loading trays are mounted on the trunk to align with respective powder cars.

Data

All hoists have the same capacities and rates of delivery. The vertical lift varies for outboard and center gun turret installations and for the different turrets. These and other data are:

Hoist capacity	
Powder car (powder bags)	6
Vertical lift, feet	
Powder hoist designation	
Mk 9 Mod 0	45.48
Mk 9 Mod 1	45.64
Mk 9 Mod 2	45.48
Mk 9 Mod 3	54.08
Mk 9 Mod 4	54.14
Mk 9 Mod 5	54.08
Mk 9 Mod 6	43.08
Mk 9 Mod 7	43.14
Mk 9 Mod 8	43.08
Adjustable limits, feet	35 to 57.50
Hoist speed (longest vertical lift)	
Cycle time, seconds maximum	
Servo electrical	12.50
Manual mechanical (hoisting)	15.00
Manual mechanical (lowering)	12.00
Weights (pounds)	
Electric motor	2550
Electric controller	235
A-end assembly	1679
B-end assembly	2642
Powder car (empty)	2050

DETAIL DESCRIPTION

Power drive

The powder hoists are driven by identical electric-hydraulic power drive assemblies that consist of:

Electric motor
Electric controller
Motor to A-end couplings (two)
A-end assembly
B-end assembly
Auxiliary pump
Latch and vent valve
Safety car stop operating device
Safety car stop release valve
Control linkage
Dashpot

Component locations and arrangements. Located forward of the hoist trunks, the power drive units (fig. 11-1) are mounted above and within spaces formed by the gun girder box weldments. Left and center hoist units are mounted within the left box weldment, and the right hoist units are mounted within the right box weldment. At the top of the box weldments, girder cap plates subdivide the spaces and provide flooring and foundations for the electric motor and B-end assemblies. The A-end assembly, located below the cap plate and beneath the electric motor, is connected to the B-end by the main system hydraulic transmission pipes. The auxiliary pump is mounted on the electric motor upper end. Power drive control linkage extends rearward from the A-end assembly through the hoist trunk to the operator's control station.

Electric motor. A squirrel-cage induction type, the electric motor is flange-mounted on the top of the gun girder cap plate. Vertically arranged, the motor has its output shaft at the lower end and is coupled to the A-end main shaft through two flexible couplings and a connecting shaft.

Motor data.

Type	squirrel cage, induction
Design features	waterproof, fan cooling, vertically mounted, direct drive
Horsepower	100
Revolutions per minute, synchronous	1800
Revolutions per minute, full load	1770
Rotation (looking down)	counterclockwise
Speed class	constant
Voltage	440
Amperes, full load	90
Amperes, locked rotor	950
Phases	3
Cycles	60
Ambient temperature, C	40
Torque class	normal
Weight, lb	2550
Manufacturer	Westinghouse Electric & Manufacturing Co.
Manufacturer's designation	CS-753
Drawing	274358

Electric controller. Each electric motor is powered and controlled through an across-the-line magnetic-type controller. Each controller contains a main contactor, overload relays, reset relays, and a hand-operated circuit breaker. Mounted in the machinery space of the upper projectile flat, the controller is controlled from a master pushbutton switch at the hoist operator's station. Normally open, the switch is closed to start the electric motor by pressing the START-EMERG button. The motor is stopped by pressing the master STOP button or an emergency stop pushbutton at the lower door operator's station.

Controller data.

Type	waterproof, semiautomatic, across-the-line starter, automatic circuit breaker, controlled by remote pushbutton
Ampere rating, full load	126
Protection	
Overload, thermal type	
Adjustable range, amp.	125.8 to 170.2
Normal setting, amp	128.5
Short circuit, automatic circuit breaker, amp	1800
Undervoltage	
Drop-out voltage	50
Sealing voltage	370
Shock rating	150
Weight, lb	235
Manufacturer	Westinghouse Electric & Manufacturing Co.
Drawing	274360

Motor to A-end couplings (two). The electric motor shaft is coupled to the A-end shaft through a connecting shaft and two identical flexible couplings. Splined at each end, the connecting shafts for right and center power drive assemblies are 11.16 inches long, the connecting shaft for the left assembly is 13.75 inches long. The couplings, spline fitted at each end of a connecting shaft, are floating, self-aligning, extended, commercial units with design details as shown in figure 8-7 of chapter 8. Each coupling comprises a rigid hub which connects to a flexible sleeve and flexible hub. The flexible hub has external teeth at the shaft end which mesh with the internal teeth of the flexible sleeve. A slight clearance between the meshing teeth permits drive with small misalignment between the motor and A-end shaft. Each coupling is provided with a grease fitting for lubrication.

A-end assembly. The A-end assembly (fig. 11-2) consists of the components listed below. Type, arrangement, and functional purpose of the components are described in following paragraphs:

Hydraulic pump
Gear train
Control and supercharge pump
Control case
Oil filter
Oil supply tank

Hydraulic pump. Consisting of rotating and non-rotating groups, the pump is mounted in a housing and yoke. The rotating group comprises a cylinder block, seven pistons and connecting rods, a universal link and pin assembly, and the drive shaft. A yoke, valve plate, and valve block comprise the non-rotating group. The cylinder block and piston assembly are ball-bearing-mounted and are spring-held against the valve plate. The drive shaft, also ball-bearing-mounted, provides sockets for the connecting rods which attach to pistons within the cylinder block. Mounted within the cylinder block and main shaft, the universal link and pin assembly provides flexible drive between the two components. The valve plate and valve block are mounted in the yoke which is pintle-mounted on the pump housing. This arrangement provides a flexible drive connection between the drive shaft and cylinder block. The pump regulates hydraulic motor speed and direction of rotation as it is tilted or offset from neutral by its yoke, which is connected to the servo and manual control devices.

The A-end hydraulic pump is a housing-enclosed multi-piston unit. It is a type K, riciprocating, variable-stroke, rotating pump of modified commercial design.

The hydraulic pump unit, mounted vertically within the pump housing, is attached to the housing upper end with the splined drive shaft extending upward. Connected to the electric motor by the coupling arrangement described previously, the pump is continuously driven at approximately constant speed.

There are two centering spring assemblies, one for hoisting and one for lowering, which exert pressure on the pump yoke through spring-loaded plungers. Mounted vertically within the pump housing, the assemblies are so arranged that the plungers bear on arm mounted rollers of the pump yoke. The plungers are retracted by main system high pressure. After completion of a hoisting or lowering stroke, the assemblies return the pump yoke to a neutral position slightly offset toward hoisting.

The limit switch, used in the electric motor starting circuit, is mounted on top of the pump housing between the centering spring assemblies. It opens the starting circuit whenever the pump yoke is offset from a near-neutral position. This prevents a starting overload on the electric motor. It is a plunger-operated, two-pole normally closed switch. The switch plunger is operated by a limit switch cam mounted on the pump yoke midway between the arm-mounted rollers described above.

Gear train. A case-enclosed gear train assembly, comprising input, idler, and drive spur gears, is mounted on top of the A-end case. Driven at constant speed by electric motor input to the A-end pump, the assembly reduces electric motor speed to drive the control and supercharge pump at 1200 revolutions per minute.

Control and supercharge pump. The control and supercharge (servo) pump is a multiple vane, constant displacement, radial type. It is mounted on top of the gear train case by a flange attached to the pump housing. The pump is driven by a shaft spline fitted to the gear train drive gear. With its intake line connected to the A-end pump reservoir, the pump discharges through a duplex filter and control (servo) pump bypass valve into the A-end control case. The pump has a rated capacity of 11.0 gallons per minute at a pressure of 160 pounds per square inch, regulated by the circuit relief valve.

Control case. The control case, mounted on the side of the pump housing, is a valve block assembly with control levers. The valve block comprises a servo stroking piston, control pump relief valve, power failure valve, venting valve, control pump bypass valve, check valve, and servo valve. The control levers connect valve block components to the selector control lever and the control lever, in addition to operating the control pump bypass valve.

A-end mounting and access arrangements. The A-end pump housing is mounted on top of a zinc coated,

welded steel supply tank. Access to the tank is through inspection openings, normally closed by removable covers which are mounted on the tank ends.

Oil filter. A screen-type filter in the control pump circuit removes foreign material from the hydraulic fluid before it enters the control case. The filter assembly, mounted on the side of the supply tank, comprises two elements which are used simultaneously in normal operation. However, a control valve permits individual use of either filter element, making it possible to clean a fouled element without stopping the power drive.

Oil supply tank. Providing a mounting base for the A-end pump housing, the supply tank is secured to its gun girder foundation by bolts and integral tank mounting feet. The tank and A-end assembly may be drained through a normally closed plug in the tank end. Filled through a removable cap in the side of the pump housing, the tank fluid level is verified by high and low level trycocks in the side of the tank.

B-end assembly. The B-end assembly (fig. 11-3) consists of the components listed below:

Hydraulic motor
Hoisting drum
Brake drum assembly
Foot valve
Acceleration and deceleration cams

Hydraulic motor. The hydraulic motor, consisting of rotating and non-rotating groups, is similar to the A-end hydraulic pump except that its cylinder block and valve plate have fixed offset position. A cylinder block, nine piston and piston rods, a drive shaft, and a universal link and pin assembly comprise

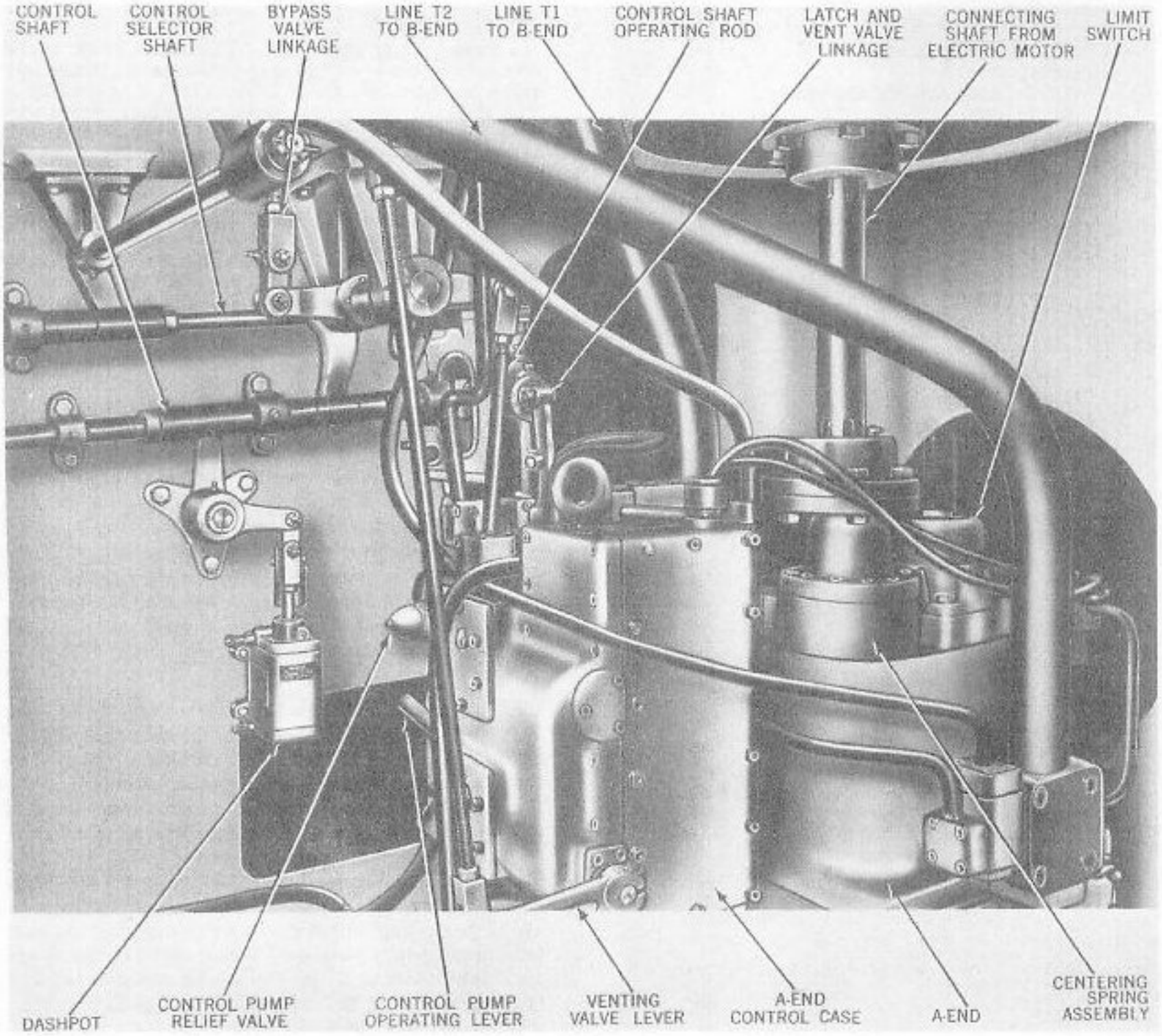


Figure 11-2. Powder Hoist A-end Assembly - General Arrangement

the rotating group. The non-rotating group comprises the motor housing, valve block, and valve plate. The rotating assembly is driven through a closed hydraulic circuit from the A-end pump which is connected to the B-end valve block by hydraulic transmission lines. Motor rotation is transmitted through the drive shaft, which is spline-fitted to the hoist drum. Hydraulic motor speed and direction of rotation are determined by the direction and degree of pump yoke offset.

The B-end hydraulic motor, a multi-piston unit, is a type K, reciprocating fixed stroke, rotating pump of modified commercial design. The hydraulic motor unit is horizontally mounted on a welded steel base plate which forms the foundation for the complete B-end assembly.

Components. The hydraulic motor consists of the following components:

Motor housing
Valve block
Valve plate
Cylinder block
Pistons and piston rods
Drive shaft
Universal link and pin assembly
Relief valves
Check valve

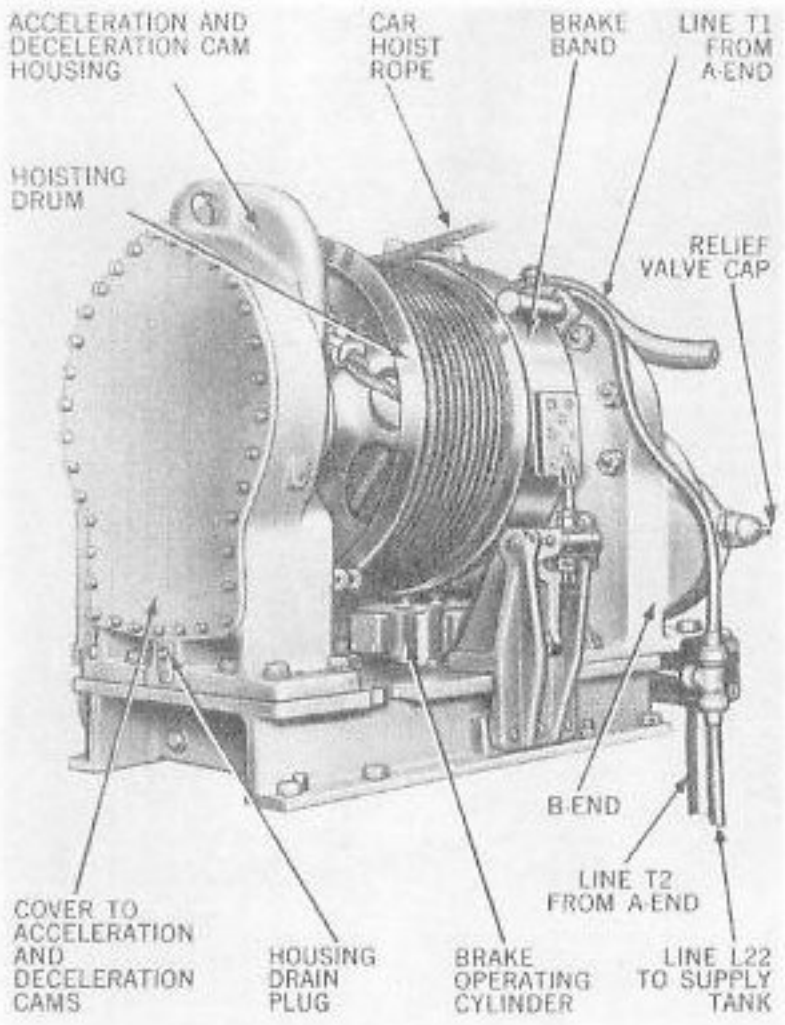


Figure 11-3. Powder Hoist B-end Assembly - General Arrangement

Relief valves. The hydraulic motor relief valves (two) are located in the B-end valve block. Identical valve assemblies, they are spring-loaded, plunger-type valves arranged in opposed positions, with separate oil passages. These extend to the main transmission pipe ports of the B-end valve plate. The valves are adjusted to relieve main system high pressure in excess of 2100 pounds per square inch.

Check valve. The check valve is located in the B-end valve block. It is a spring-loaded plunger-type valve that prevents excessive high pressure build-up at the start of a lowering cycle.

Hoist drum. The hoisting drum (fig. 11-3), a machined cylindrical steel weldment, is spline fitted on the hydraulic motor drive shaft. Thread-grooved to insure even winding of the powder car hoist rope, the drum has flanges at its outer ends to retain the rope on the drum.

Brake drum assembly. The brake drum assembly comprises the brake drum, brake band, brake operating mechanism, and a brake ratchet assembly. The brake drum, a machined cylindrical steel weldment, is fitted with free bearing on the hydraulic motor drive shaft. It is connected to and driven by the hoisting drum through the brake ratchet assembly. The brake band is a steel band with attached brake lining material. Slightly narrower than the brake drum around which it is mounted, the band has riveted-on end pieces for attachment and adjustment. The brake operating mechanism is connected by a short link to the end of a brake operating lever which is attached to both ends of the brake band.

Brake operating mechanism. Secured to the welded steel base plate, the brake operating mechanism comprises a pressure-operated cylinder, links, and levers which operate to release or apply the brake. Pressure-operated to release, the brake is applied by venting the brake cylinder; this allows the spring in the cylinder to move the piston and linkage to contract the brake band. When the brake is released by main system high pressure, the band is forced out to rest against five adjustable stops, which hold the band away from the brake drum.

Foot valve. Mounted on the bottom of the B-end valve plate, the foot valve assembly is controlled by linkage mounted on the motor unit base plate. The foot valve prevents the powder car from lowering at the start of a cycle, while the brake is released and the main circuit pressure is building up to support the load. When stopping, after the main circuit is vented, the foot valve holds the load until the brake has had time to apply. The foot valve functions only at the beginning and end of a cycle because its control linkage is mechanically connected to the operating control linkage. As the A-end pump is offset from center, the foot valve linkage opens a valve which bypasses the foot valve. During a hoisting cycle, the foot valve is bypassed through a check valve in addition to the bypass valve.

Acceleration and deceleration cams. Four cams control the hoisting and lowering acceleration and deceleration rates. The cams are adjustable for positioning the flight and also for controlling its length.

Cam housing. Located on the end of the B-end output shaft, the steel cam housing provides a mounting for the outboard bearing of the drive shaft. The housing includes a reduction gear which drives a cam support assembly. Geared to the output shaft, the cam support turns less than one revolution for a hoist flight of 53 feet. The acceleration and deceleration cams are secured to the cam support.

Cam controlled linkage. A rocker arm and shaft assembly, located at the lower end of the cam housing, transmits motion controlled by the cams to the A-end control rod. This motion is transmitted to the A-end through the control linkage and limits the degree the A-end pump may be offset. This determines the maximum speed of the hoist at each position of the powder car.

Differences between the B-end assemblies. B-end assemblies consist of exactly the same components for right and left installations, but the components are assembled differently. The method of changing power equipment from right-hand to left-hand is described on page 11-48.

Hydraulic system data.

Type . . . variable displacement speed gear	
Driven speed of pump, rpm	1800
Speed of hoisting drum	
Hoisting, rpm	168
Lowering, rpm	178
Torque load	
Normal, rated, ft-lb	2400
Maximum, rated, ft-lb	3750
Oil temperatures	
Normal operating range, F . . .	120 to 175
Maximum permitted, F	185
Displacements	
Pump, cubic inches per rev	11.84
Motor, cubic inches per rev. . . .	158.62
Manufacturer	Vickers, Incorporated
Manufacturer's designation	N-323
Drawings	325000, 325001

Auxiliary pump. The auxiliary pump is a multiple vane, constant displacement, radial type. It is mounted on the upper end of the hoist electric motor by an integral flange of the pump housing. Connected to the rotor shaft, the pump is directly driven at 1800 revolutions per minute by the electric motor. With its intake line connected to the supply tank, the pump discharges through a duplex filter into the hoist upper door hydraulic system, described on page 11-9. The pump has a rated capacity of 30.0 gallons per minute at a pressure of approximately 75 pounds per square inch, which is regulated by the system relief valve.

Latch and vent valve. The latch and vent valve, flange mounted on the forward end of the A-end case, is a two-position, spool-type valve. Connected to the control selector linkage, it acts during a mechanically controlled cycle to vent main system pressure and also to apply the hoist drum brake. The valve latch is mechanically held out of the hoist control linkage cam notch when the control selector lever is at SERVO ELECTRICAL. The valve, pressure-operated to withdraw the latch, is spring- and pressure-operated to return the latch to the cam notch. In mechanical control, the latch prevents movement of the hoist operator's control lever until the safety car stop release valve is moved to its start position. This prevents inadvertent lowering of the powder car on to the safety car stop device.

Safety car-stop operating device. The safety car-stop operating device (fig. 11-12) is a flange mounted on the forward side of the mounting plate that supports the safety car-stop release valve. Hydraulically connected to the valve, the device consists of a housing enclosed plunger which is attached to a lever mounted on the safety latch operating shaft. The device operates a pair of safety latches (described on page 11-12). These are withdrawn hydraulically from the path of the powder car when the starting lever is positioned at START. After a few inches car movement, the starting lever is released and the latches are spring-operated to return into the path of the car.

Safety car-stop release valve. The safety car-stop release valve, flange mounted at the hoist operator's station (fig. 11-4), is a two position, spool-type valve. It opens or blocks main system pressure flow to the safety car-stop operating device. Connected by linkage to the starting lever, the valve is manually operated. In the start position, it functions to start a cycle and to withdraw the safety latches from the path of the powder car. Spring-loaded, the valve returns to the stop position when the starting lever is released.

Control linkage. Control linkage elements (fig. 11-2) are located forward of the hoist trunk and interconnect the A-end control case and the control lever. The linkage consists of a steel bracket and shaft, to which are secured levers and adjustable control rods. Needle bearings are used to eliminate friction. The linkage connects the cam rocker arms in the B-end to the control pump operating lever at the A-end. The motion of the B-end cams is transmitted by the control linkage to the A-end pump yoke to limit hoist acceleration and deceleration rates.

Dashpot. The dashpot (fig. 11-2), flange mounted on the gun girder adjacent to the A-end, is a valve block arrangement of a dashpot piston, two ball check valves, and two plunger-type feed control valves. The piston is attached by a clevis and lever to the hoist control shaft. During mid-cycle (that is, when the rocker arms are clear of the acceleration and deceleration cams), the assembly prevents rapid shifting of the control lever. The assembly is adjustable by restrictions placed in passages to the feed control valves to slow down movement of the control lever. This sets the hoist acceleration and deceleration rates to not greater than 16 feet per second, nor less than the rates which are determined by the cams in the B-end.

Powder hoist trunk

The powder hoist trunks comprise the powder car hoistways and accessory components within them. The three powder hoist trunks are similar enclosed

vertical hoistways (fig. 11-1) of rectangular plan section. They extend from the powder handling room and curve upward and rearward to the gun house roof. Left and center trunks rise within the left gun girder box weldment; the right trunk is similarly located within the right gun girder box weldment.

Components. The powder hoist trunk consists of the components listed below:

Car rails
Loading trays
Car buffer, lower
Car buffer, upper
Hoisting sheave
Car movement controls and interlocks

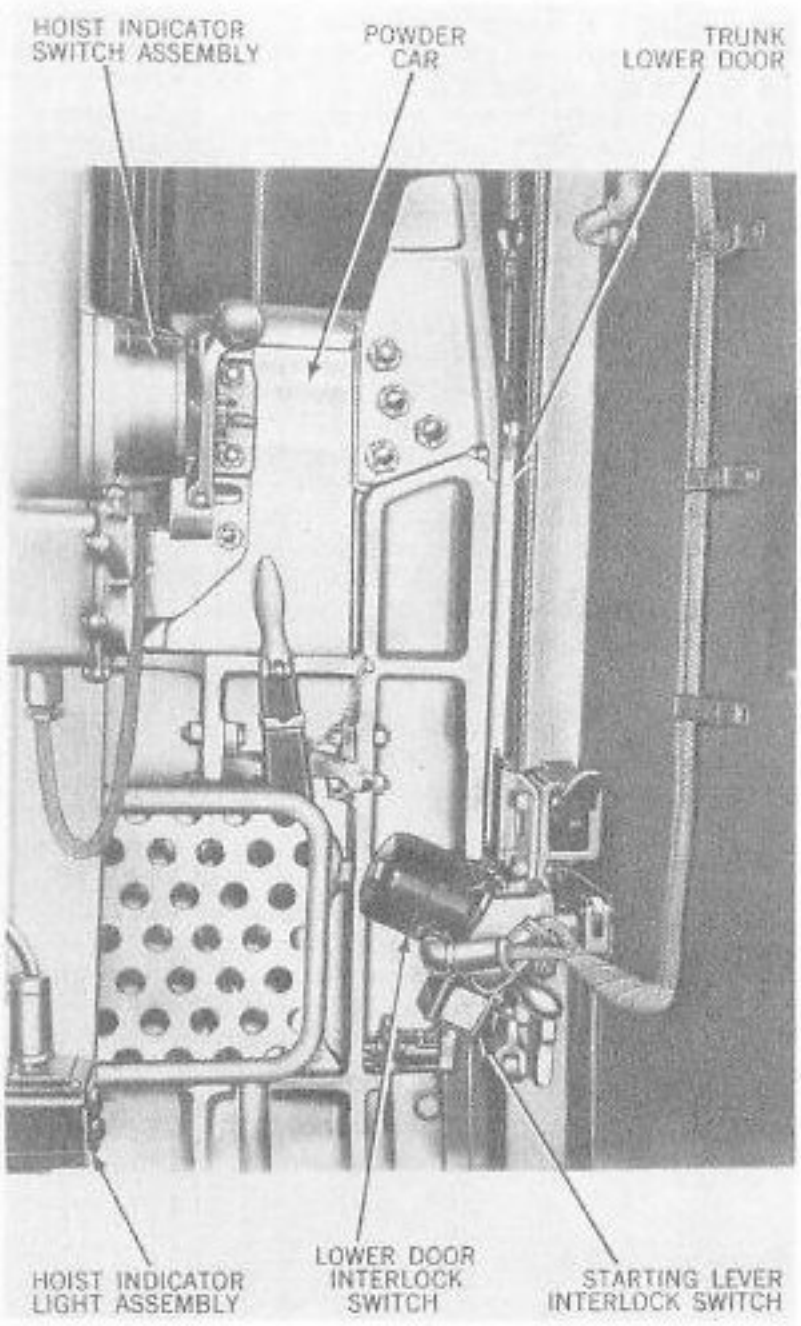


Figure 11-4. Powder Hoist Lower Door Operator's Station - General Arrangement

Car rails. The car rails provide curving double tracks for the powder car and are in vertical planes parallel to each other and to vertical planes of their respective gun axes. Each rail is made in five cast bronze segments. These are riveted to the side of the hoist trunk opposite the lower and upper door apertures with a width of 64.03 inches between rails. The lower segment of the forward rail is portable for powder car installation or removal.

Loading trays. The loading aperture at the lower end of the hoist trunk is provided with a loading tray assembly. This assembly comprises two fixed trough-like brass trays which are horizontally spaced 22.5 inches apart. The lower tray is 25.2 inches above the powder handling room platform. The trays tilt down at the forward end to align with the powder car trays when the car is at the loading station.

Lower car buffer. The lower car buffer assembly comprises two identical spring and hydraulic buffer units and an expansion tank. All are mounted at the bottom of the hoist trunk with the buffer units aligned to contact the forward and rear ends of the powder car. The buffer cylinder has throttling grooves of variable depth in its wall. A coil spring on the buffer piston rod beneath the piston rod head augments the buffing action and returns the piston to full stroke after it has been compressed. Located midway between the buffer units, the expansion tank provides a common buffer fluid reservoir for both hydraulic cylinders and is connected to them by copper piping. The buffer assembly is placed so that the powder car is 0.5-inch above the buffers when at the loading station. The maximum buffing stroke is 5.75 inches.

Upper car buffer. The upper car buffer comprises four rubber buffer pads. These are located immediately below the hoisting sheave and are attached to the same side of the hoist trunk as the car rails. Clearance between the pads and the powder car stop is 1.25 inches, when the car is at the upper unloading station.

Hoisting sheave. The hoisting sheave, mounted on brackets bolted to the sides of the hoist trunk, is suspended beneath the gun house roof. A 16-inch diameter single-grooved wheel, the sheave guides the car hoist rope and has free rotation on its mounting pin.

Car movement controls and interlocks. Car movement, car stopping at loading and unloading stations, and trunk door opening and closing are coordinated by controls and interlocks described on page 11-13.

Trunk lower door assembly

The loading aperture for each powder hoist trunk is fitted with a vertically sliding, manually operated, two section door. The upper section rises and the lower section drops when the door is opened. Both sections come together, when closed, at the level of the upper loading tray (as described above). The lower door is arranged with latches to prevent door opening movement except when the powder car is at the bottom of the hoist trunk.

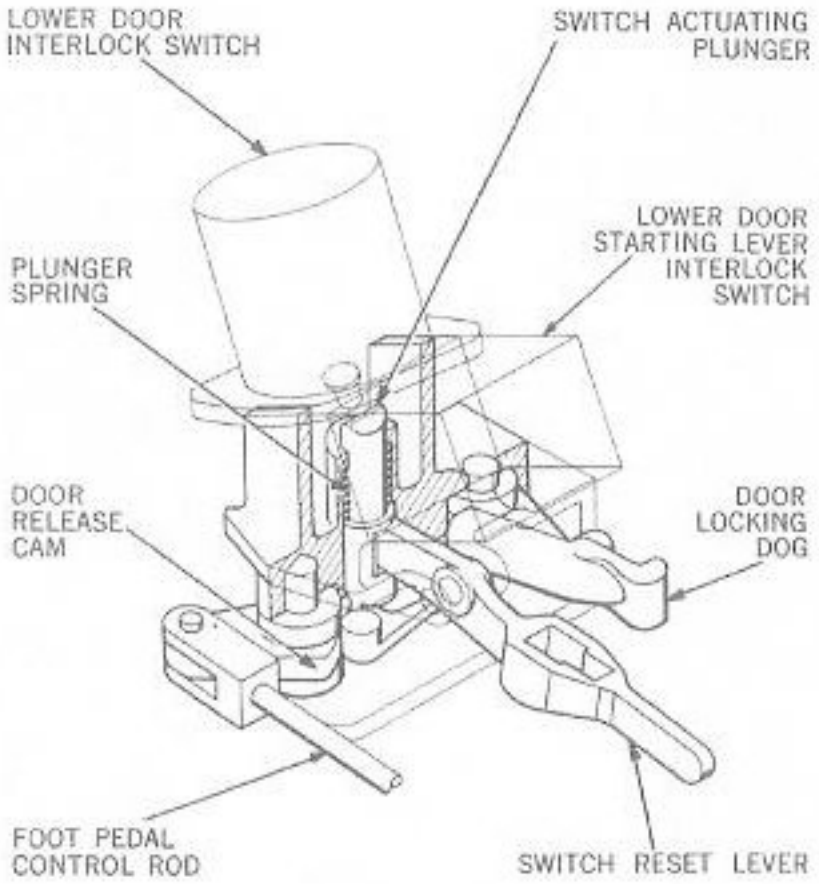


Figure 11-5. Powder Hoist Lower Door Latch - Cutaway View

Components. The trunk lower door assembly consists of:

Door
Door stops
Door latch
Foot-operated latch

Door. Made in sections, the lower door comprises two similar light weight, fabricated steel panels with stiffeners of the same material. Weighing approximately 57 pounds the door panels are identically rhomboid shaped. Arranged to slide in vertical channels of the supporting frame, the two panels are connected by a wire rope that passes around grooved sheaves. In this arrangement, each door section acts as a counterweight for the other in door opening or closing movements.

Door stops. Wedge-shaped door stops are mounted on the upper and lower edges, respectively, of the upper and lower door sections. These stops contact bracket mounted rubber bumpers which are arranged on the inner sides of the trunk both above and below the door aperture to limit door opening movement.

Door latch. A mechanical latch located on the inside of the door, the door locking dog (fig. 11-5) is spring actuated to latch when the door is closed and the powder car begins to ascend. The dog is arranged with a car actuated unlatching lever, located inside the hoist trunk, which projects into the path of a latch operating cam mounted on the car (page 11-12). Cam and lever function to unlatch the door during the final 2.75 inches of car descent.

Foot-operated latch. Operated by a foot pedal at the lower door operator's station, the foot-operated latch is a spring actuated device. It latches the door sections together until released by the operator when the car is at the loading station. The latch operates in conjunction with the lower door interlock switch and the starting lever solenoid switch so that the hoist cannot be operated when the lower door is open.

Trunk upper door assembly

The unloading aperature for each powder hoist trunk, located in the respective gun room, is fitted with a door hinged at the lower door sill. The door opens downward into the gun room to form a transfer tray between the powder car and the open projectile hoist cradle. The door is shown in its closed position in figure 11-6.

Components. The trunk upper door assembly consists of:

Door
Door locking dog mechanism
Dog locking latch
Door operating mechanism

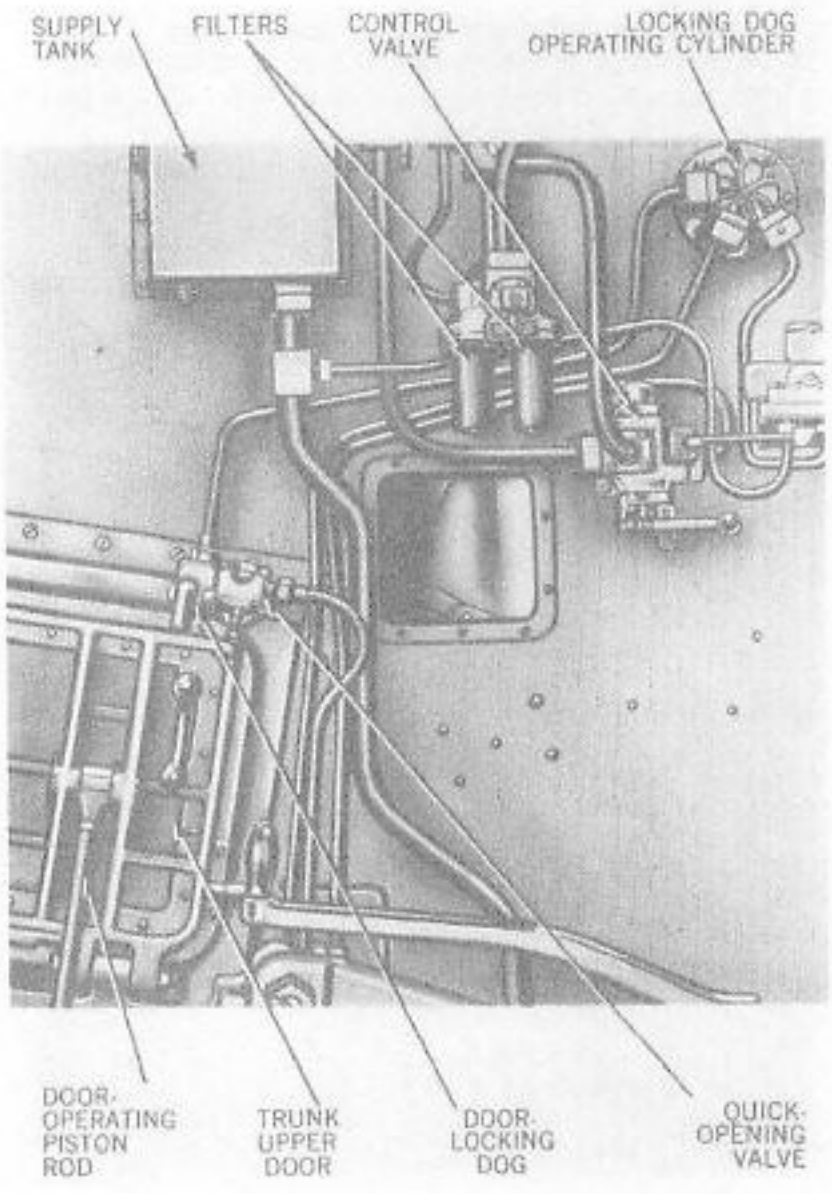


Figure 11-6. Powder Hoist Upper Door Control Station - General Arrangement

Door. The door is a rectangular aluminum alloy casting with integral hinge lugs on its lower edge. The inner edge of the door is fitted with a rubber-cored asbestos-metal-cloth gasket which is secured by an aluminum retaining strip. The outer face, fitted with seven bronze dog wedges, has two integral lugs for mounting the door operating piston rod bearings. A cast bronze door frame, riveted in the trunk door aperture provides integral mating hinge lugs and a contact flange for the door hinge lugs and gasket respectively.

Door locking dog mechanism. The door locking dog mechanism comprises seven door locking dogs which are simultaneously operated by a linkage system to lock or to unlock. This system is actuated by a toggle and yoke linkage which is normally operated hydraulically, but which may also be operated by an emergency hand crank mechanism (fig. 11-7). Each dog locking operating mechanism is attachable to the toggle linkage by a removable coupling pin. Each is secured in a stowed position when it is uncoupled from the linkage.

Dog locking latch. The main toggle link of the locking dog linkage has a latch lug which engages a spring-loaded hook of an interlock hook and arm lever (when the dogs are in a closed position). The arm of the lever projects into the path of the powder car and is pushed back by the car to release the hook (and the toggle linkage) when the ascending car is 2.5 inches from its upper unloading position. When moving to unlatch the dog linkage, the interlock hook and arm lever operates a normally closed interlock switch.

Door operating mechanism. A hydraulic assembly, the upper door operating mechanism consists of a door operating cylinder, a locking dog operating cylinder, an auxiliary pump, a control valve, and a powder door solenoid valve. These units are shown schematically in figures 11-8, 11-9, and 11-10.

The door opening circuit is a low pressure hydraulic system independent of the car hoisting hydraulic system. The door operating piston is spring counterbalanced. Operating pressure is derived from the auxiliary pump described on page 11-7. The door control station is in the respective gun room.

The powder door solenoid valve, added by Ordalt, is an interlock that prevents door opening upon operation of the control valve until the gun is in battery, the breech is open, the bore clear condition has been verified, and the bore clear switch has been depressed, and the rammer has returned to the fully retracted position after ramming a projectile. After the above conditions are satisfied, the solenoid valve permits door opening, as shown in figures 11-8, 11-9, and 11-10, until the gun captain's ready switch is positioned to READY after loading. The powder door valve solenoid is controlled by the interlock portion of the IR circuit as explained in chapter 15.

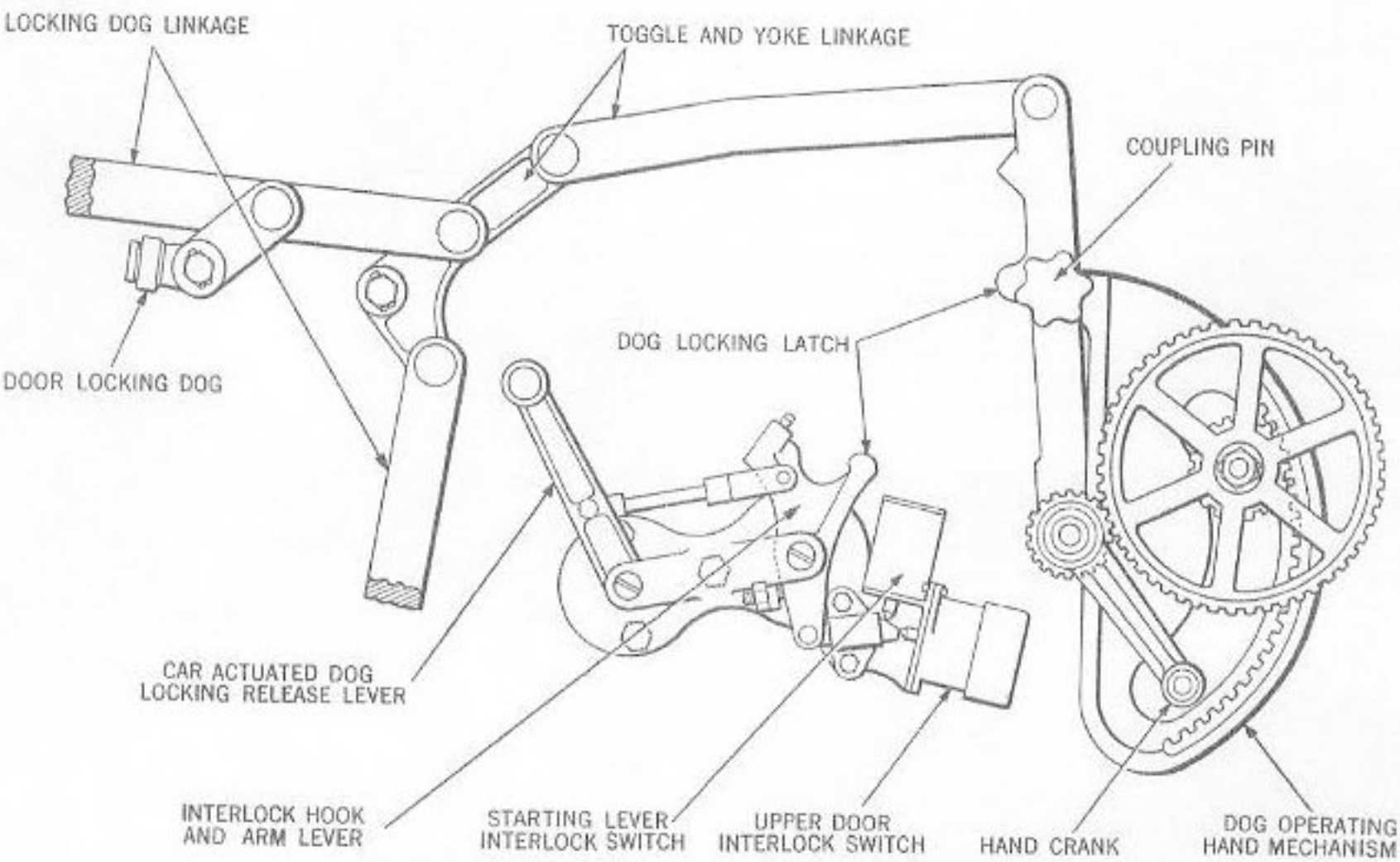


Figure 11-7. Upper Door Dog Operating Mechanism (Hand)

With the operating control at NEUTRAL (fig. 11-8), auxiliary pump pressure is vented to the supply tank through the relief valve. When the operating control is at OPEN (fig. 11-9), pressure is ported to the locking dog operating cylinder. This continues until final movement of the cylinder piston uncovers a port which ports the pressure to the top of the door operating piston. When the operating control is at CLOSED (fig. 11-10), pressure is ported to the locking dog operating cylinder automatically as the door closes by tripping of a quick-opening valve by the final closing movement of the door.

Powder car

The powder car (fig. 11-11) is arranged with guide wheels which bear on the car rails described on page 11-8. It is equipped with dumping trays and has attached control and operating cams and devices. The car conveys a full service powder load to the gun in each hoist cycle. Connected to the car hoist rope, the car has vertical movement through the hoist trunk (fig. 11-1).

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.

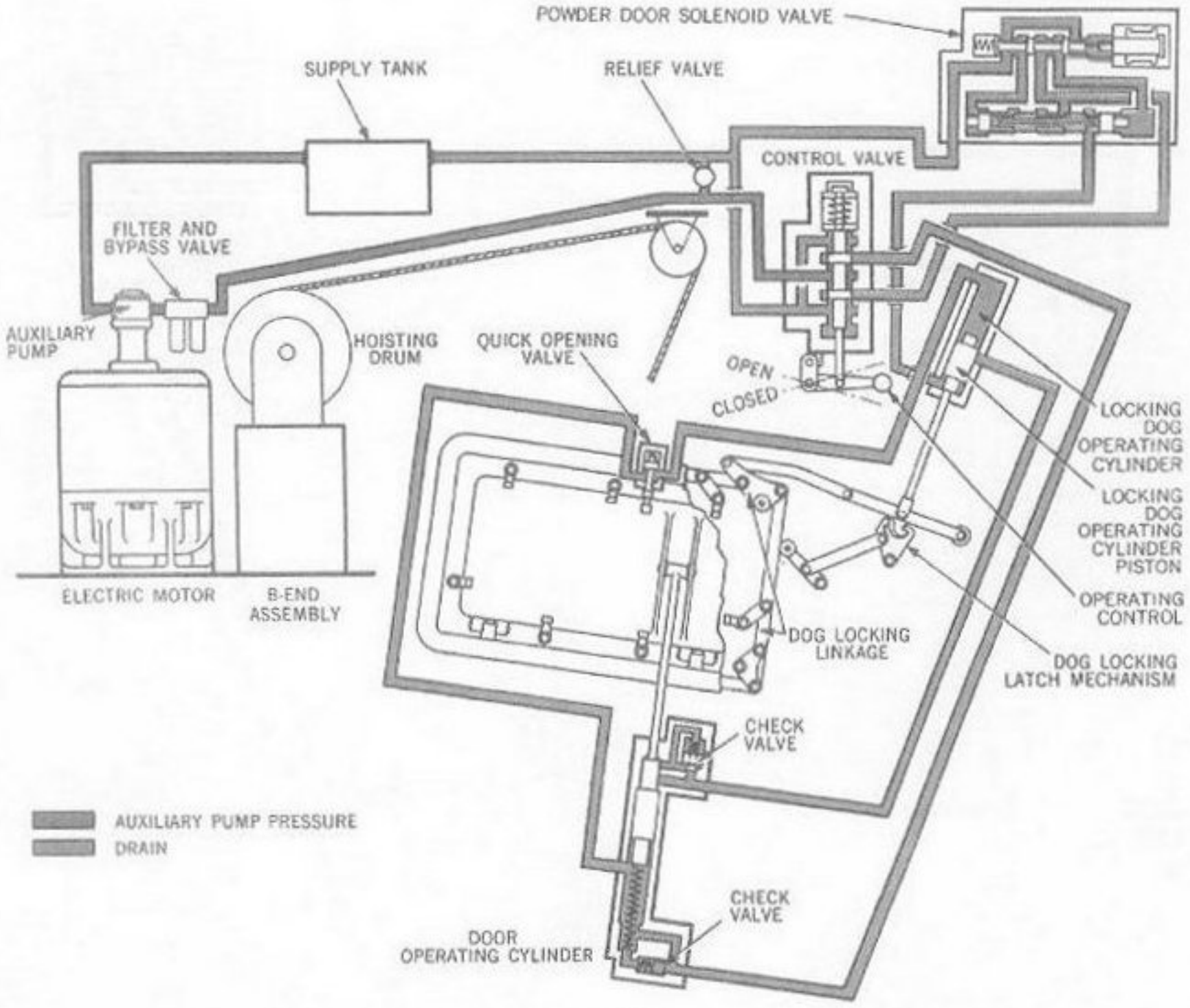


Figure 11-8. Trunk Upper Door Closed, Control Neutral - Schematic Diagram.

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

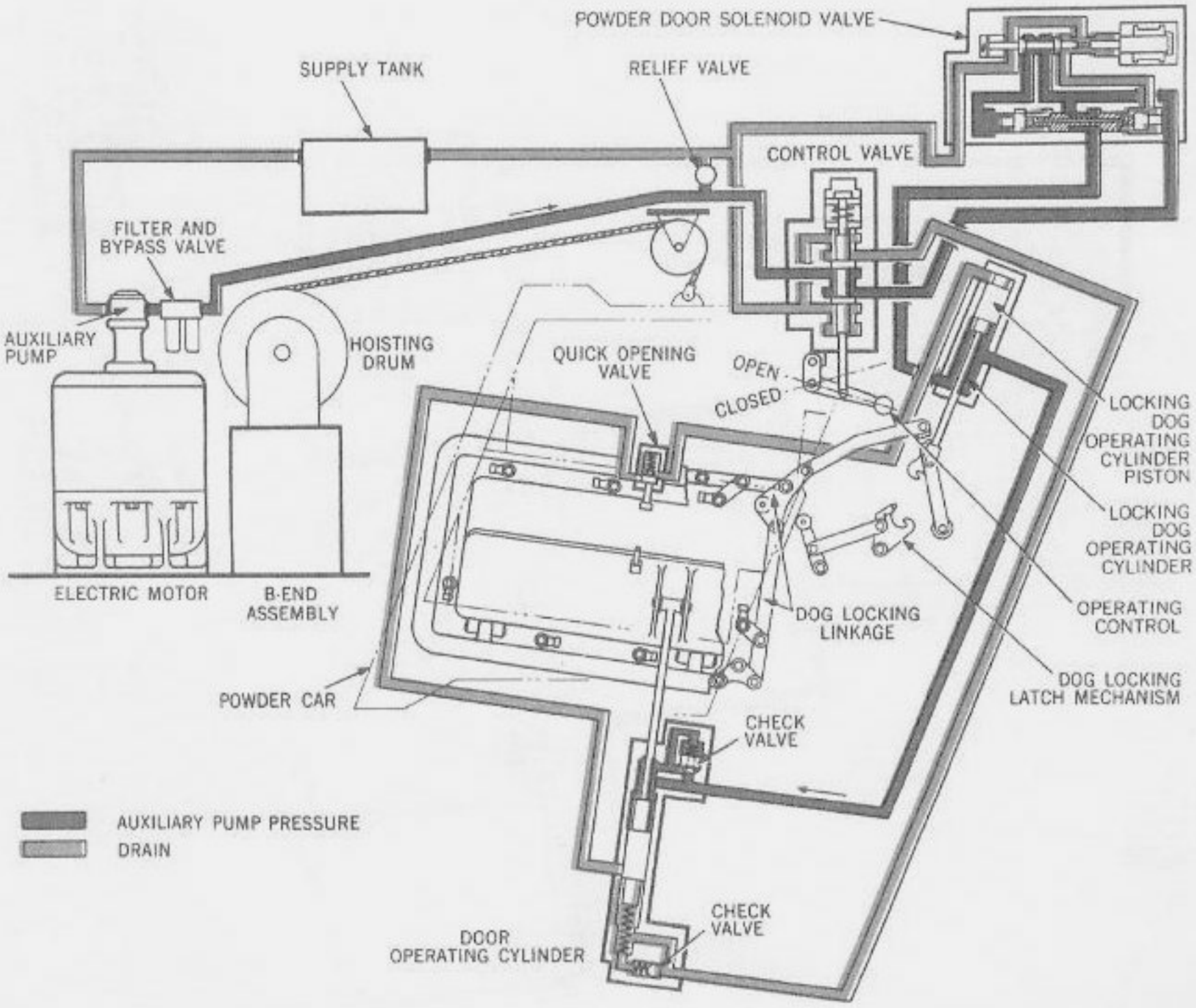


Figure 11-9. Trunk Upper Door Opening, Control at OPEN - Schematic Diagram.

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

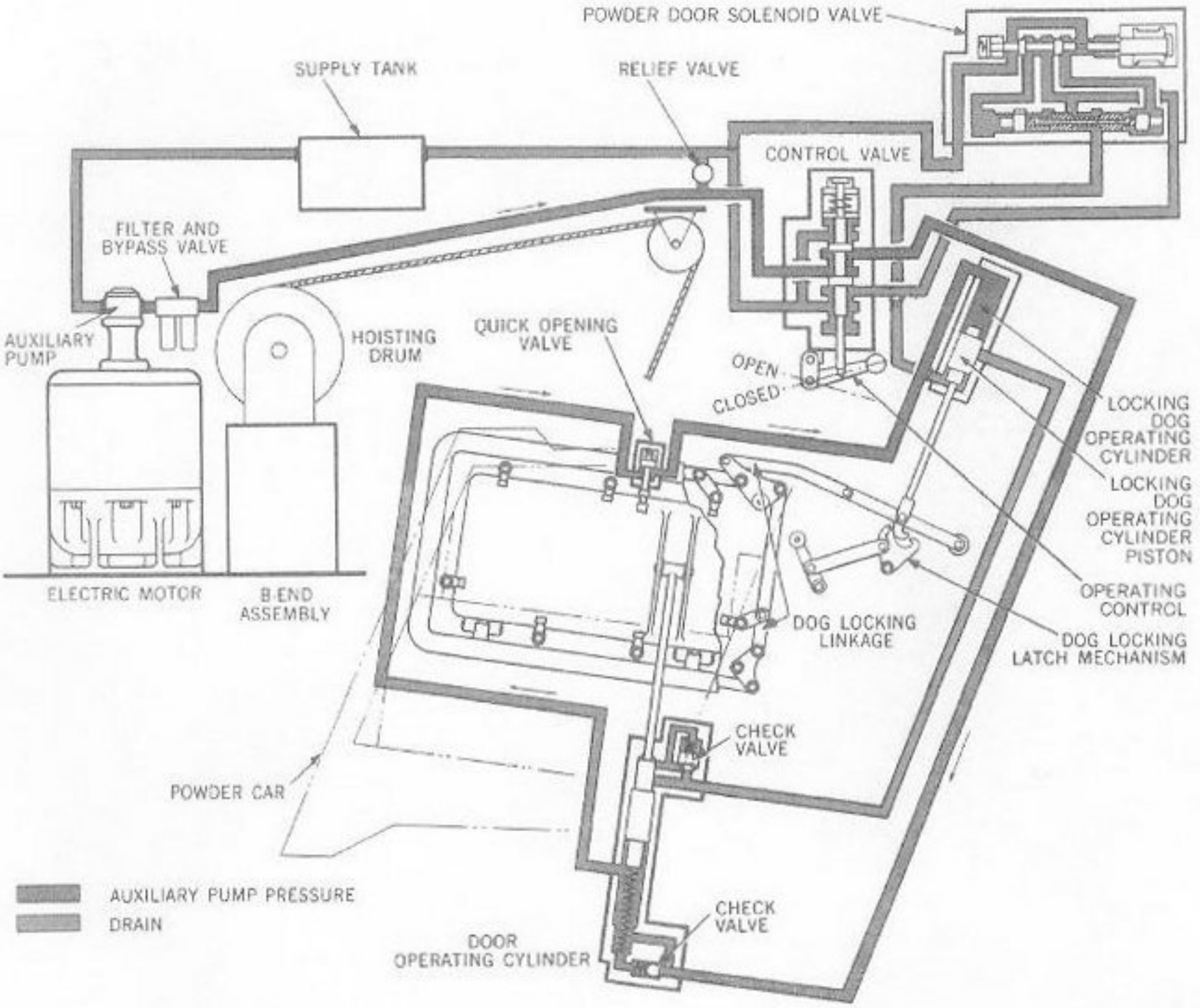


Figure 11-10. Trunk Upper Door Closing, Control at CLOSED - Schematic Diagram.

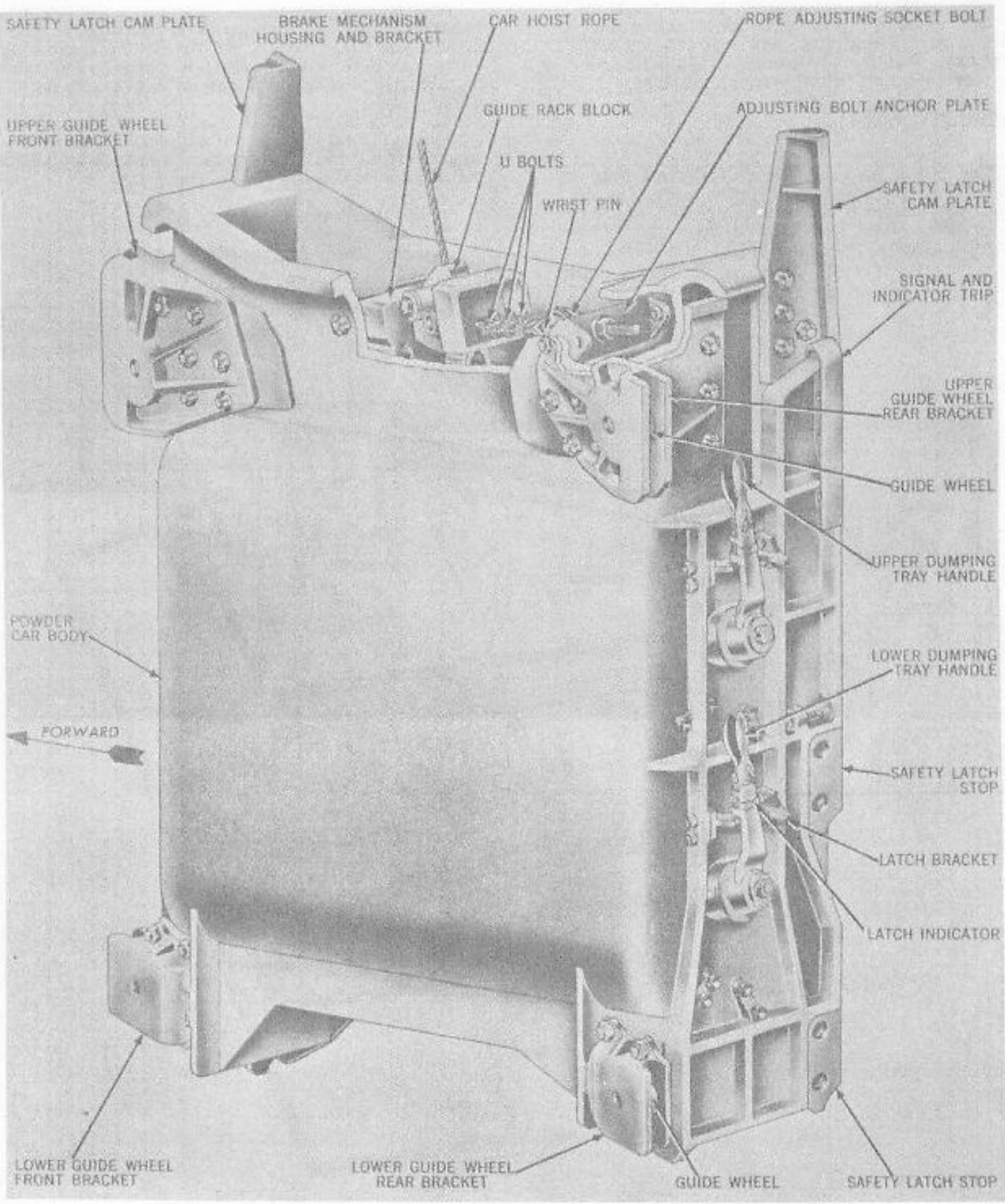


Figure 11-11. Powder Car, Rear View - General Arrangement

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

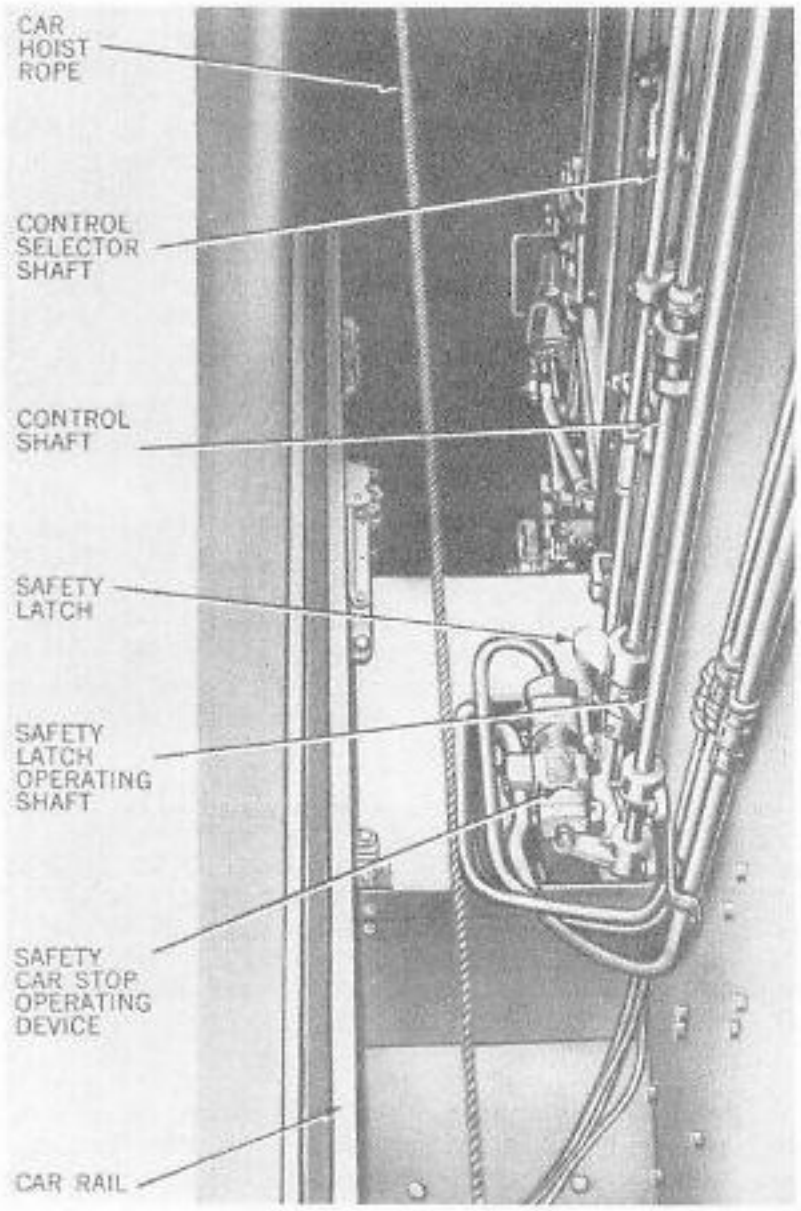


Figure 11-12. Powder Hoist Car Stop Assembly - General Arrangement

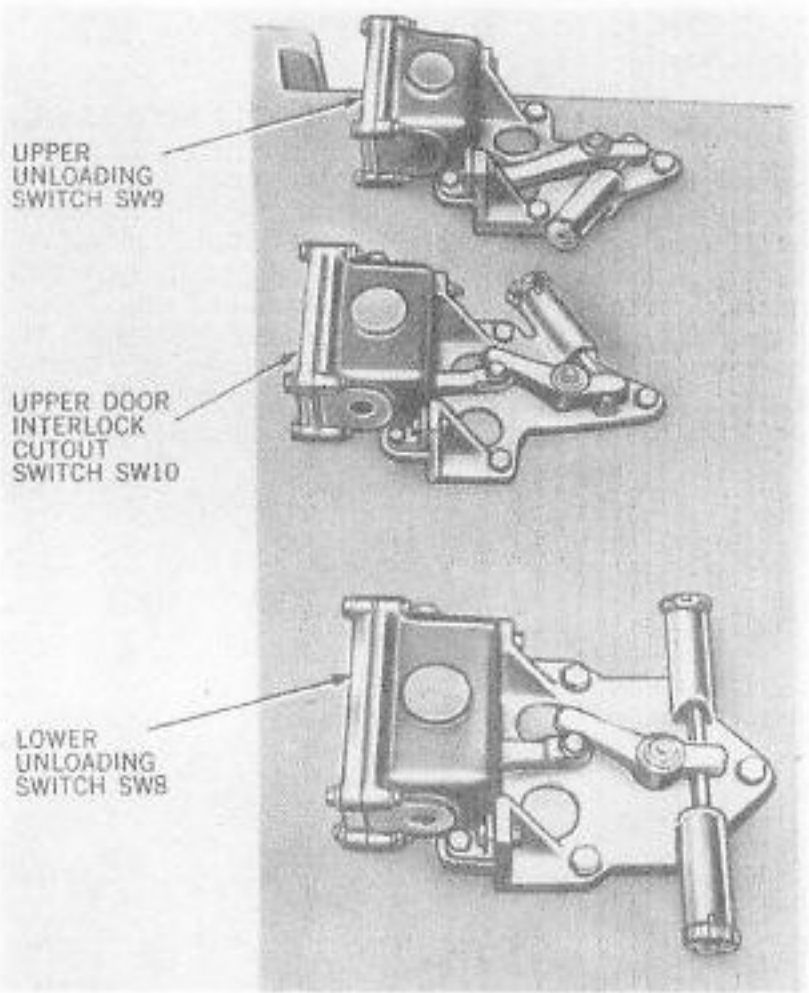


Figure 11-13. Limit Stop and Interlock Switches Trunk Upper End

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.

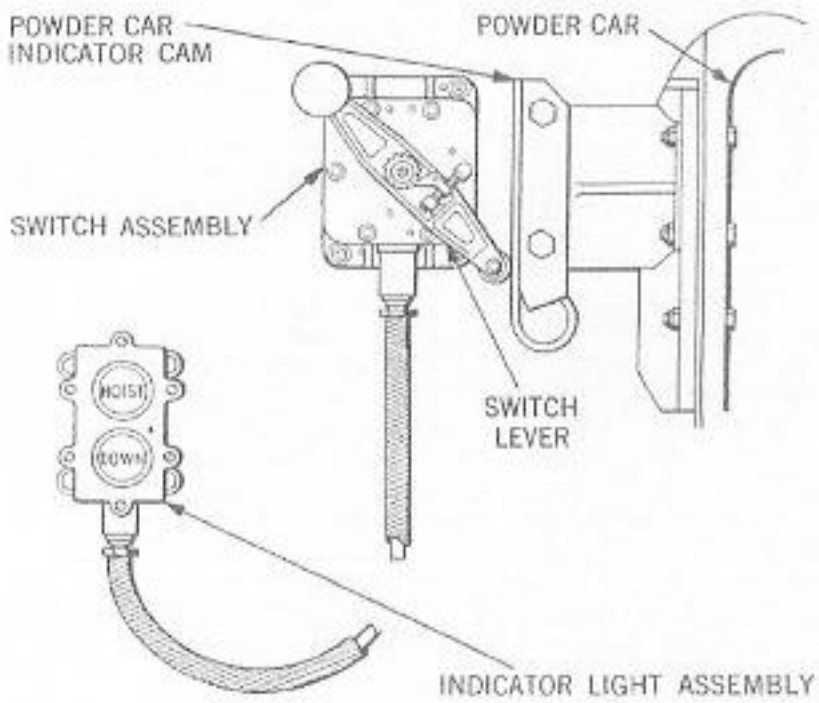


Figure 11-15. Powder Hoist Indicator and Switch Assembly - Trunk Lower End

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.

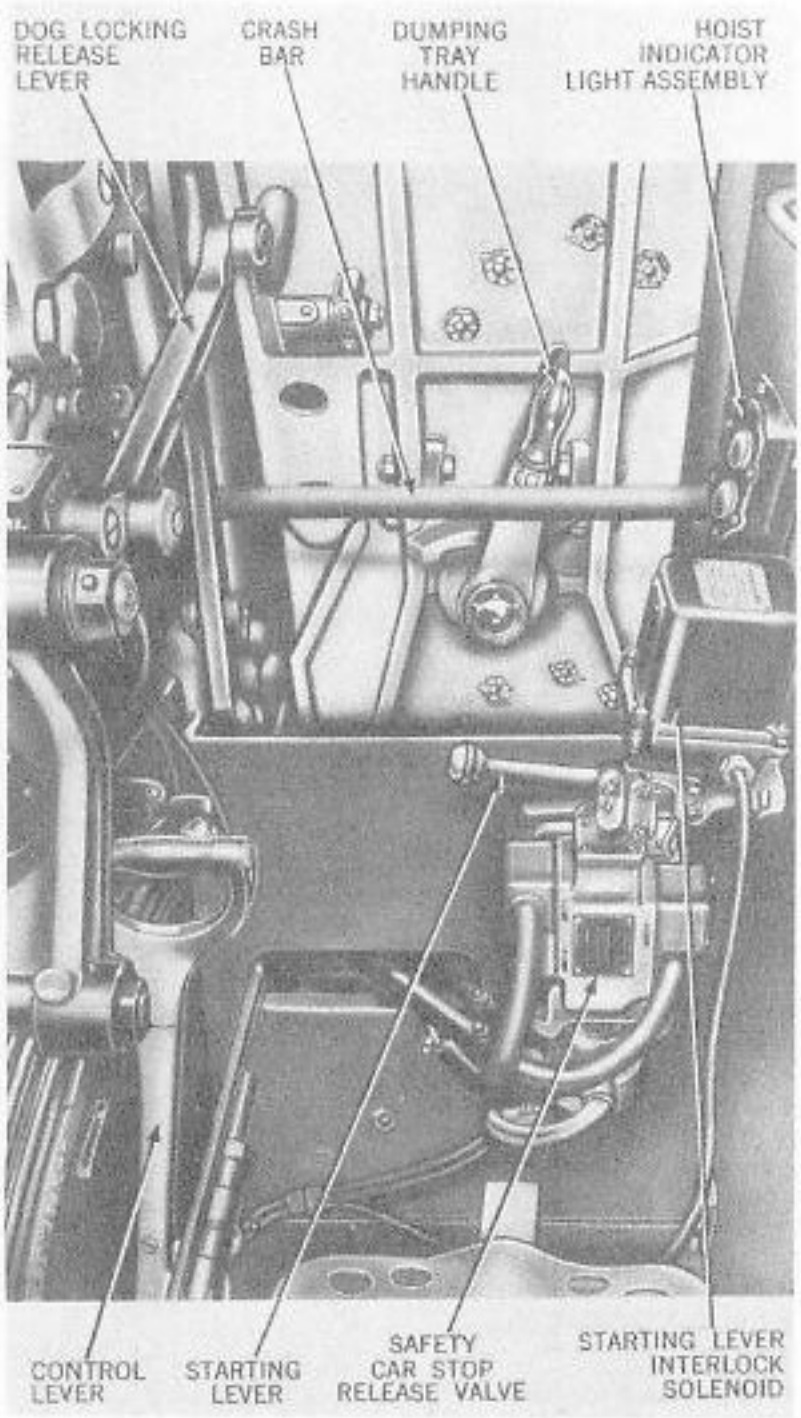


Figure 11-14. Powder Hoist Control Station - General Arrangement

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 L11 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

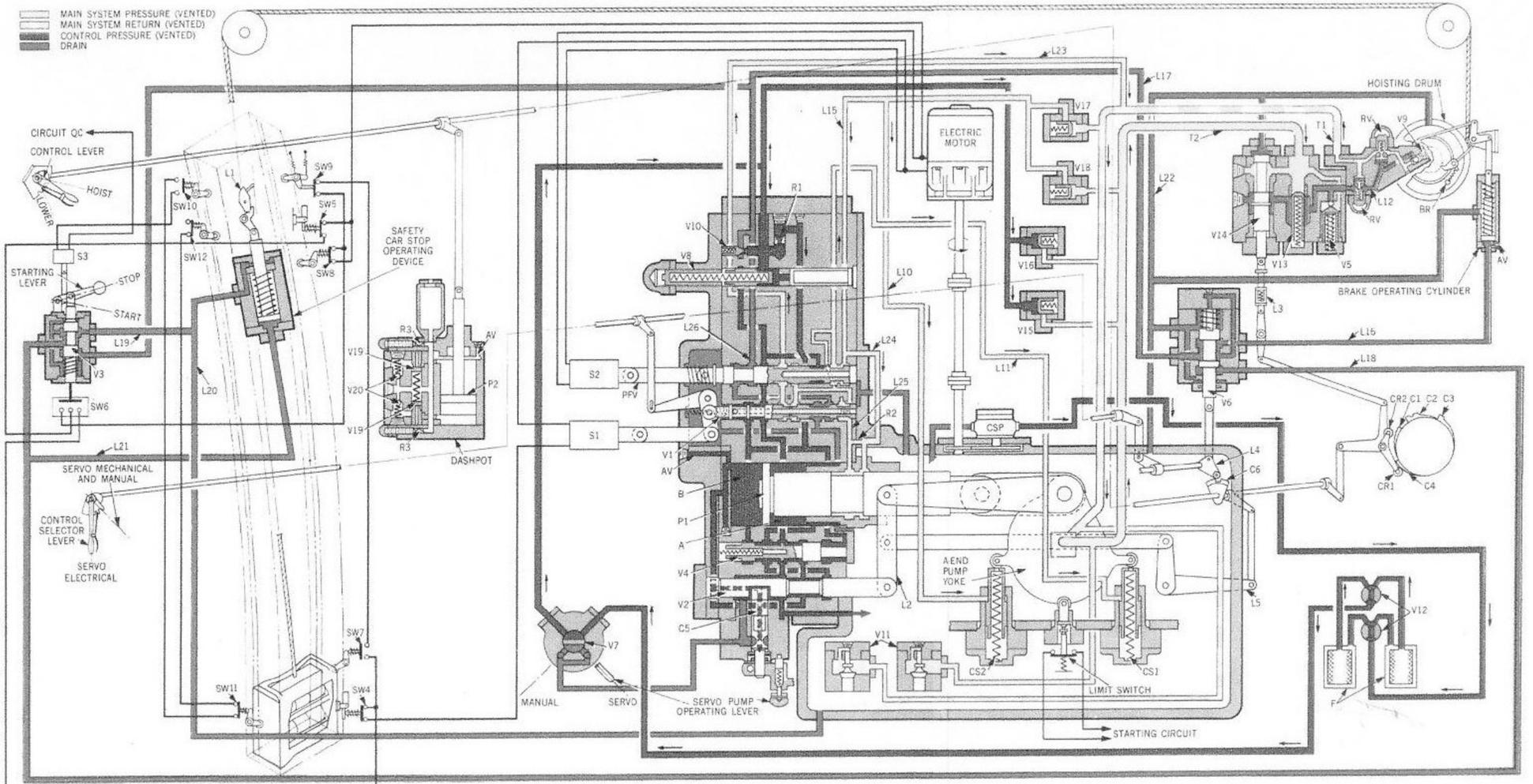


Figure 11-16. Powder Hoist, Servo Electrical Control - Stop Position, Schematic Diagram

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

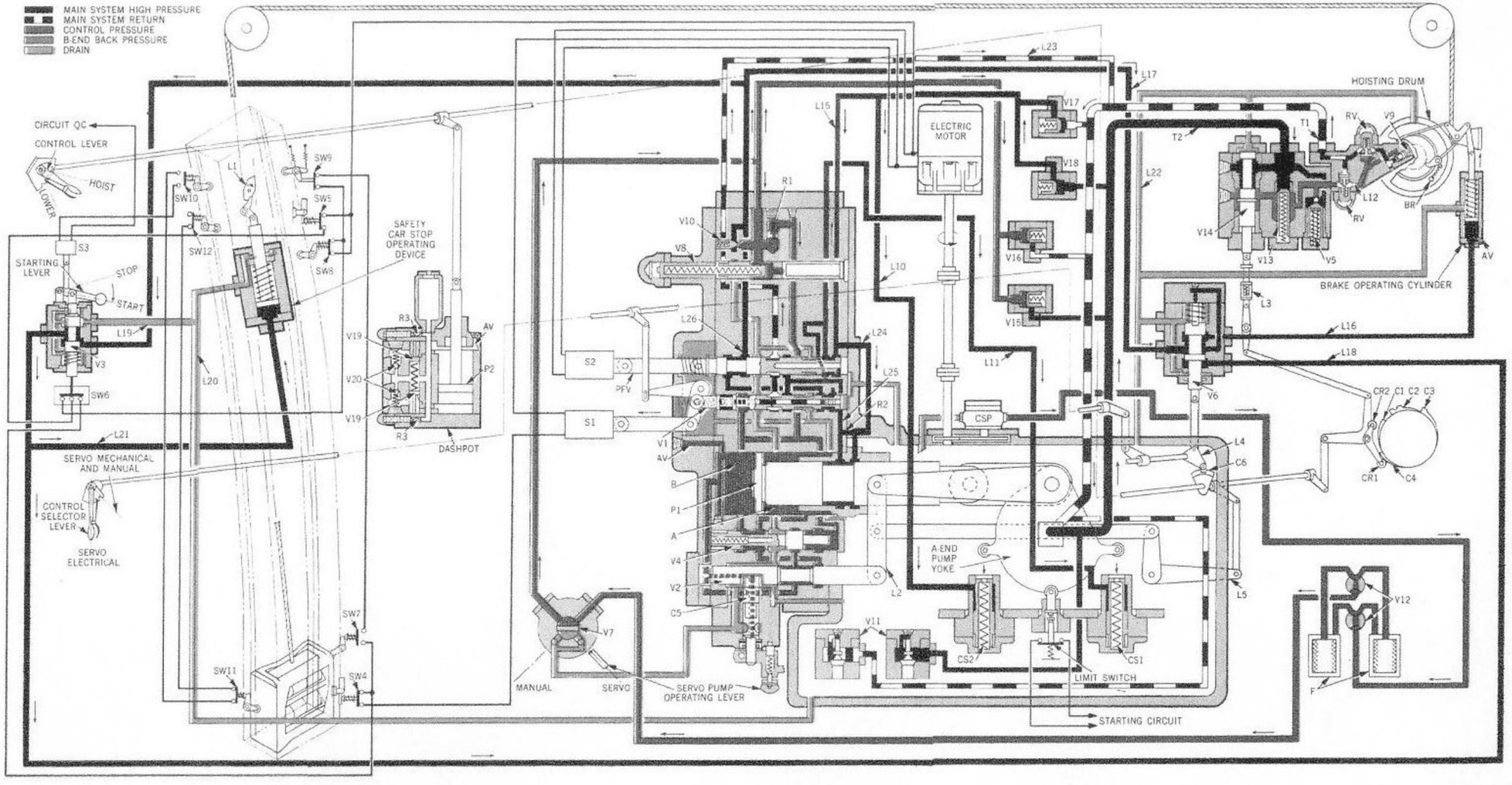


Figure 11-17. Powder Hoist, Servo Electrical Control - Controls Set Ready To Hoist, Schematic Diagram

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

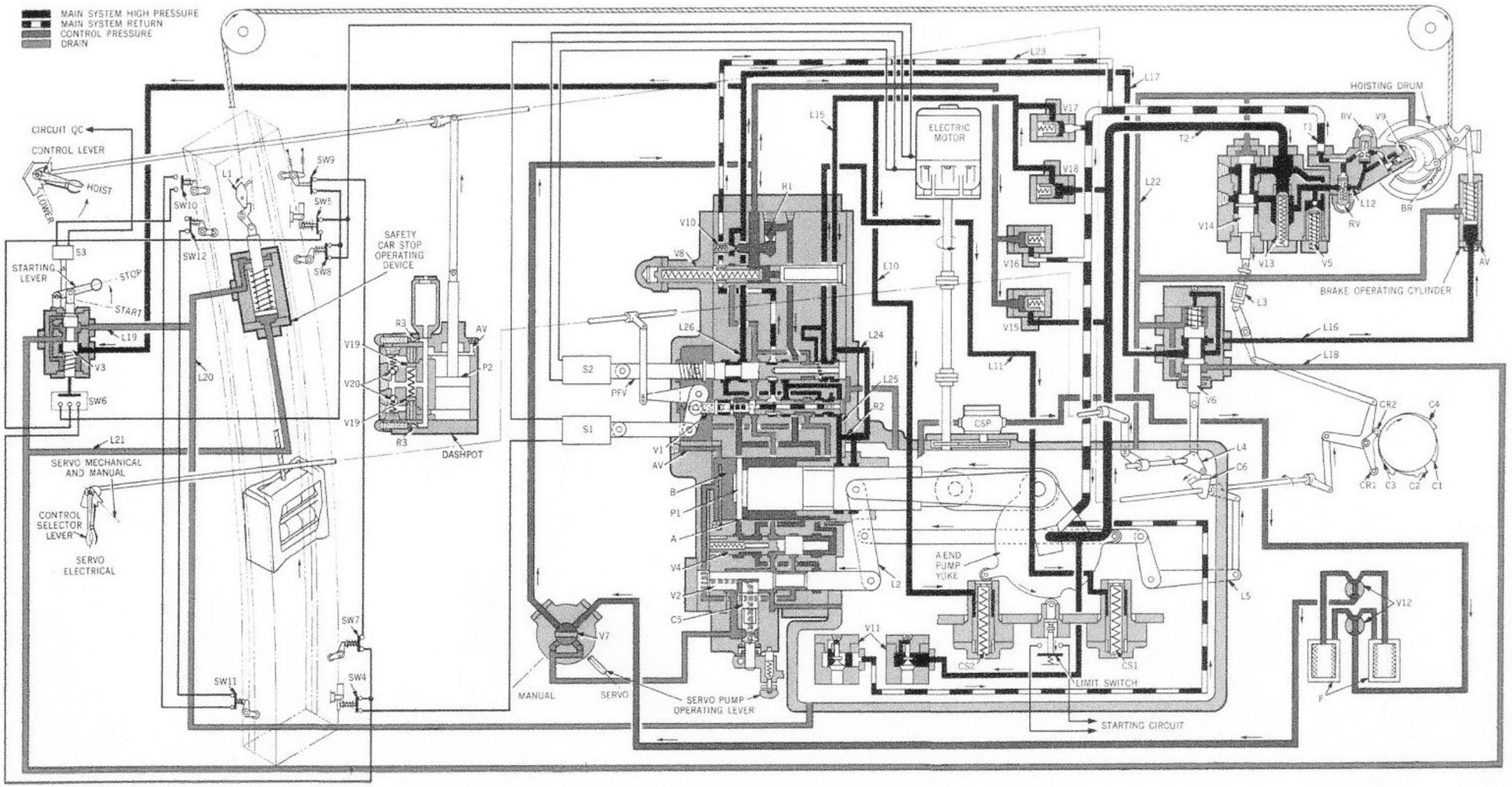


Figure 11-18. Powder Hoist, Servo Electrical Control - Hoist Position, Schematic Diagram

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

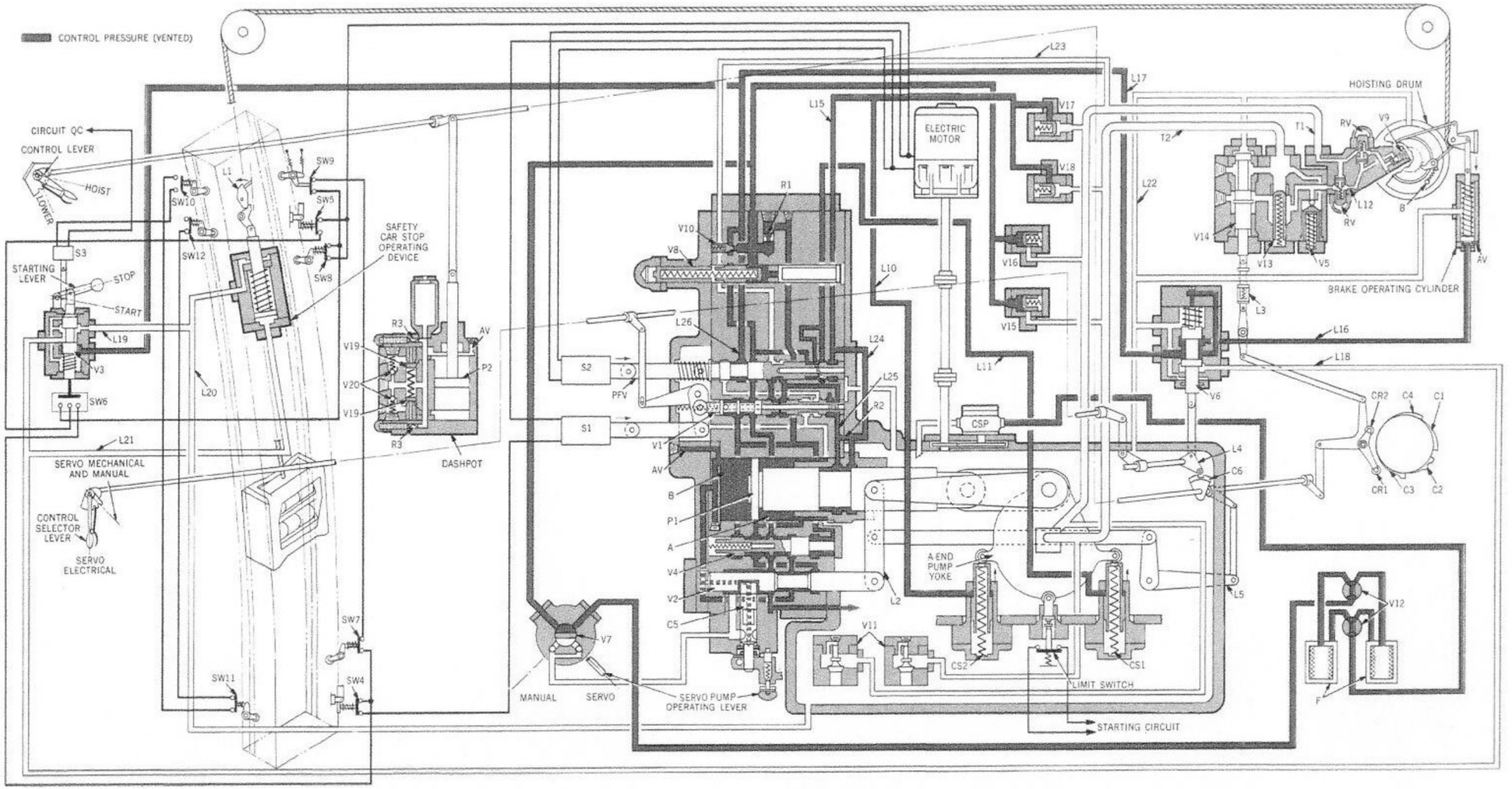


Figure 11-19, Powder Hoist, Servo Electrical Control - Power Failure, Schematic Diagram

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

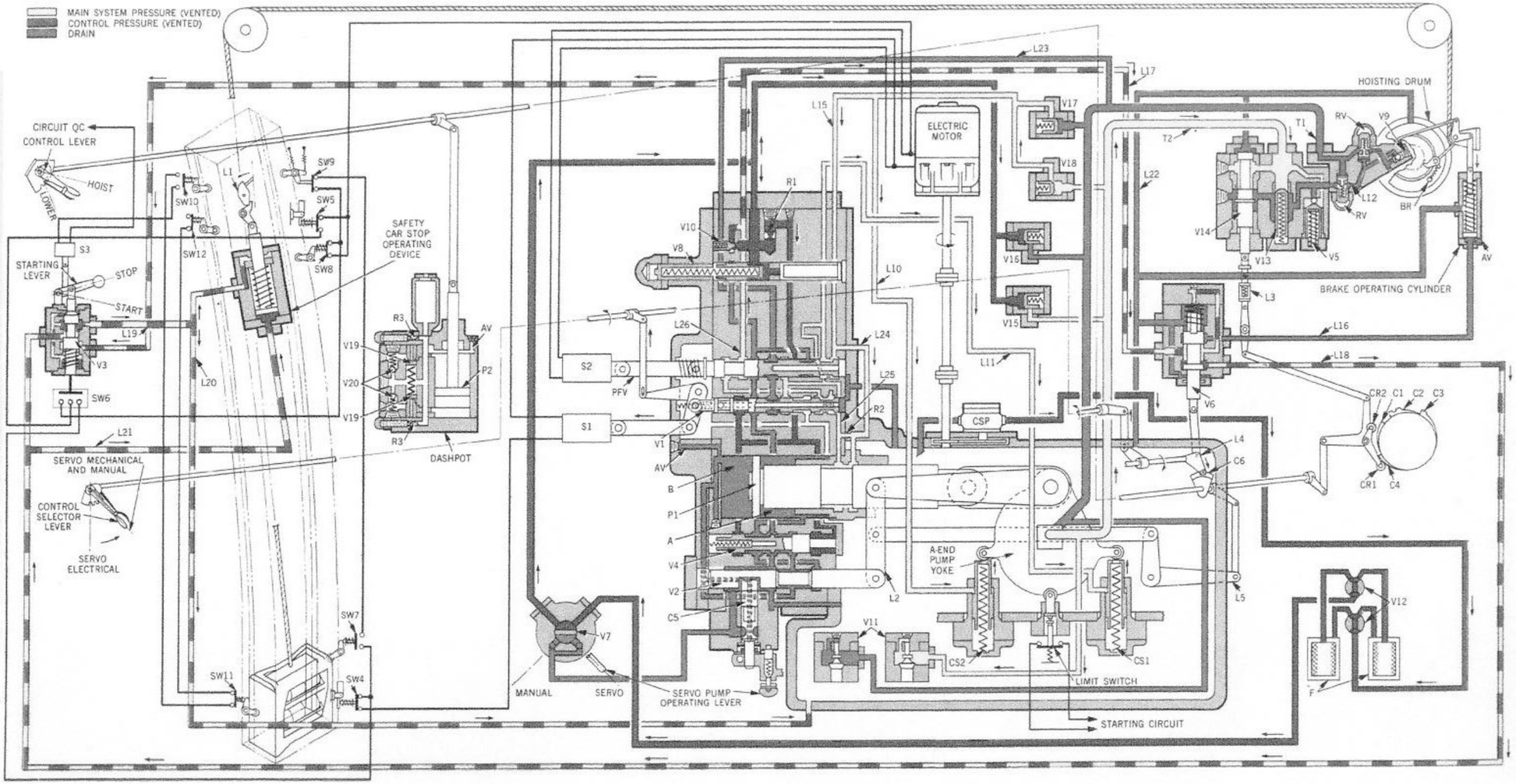


Figure 11-20. Powder Hoist, Servo Mechanical Control Stop Position, Schematic Diagram

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

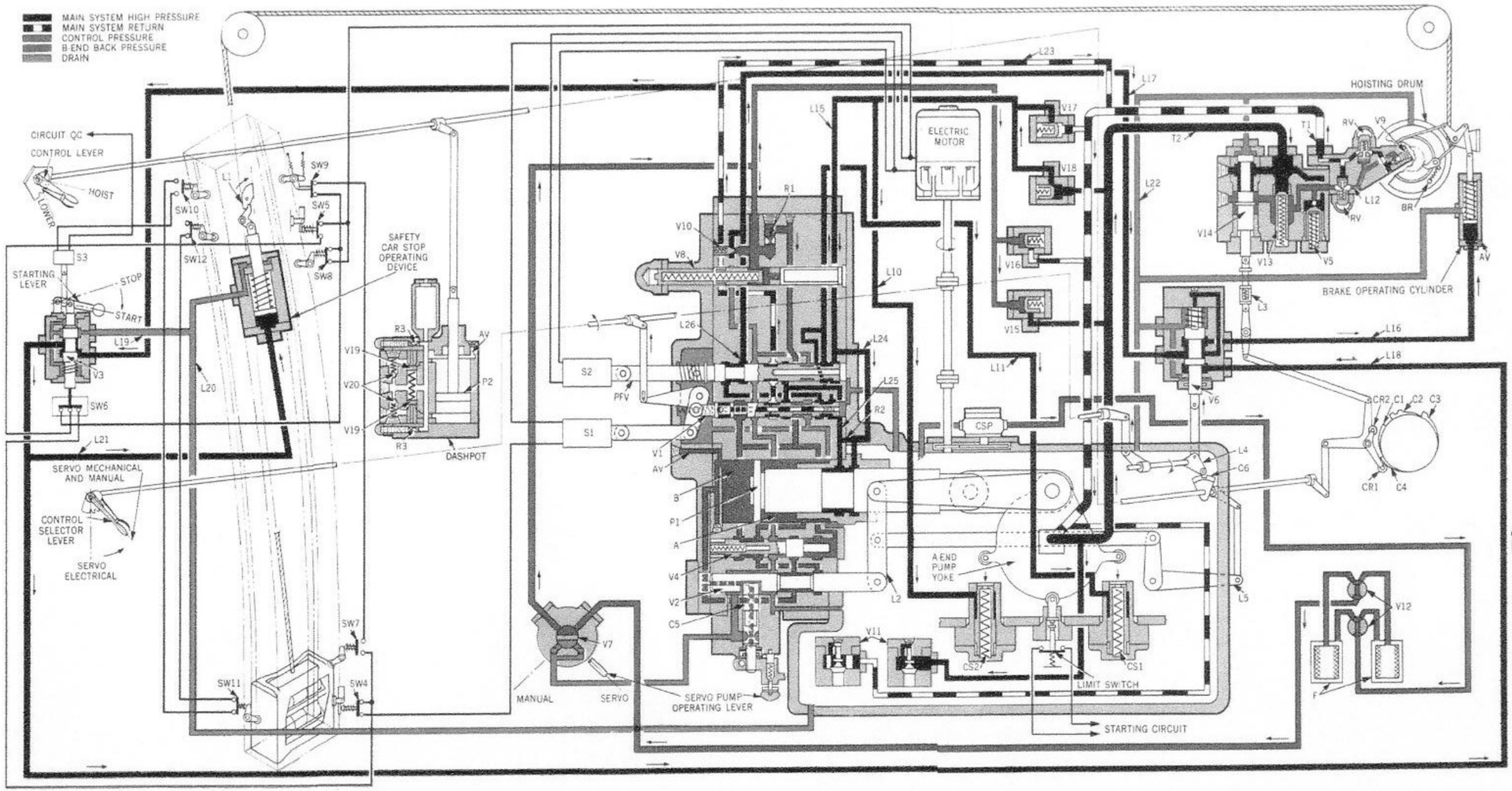


Figure 11-21. Powder Hoist, Servo Mechanical Control - Controls Set Ready to Hoist, Schematic Diagram

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

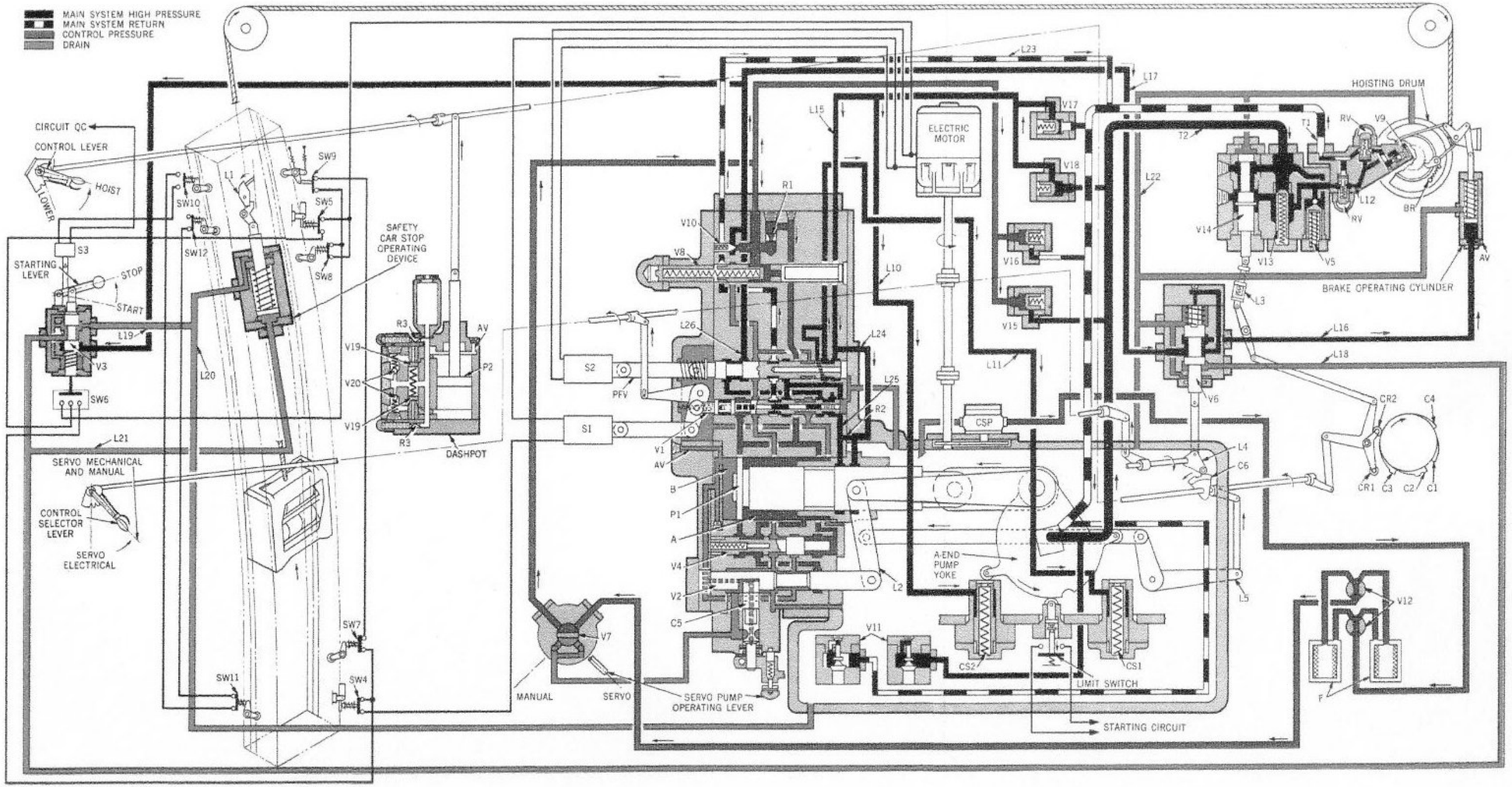


Figure 11-22. Powder Hoist, Servo Mechanical Control - Hoist Position, Schematic Diagram

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

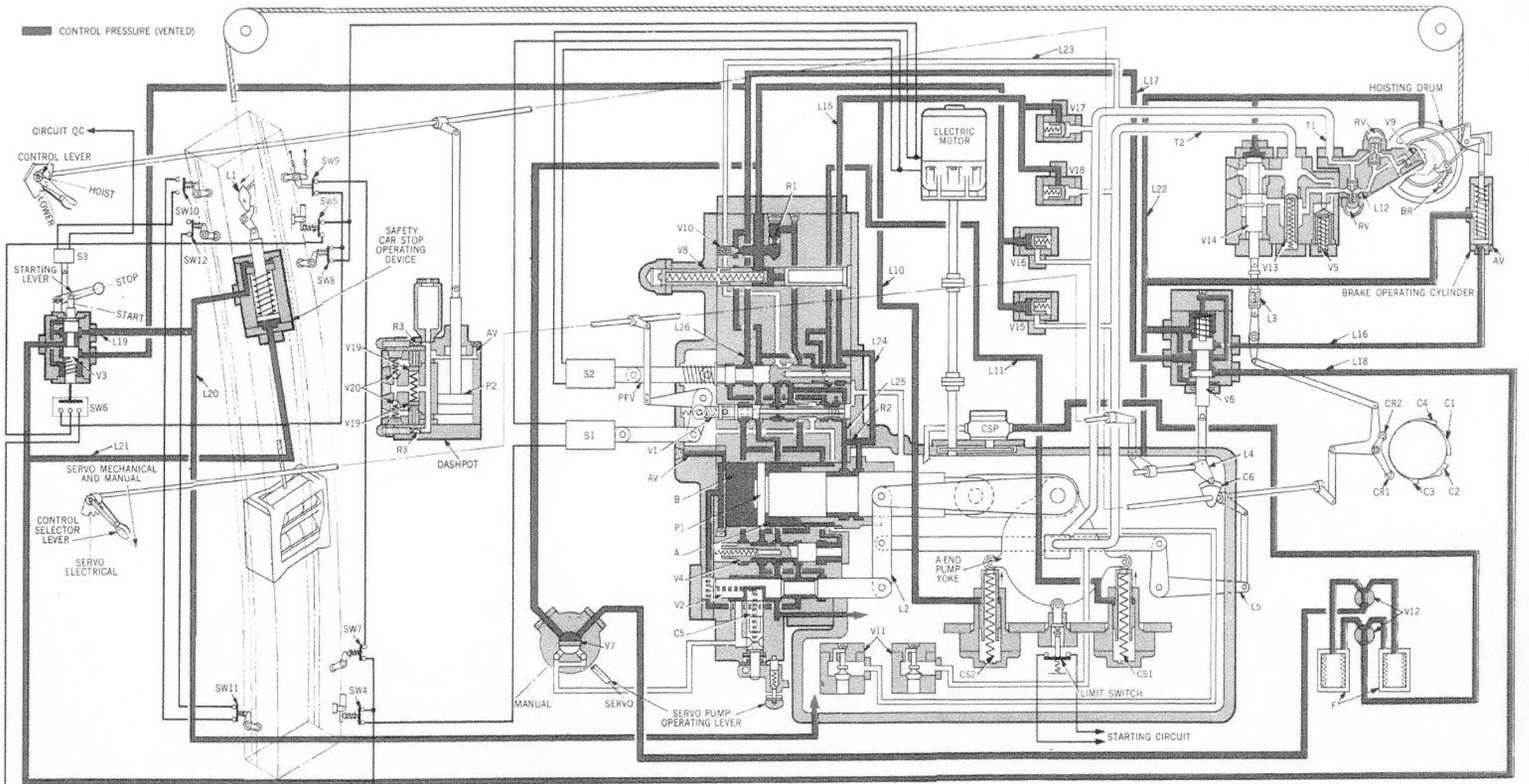
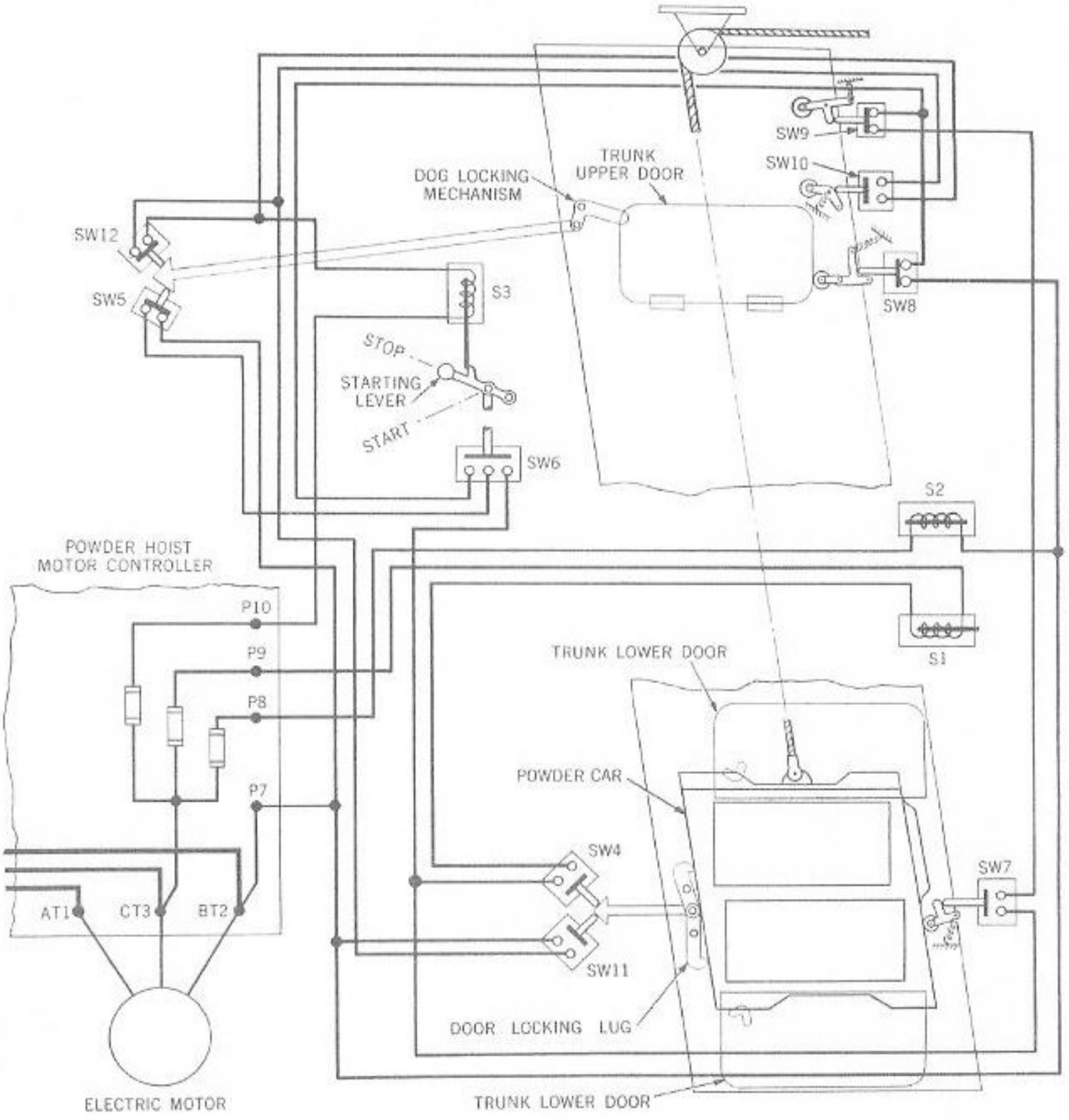


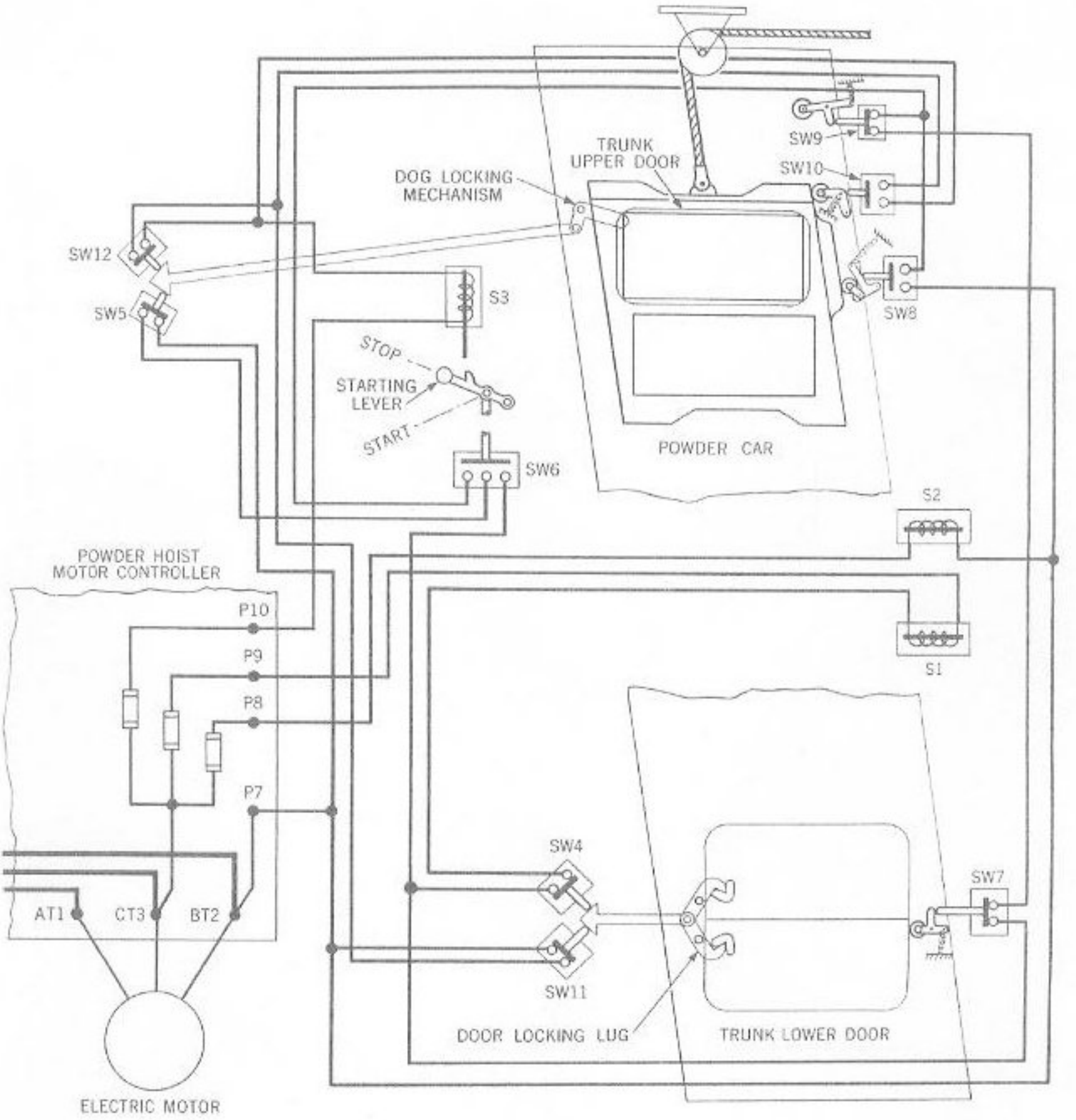
Figure 11-23. Powder Hoist, Servo Mechanical Control - Power Failure, Schematic Diagram



ELECTRICAL SYMBOLS

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

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



ELECTRICAL SYMBOLS

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

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.

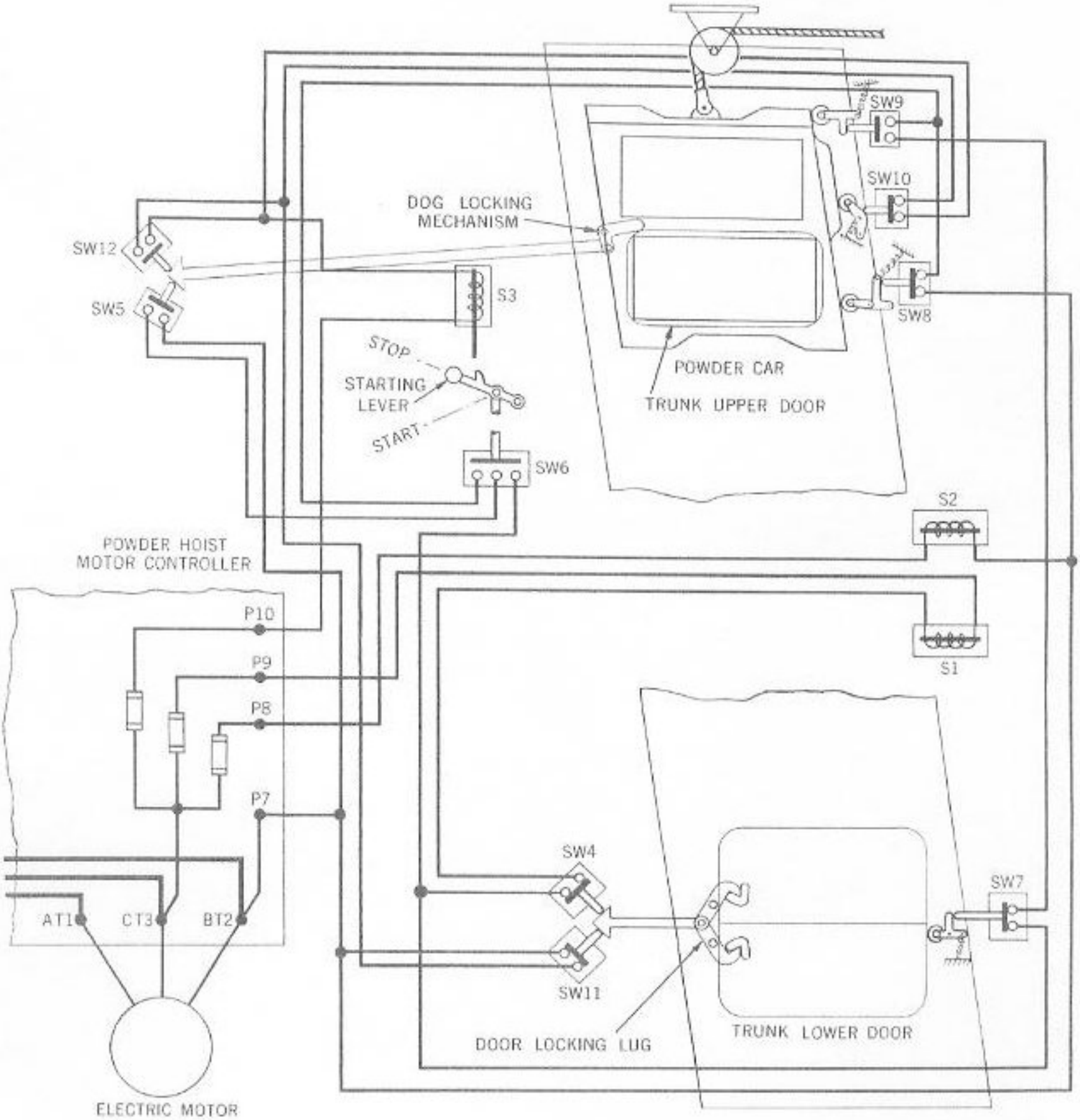
3. Air will be pulled into the main system because lines T1 and T2 will not be supercharged. Air in the hydraulic fluid will cause noise and vibration, if the hoist is run at high speed. Continuous operation under these conditions will cause improper operation of the brake and very slow starting.

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

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.

NavOrd Inst. 8350.1

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.

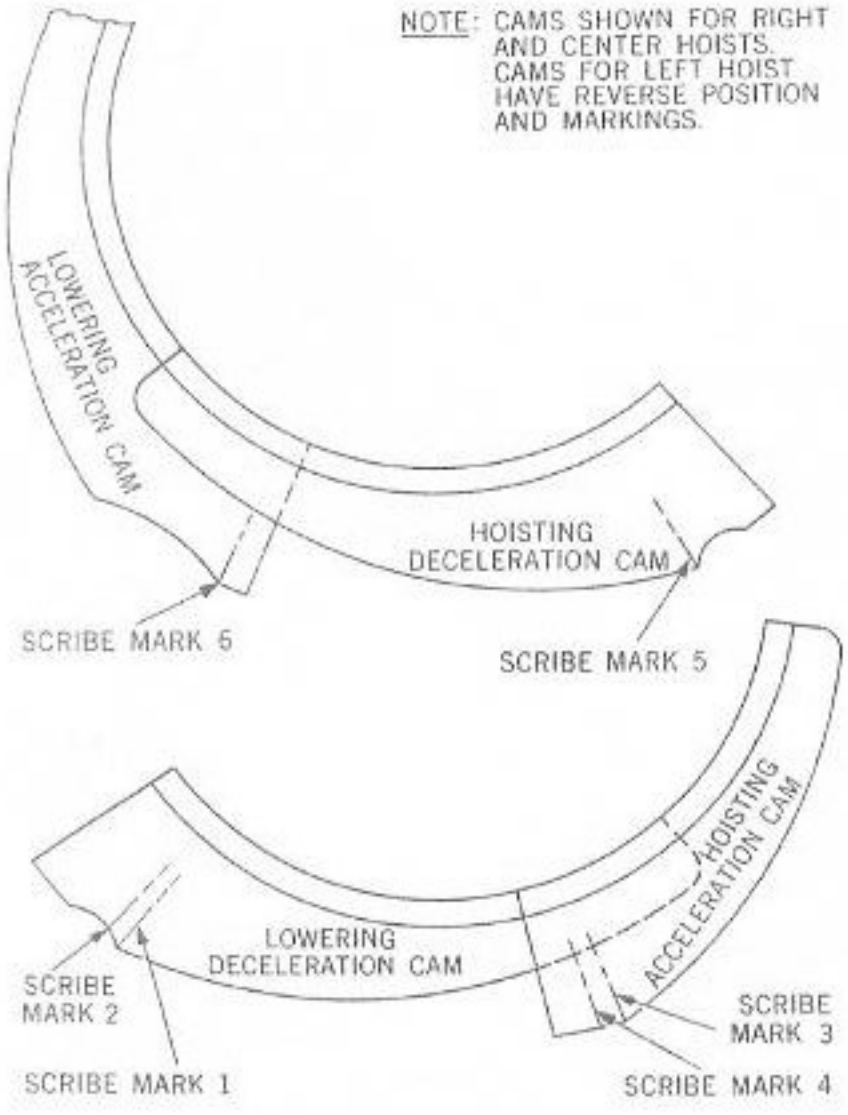


Figure 11-27, Powder Hoist B-end Cams, Locations of Scribe Marks - Adjustment

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.

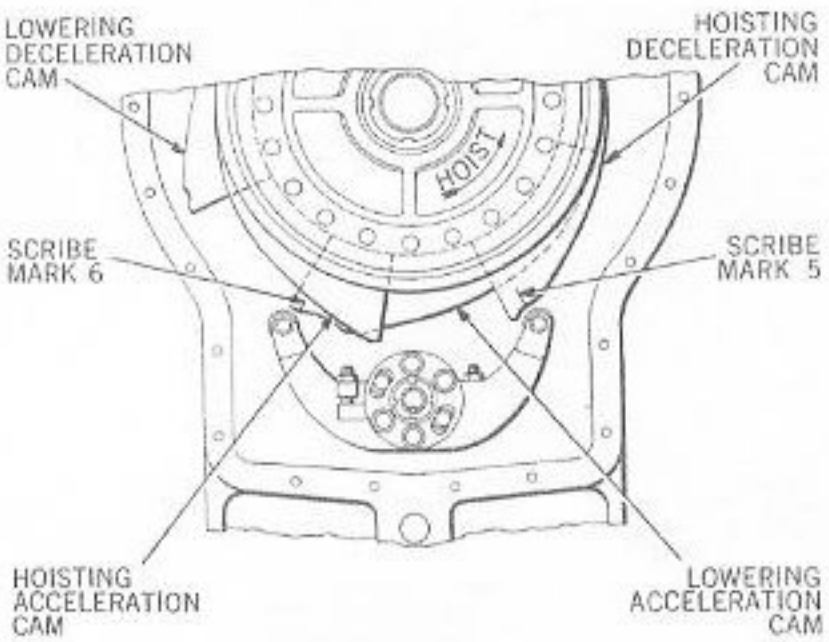


Figure 11-29. B-end Cams, Positions for Left Hoist, Car at Upper Unloading Station, Control Neutral, Adjustment.

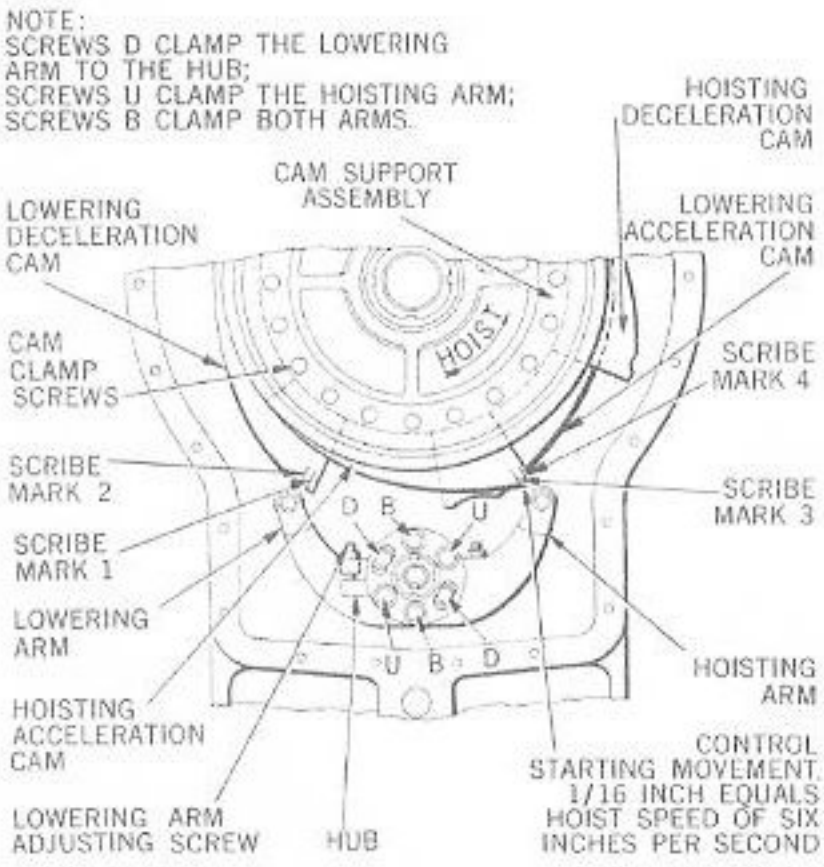


Figure 11-28. B-end Cams, Positions for Left Hoist, Car at Loading Station, Control Neutral, Adjustment.

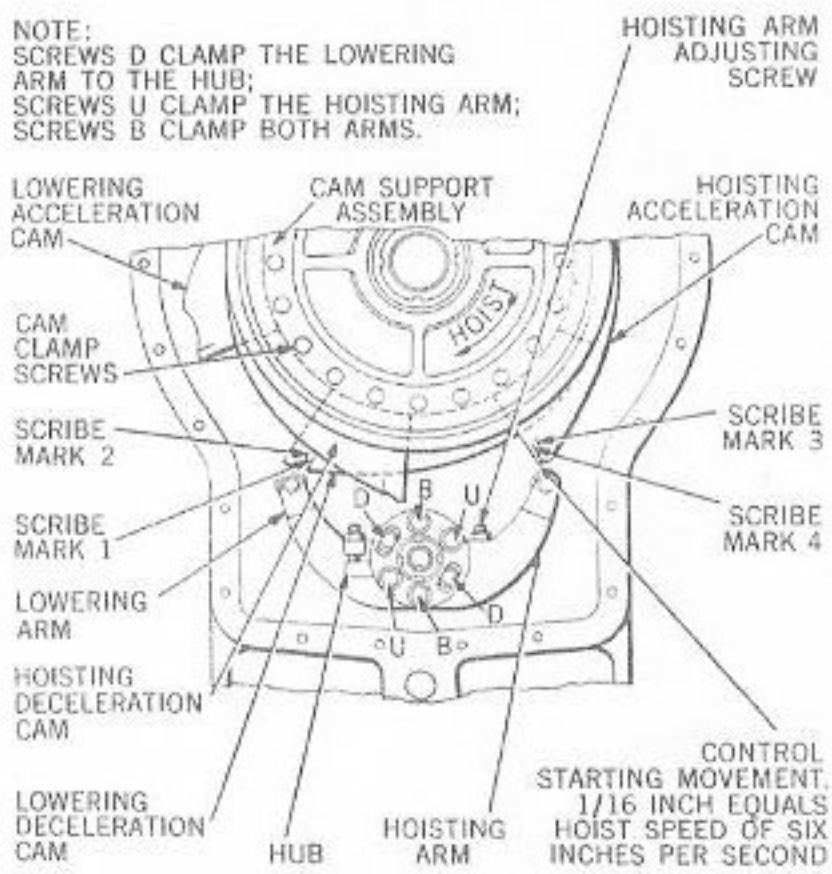


Figure 11-30. B-end Cams, Positions for Right Hoist, Car at Loading Station, Control Neutral, Adjustment.

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.

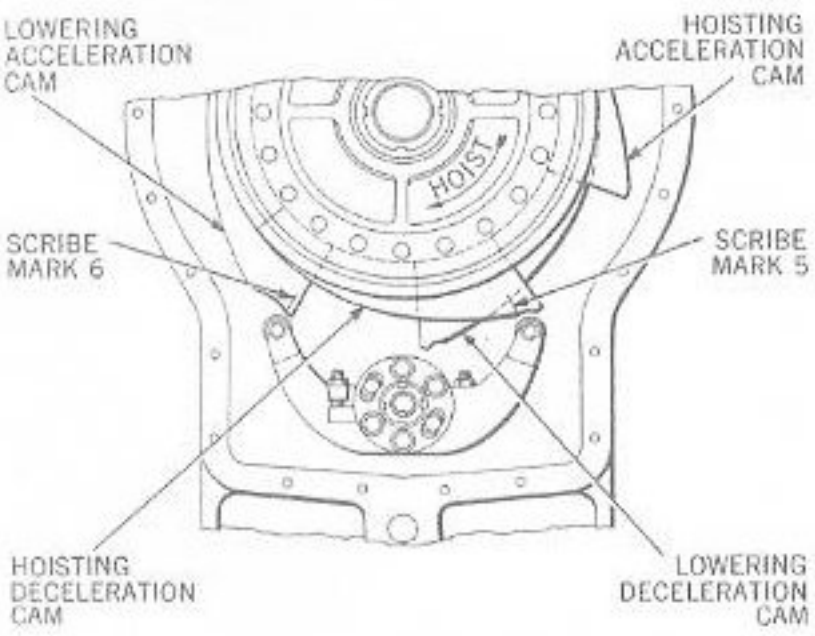


Figure 11-31. B-end Cams, Positions for Right Hoist. Car at Upper Unloading Station, Control Neutral Adjustment.

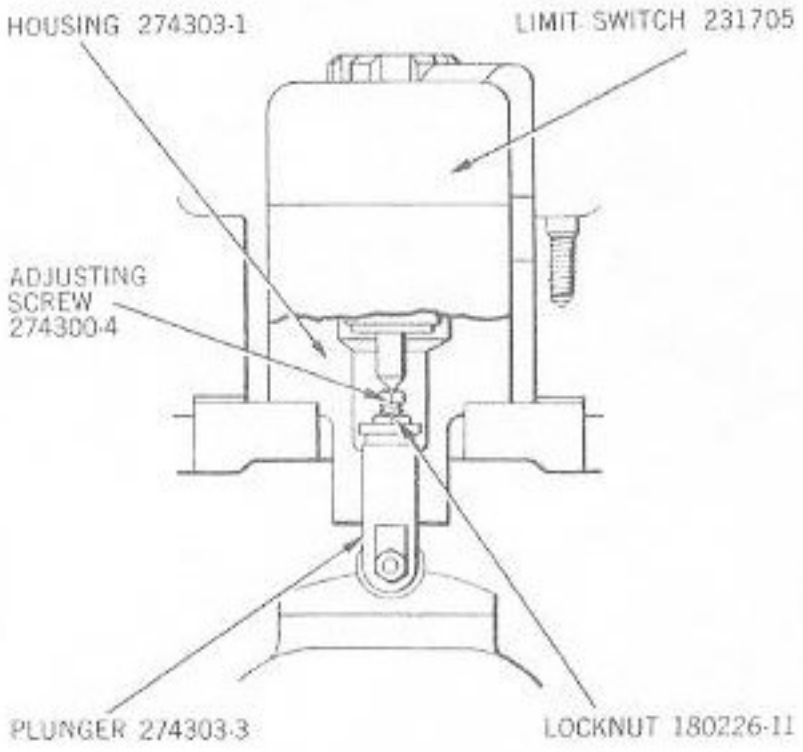


Figure 11-32. A-end Limit Switch, Adjustment.

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).

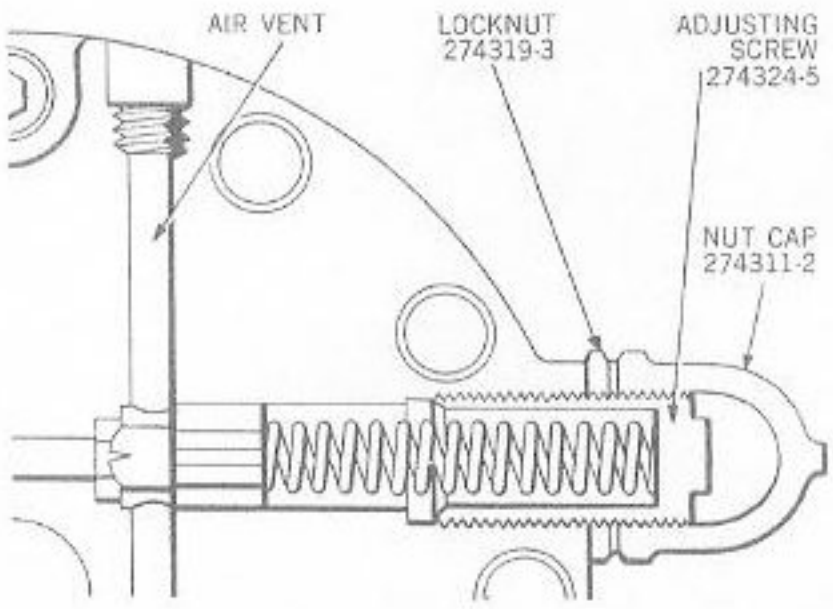


Figure 11-33. Main System Relief Valve, Adjustment.

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:

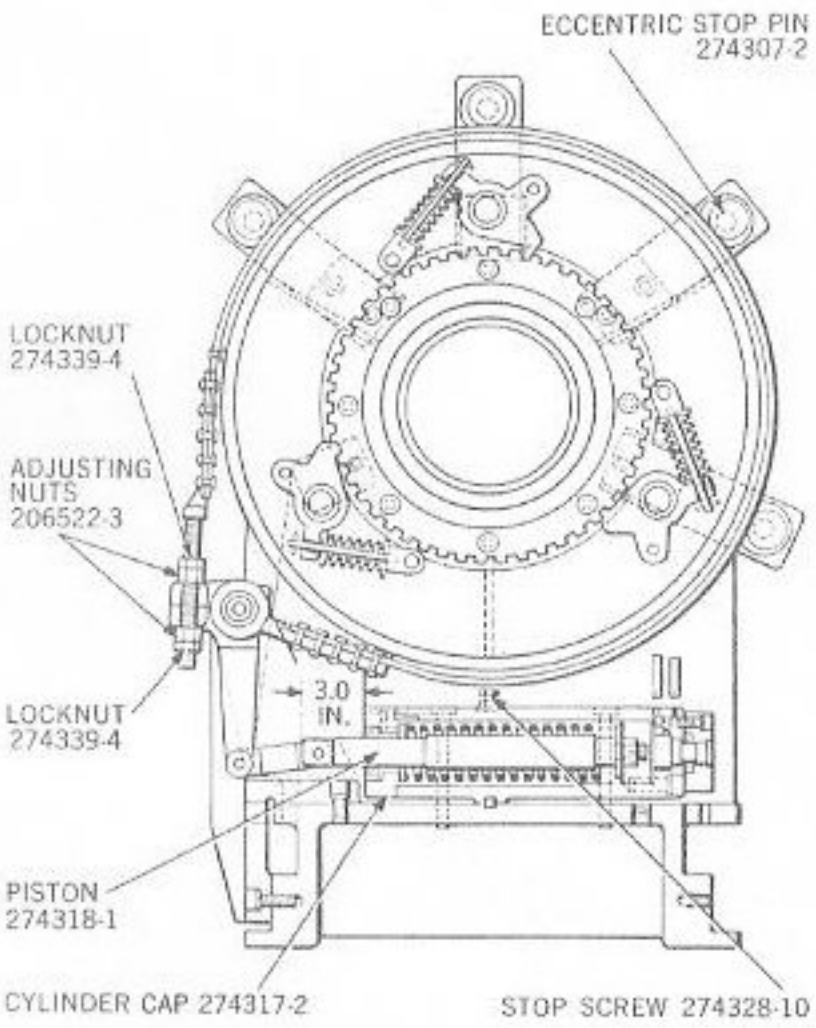


Figure 11-34. B-end Brake. Adjustment.

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 206485-14; 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.

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.

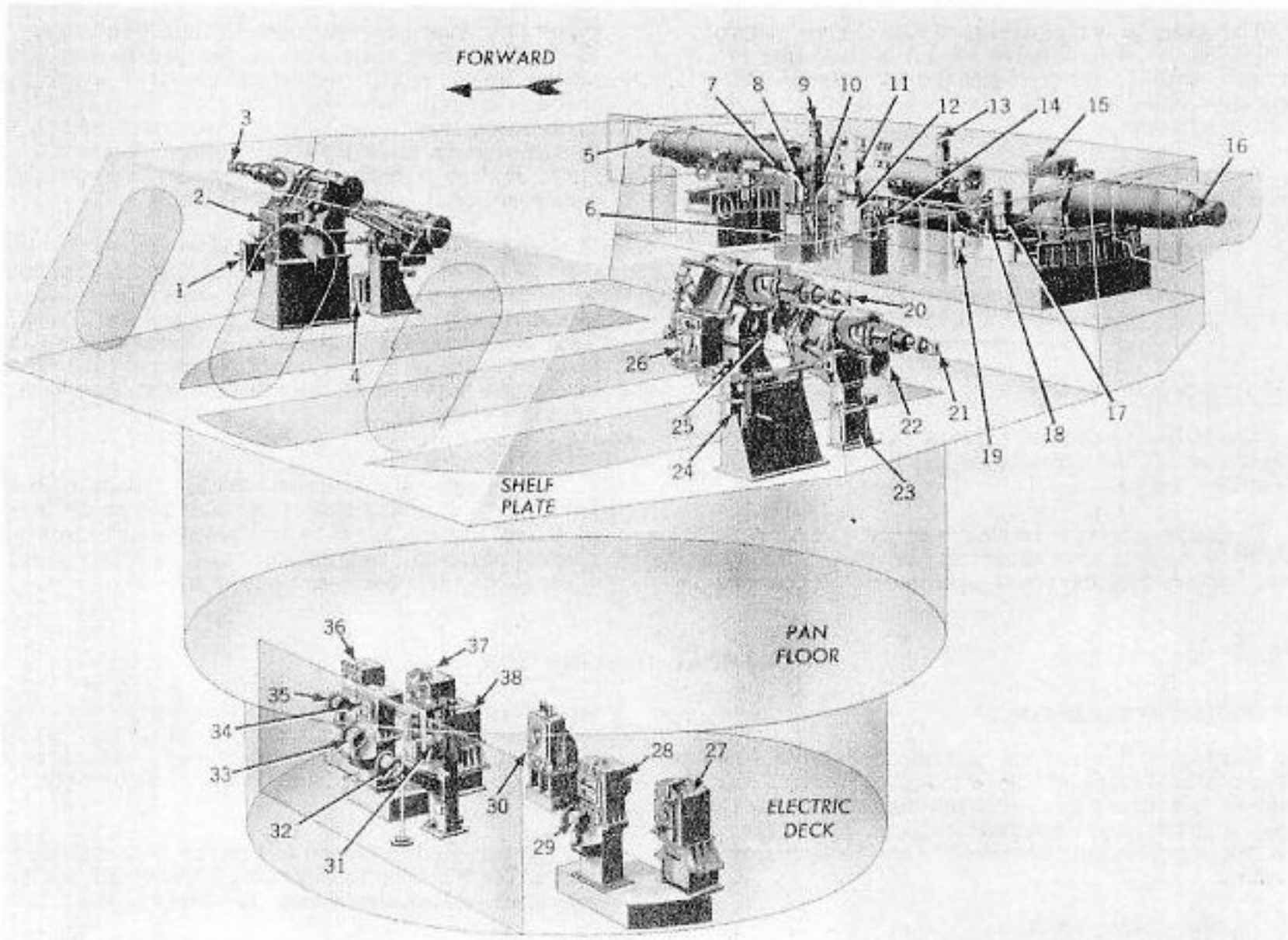
Circuit GEP. Shown in figures 12-3 and 12-5, circuit GEP connects the same fire control instruments identified above and, in addition, the following:

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.

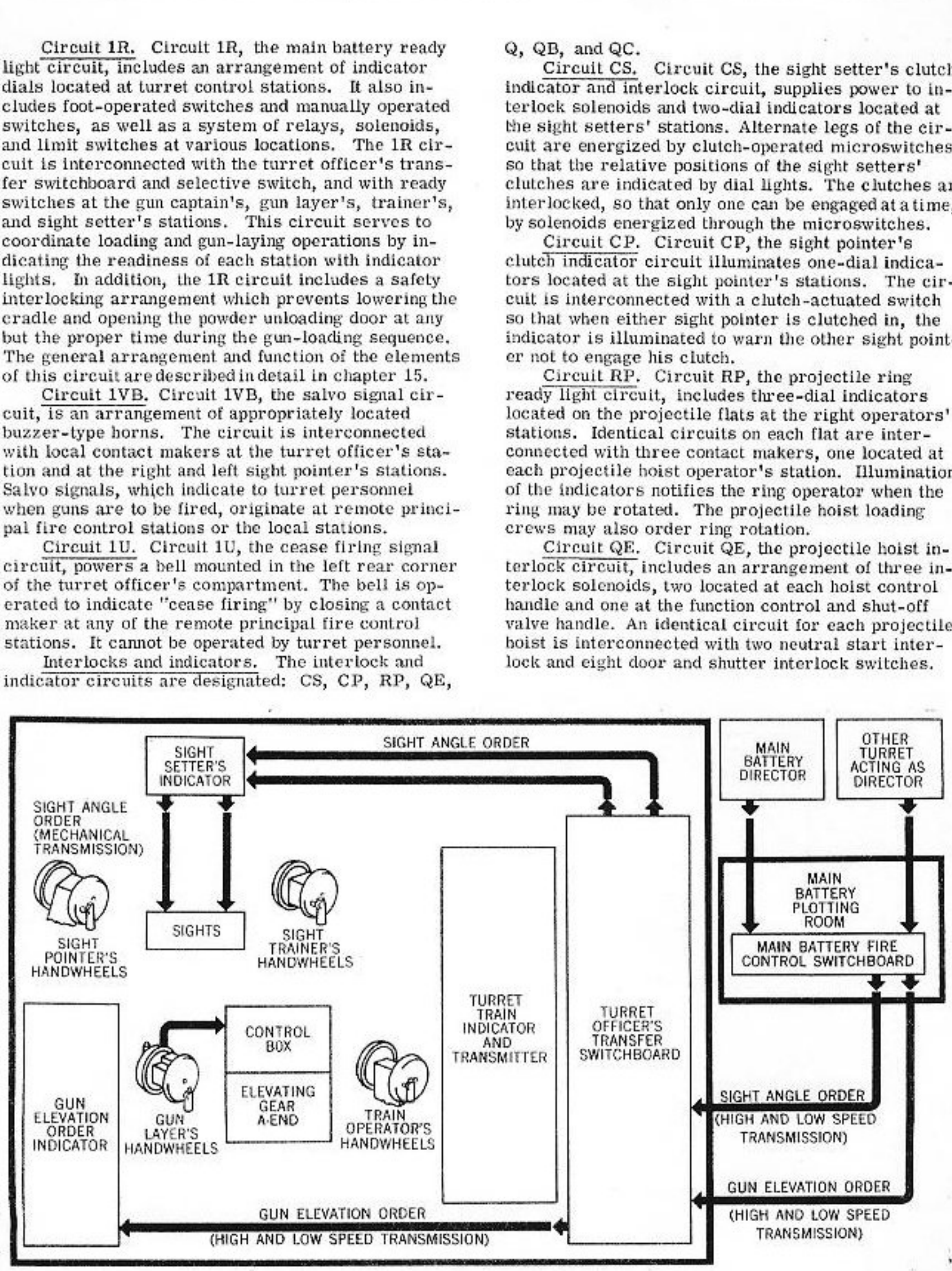


Figure 12-2. Gun Elevation Control - Circuit GE - Functional Diagram

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.

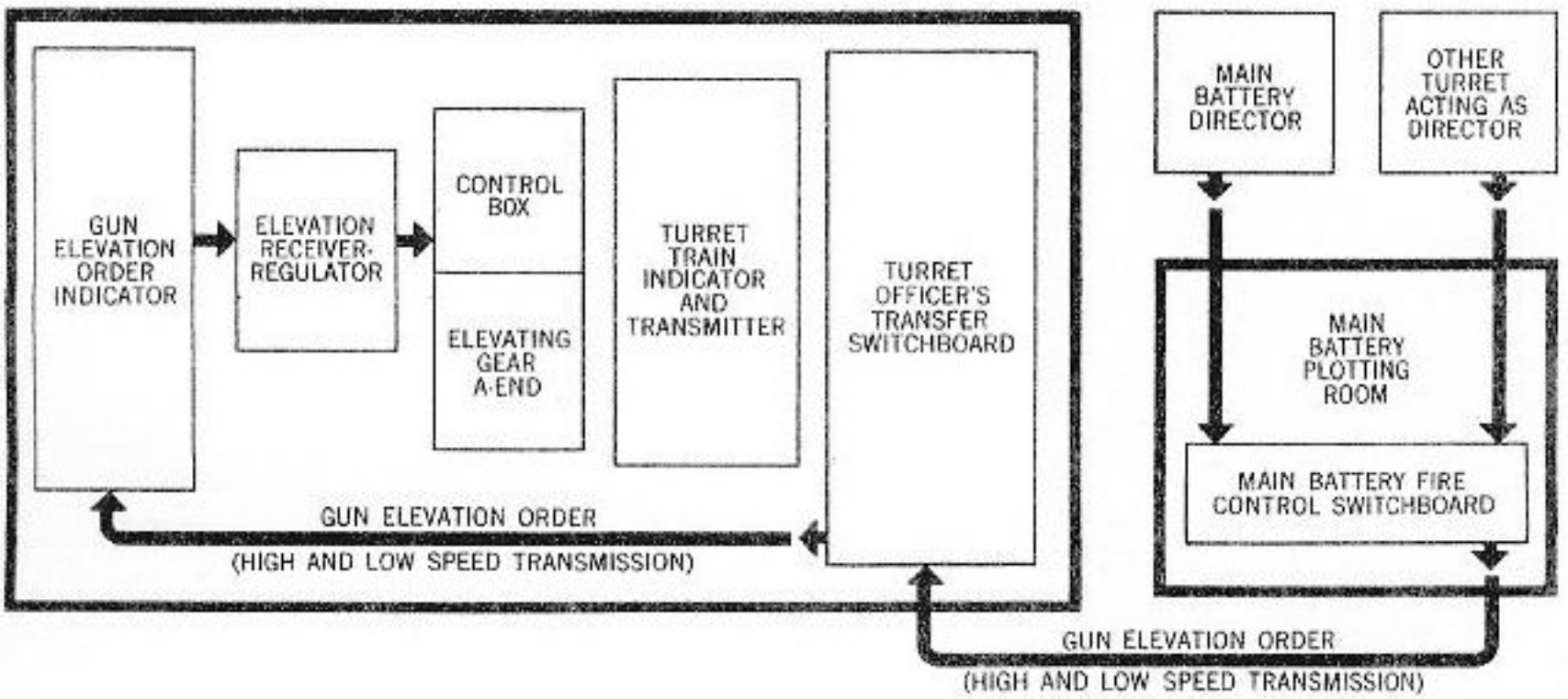


Figure 12-3. Gun Elevation Control - Circuit GEP - Functional Diagram

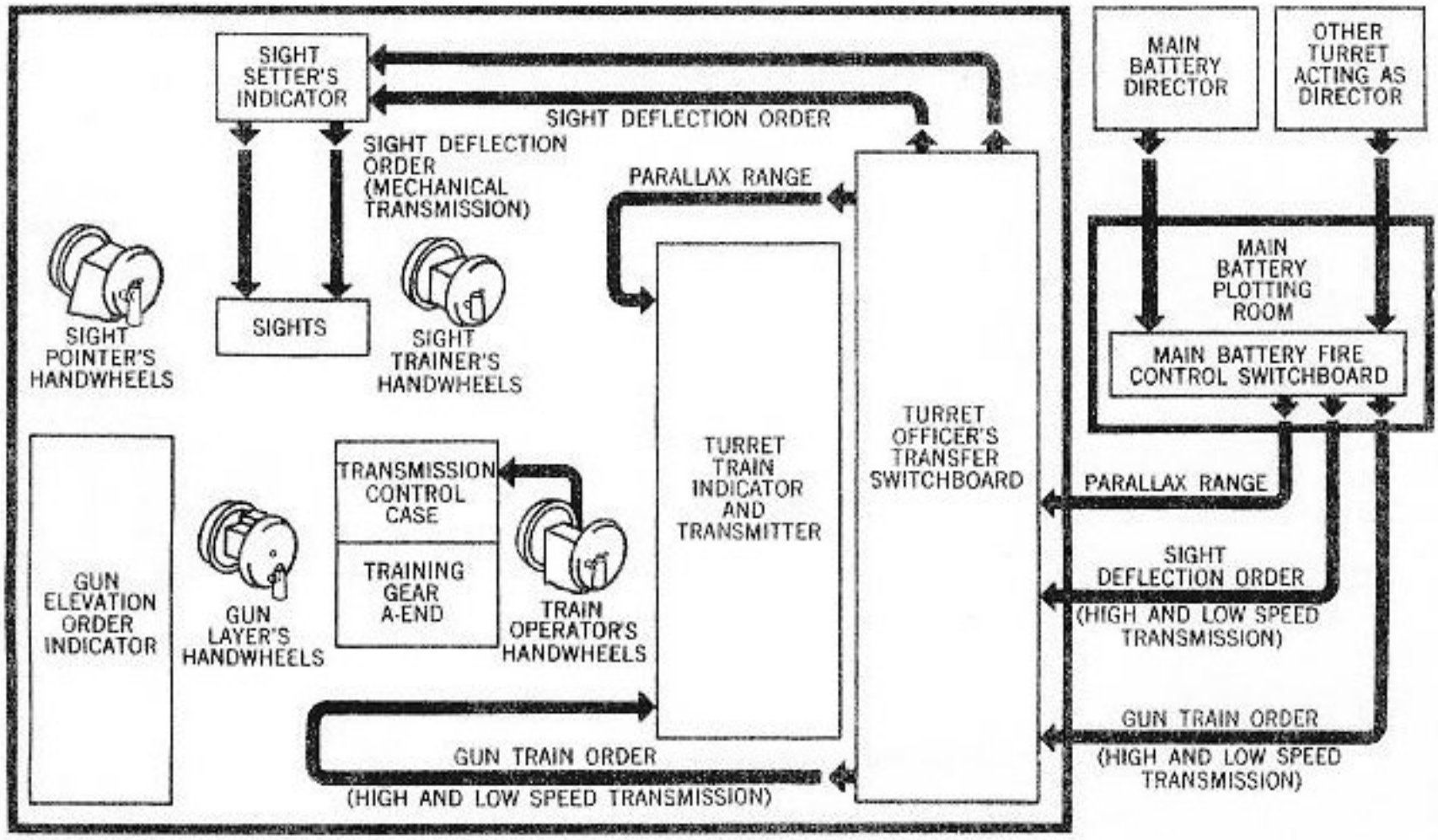


Figure 12-4. Turret Train Control - Circuit GE - Functional Diagram

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.

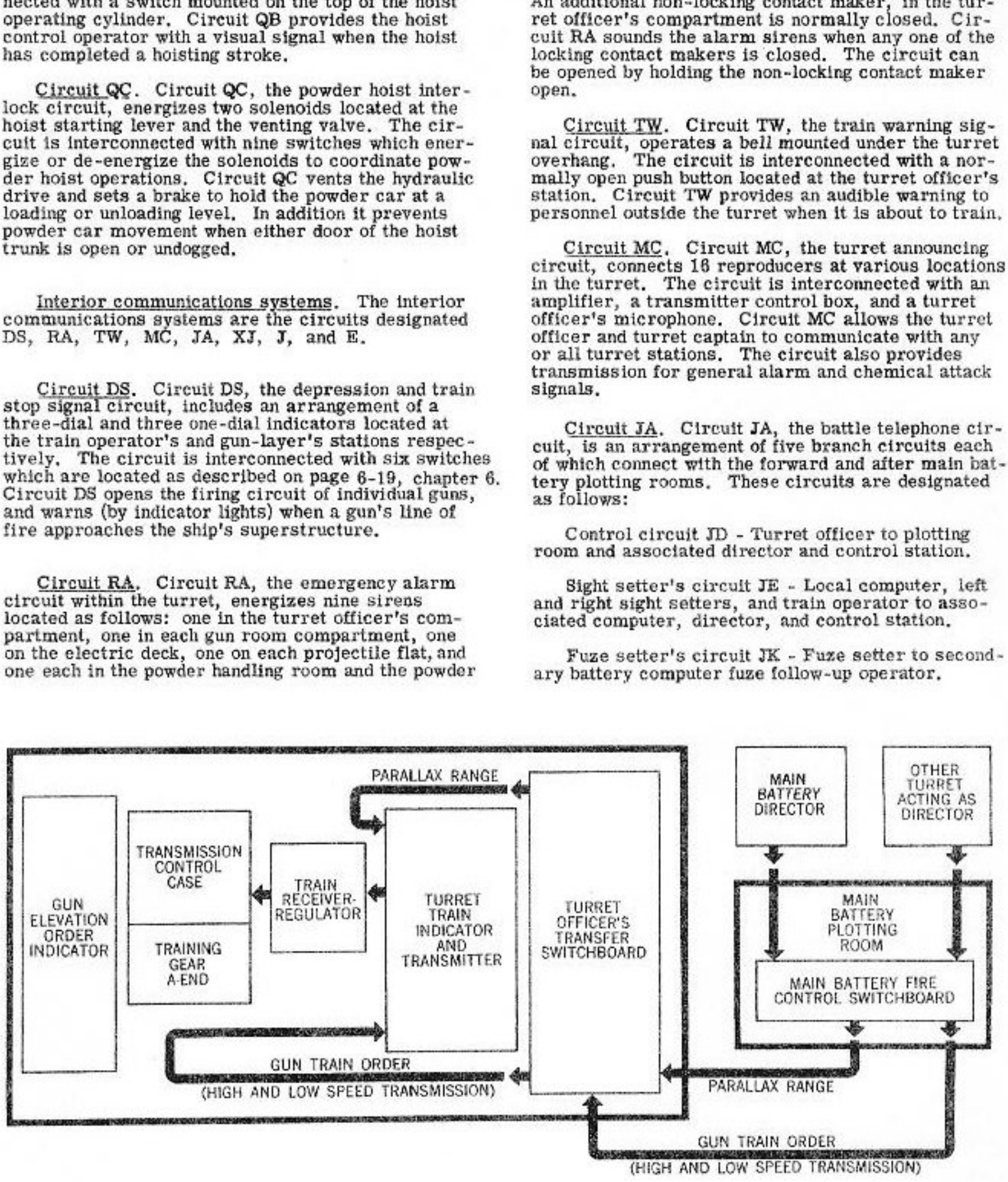


Figure 12-5. Turret Train Control - Circuit GEP - Functional Diagram

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).

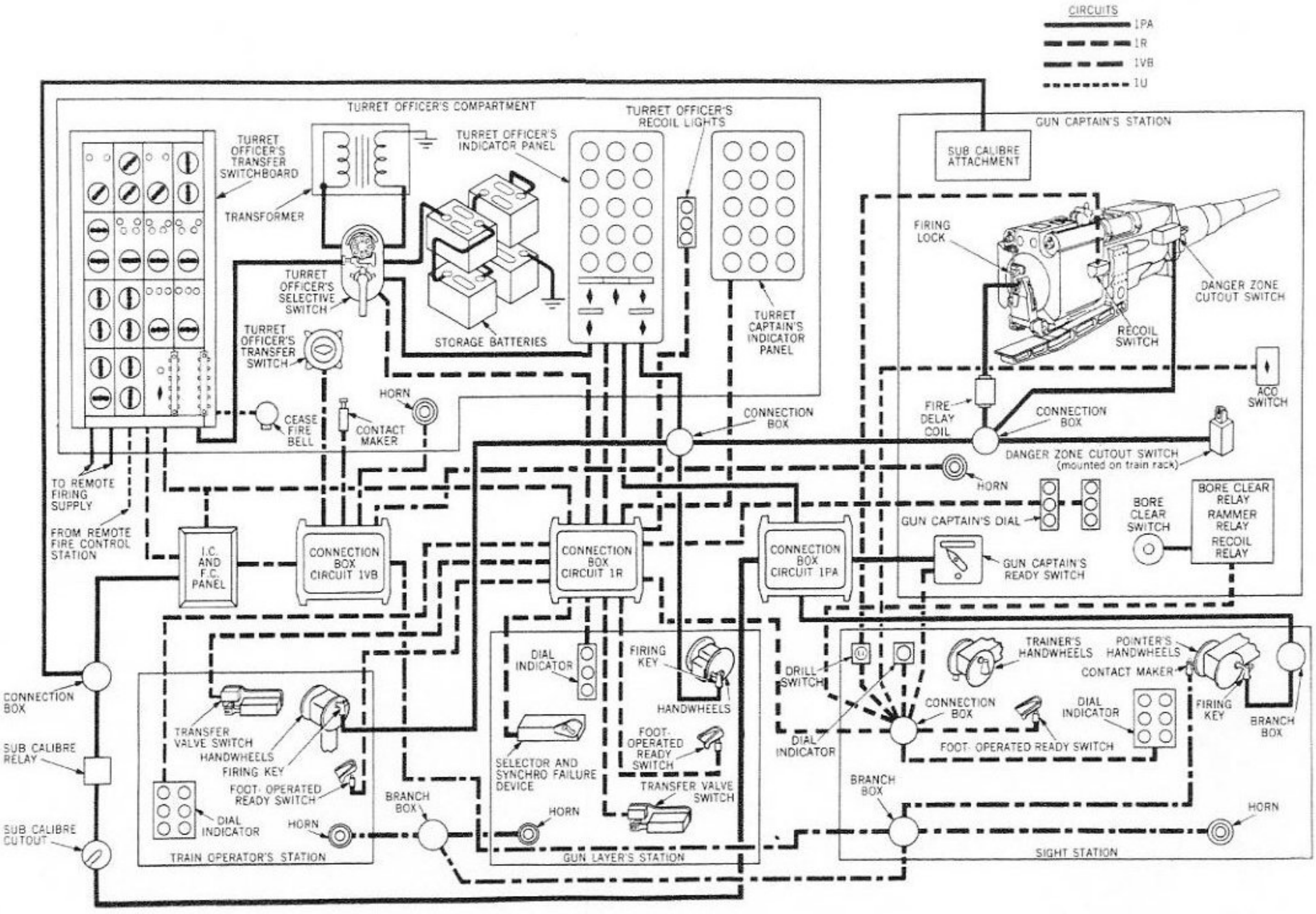


Figure 12-6. Gun Firing Control System Arrangement For Circuits 1PA, 1R, 1VB, and 1U

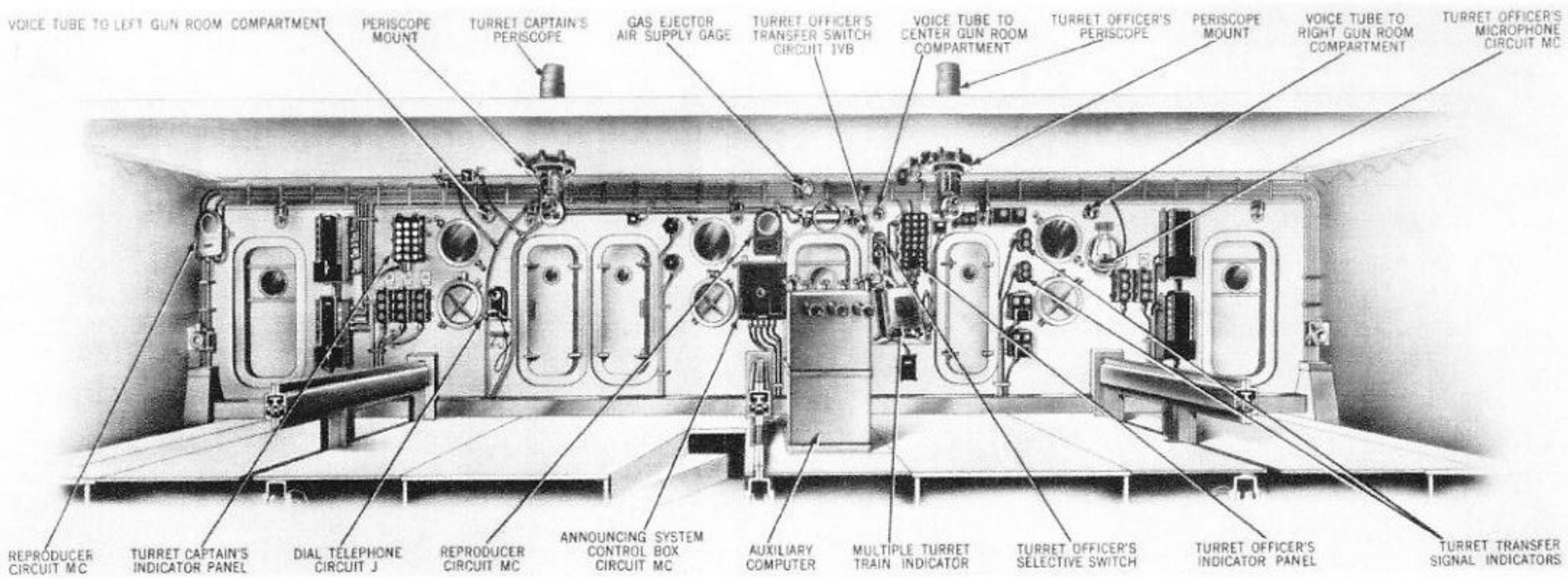


Figure 12-7. Turret Officer's Booth Fire Control Arrangement, Looking Forward

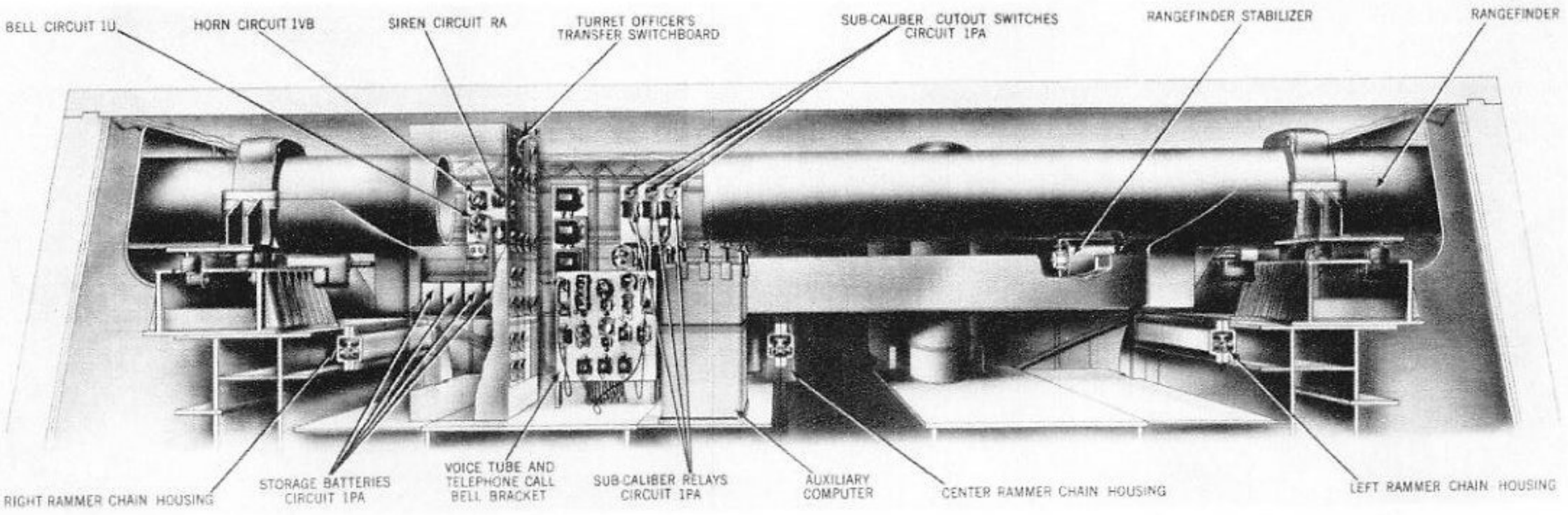
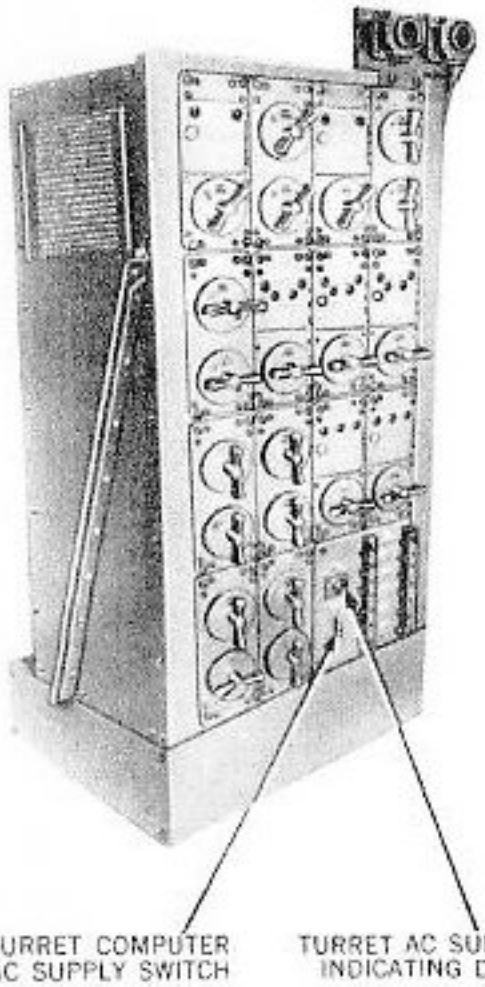


Figure 12-8. Turret Officer's Booth Fire Control Arrangement, Looking Aft



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

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.

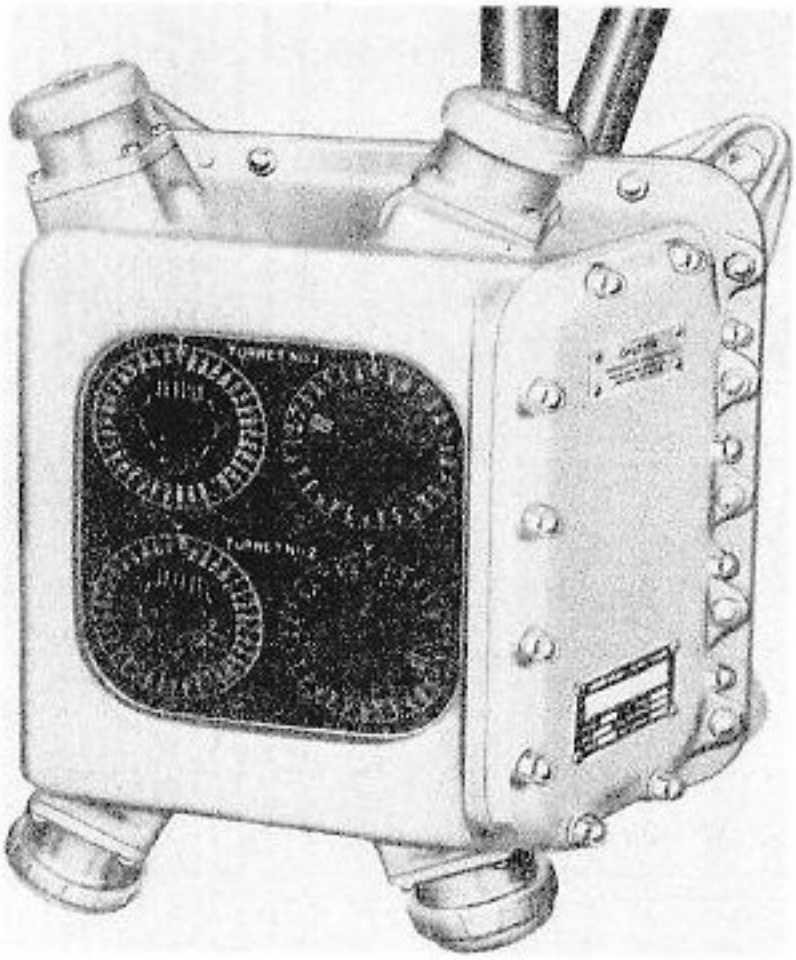


Figure 12-10. Multiple Turret Train Indicator Mk 12 Mod 7

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.

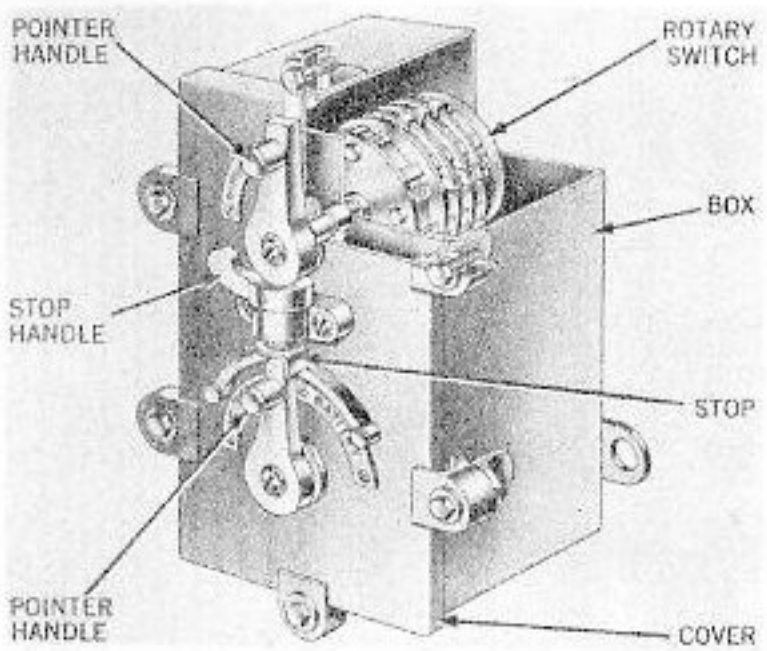


Figure 12-11. Turret Officer's Selective Switch

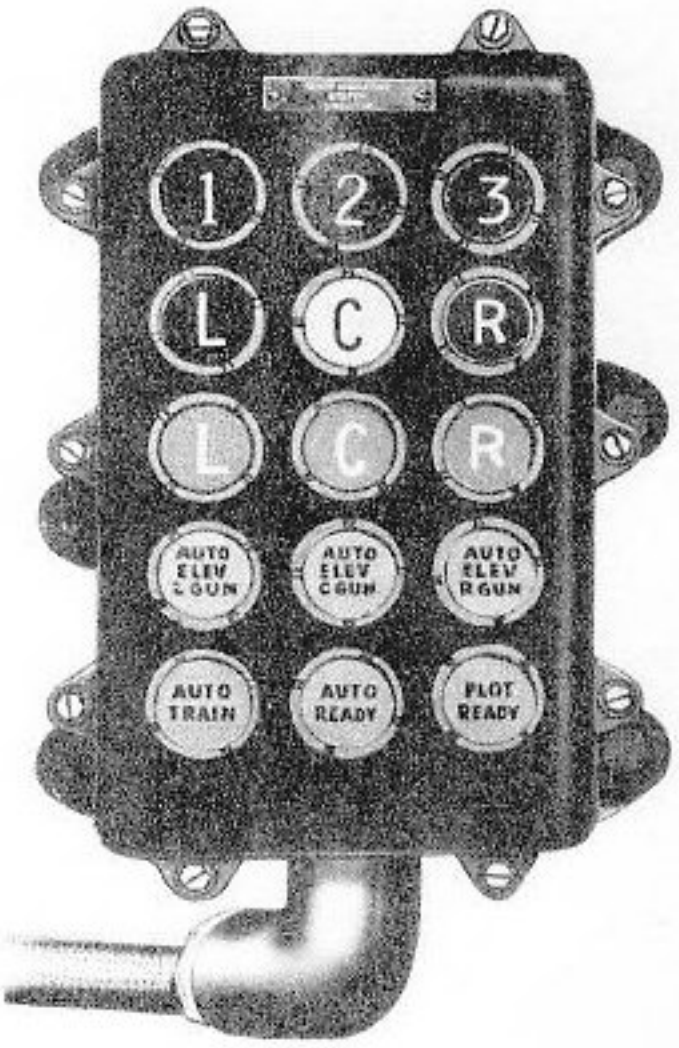


Figure 12-12. Turret Captain's Indicator Panel

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 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.

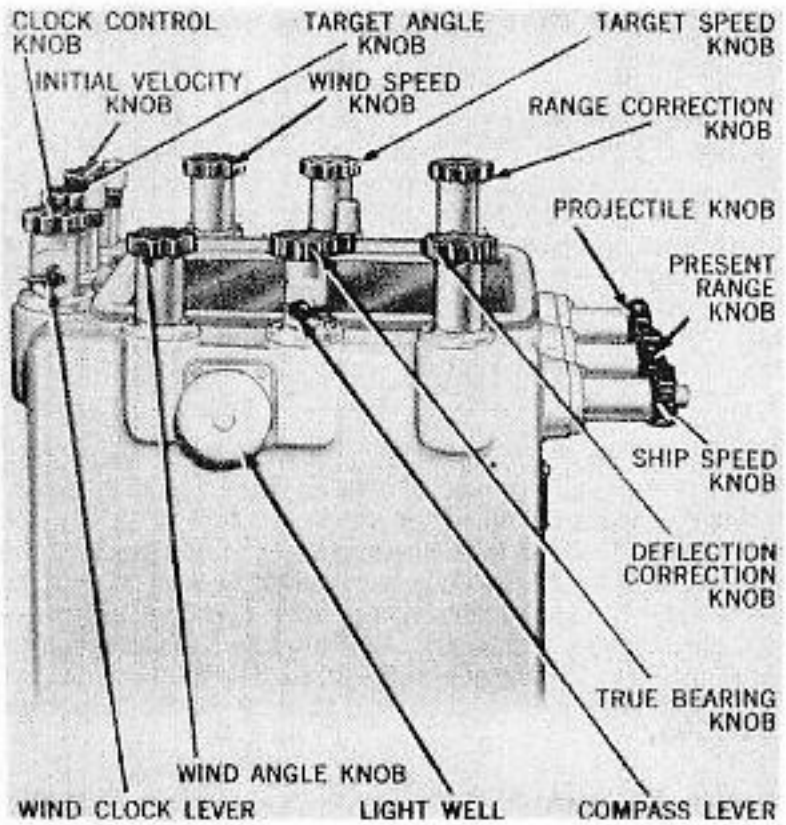


Figure 12-13. Auxillary Computer - General Arrangement

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

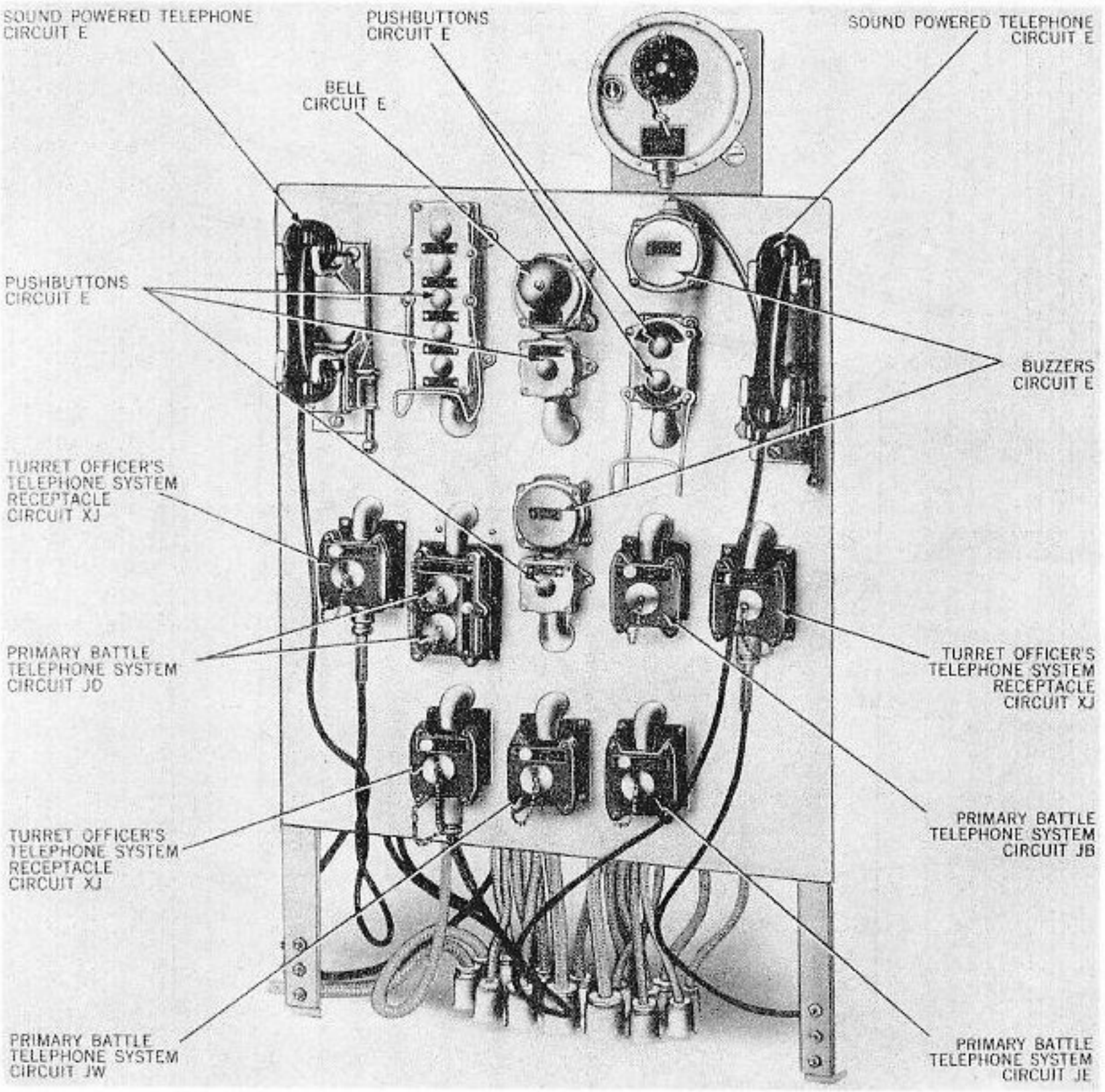


Figure 12-14. Voice and Telephone Call Bell Bracket

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.

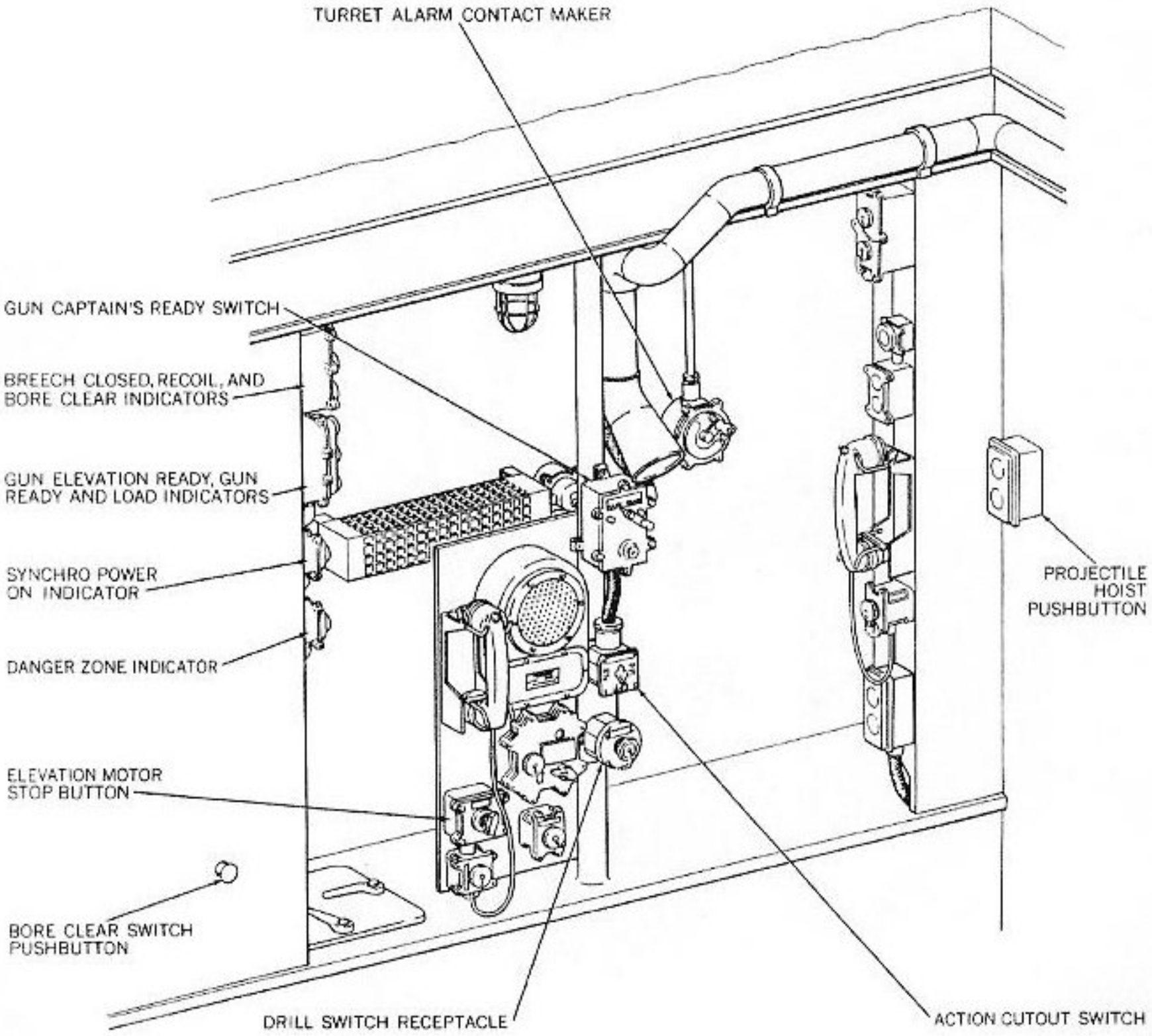


Figure 12-15. Gun Captain's Station - General Arrangement.

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.

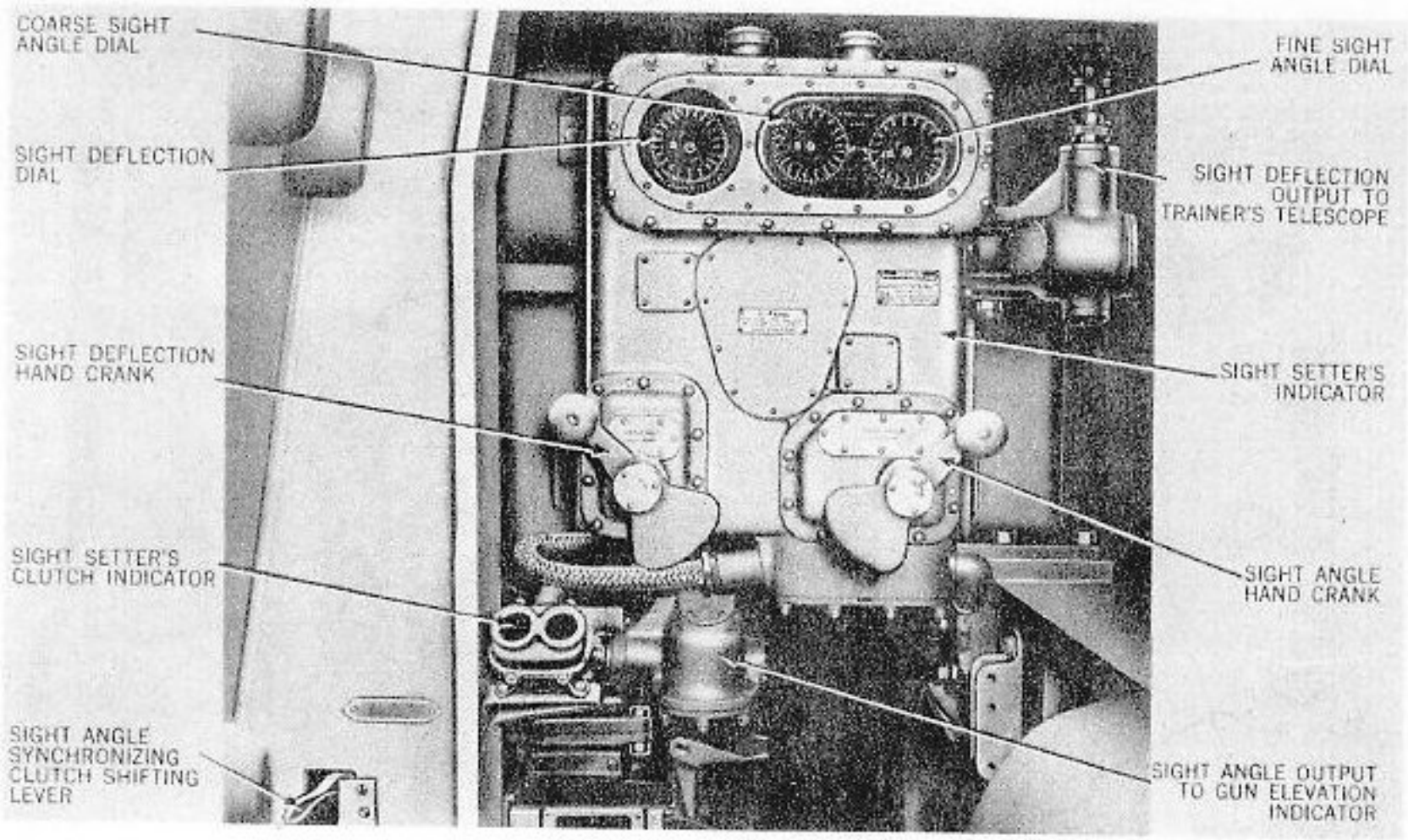


Figure 12-16. Sight Setter's Station - Fire Control Arrangement

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.

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.

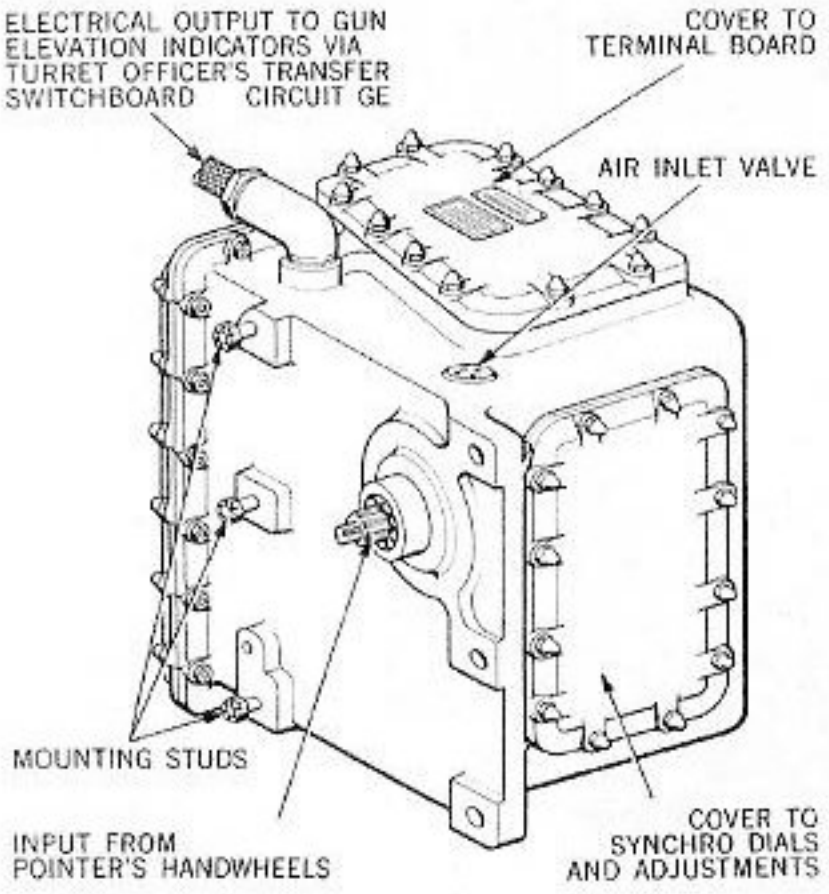


Figure 12-17. Gun Elevation Order Transmitter

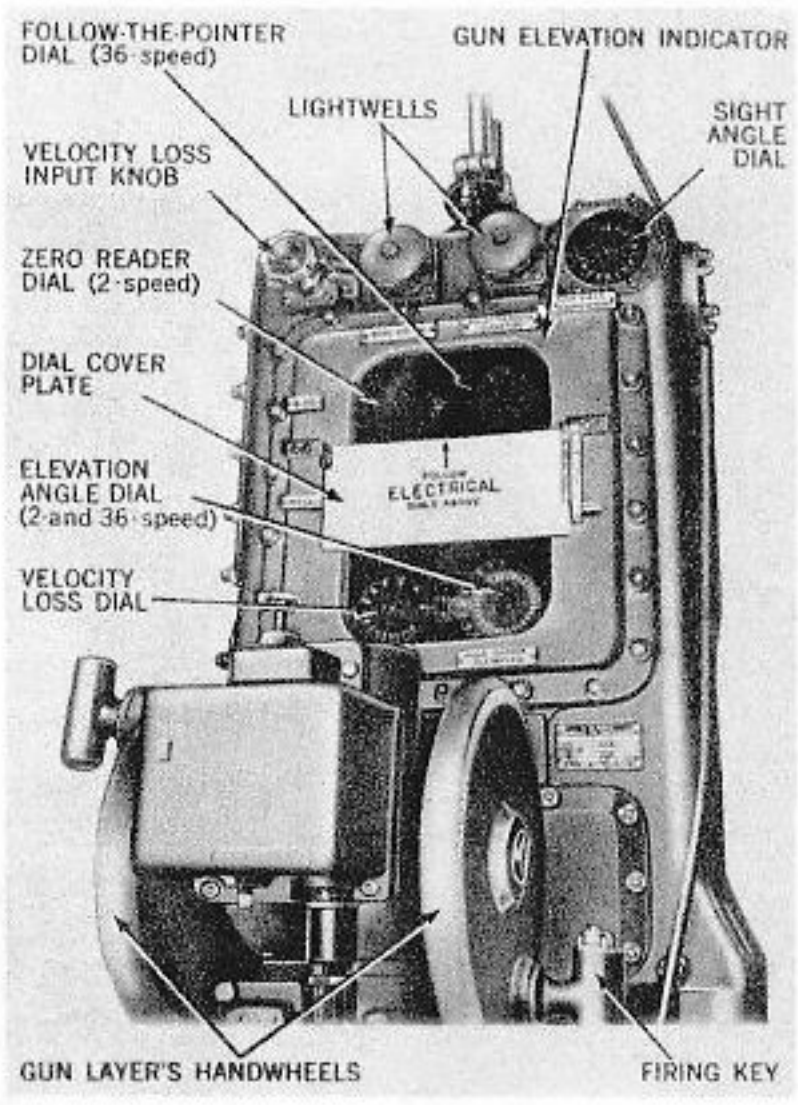


Figure 12-18. Gun Layer's Station - Fire Control Arrangement

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.

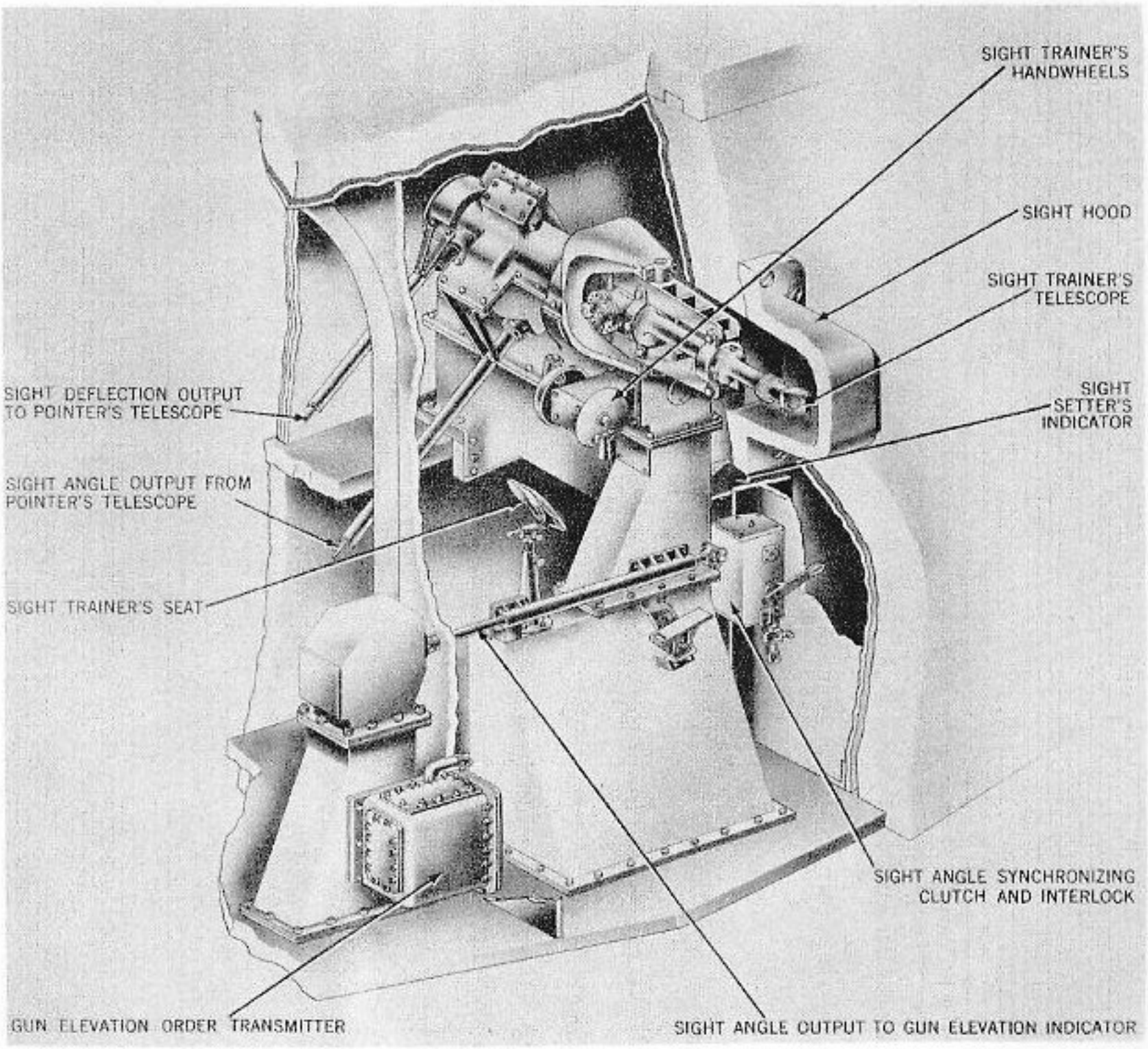


Figure 12-19. Sight Trainer's Station - Fire Control Arrangement

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.

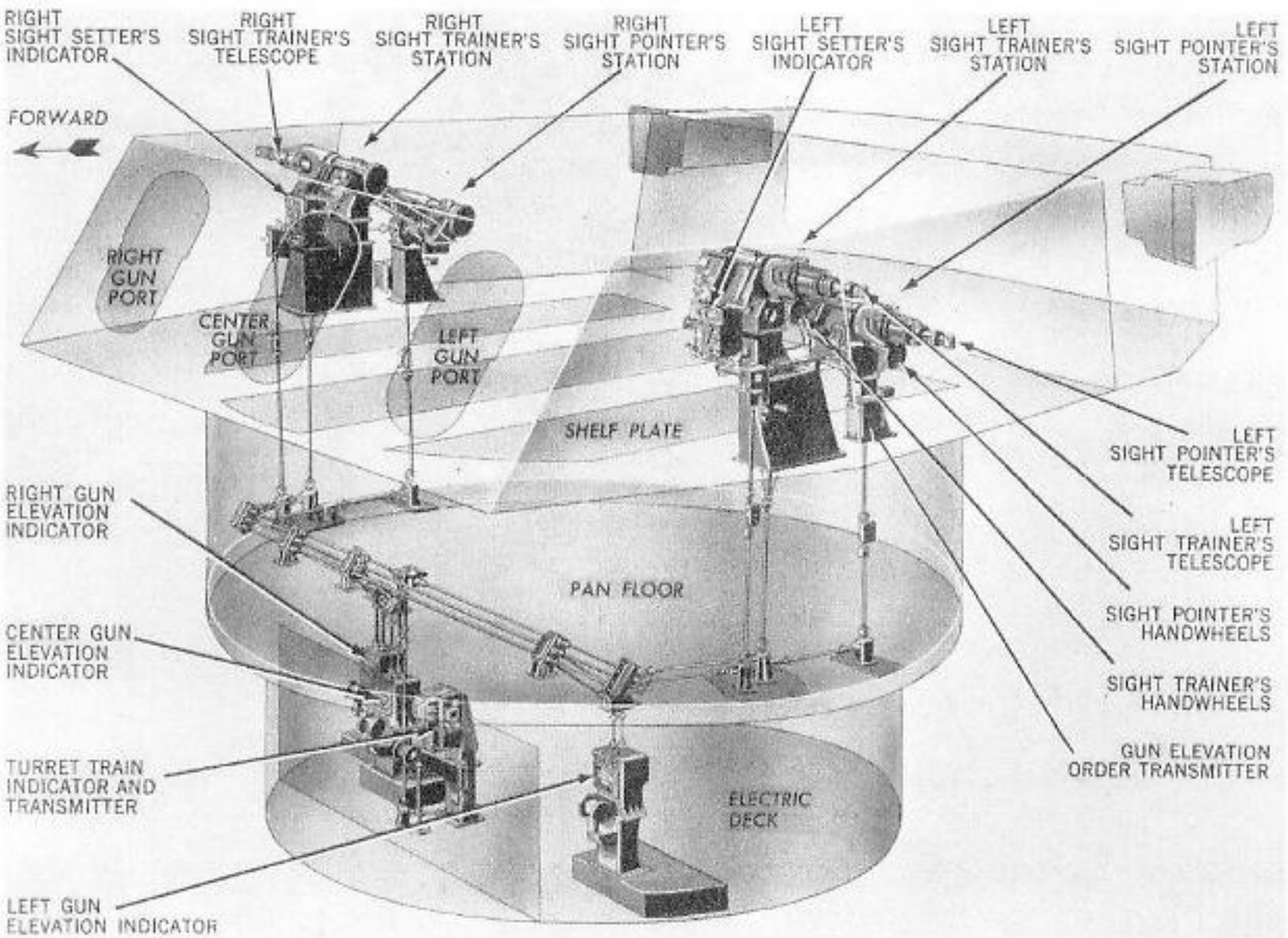


Figure 13-1. Sight and Gun Attachments, General Arrangement

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.

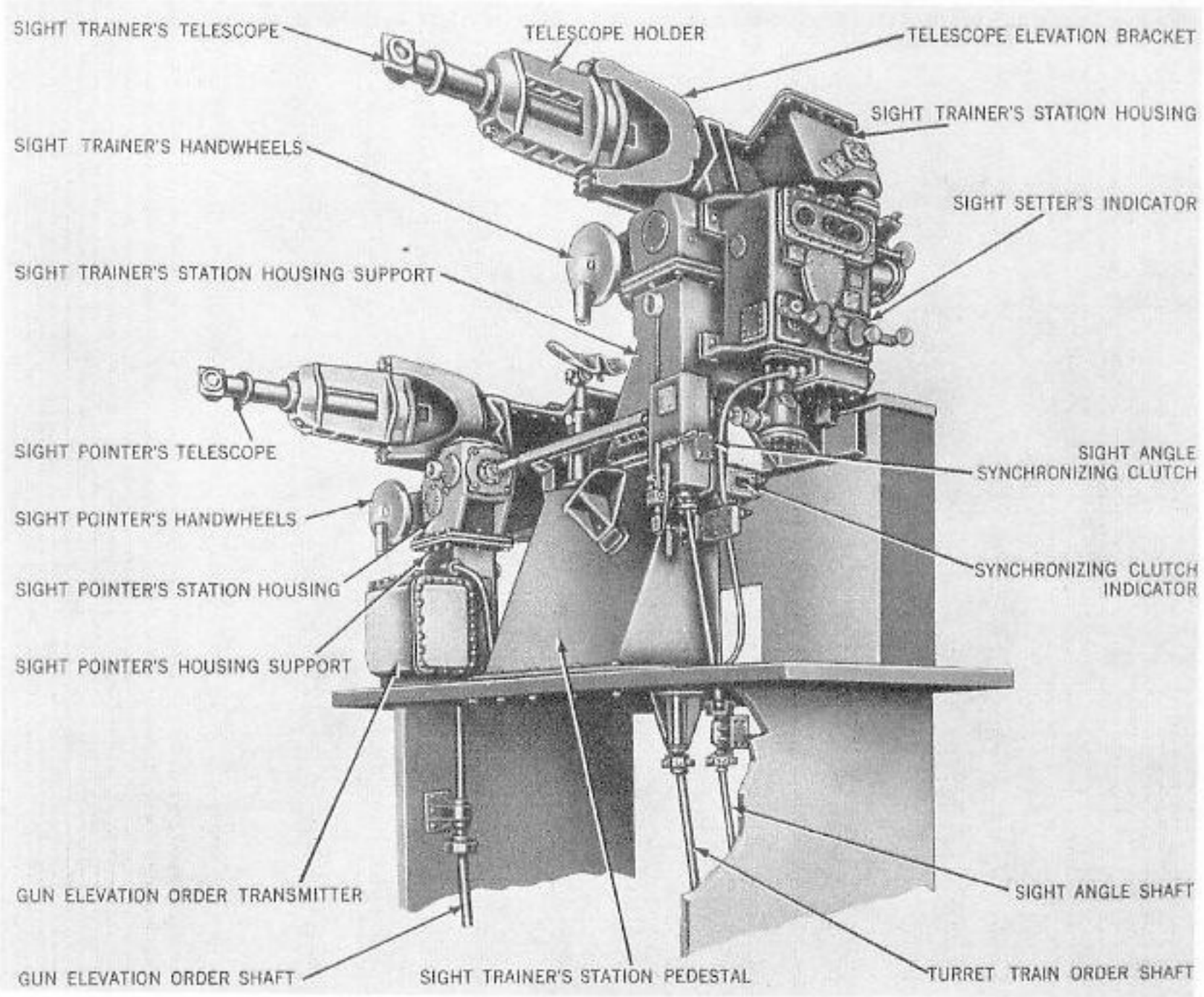


Figure 13-2. 16-Inch Sight Mk 4 Mod 2

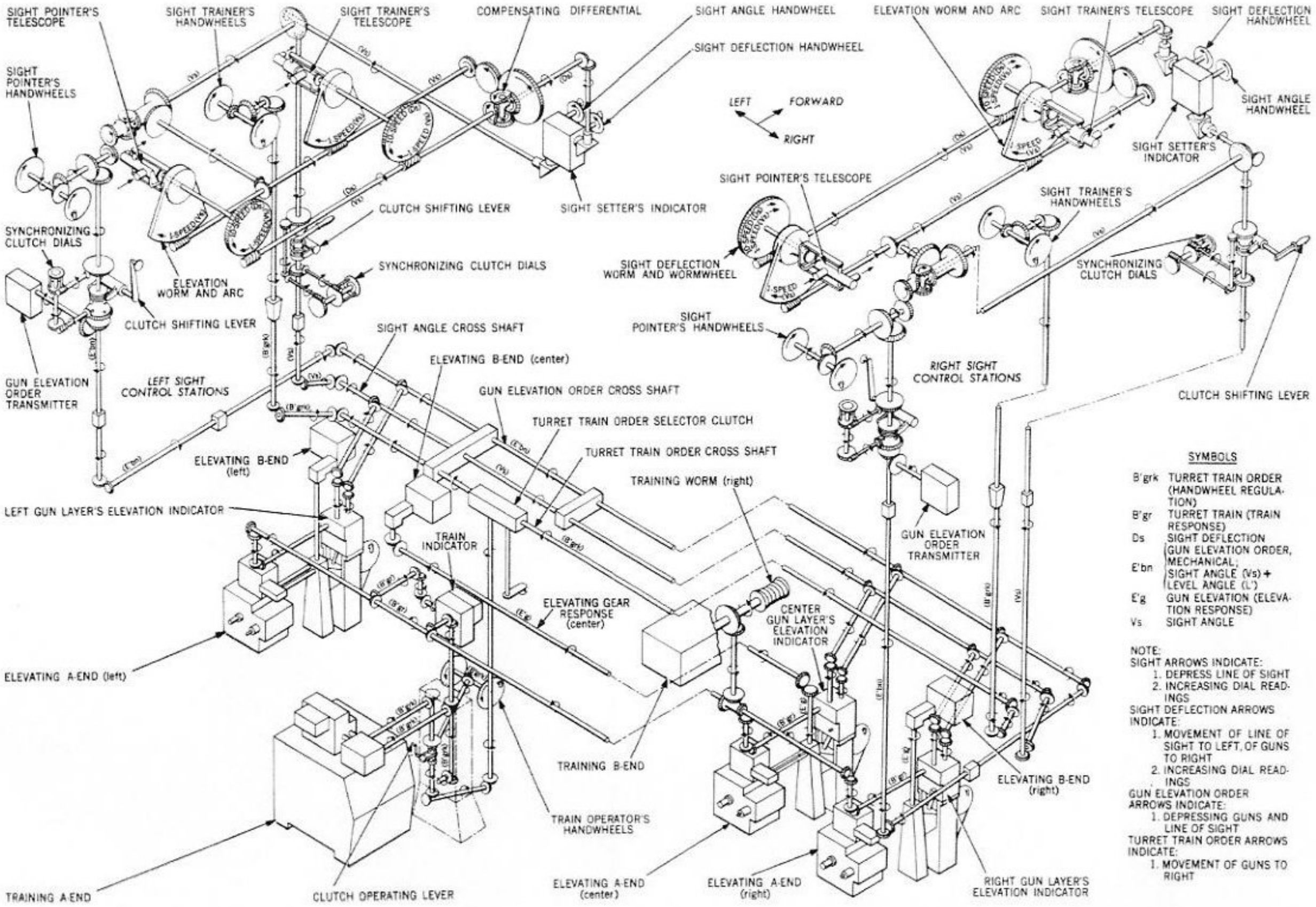


Figure 13-3. 16-Inch Sight Mk 4, Mods 2 and 3, Schematic Arrangement

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.

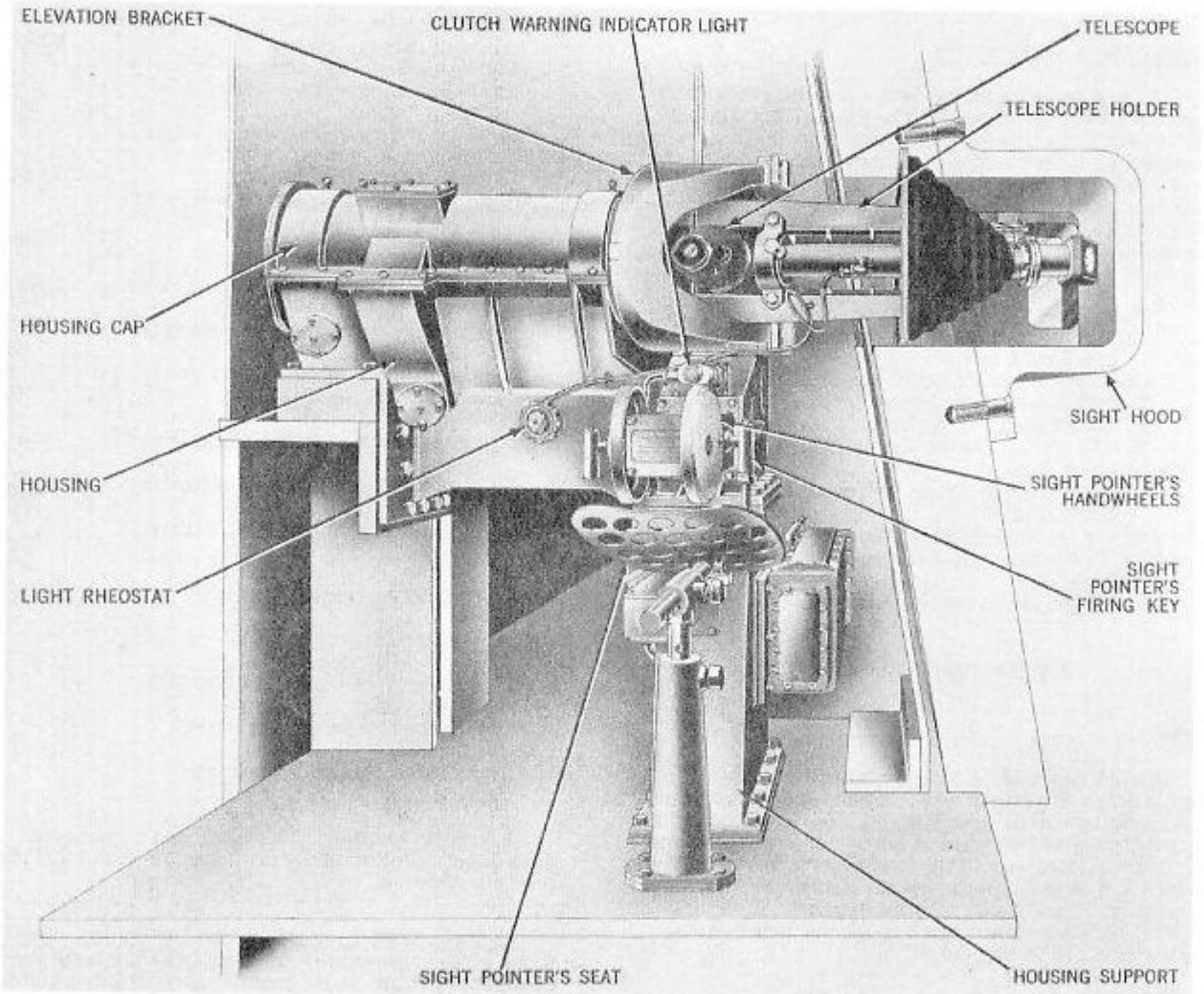


Figure 13-4. Sight Pointer's Station, 16-inch Sight Mk 4, Mod 2 or 3, General Arrangement

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.

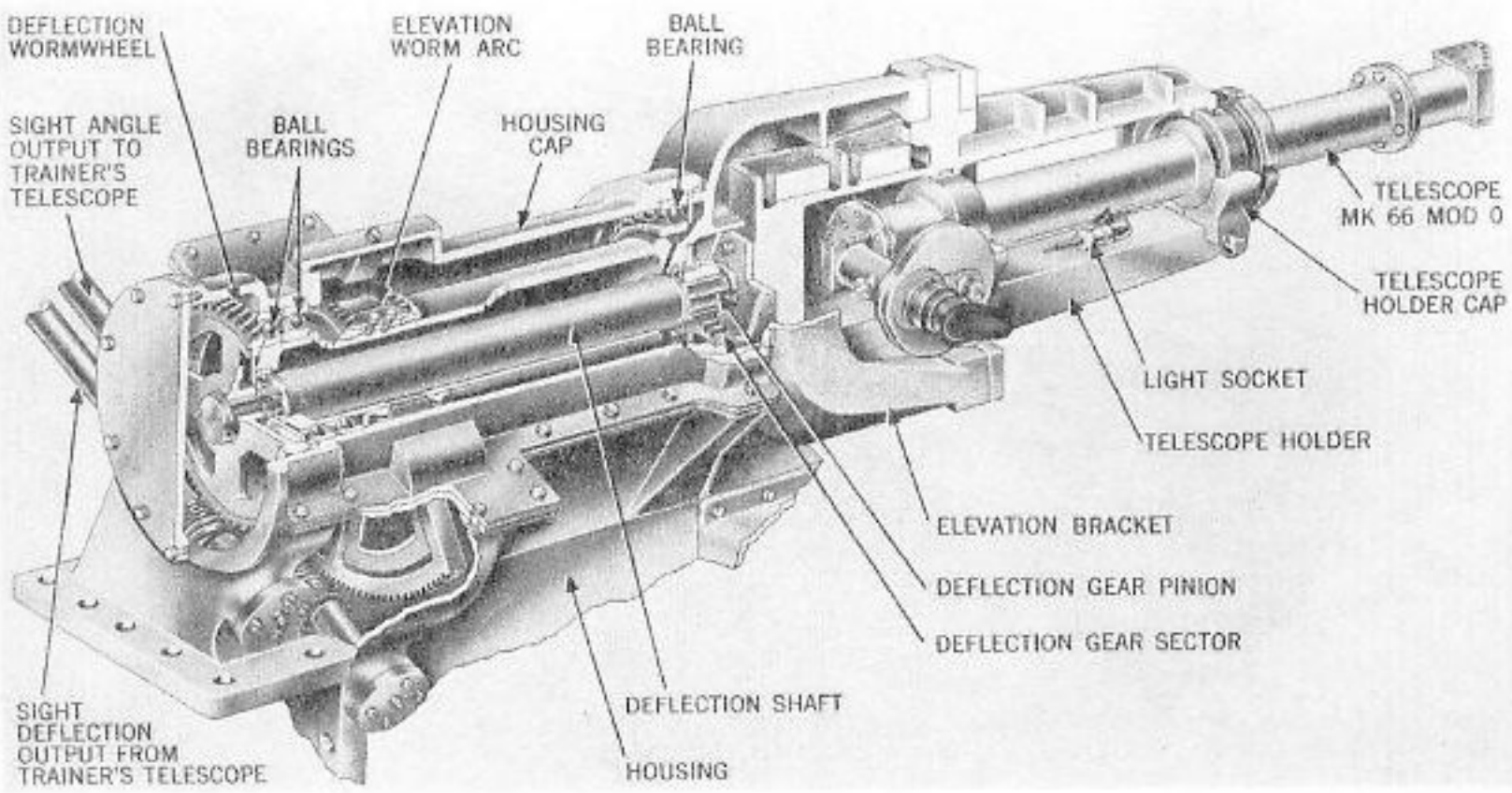


Figure 13-5. Sight Pointer's Telescope and Telescope Holder - Sectional View

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.

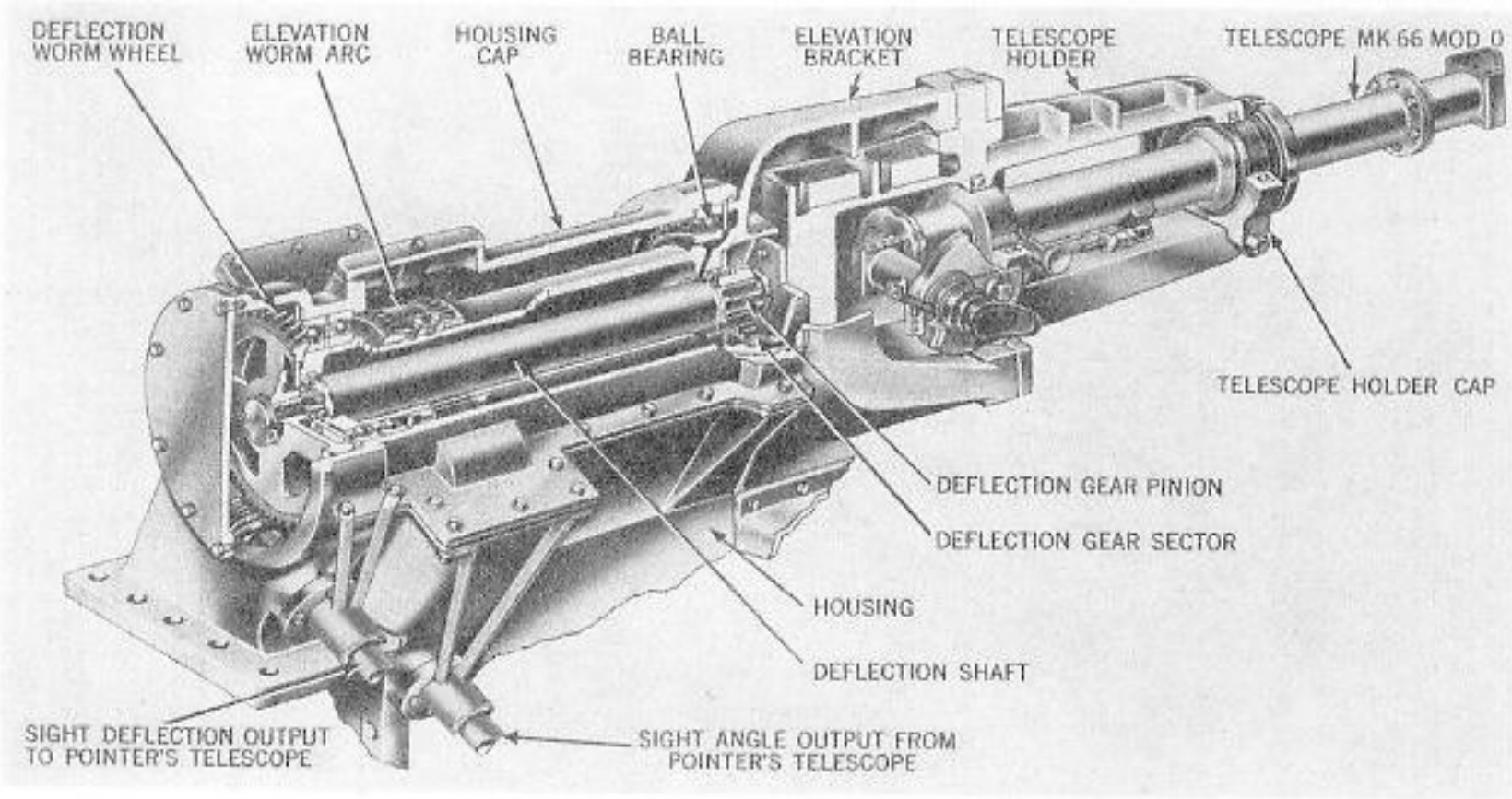


Figure 13-6. Sight Trainer's Telescope and Telescope Holder, Sectional View

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.

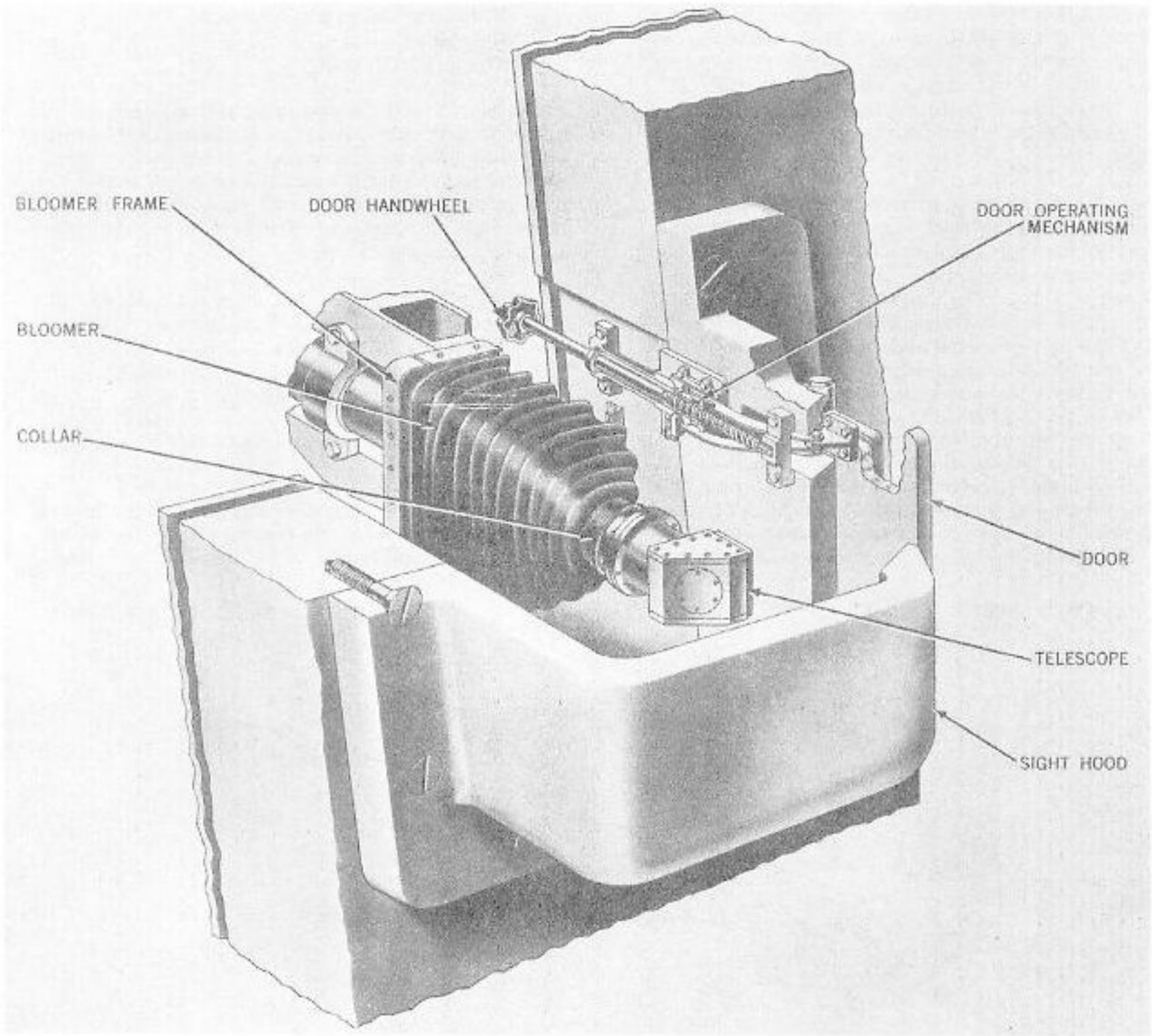


Figure 13-7. Sight Pointer's Sight Hood, Sectional View

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°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

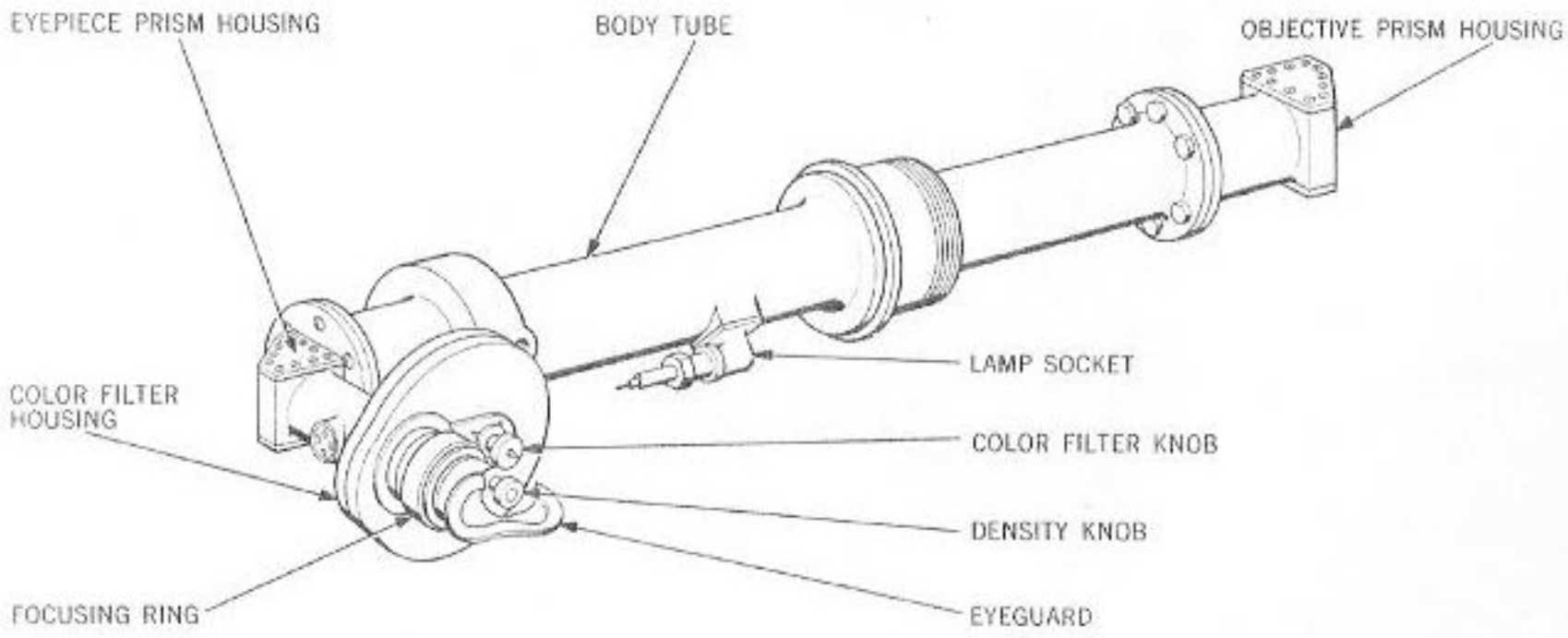


Figure 13-8. Telescope Mk 66, Mod 0, Rear View - Trainers Station

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

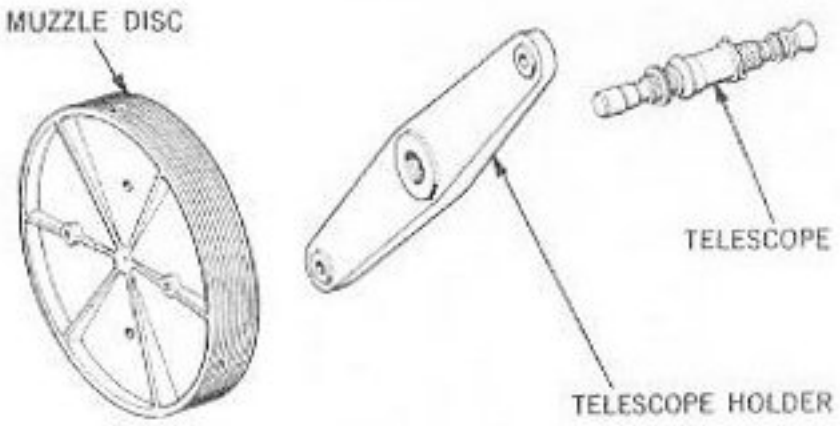


Figure 13-9. 16-Inch Bore Sight Mk 2 Mod 0, General Arrangement

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.

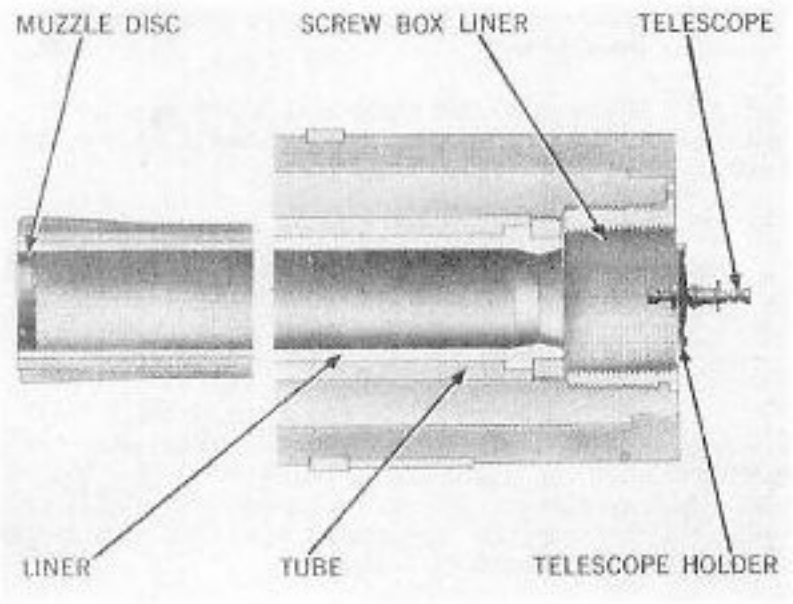


Figure 13-10. 16-Inch Bore Sight Mk 2 Mod 0, Installed in Gun

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.

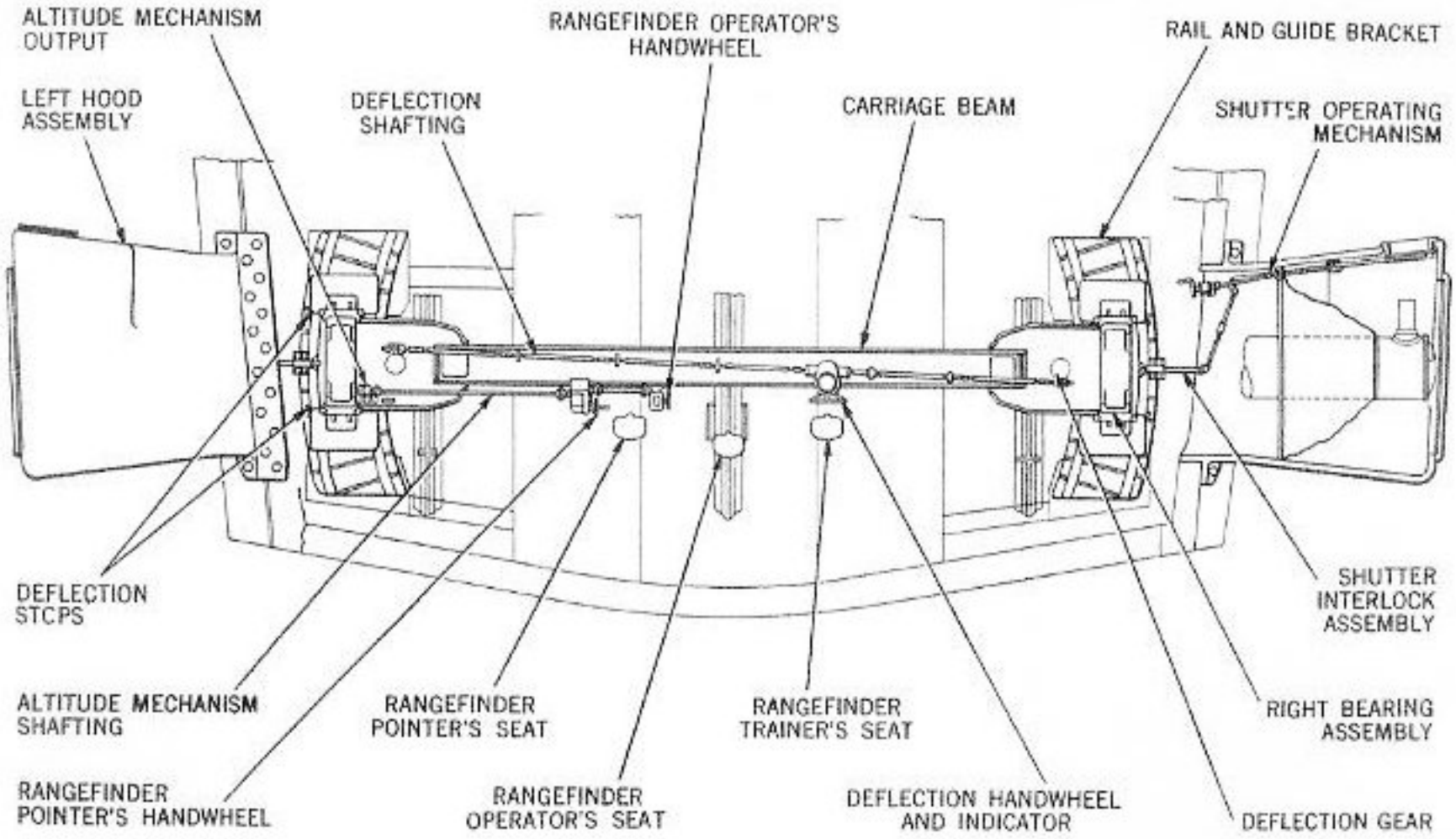


Figure 14-1. Rangefinder Stand Mk 52 Mod 0, General Arrangement

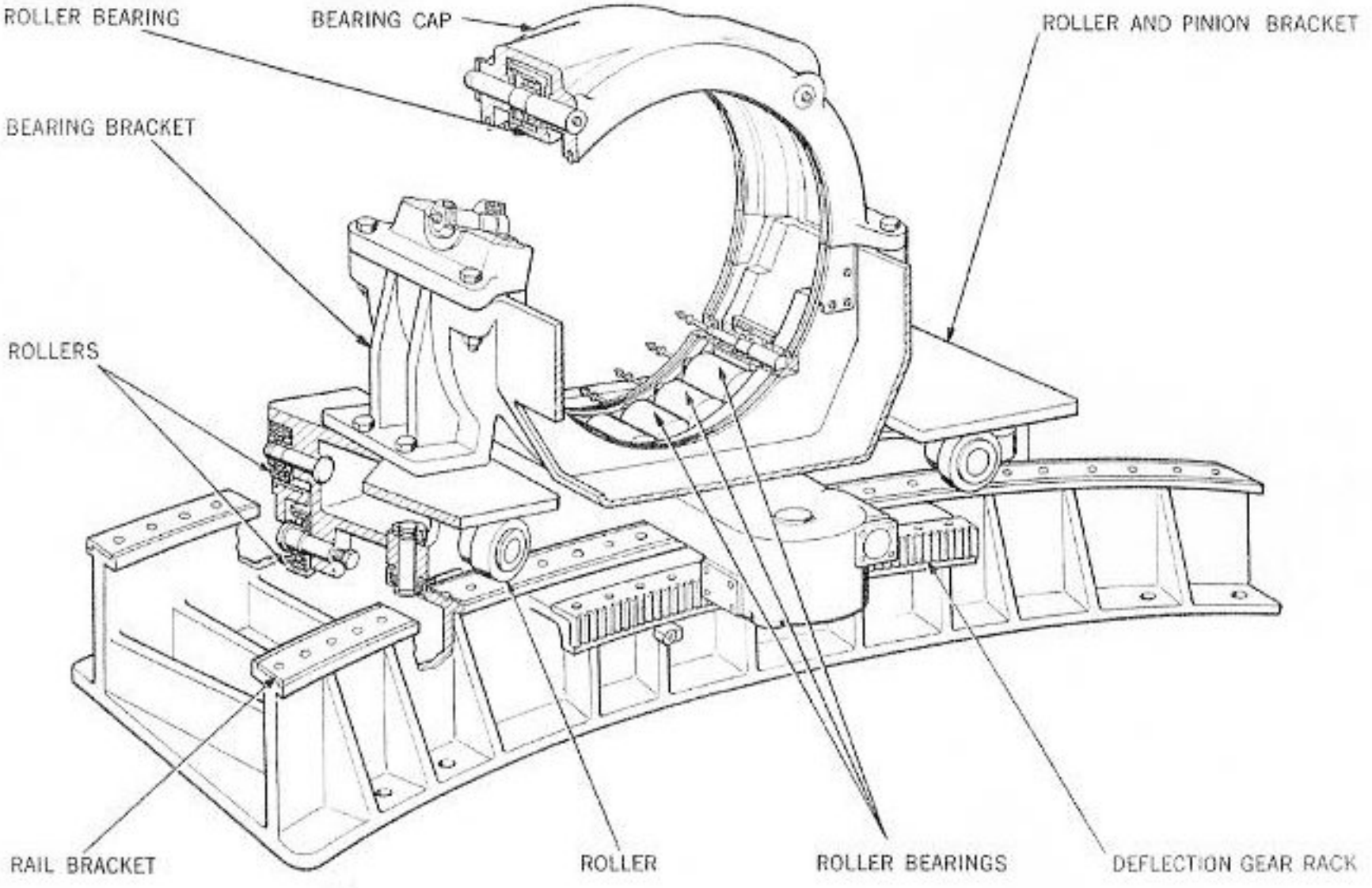


Figure 14-2. Left Rail Bracket and Bearing Assembly. Sectional View.

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.

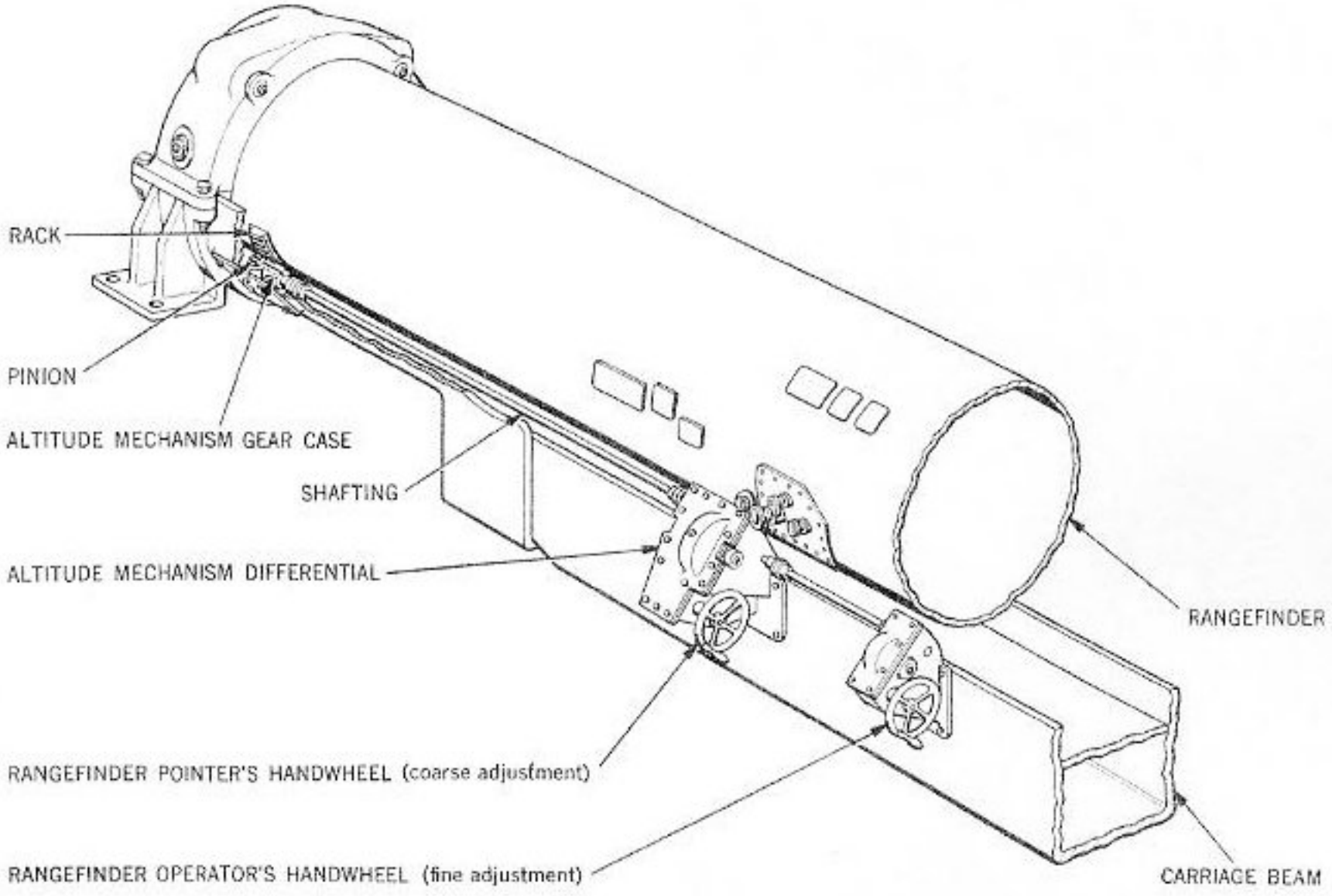


Figure 14-3. Altitude Mechanism, General Arrangement

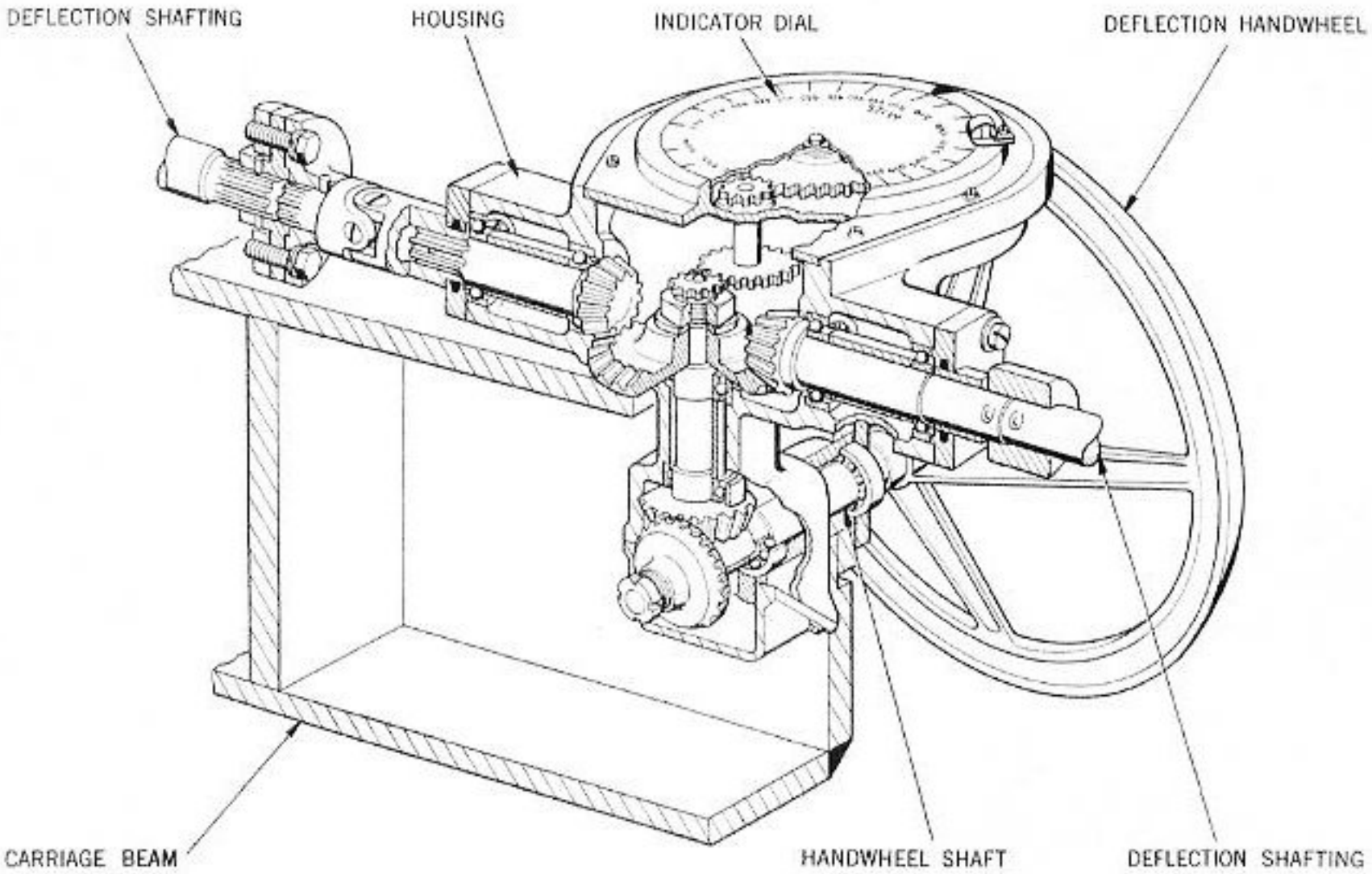


Figure 14-4. Deflection and Deflection Indicator Drive, Sectional View

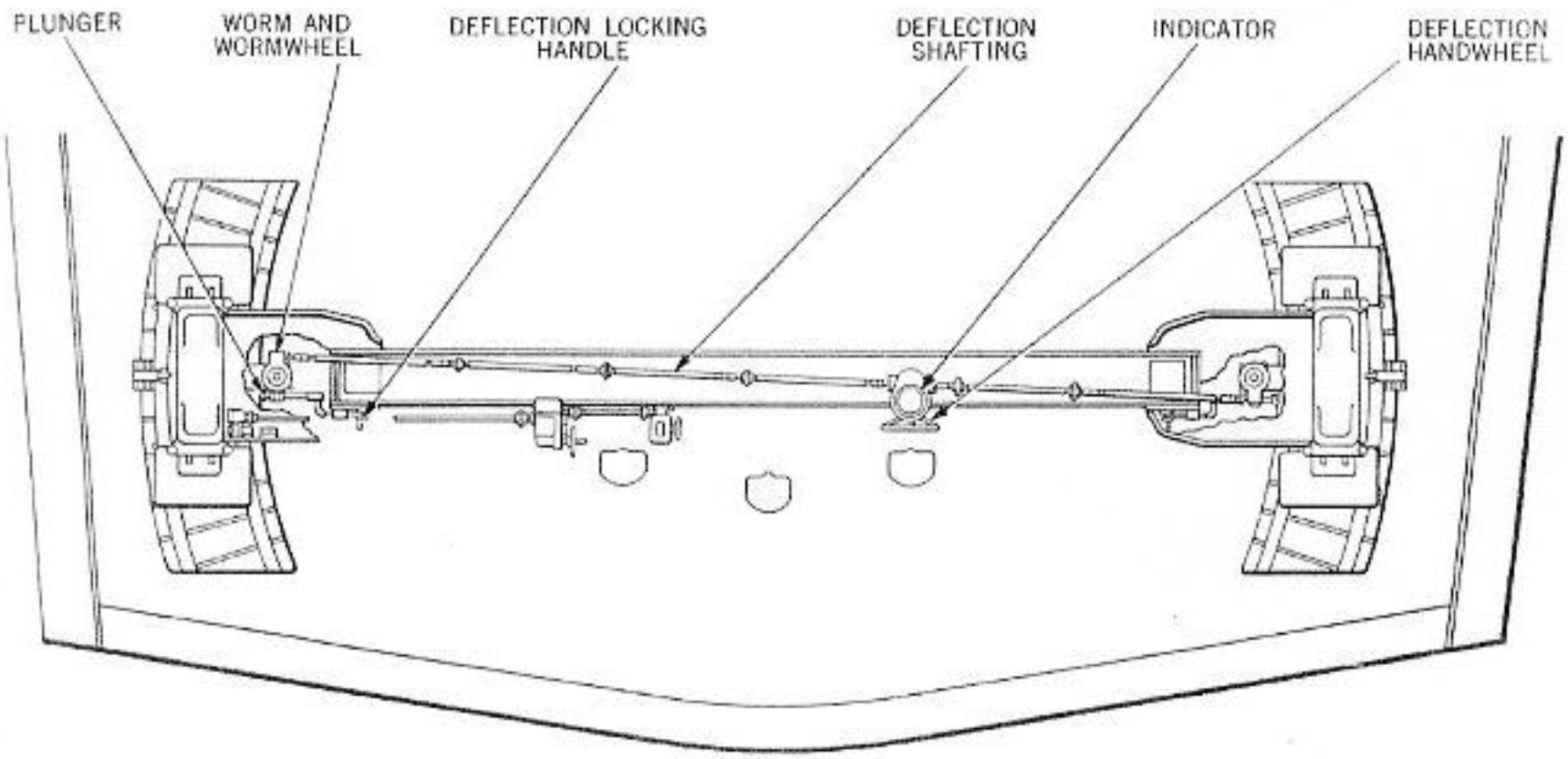


Figure 14-5. Deflection Drive and Deflection Drive and Deflection Locking Mechanism

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.

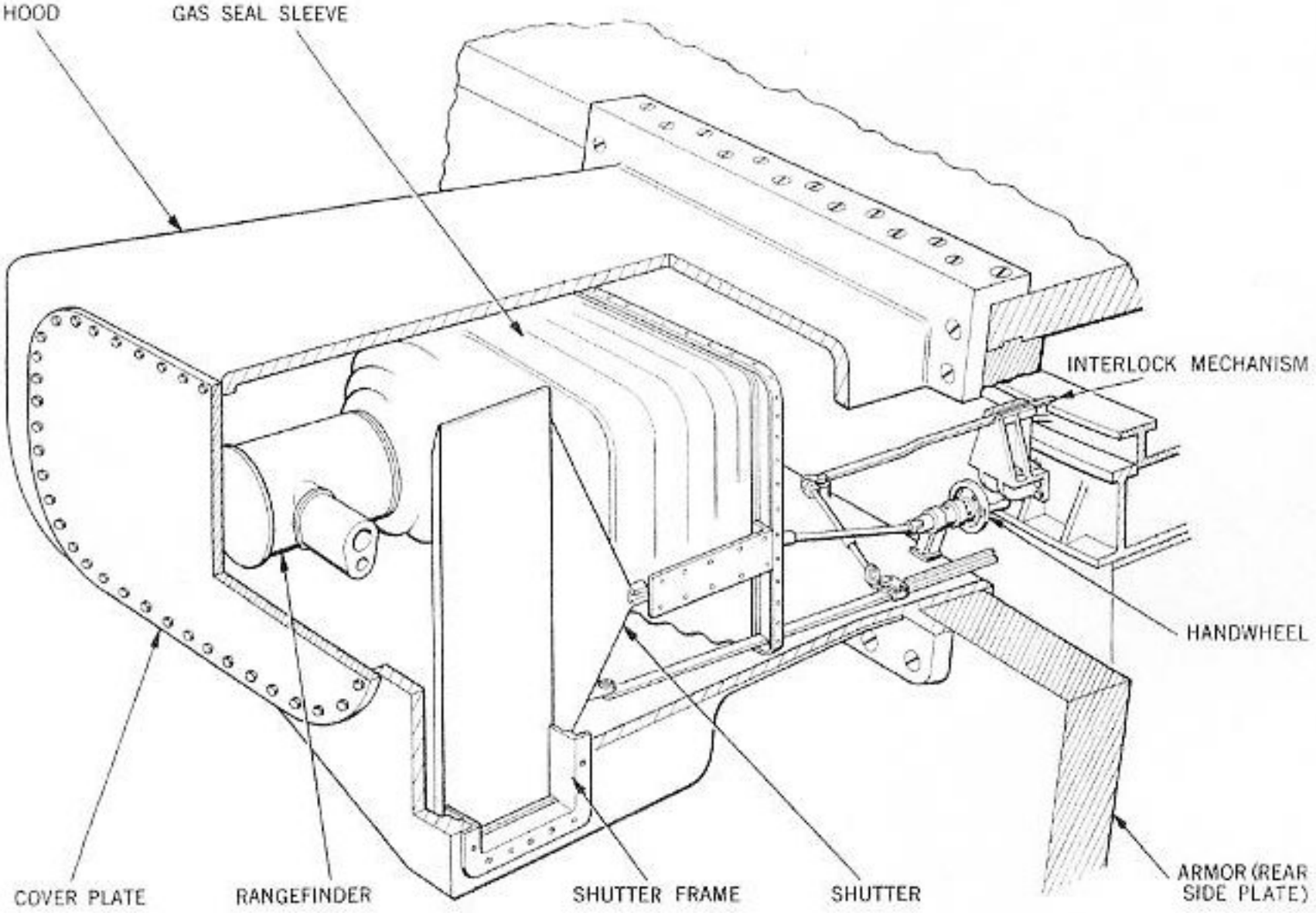


Figure 14-6. Hood Shutter Operating Mechanism and Interlock

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.

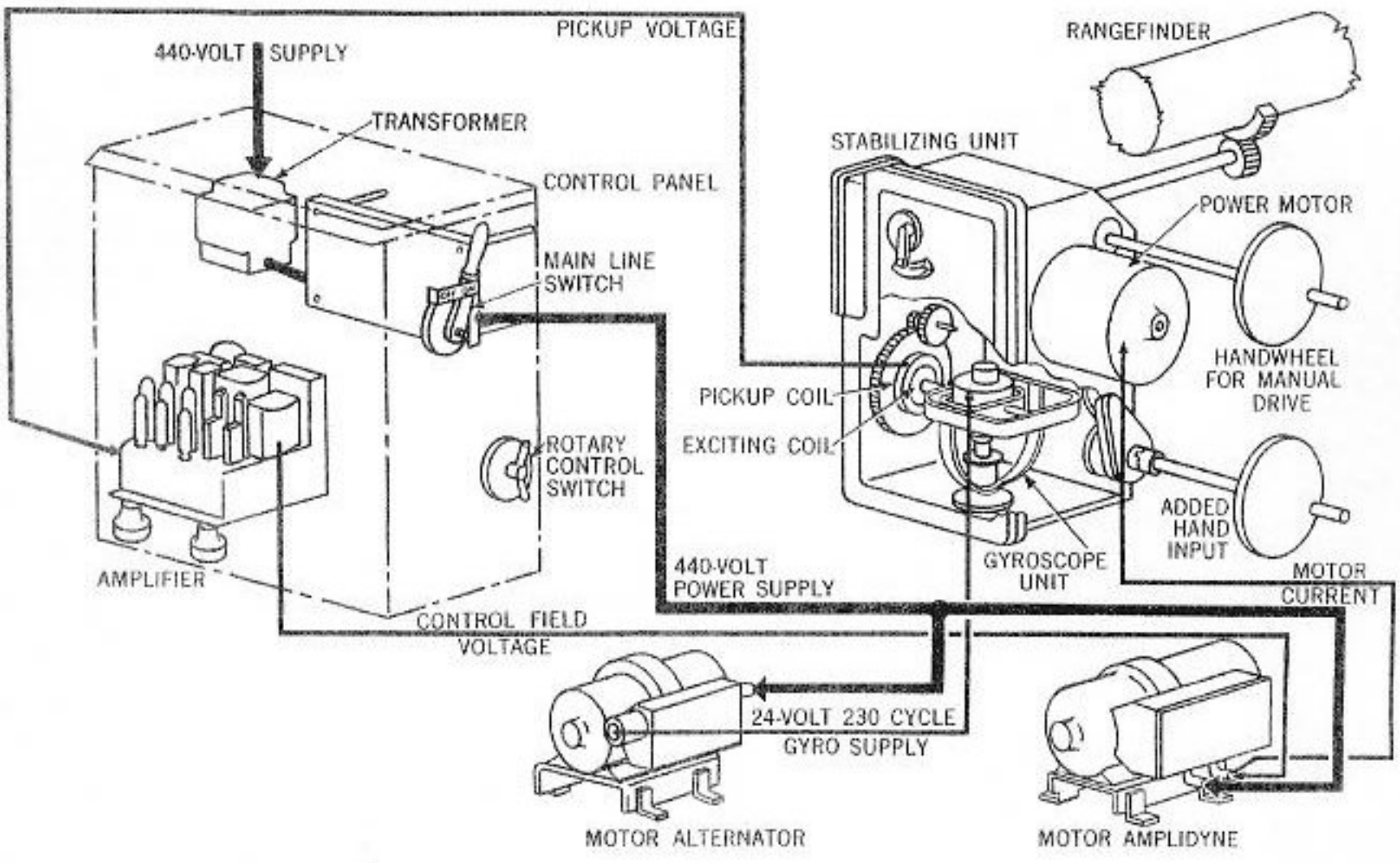


Figure 14-7. Rangefinder Stabilizer Mk 4 Mod 1, Schematic Arrangement

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.

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.

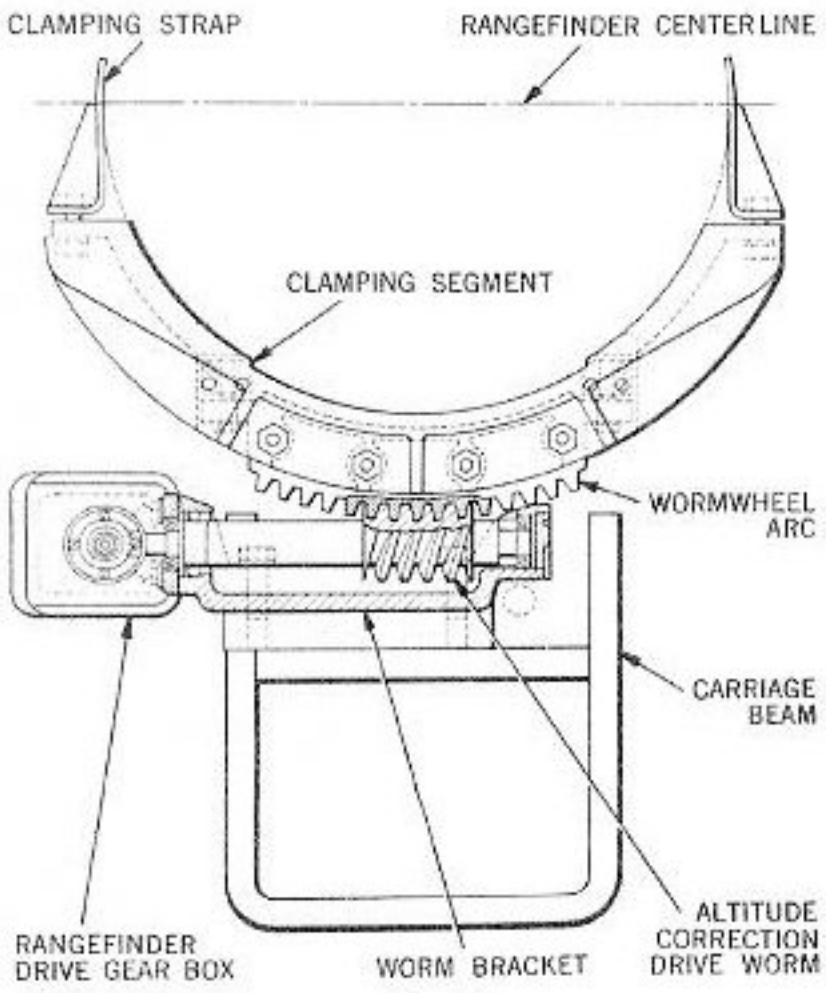


Figure 14-8. Rangefinder Stabilizer Drive

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	5,900	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.C.C. 46/23 V.C.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. 6.3-6.3-6.3-6.3-6.3-6.0-5.0/2.5 SEC. 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.

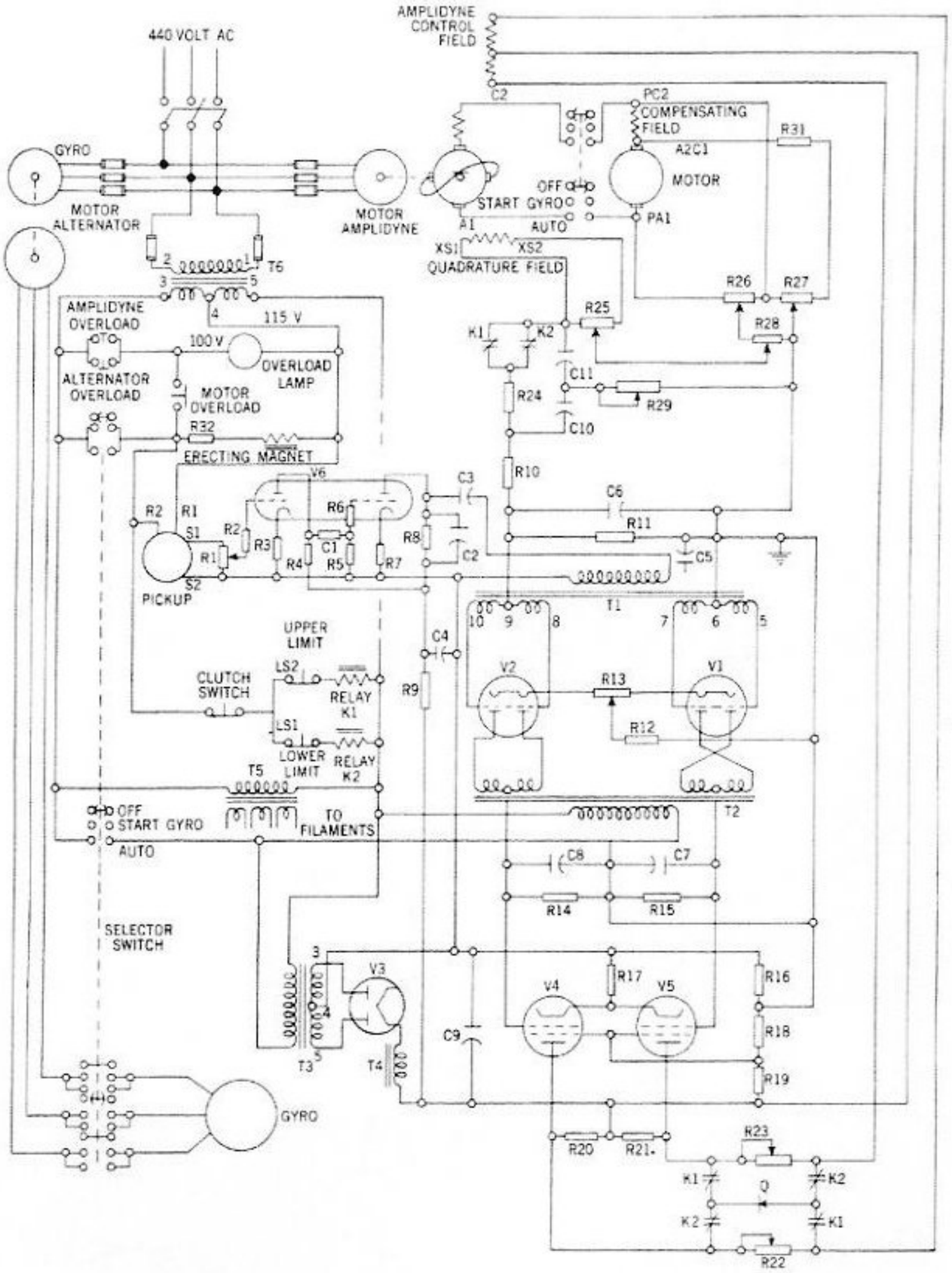


Figure 14-9. Stabilizer Circuit, Wiring Diagram

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 s elector 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.

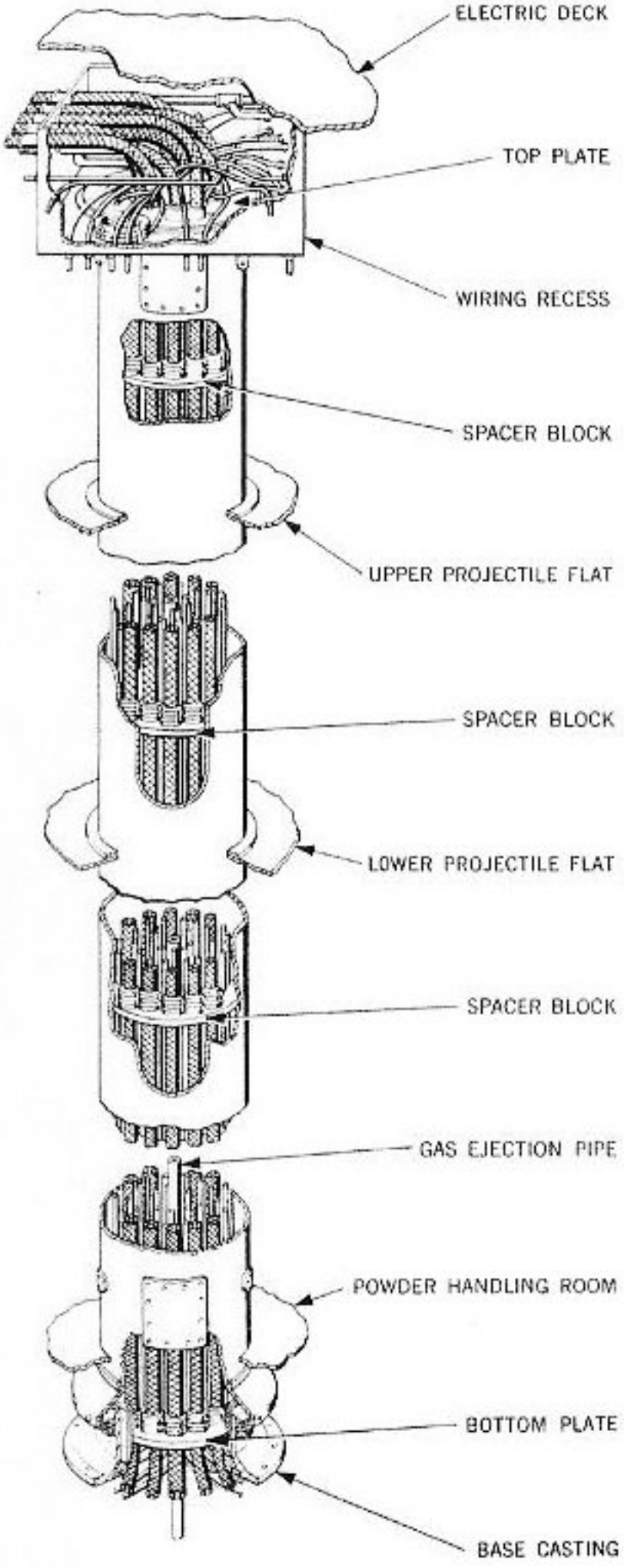


Figure 15-1. Base Casting and Central Column Wiring Tube Arrangements

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

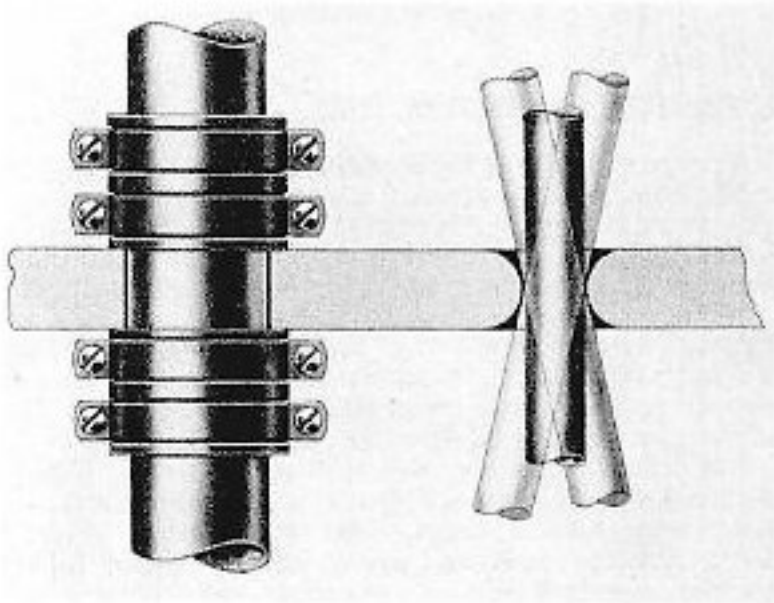


Figure 15-2. Spacer Block Arrangement for Fixed and Free Cables

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)

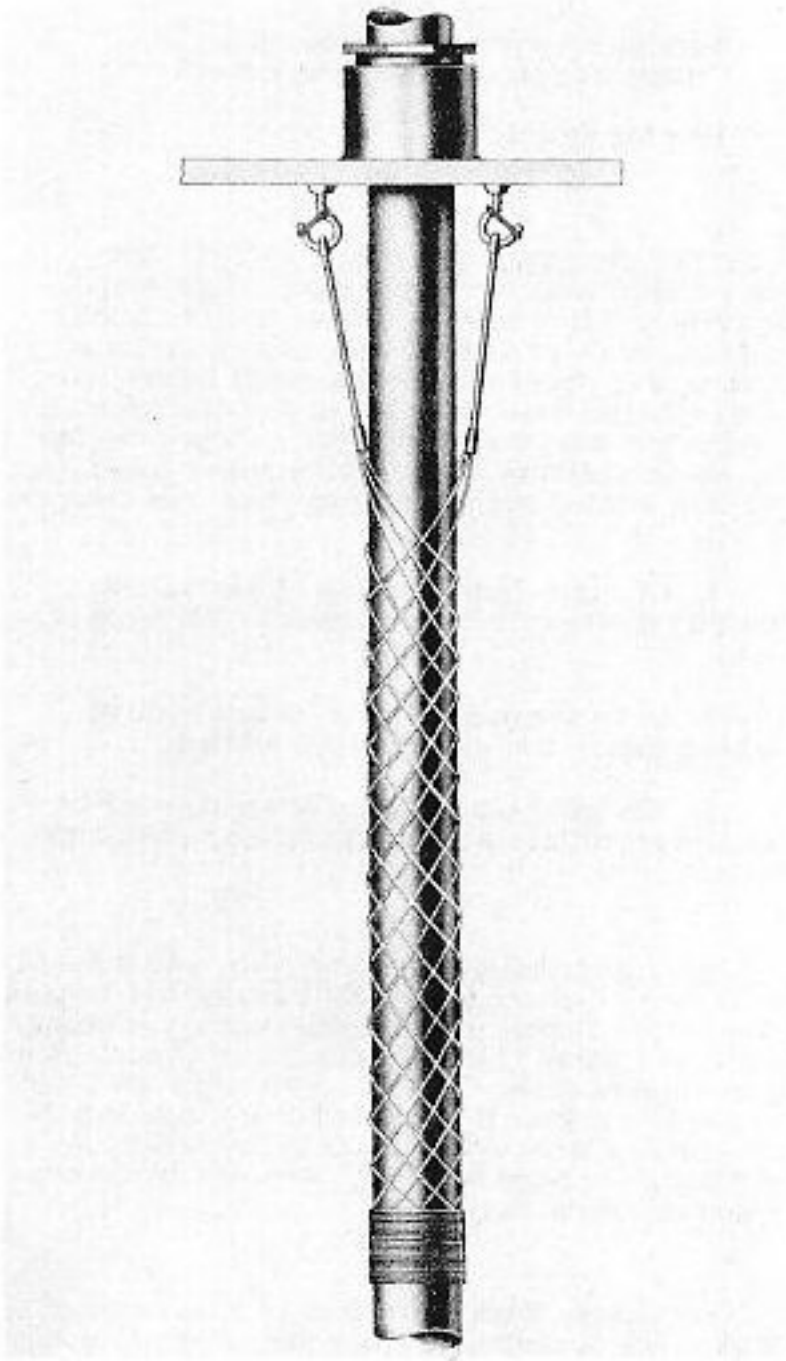


Figure 15-3. Cable Supporting Arrangement

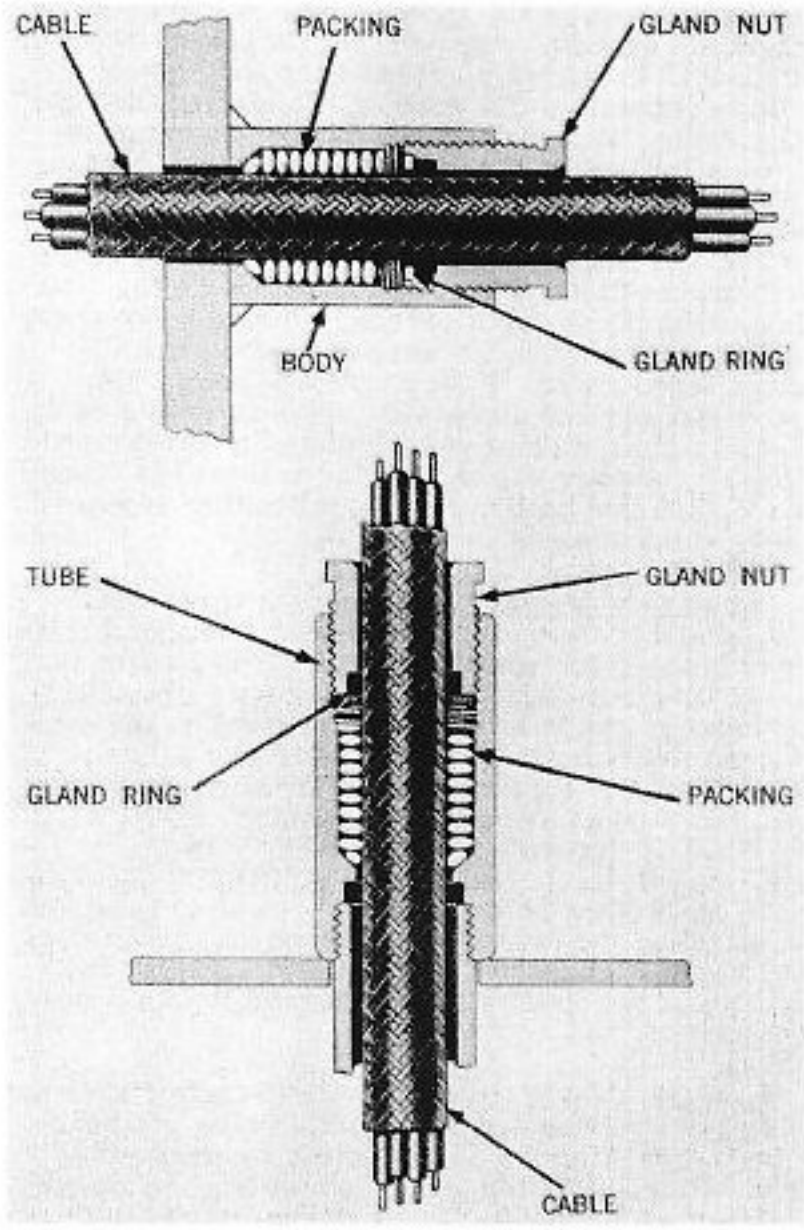


Figure 15-4. Stuffing Tubes. Typical Designs Sectioned

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
2L	FEEDER DISTRIBUTION BOX (UNFUSED)
6J	FEEDER DISTRIBUTION BOX (WITH SWITCH, FUSED)
	FEEDER CONNECTION BOX
	INDICATING LIGHT
	BRANCH BOX
M	MOTOR
	PUSH-BUTTON STATION
	PROJECTILE HOIST BRAKE
	TRANSFORMER

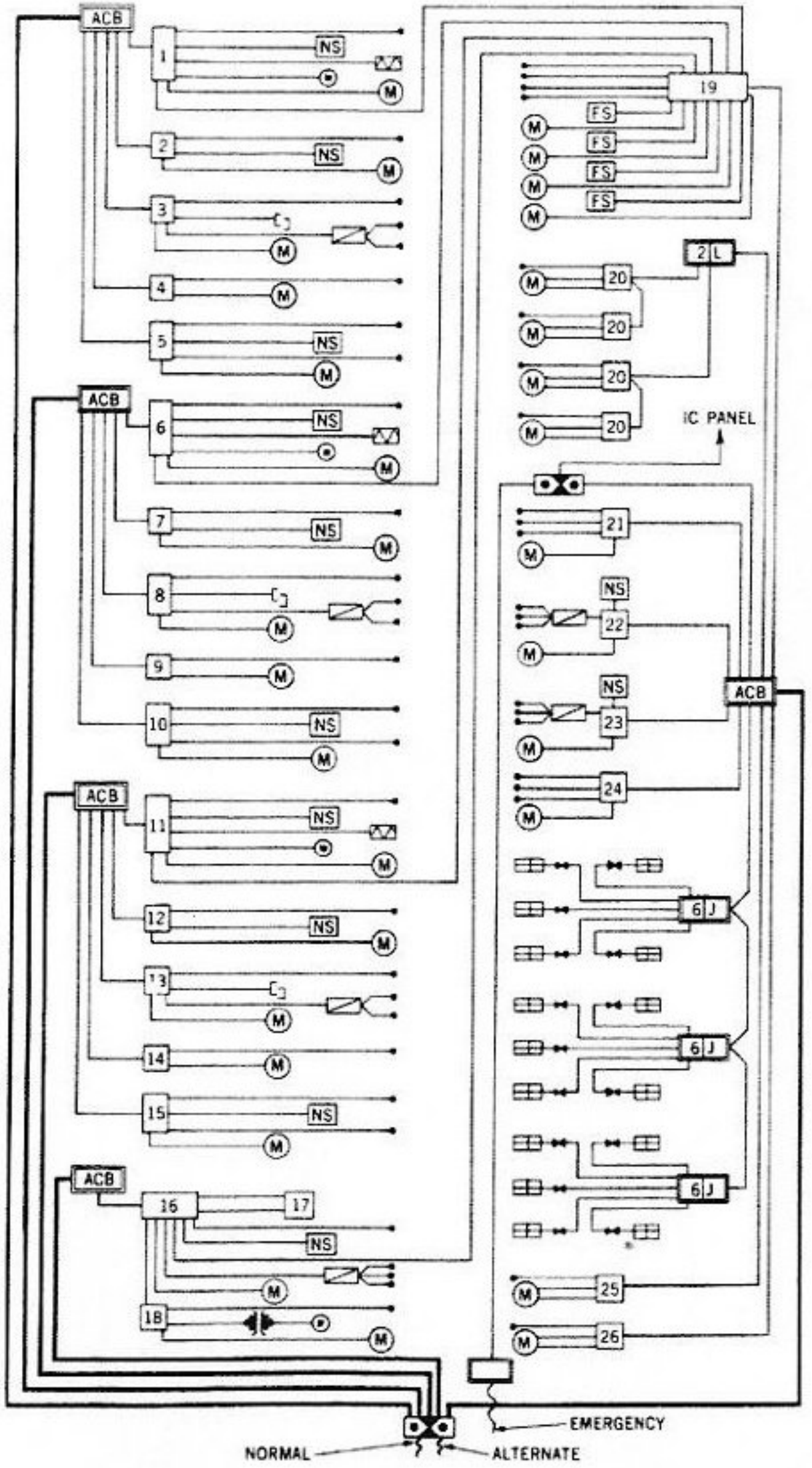


Figure 15-5. Power System Elementary Wiring Diagram

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	1600 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

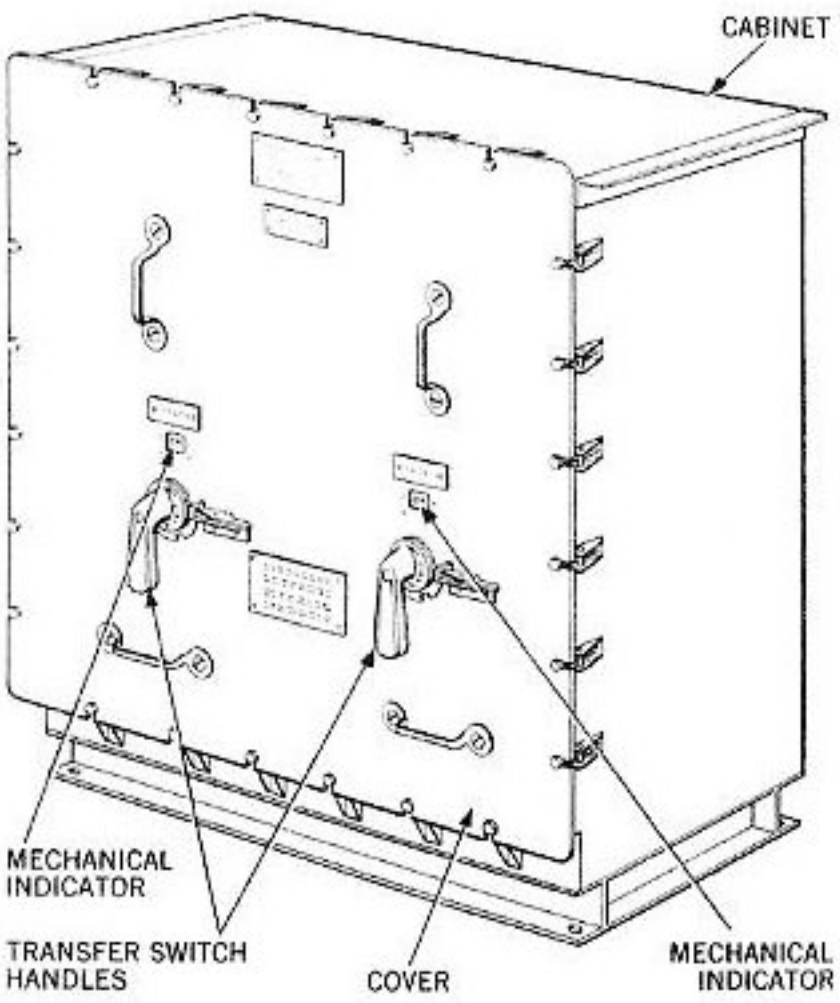


Figure 15-6. Manual Bus Transfer Panel

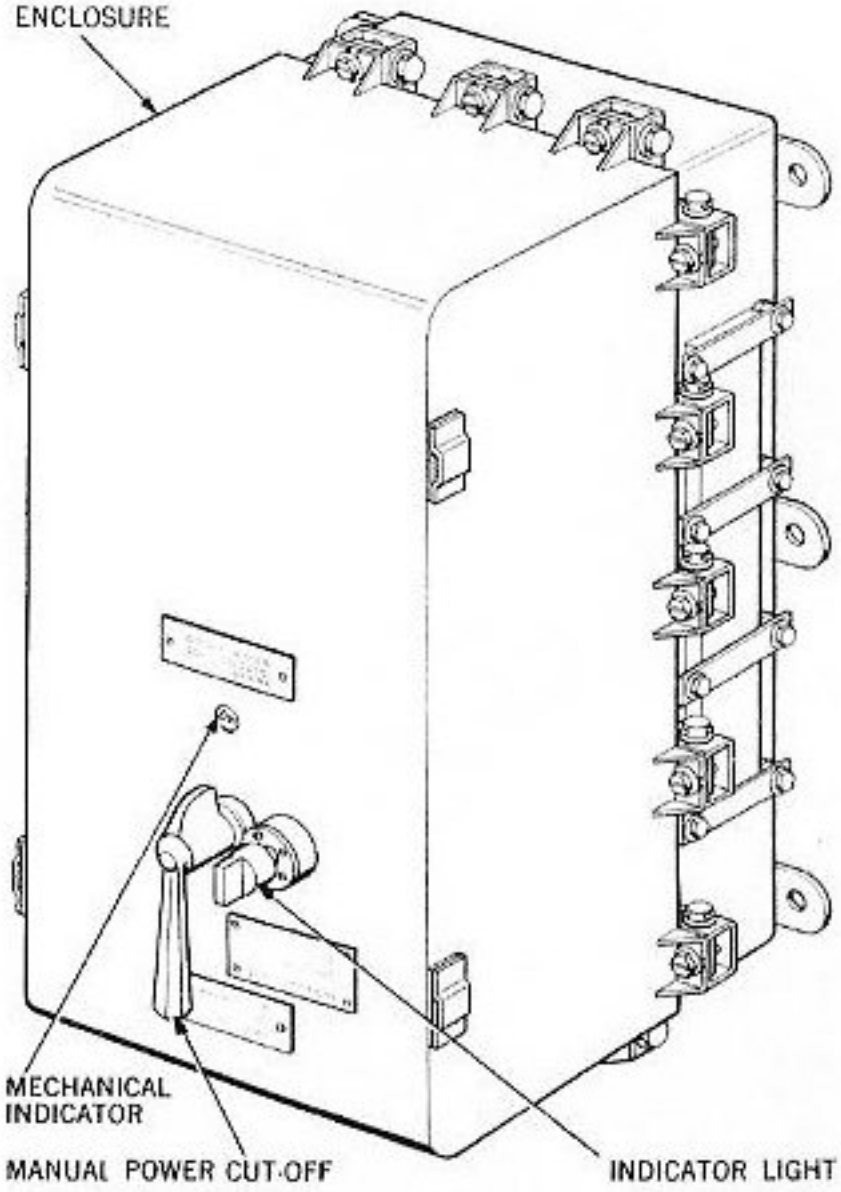


Figure 15-7. Gun Equipment Power Panel

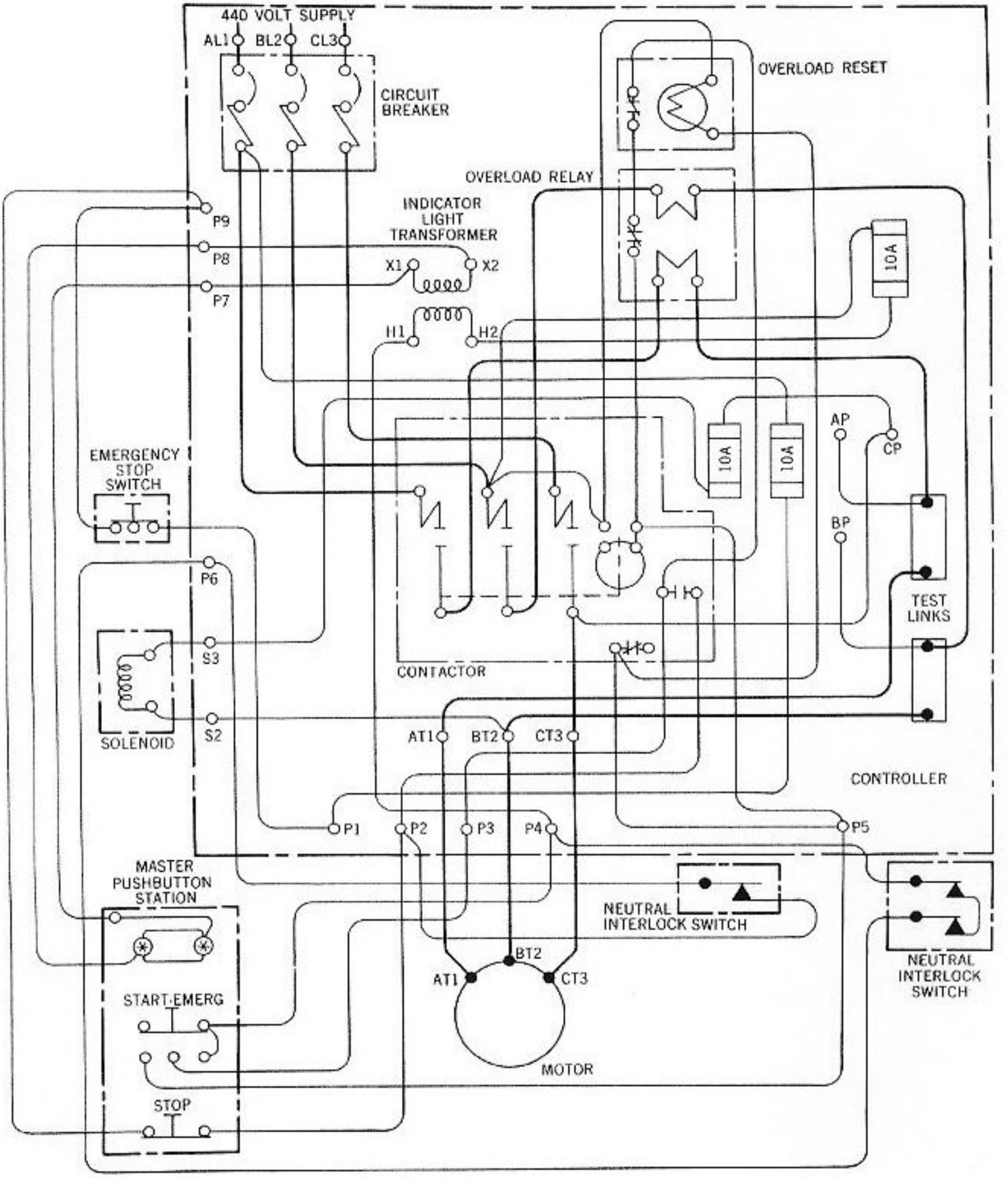


Figure 15-8. Elevating Gear Motor Controller. Practical Wiring Diagram

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.

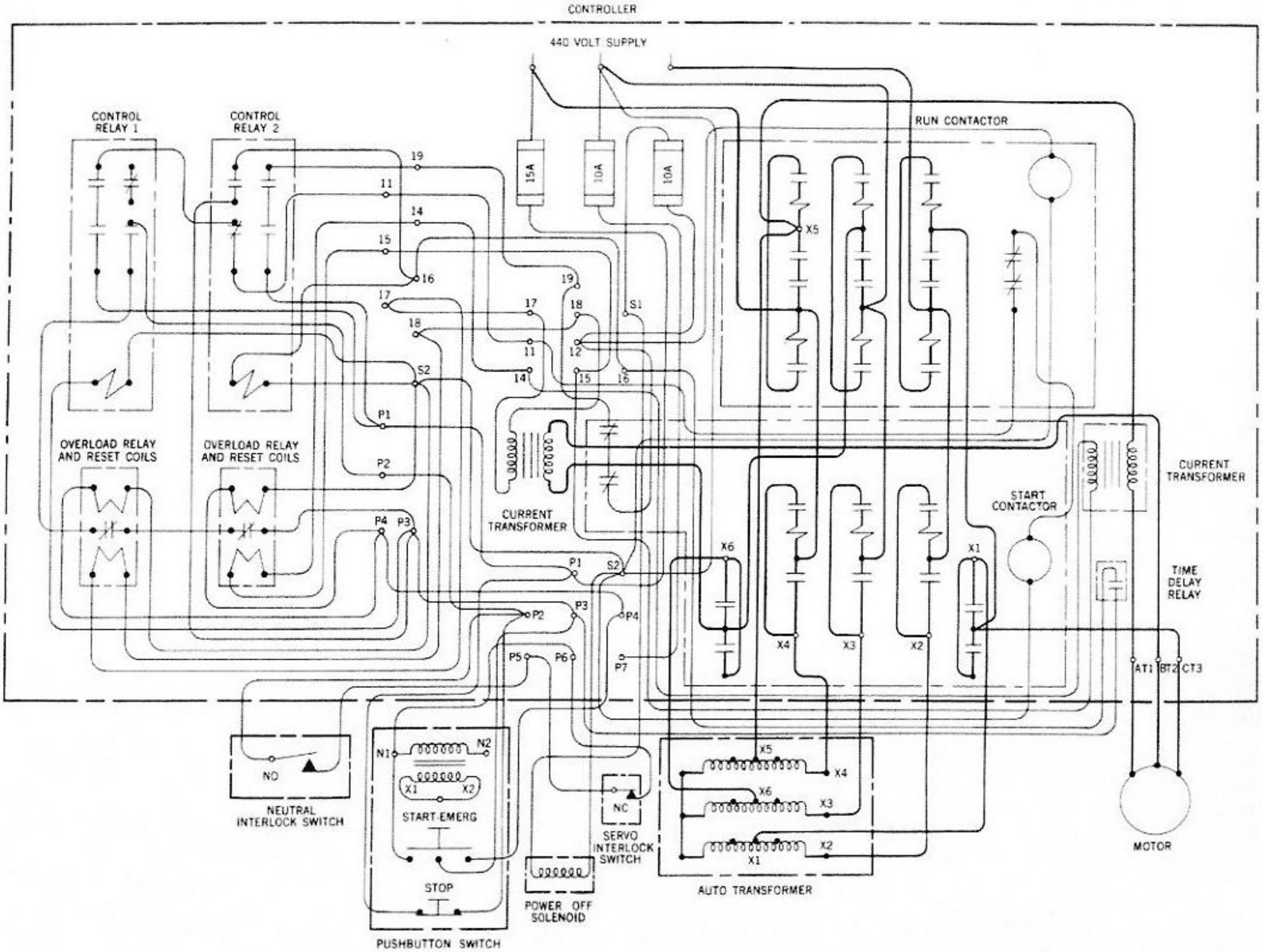


Figure 15-9. Training Gear Motor Controller, Schematic Wiring Diagram

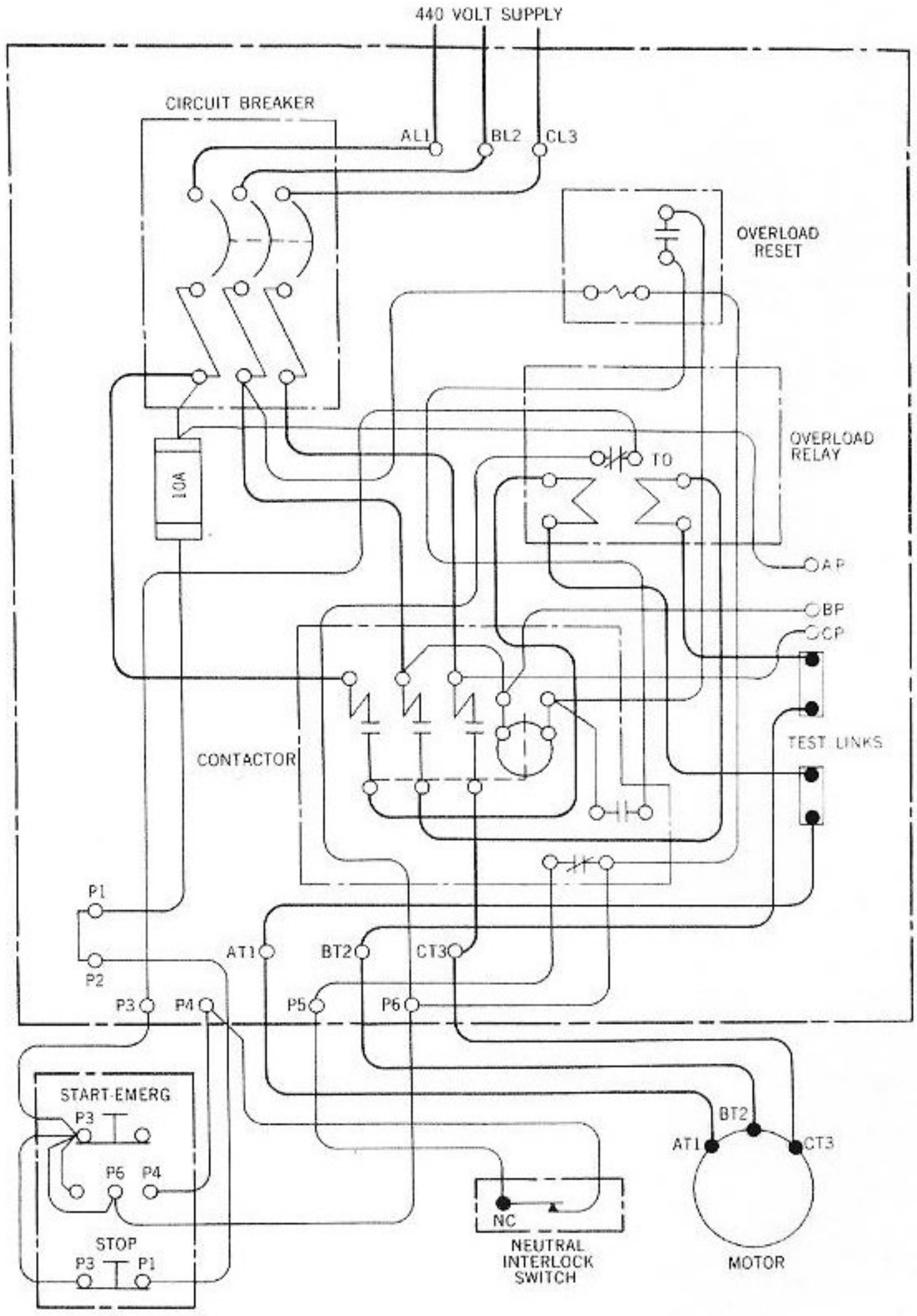


Figure 15-10. Rammer Motor Controller. Schematic Wiring Diagram

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.

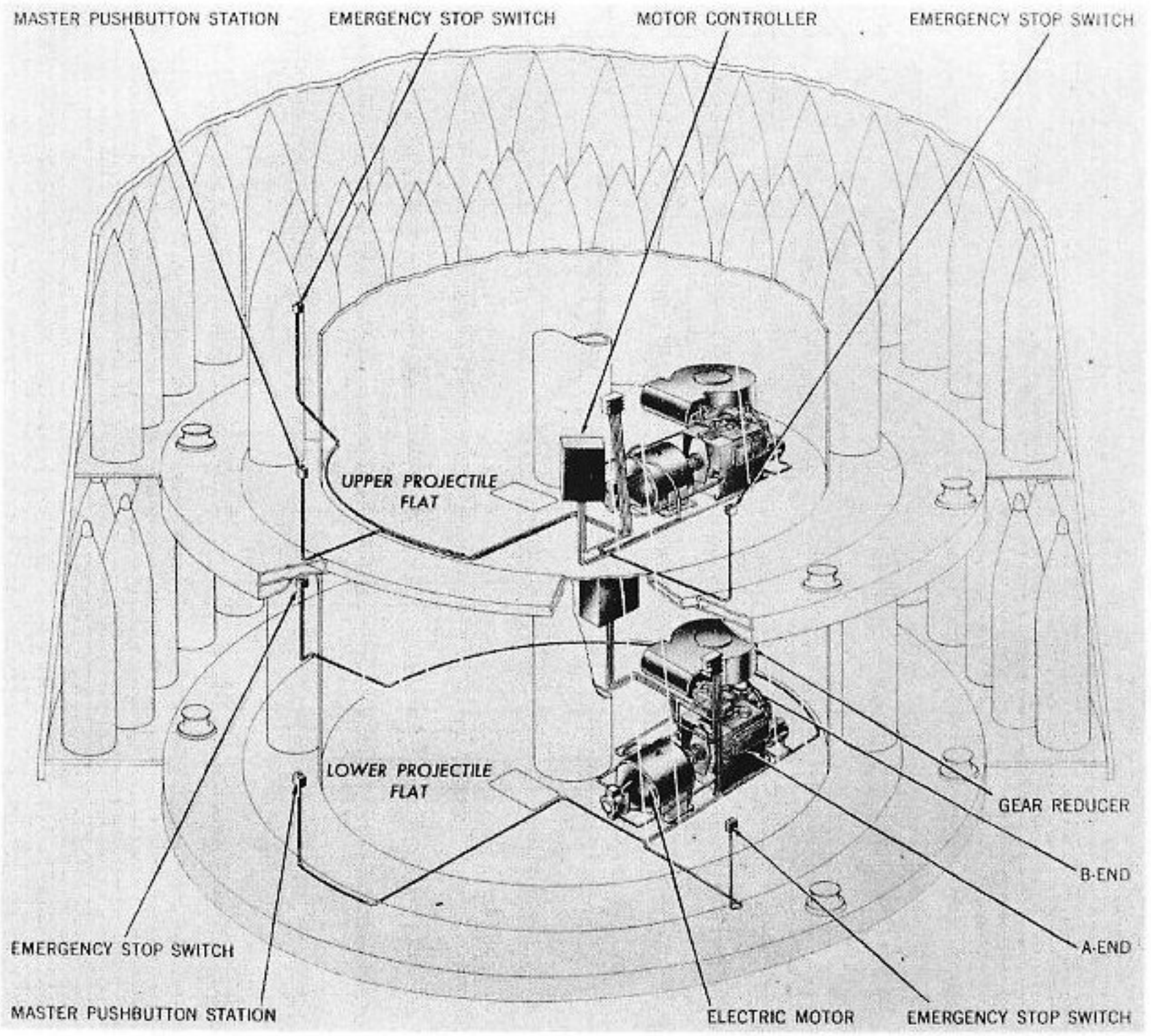


Figure 15-11. 16-inch Projectile Ring Mk 2 Mod 0 Electrical Installation

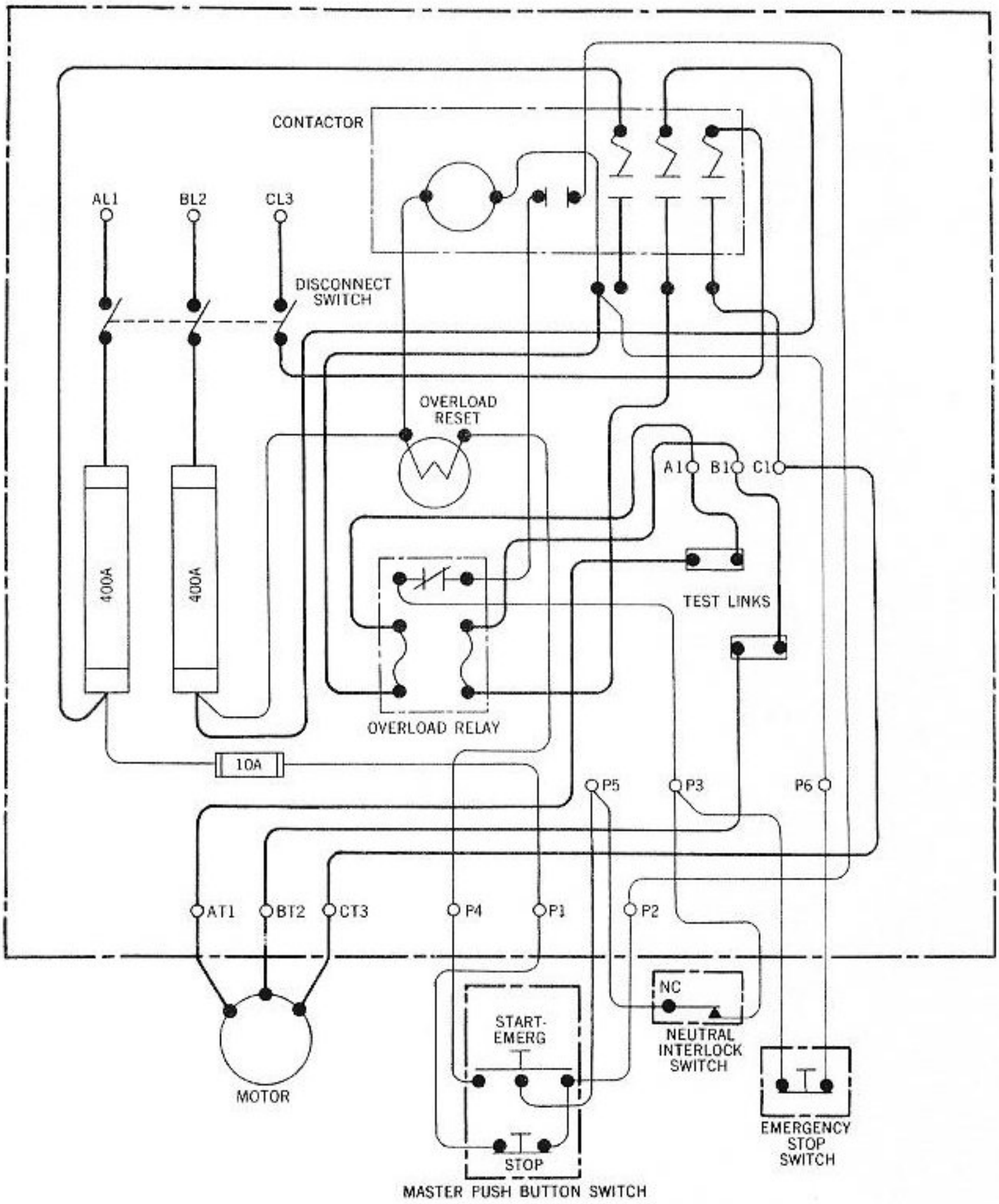


Figure 15-12. Projectile Ring Motor Controller, BB 61-62. Schematic Wiring Diagram

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.

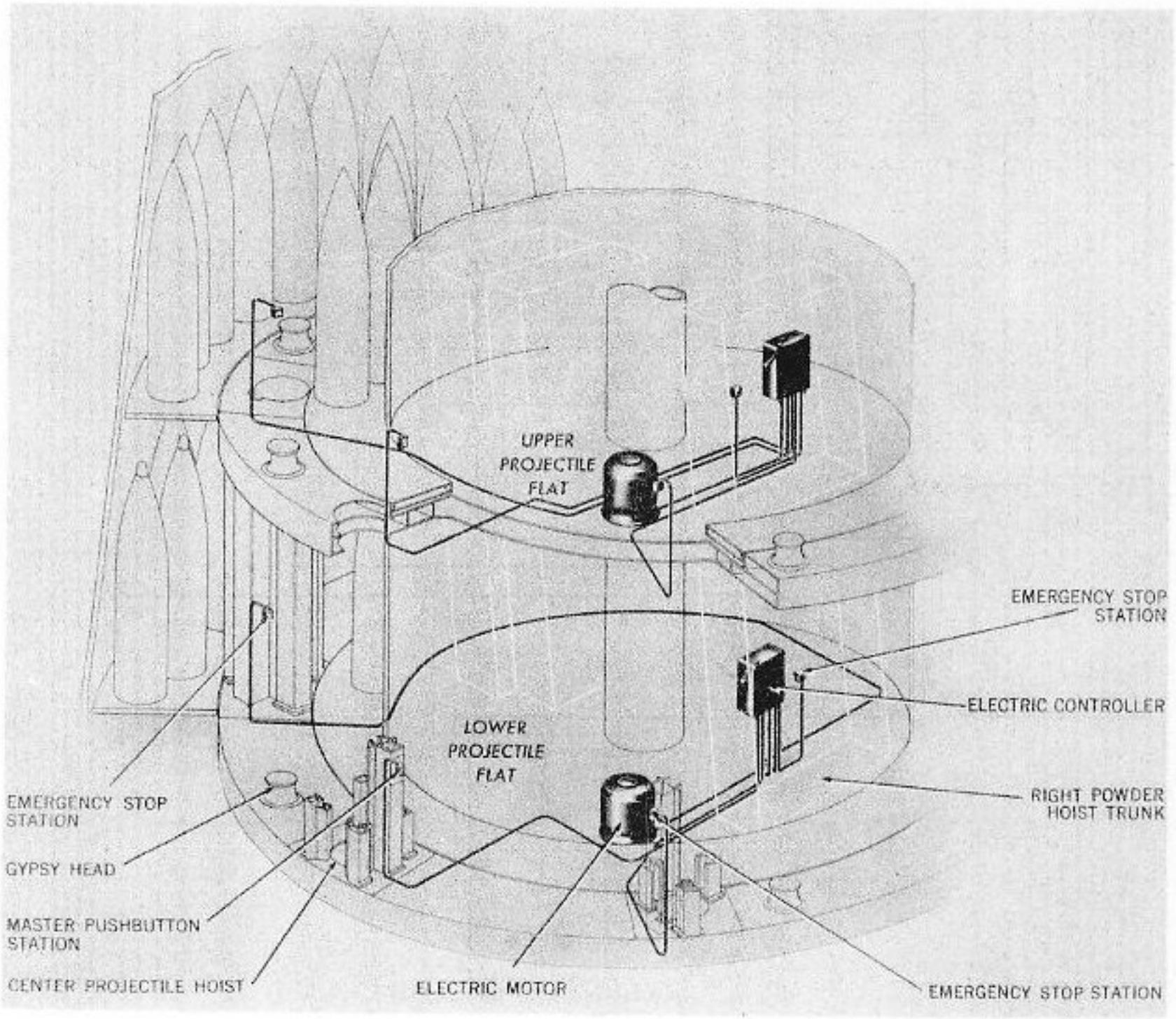


Figure 15-13. Parbuckling Gear Electric Installations, General Arrangement

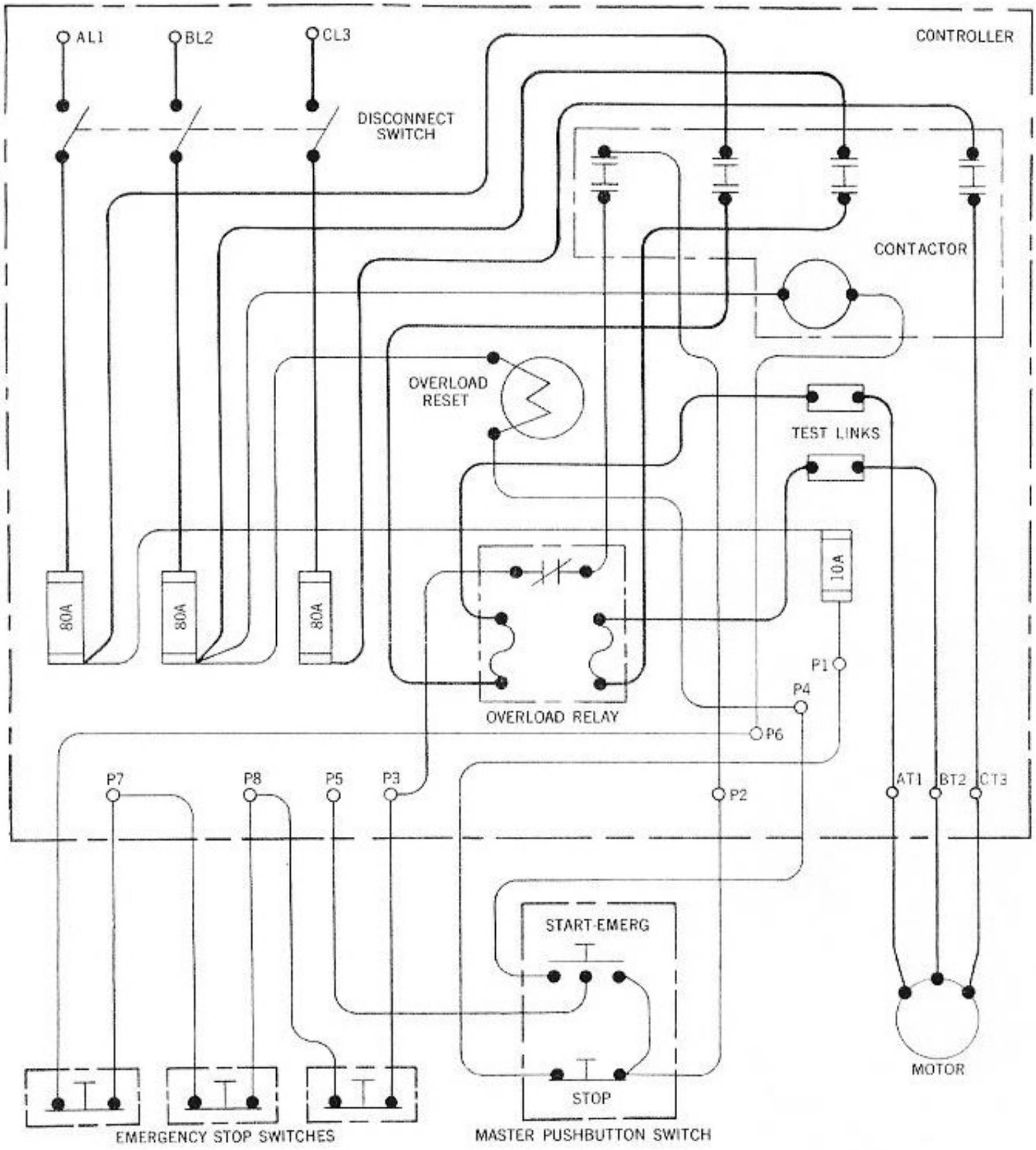


Figure 15-14. Parbuckling Gear Motor Controller. Practical Wiring Diagram

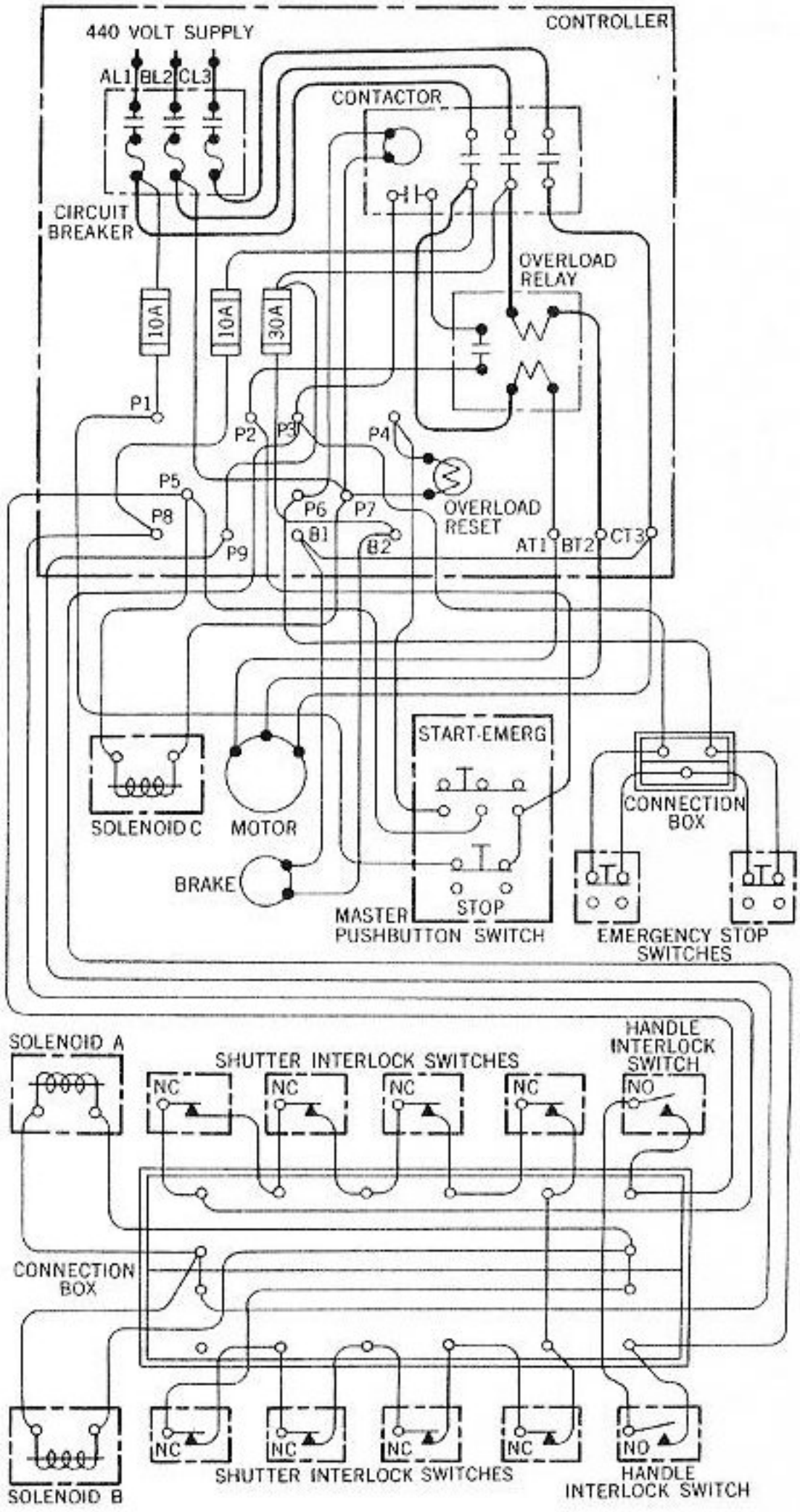


Figure 15-15. Projectile Hoist Motor Controller. Schematic Wiring Diagram

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.

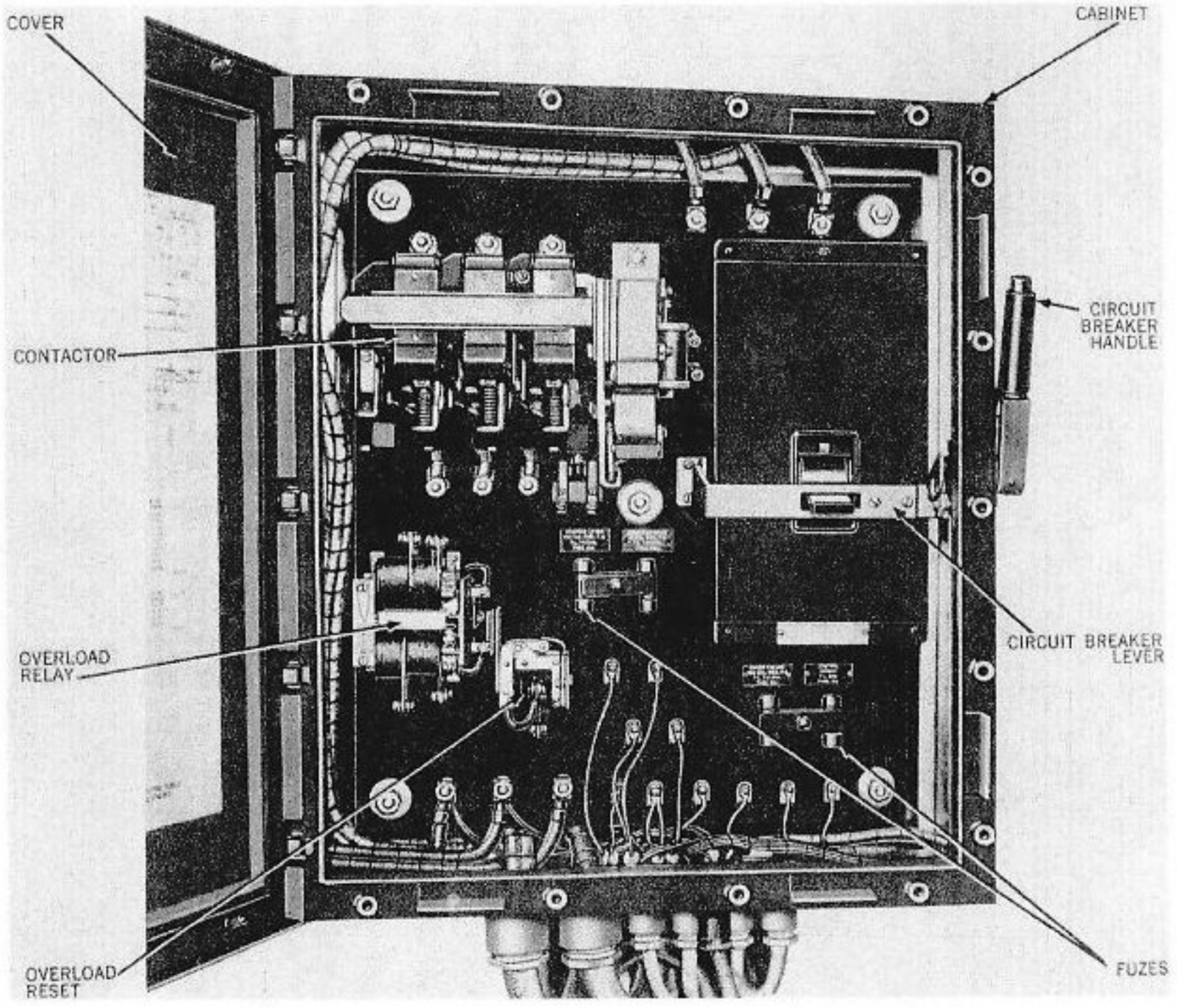


Figure 15-16. Powder Hoist Motor Controller. General Arrangement

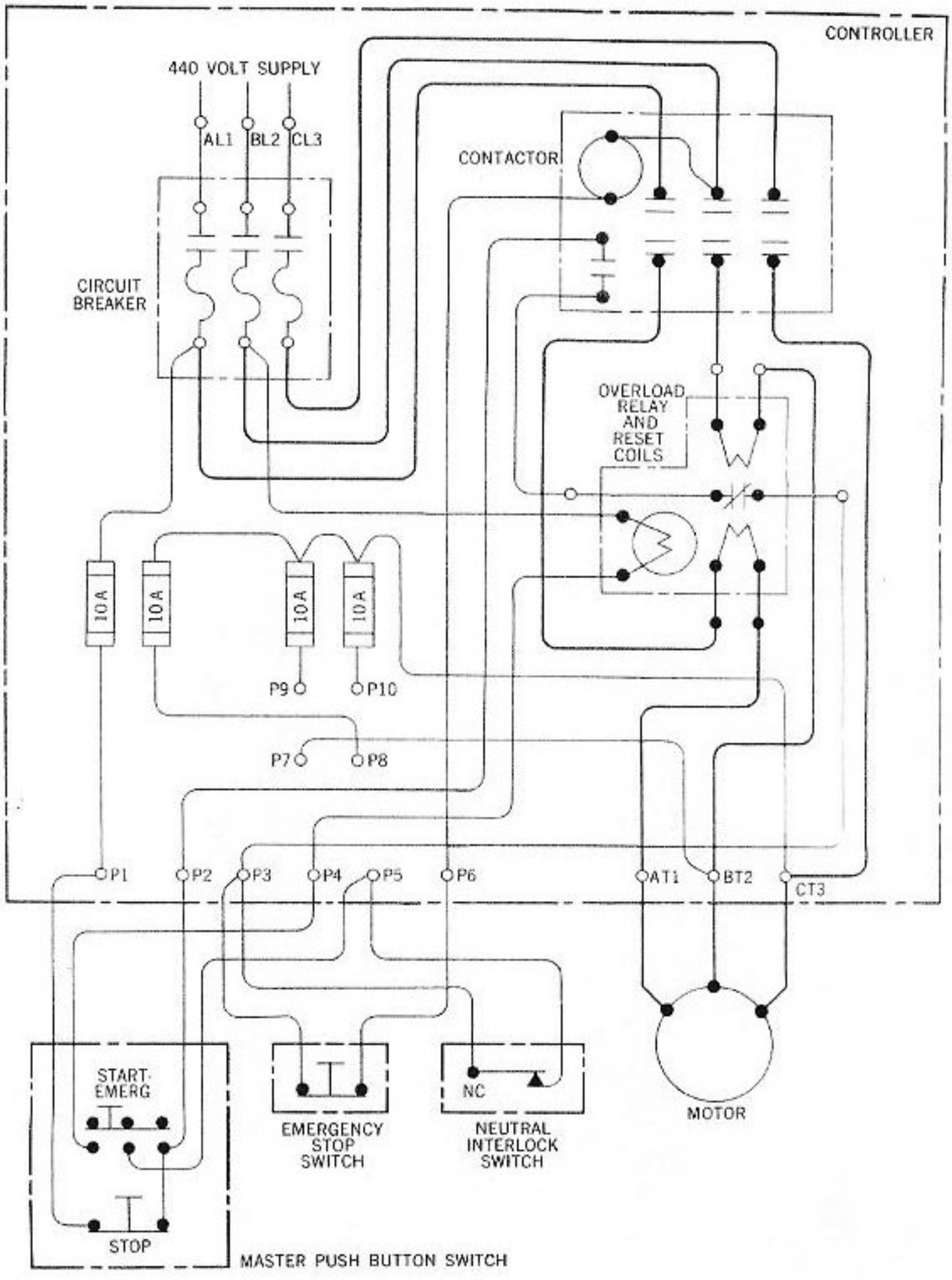


Figure 15-17. Powder Hoist Motor Controller. Practical Wiring Diagram

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

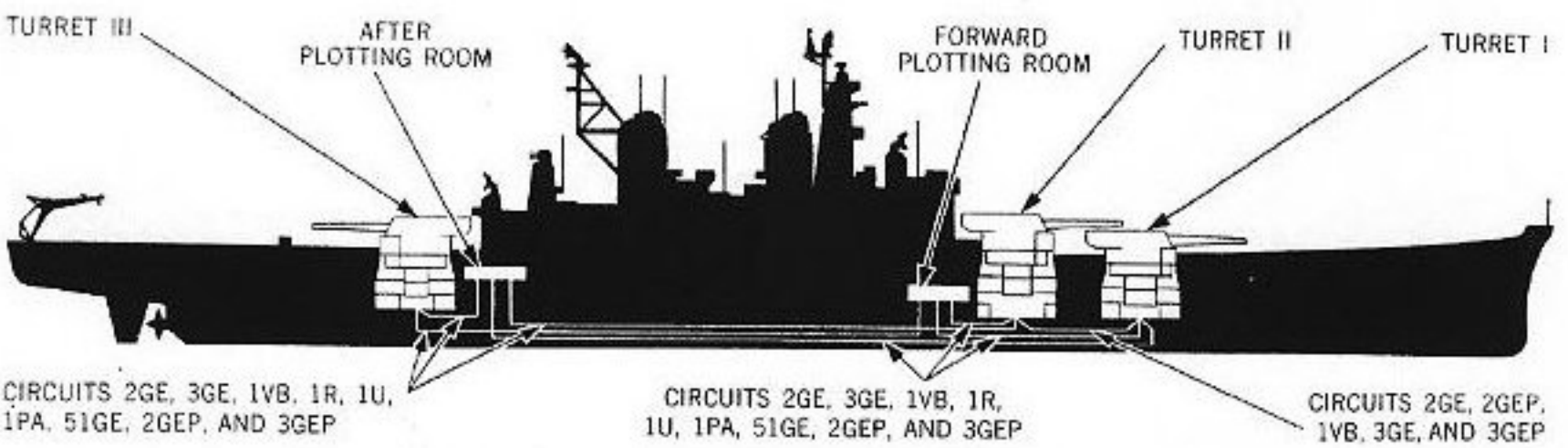


Figure 15-18. Fire Control Circuits. Plotting Room - Turret Connections

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.

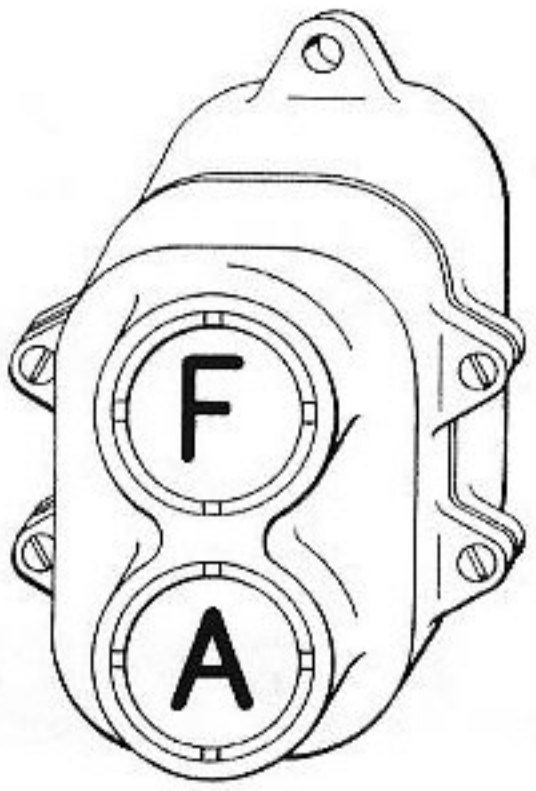


Figure 15-19. Fire Control Transfer Signal Indicator

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.

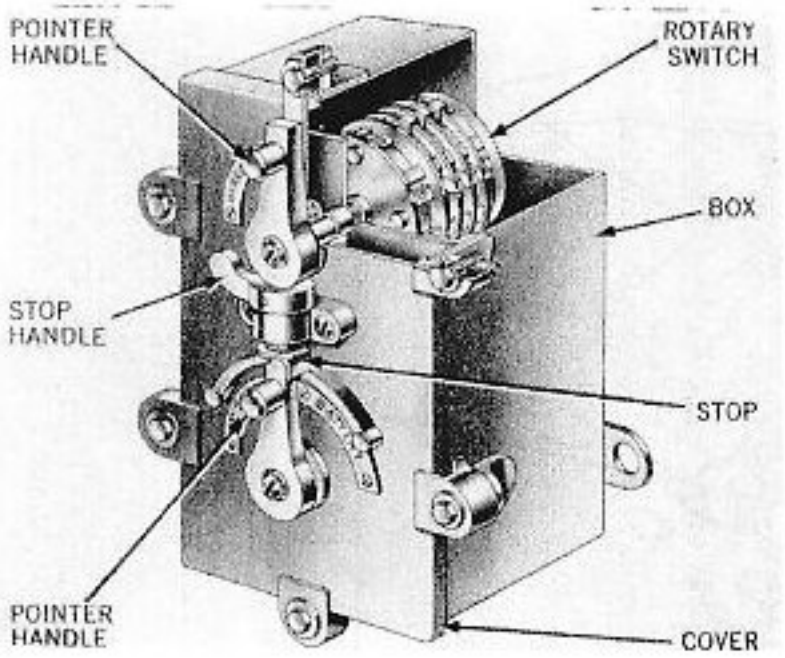


Figure 15-20. Turret Officer's Selective Switch

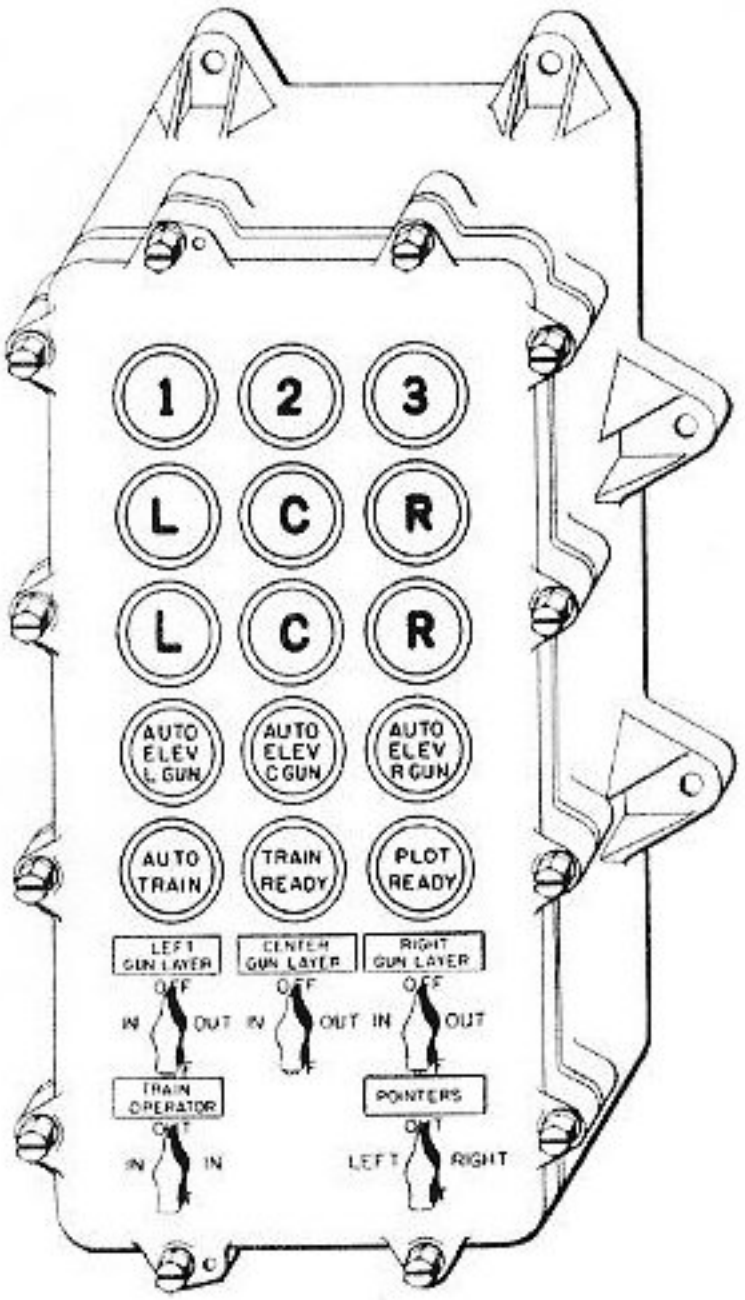


Figure 15-21. Turret Officer's Indicator Panel

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

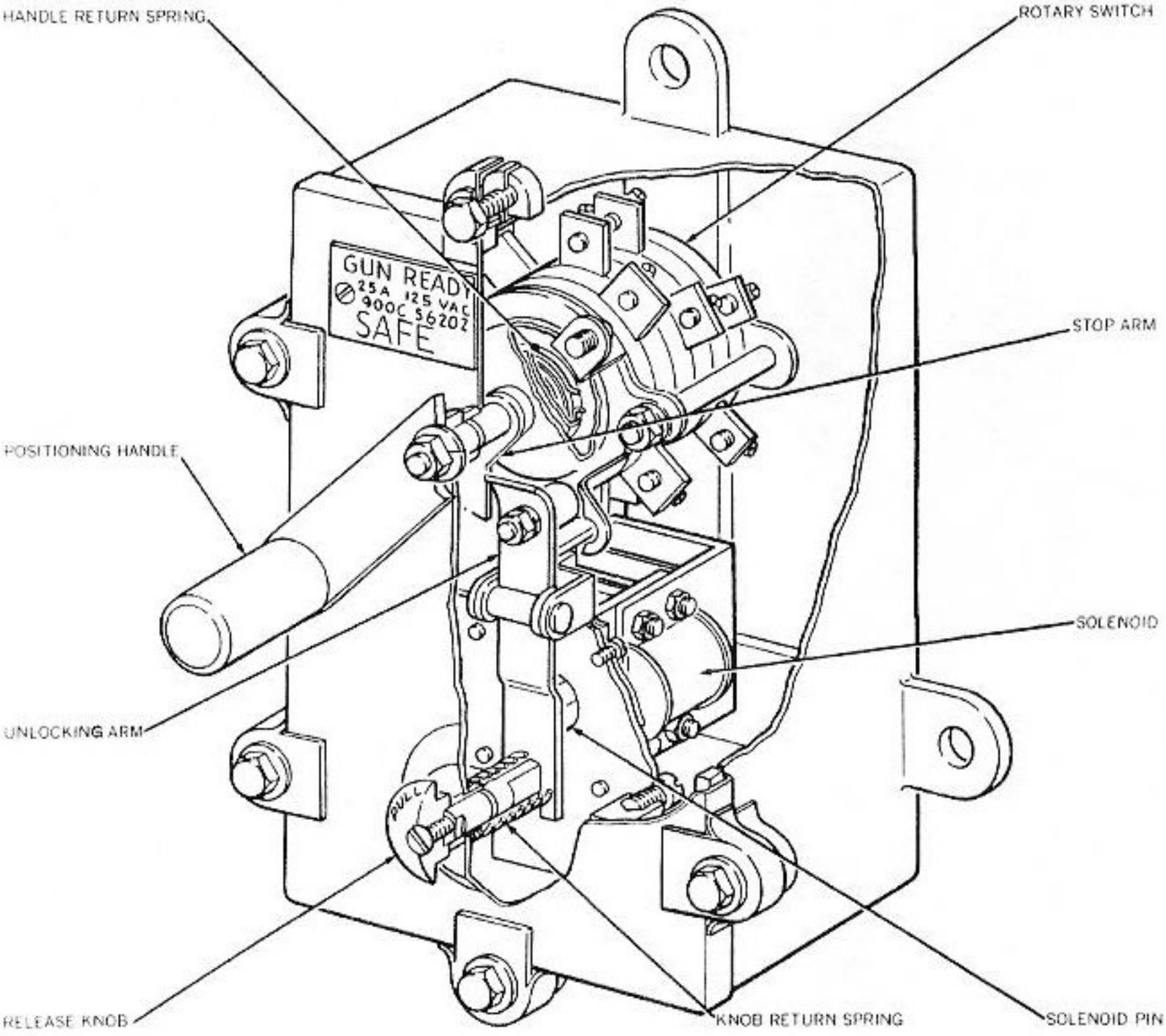


Figure 15-22. Gun Captain's Ready Switch

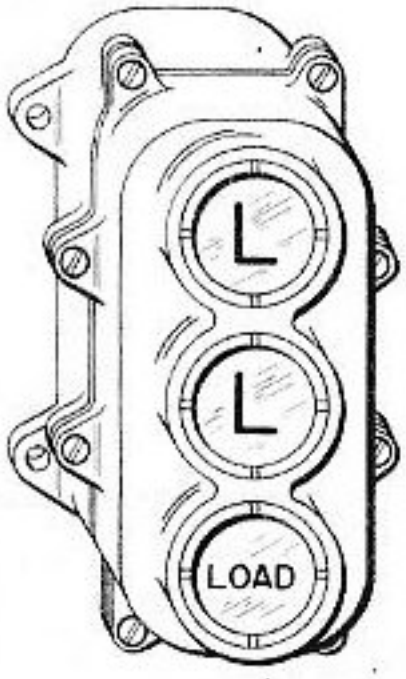


Figure 15-23. Gun Elevation Ready and Gun Ready Indicator

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.

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

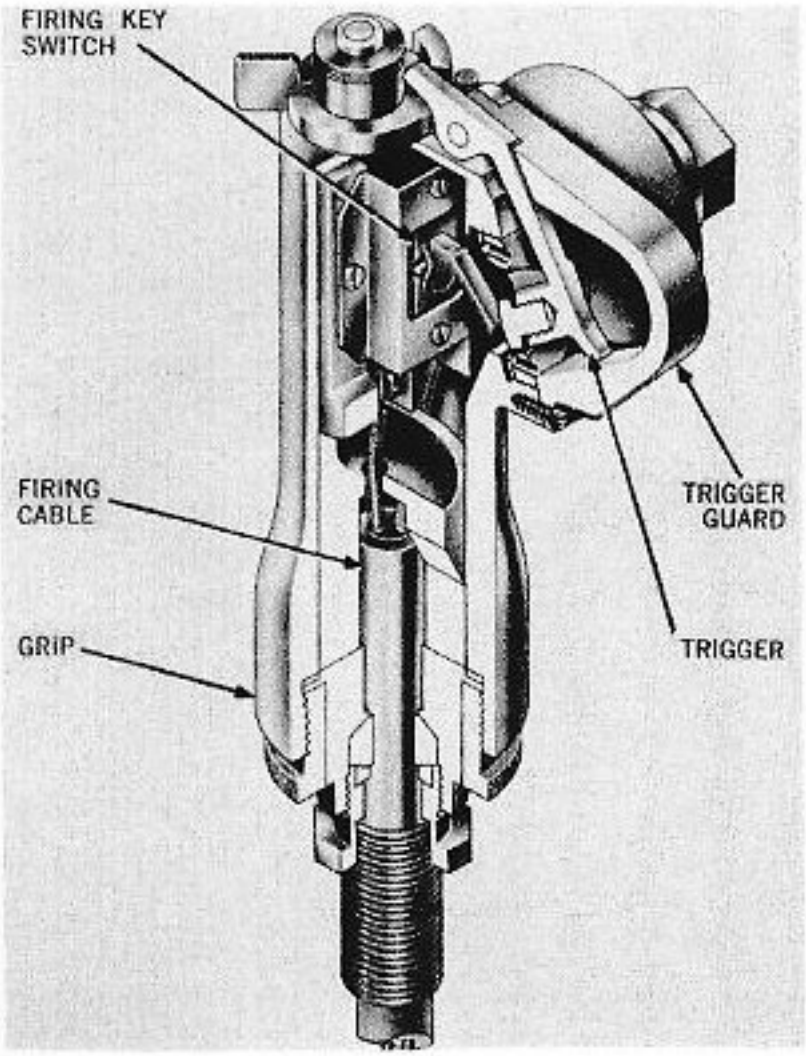


Figure 15-24. Firing Key Mk 16 Mod 8

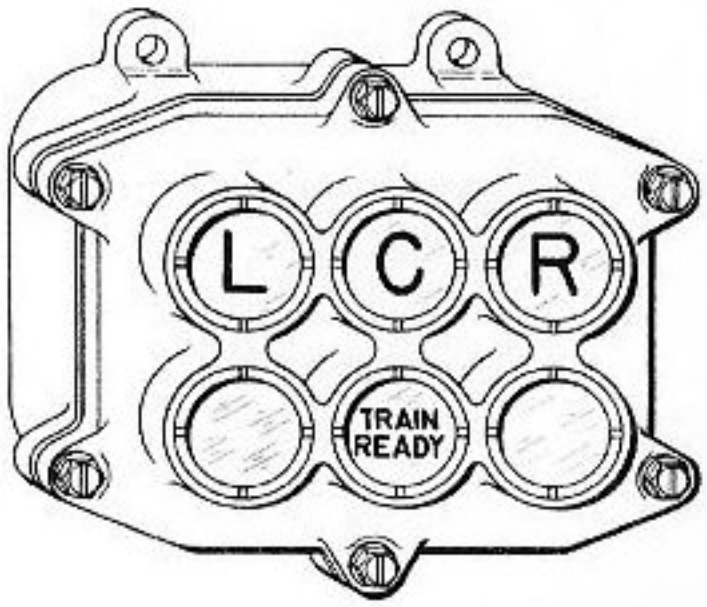


Figure 15-25. Gun Elevation and Train Ready Indicator

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

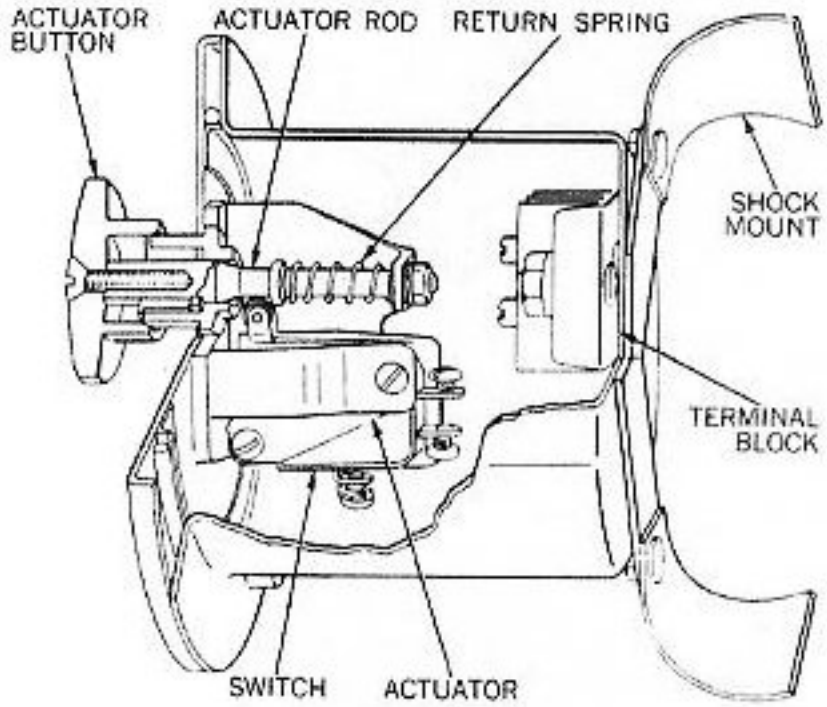


Figure 15-25A. Bore Clear Switch. Cutaway View.

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.

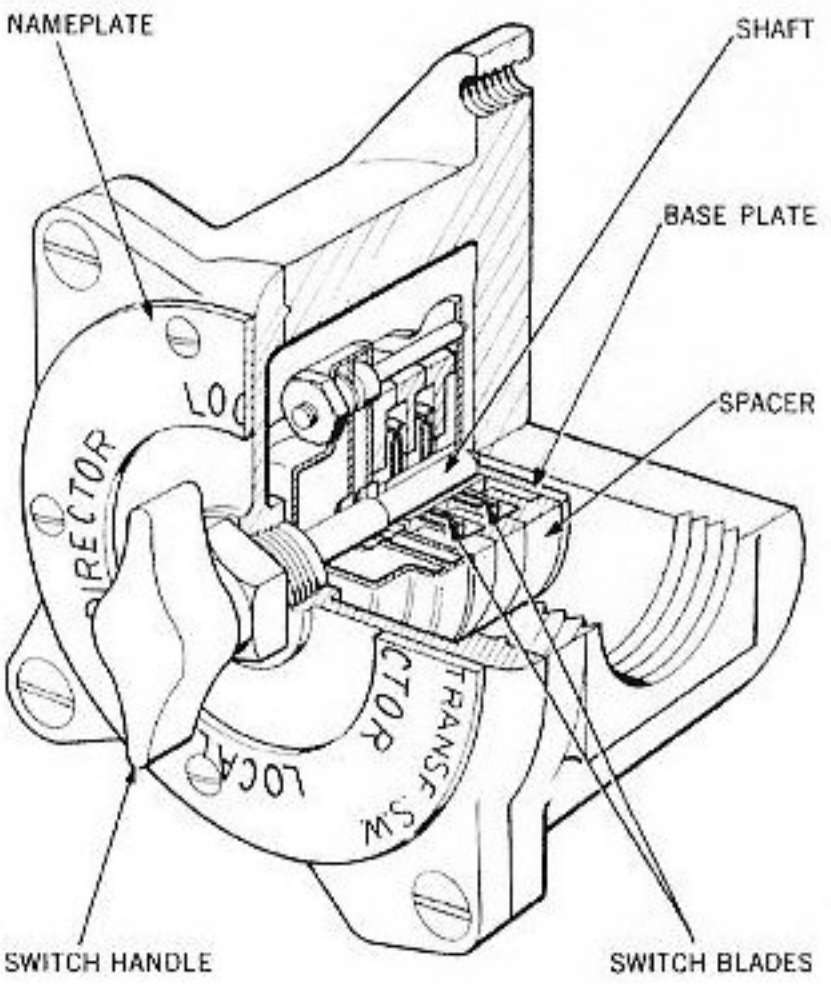


Figure 15-28. Turret Officer's Transfer Switch



Figure 15-26. Train Ready Indicator

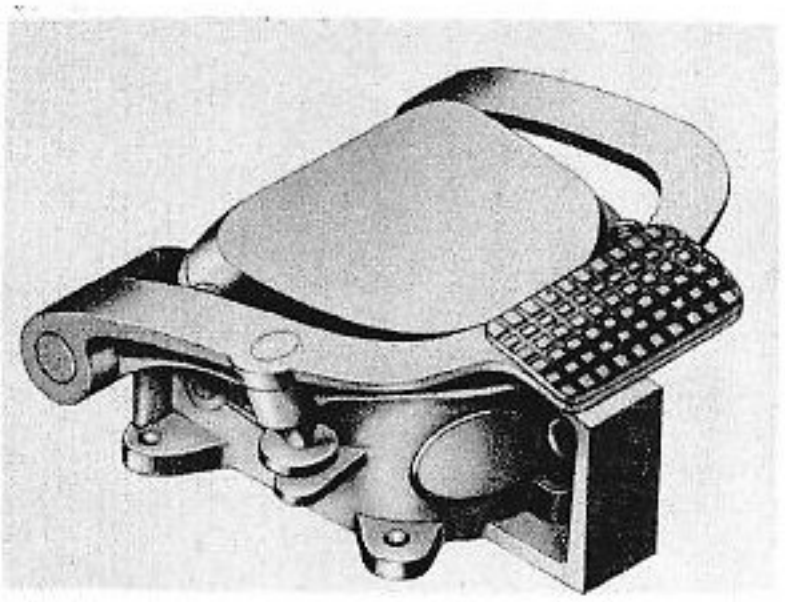


Figure 15-27. Ready Switch, Foot-Operated

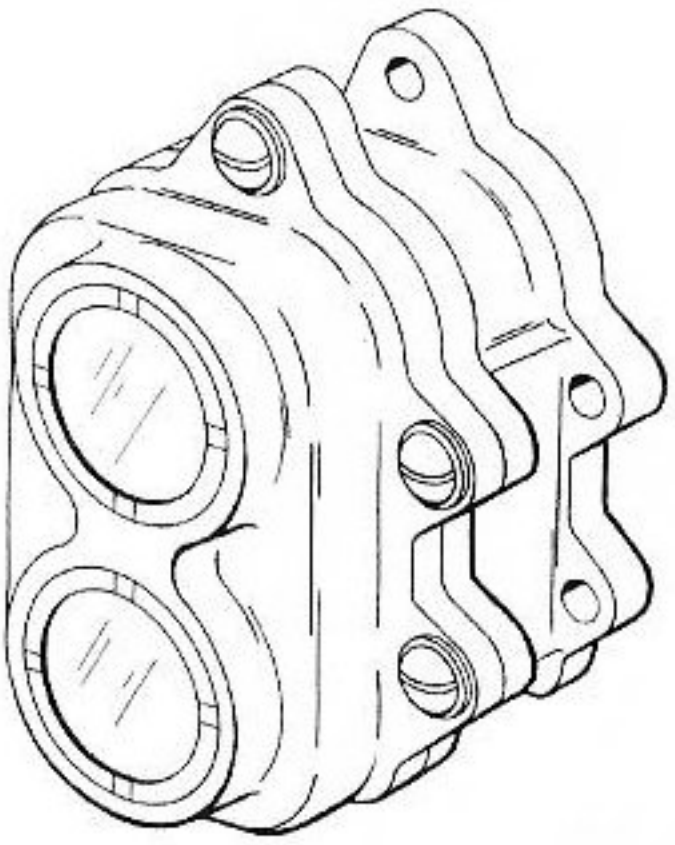


Figure 15-29. Sight Setter's Clutch Warning Indicator

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.

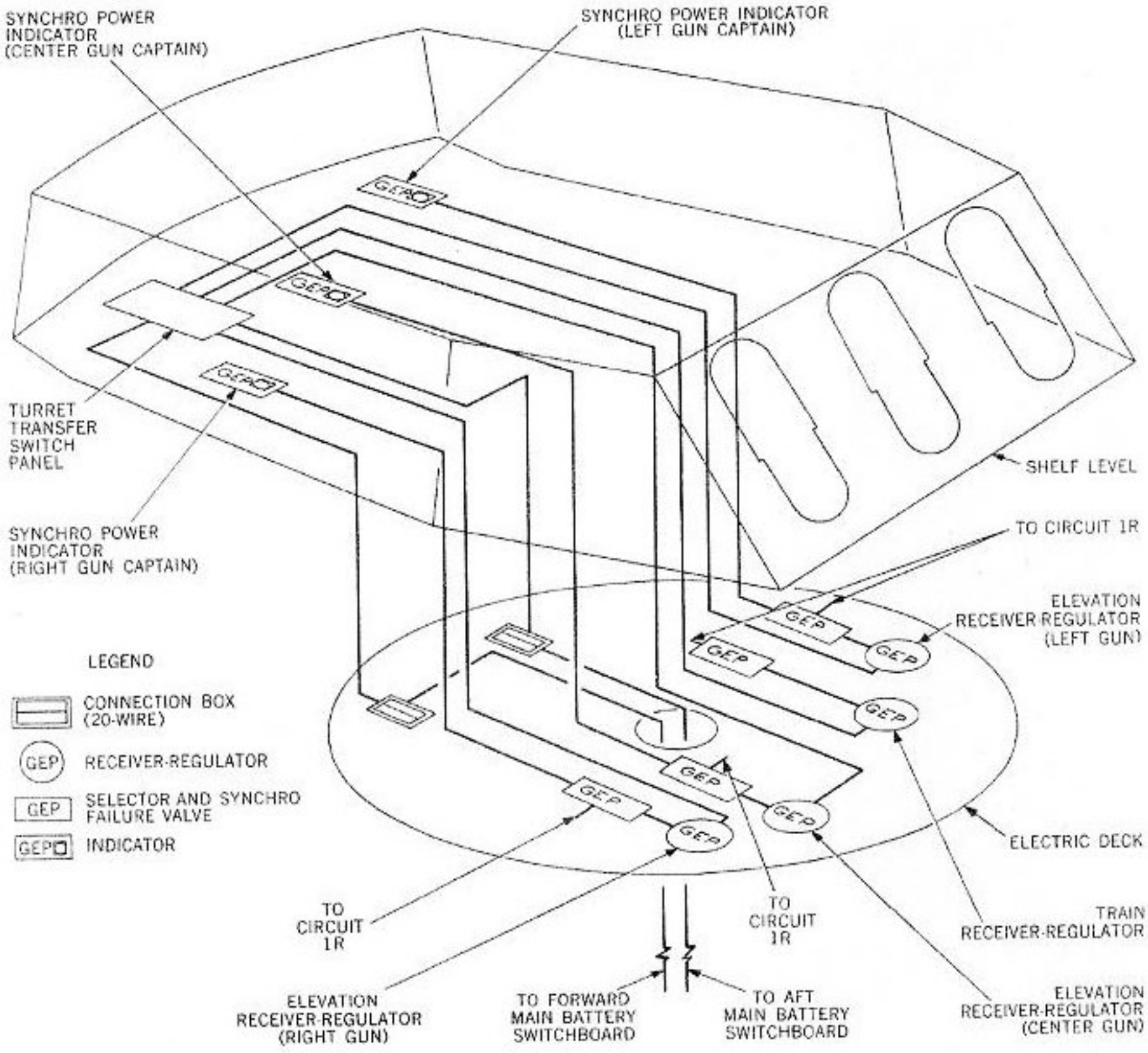


Figure 15-31. Turret Fire Control Circuit GEP. Isometric Diagram

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

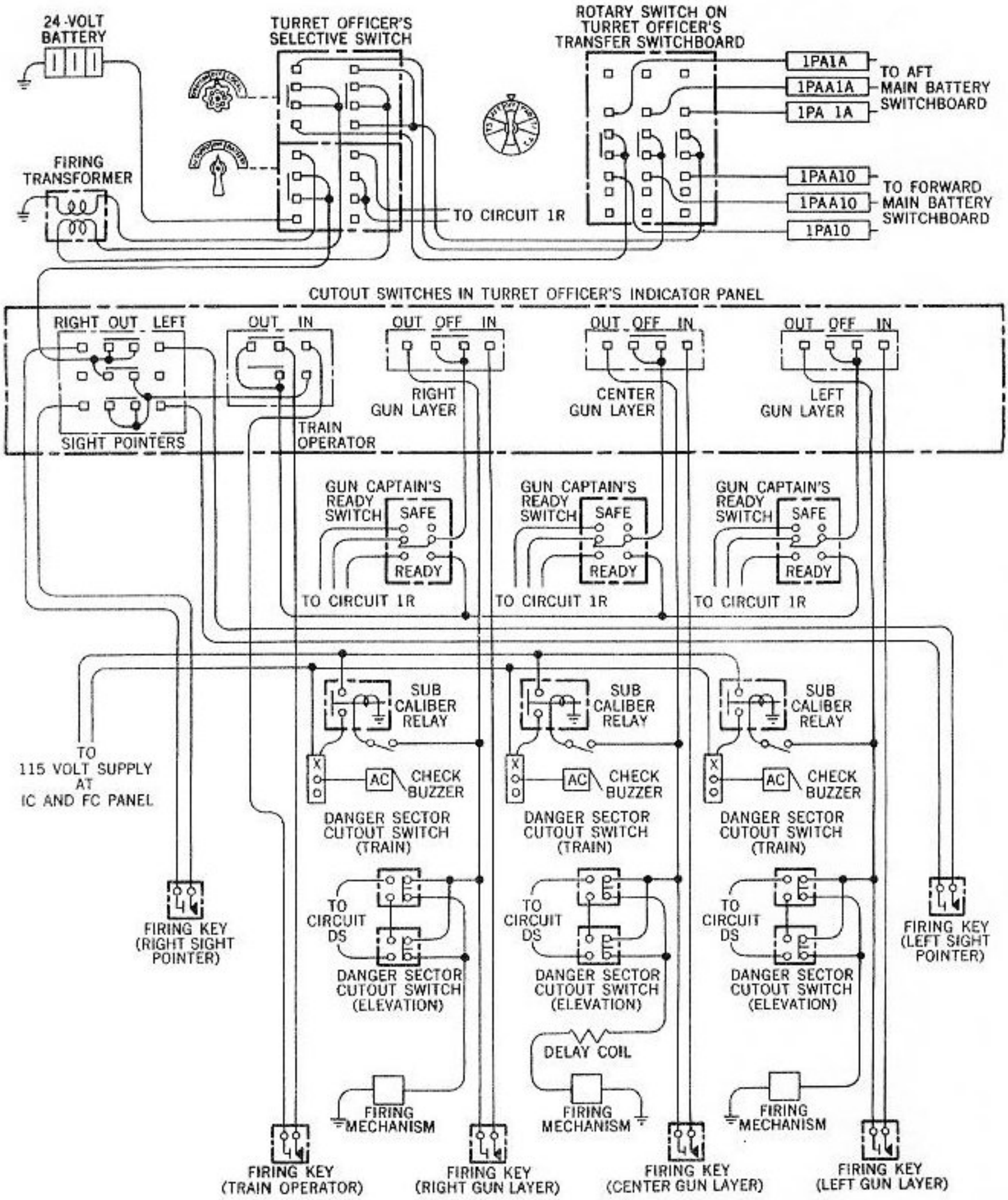


Figure 15-33. 16-Inch Firing Circuit Mk 3 and Associated Equipment. Elementary Wiring Diagram

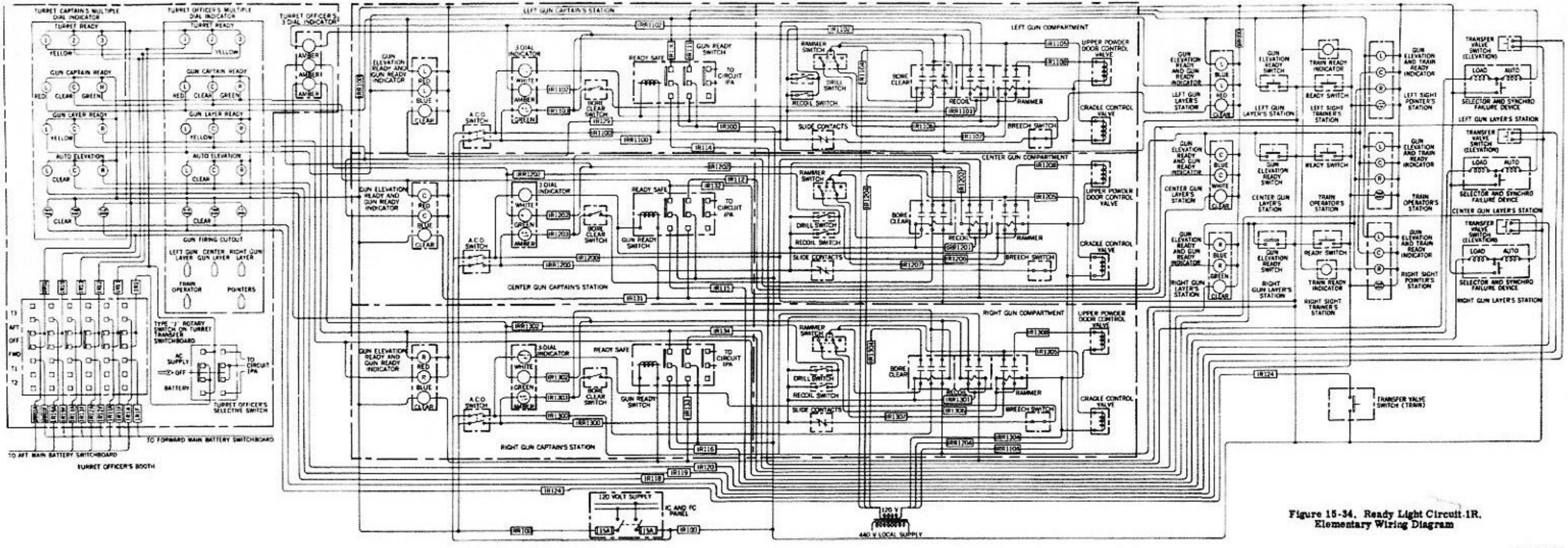


Figure 15-34. Ready Light Circuit 1R, Elementary Wiring Diagram

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.

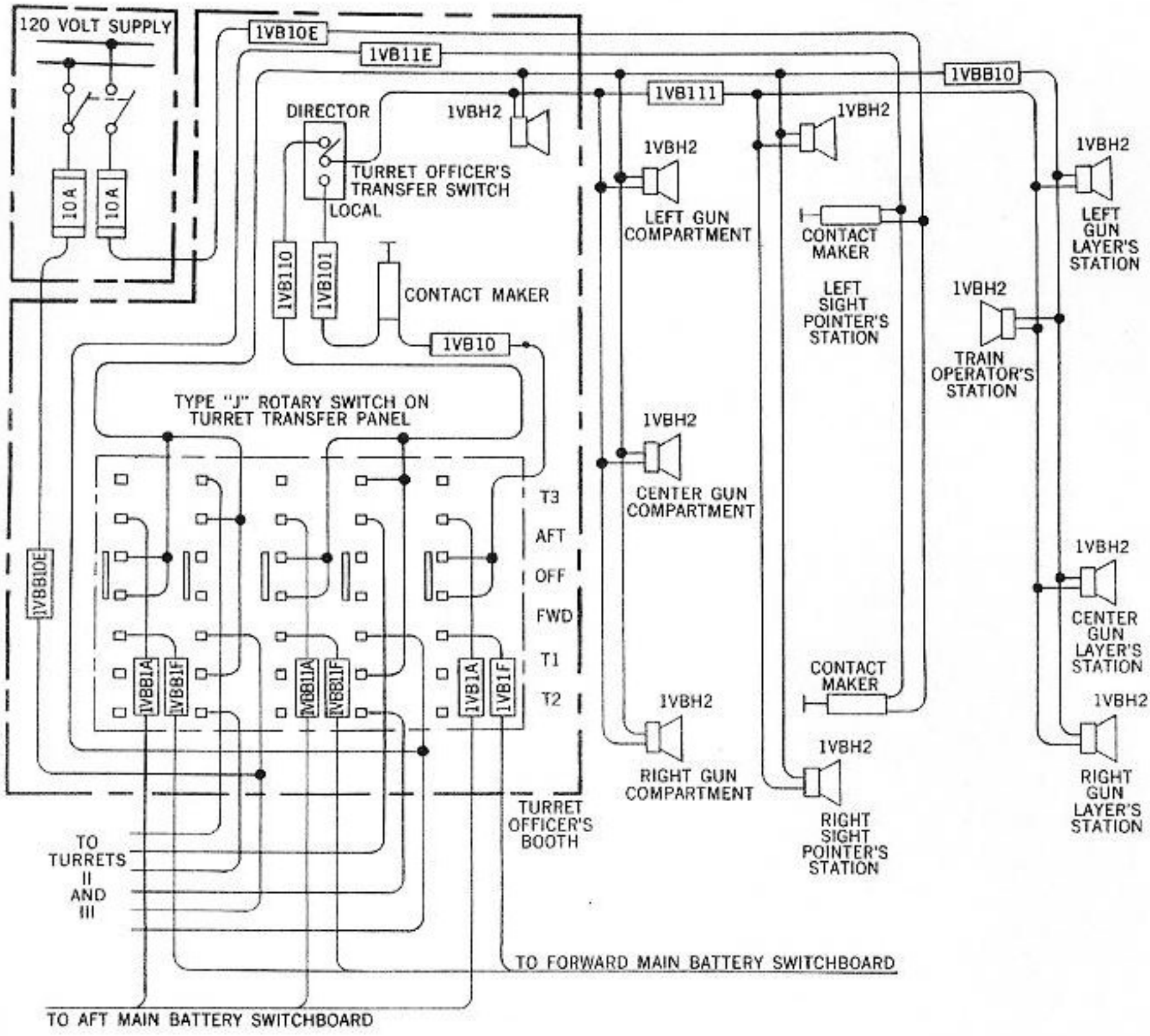


Figure 15-35. Salvo Signal Circuit 1VB. Elementary Wiring Diagram

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Safety interlock arrangement

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

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

* Added by NAVORD ORDALT 3255 and SHIPALT 819.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

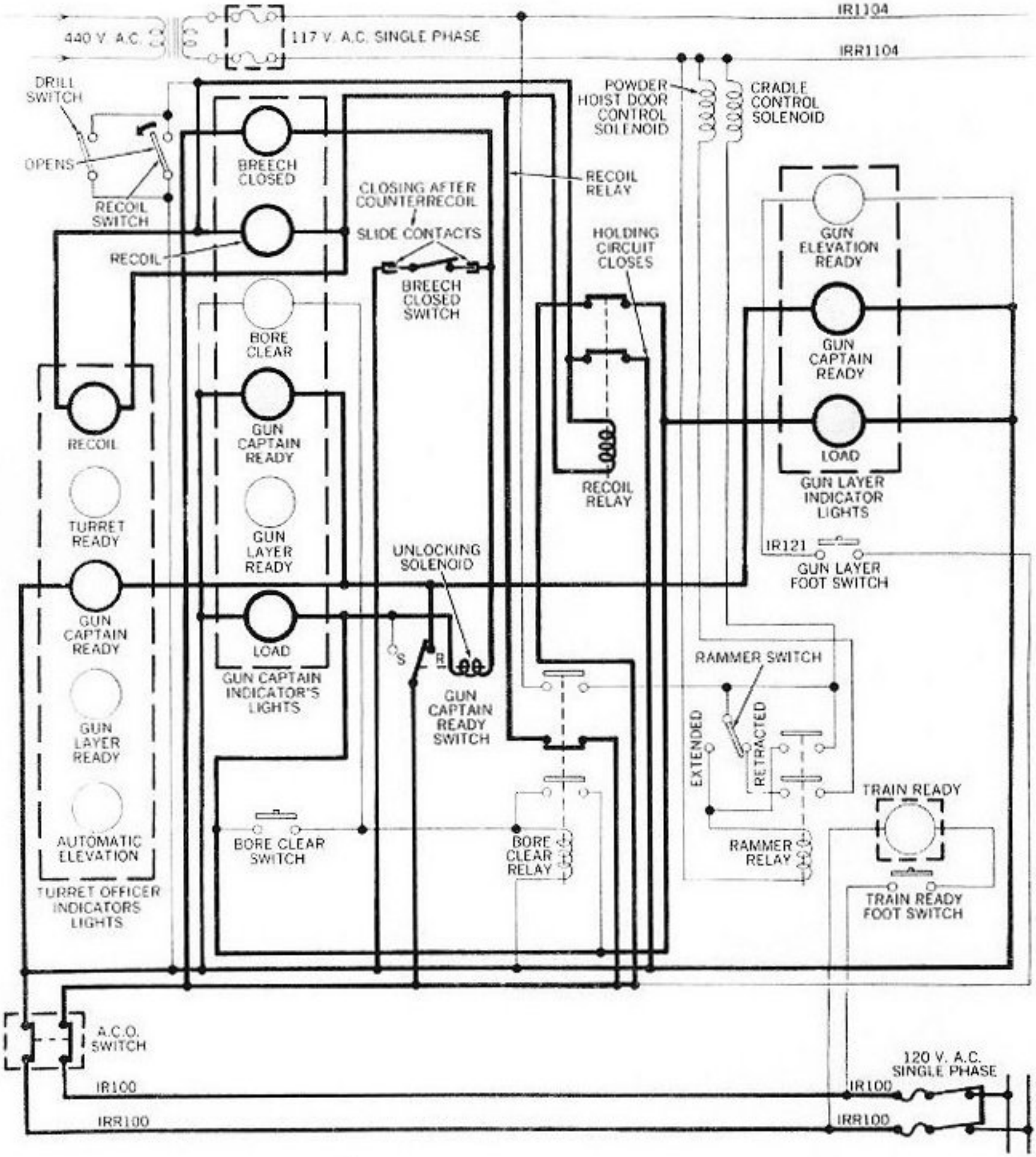


Figure 15-35A. Gun in Battery After Recoil

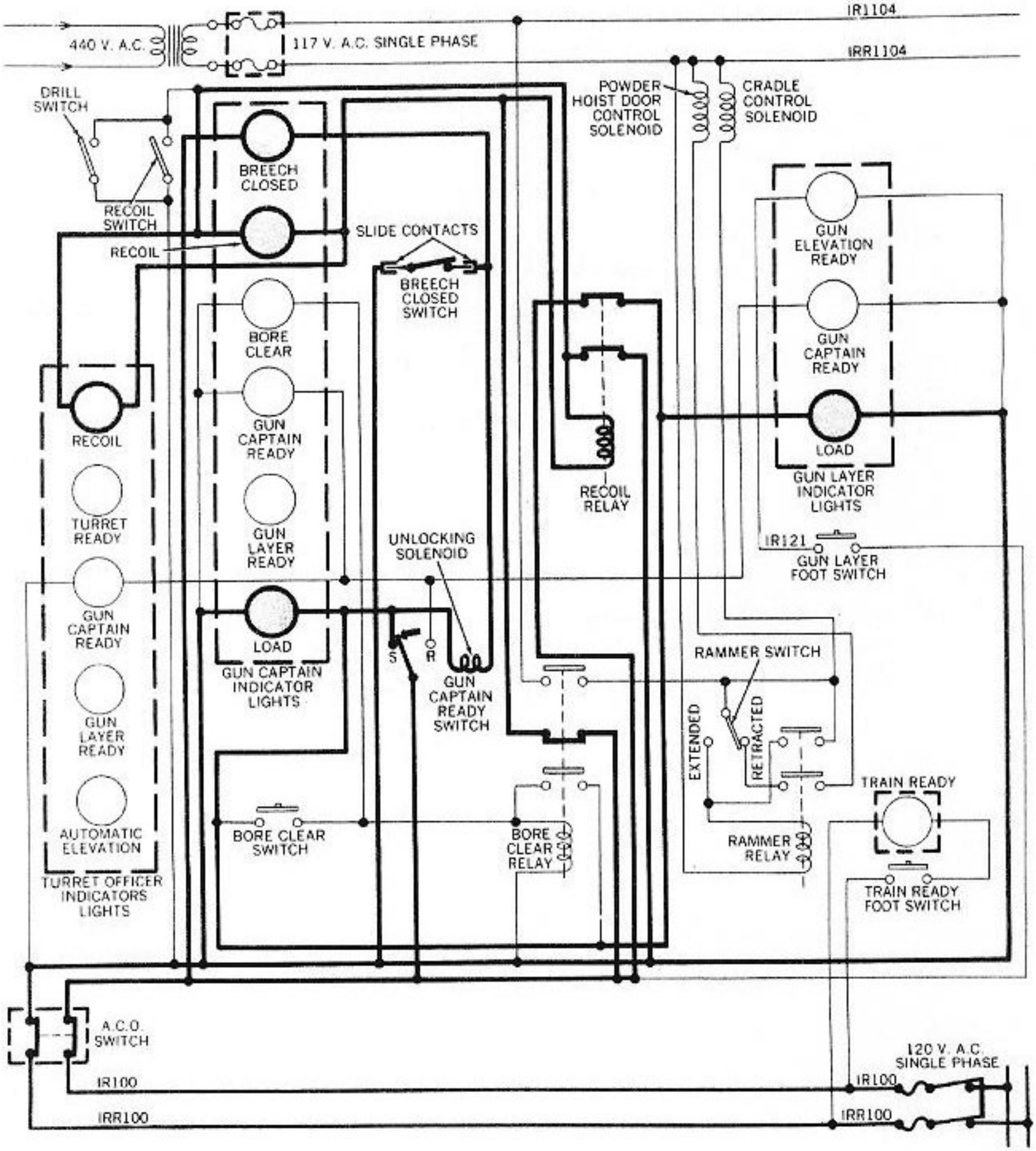


Figure 15-35B. Gun Captain's Ready-Switch Spring Returns to "Safe." Gun Moves to Loading Angle (not shown)

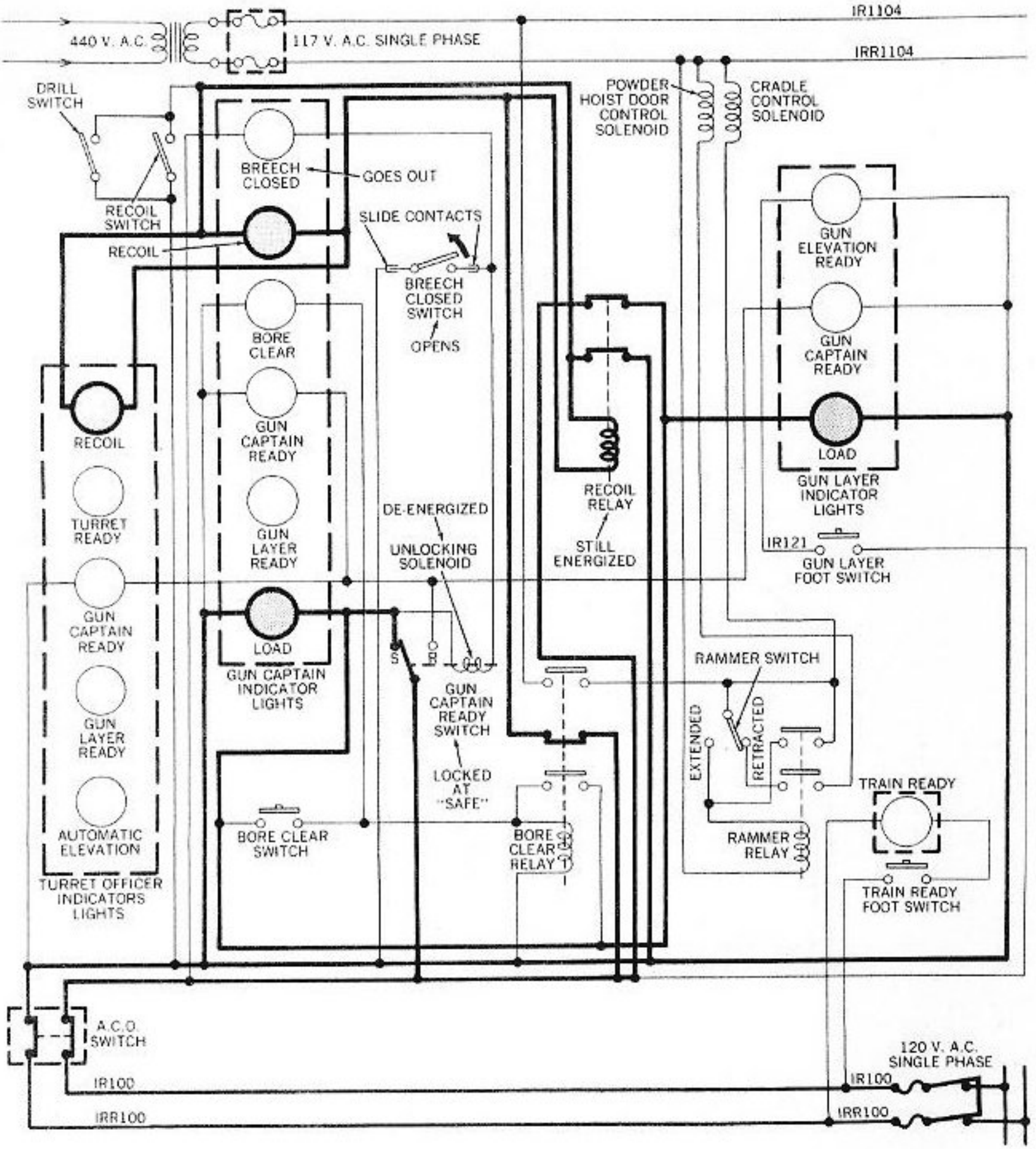


Figure 15-35C. Opening the Breech

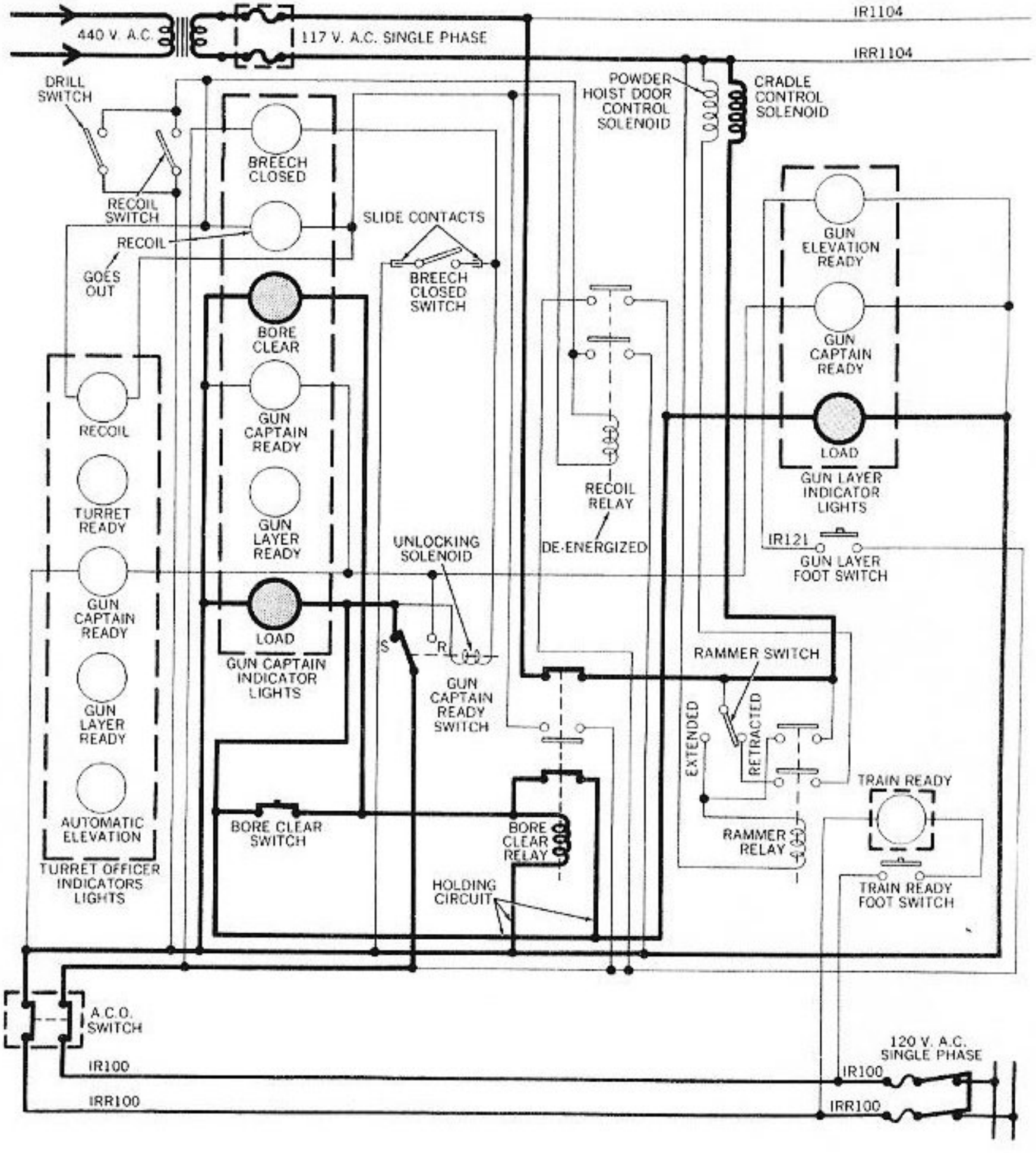


Figure 15-35D. Bore Clear Switch Button Pressed

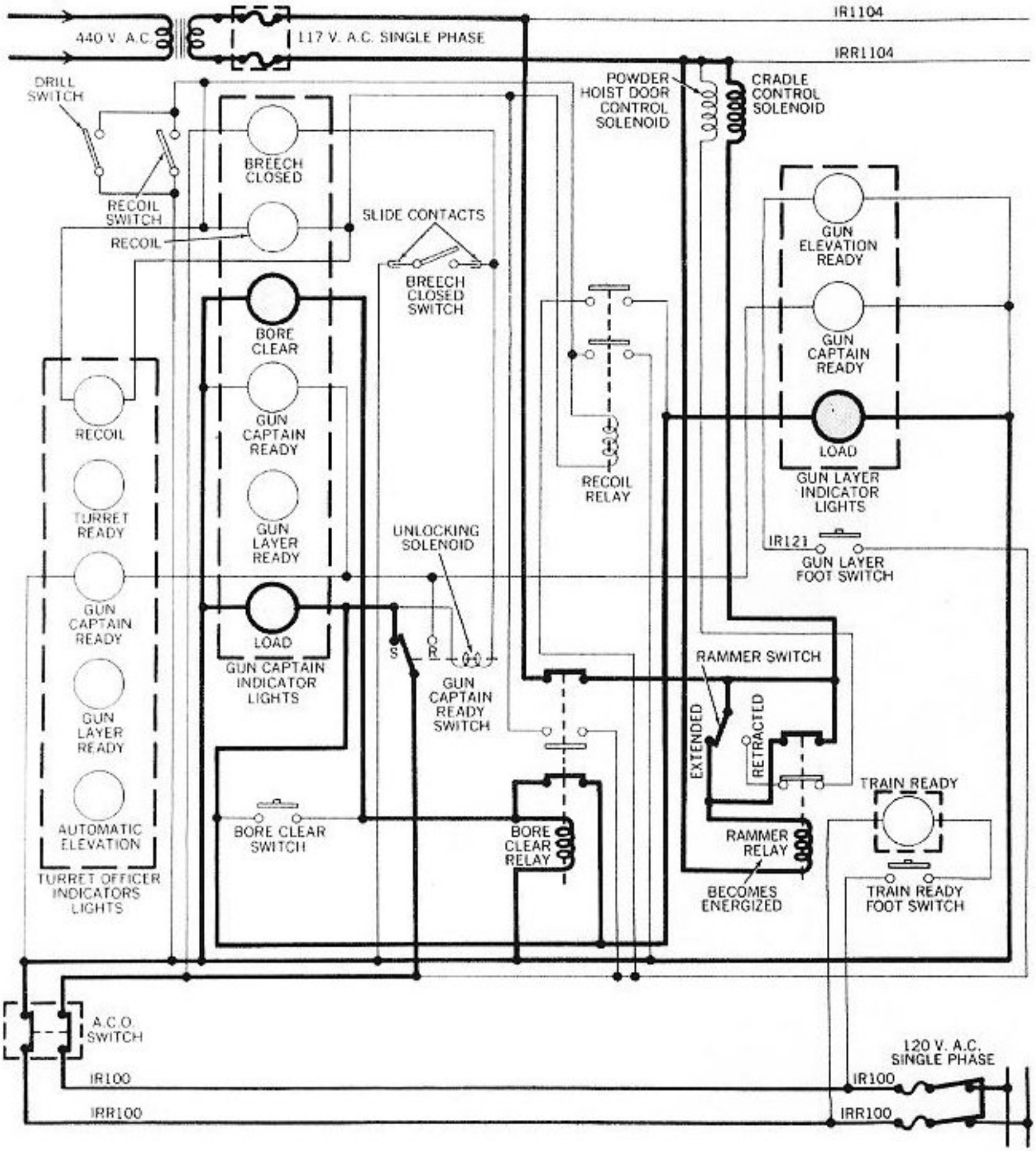


Figure 15-35E. Rammer Extended to Ram Projectile

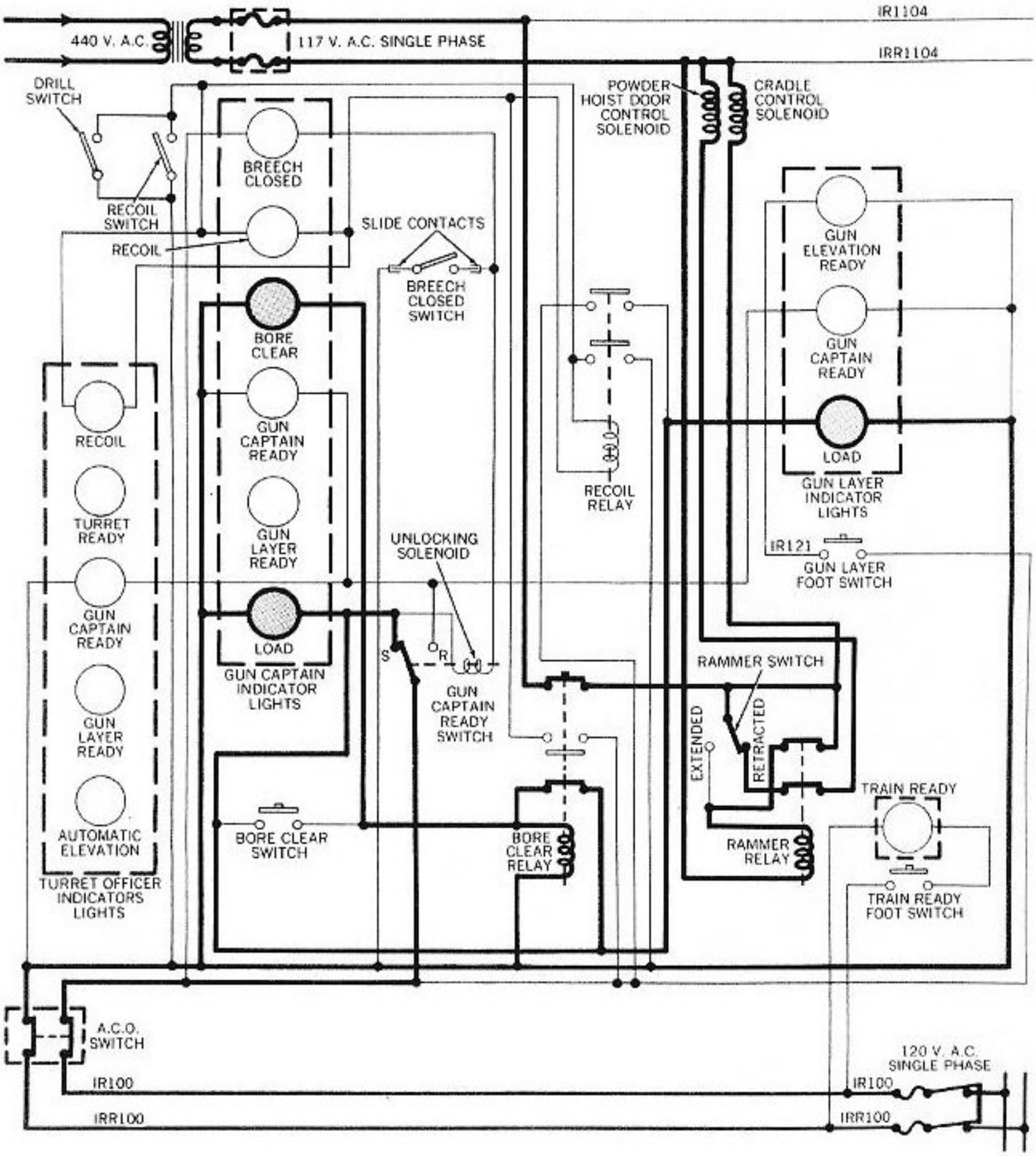


Figure 15-35F. Rammer Retracted After Ramming Projectile

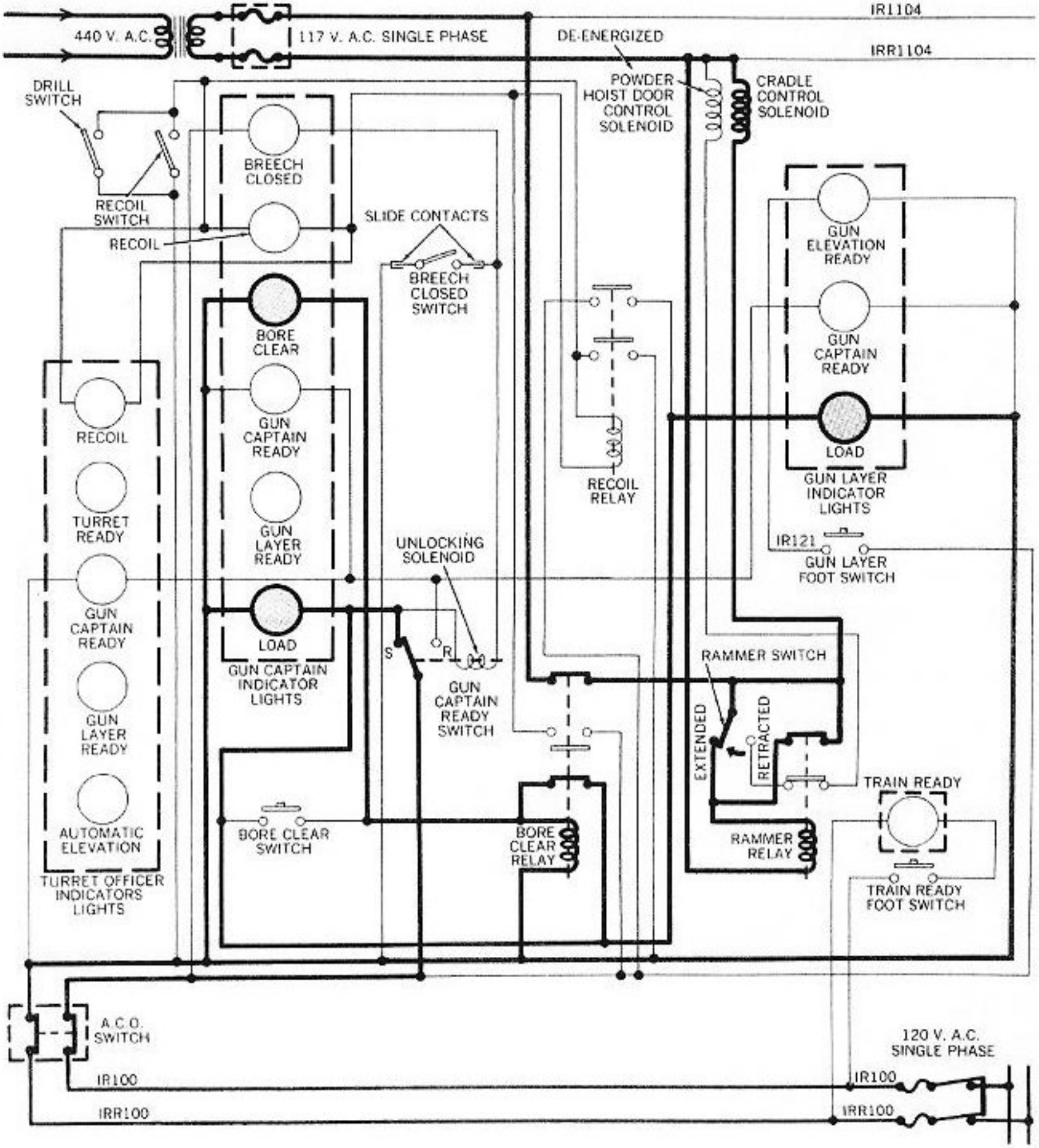


Figure 15-35G. Rammer Extended to Ram Powder Bags

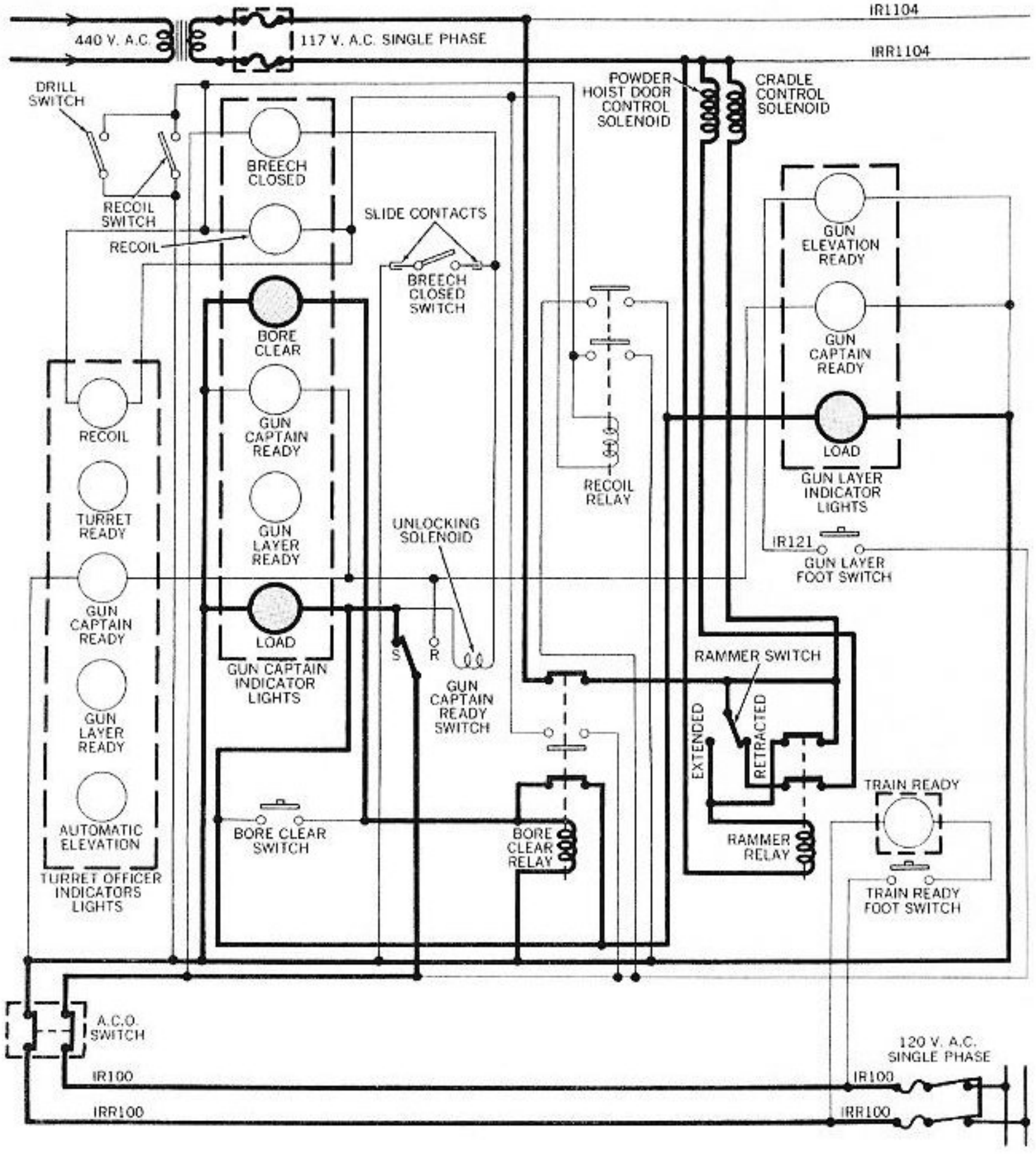


Figure 15-35H. Rammer Retracted After Ramming Powder Bags, Powder Door Closed, and Cradle Raised

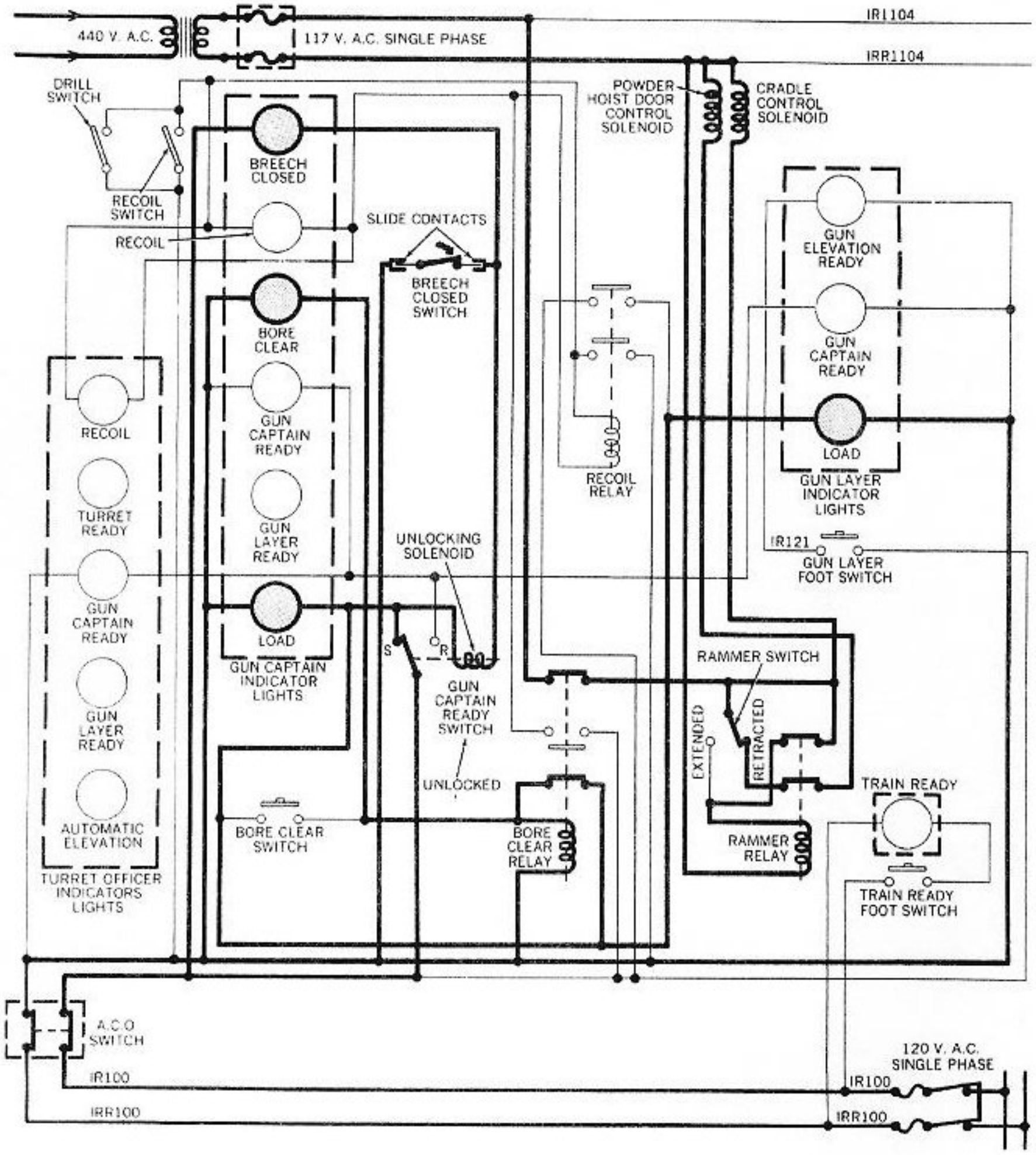


Figure 15-351. Breech Closing Action After Loading

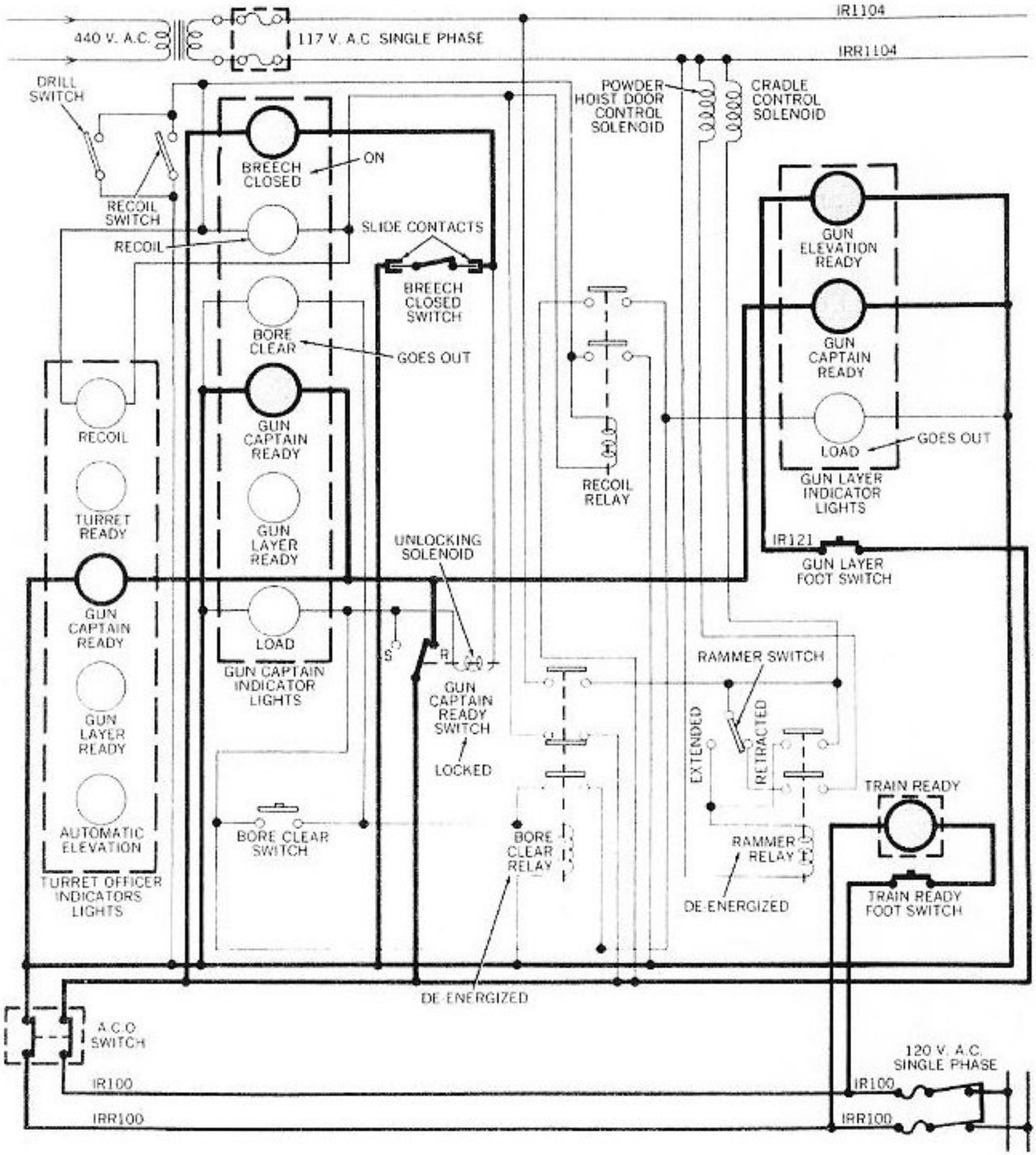


Figure 15-35J. Gun Captain's Ready Switch Positioned to Ready

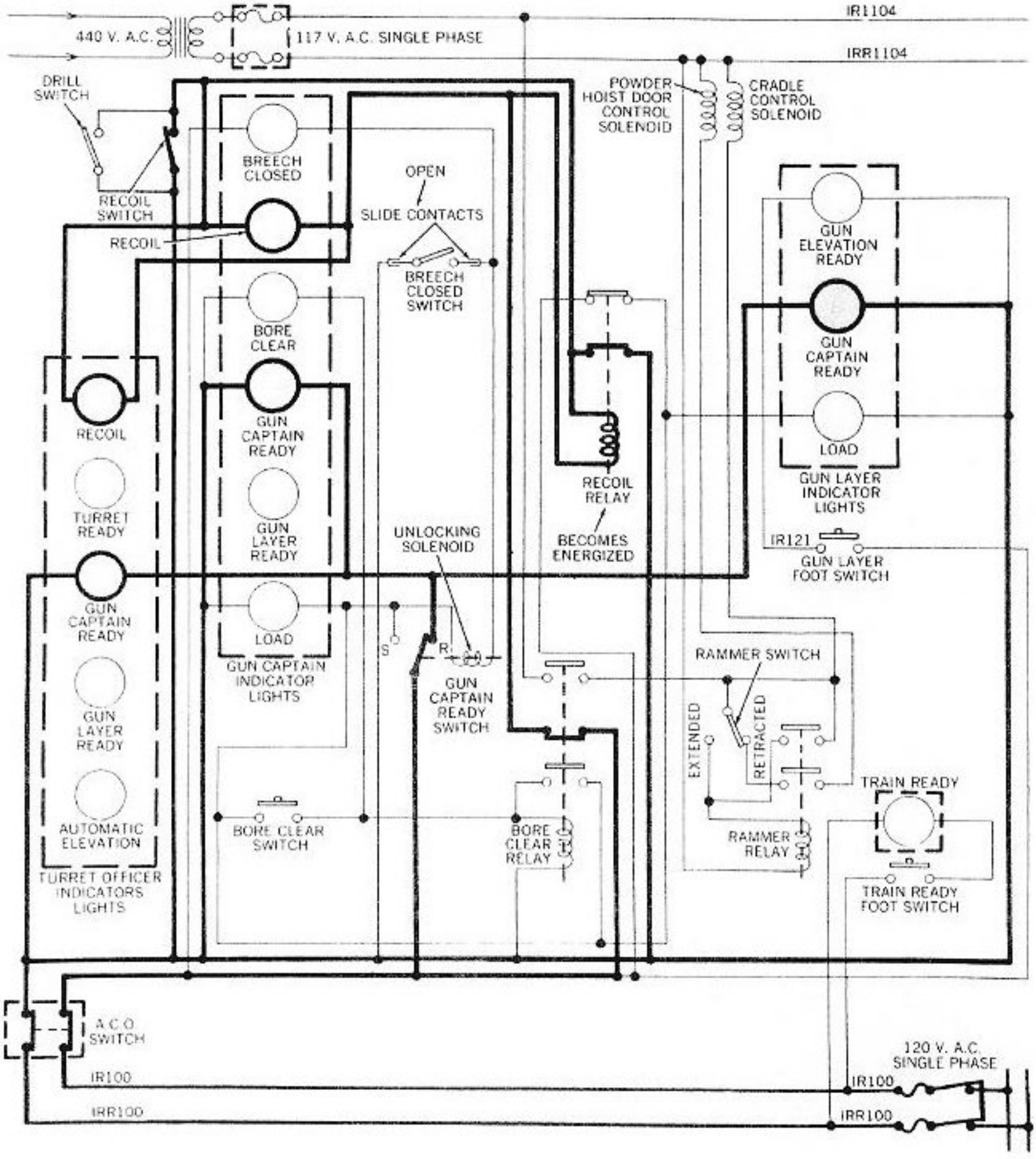


Figure 15-35K. Firing and Recoil

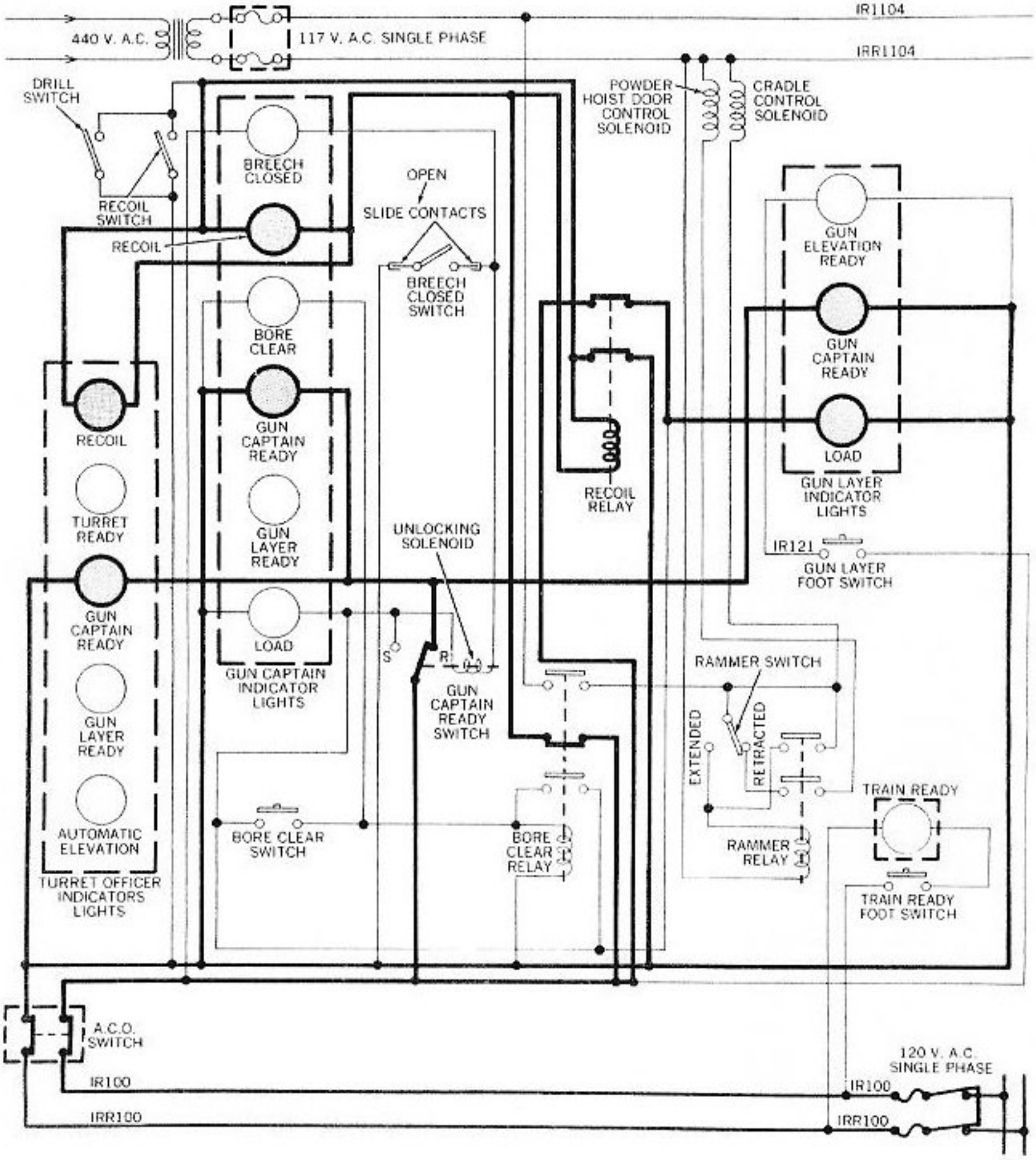


Figure 15-351. Counterrecoil

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

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

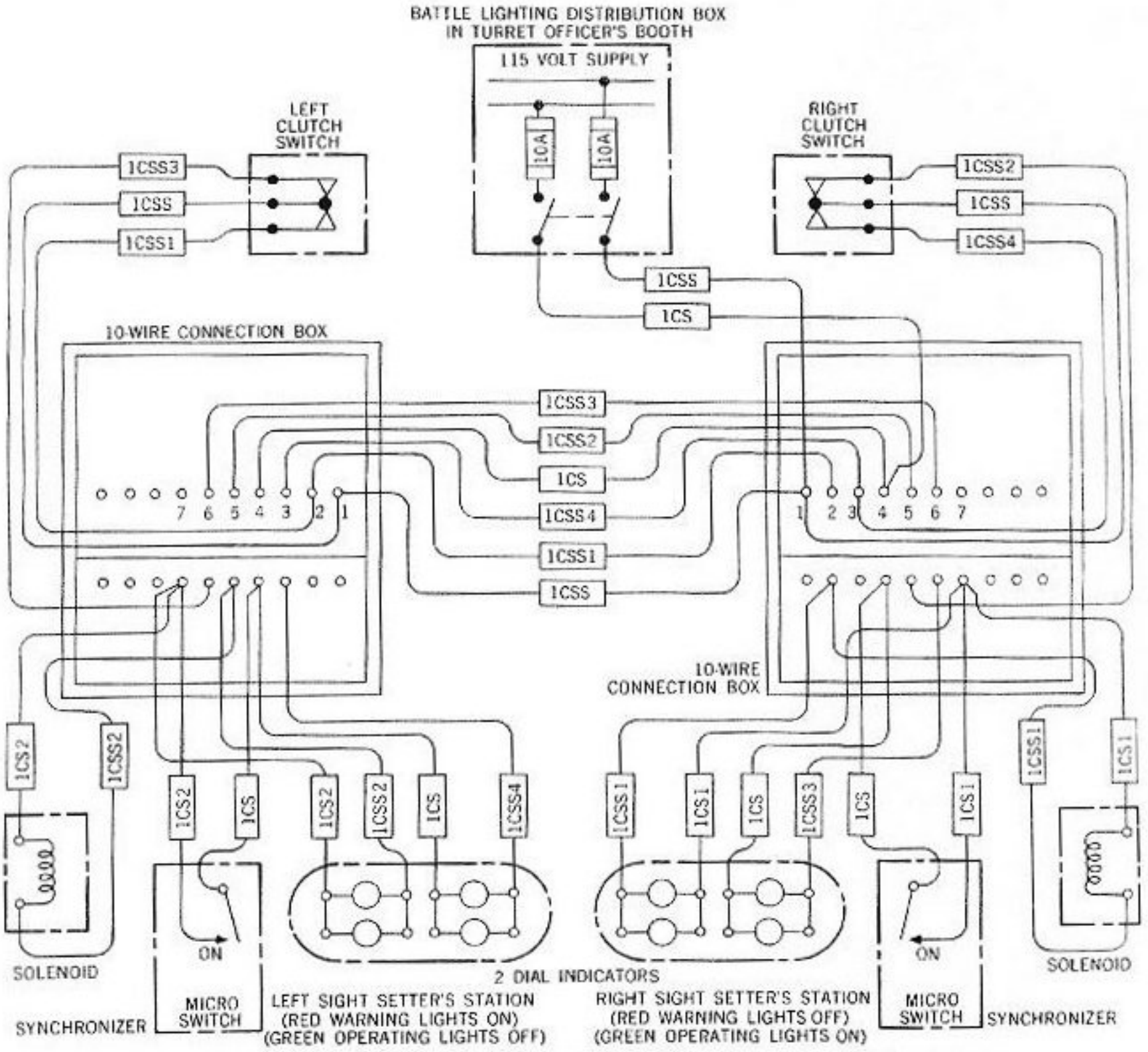


Figure 15-36. Sight Setter's Clutch Indicator Circuit CS. Elementary Wiring Diagram

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

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

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

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

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

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

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

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

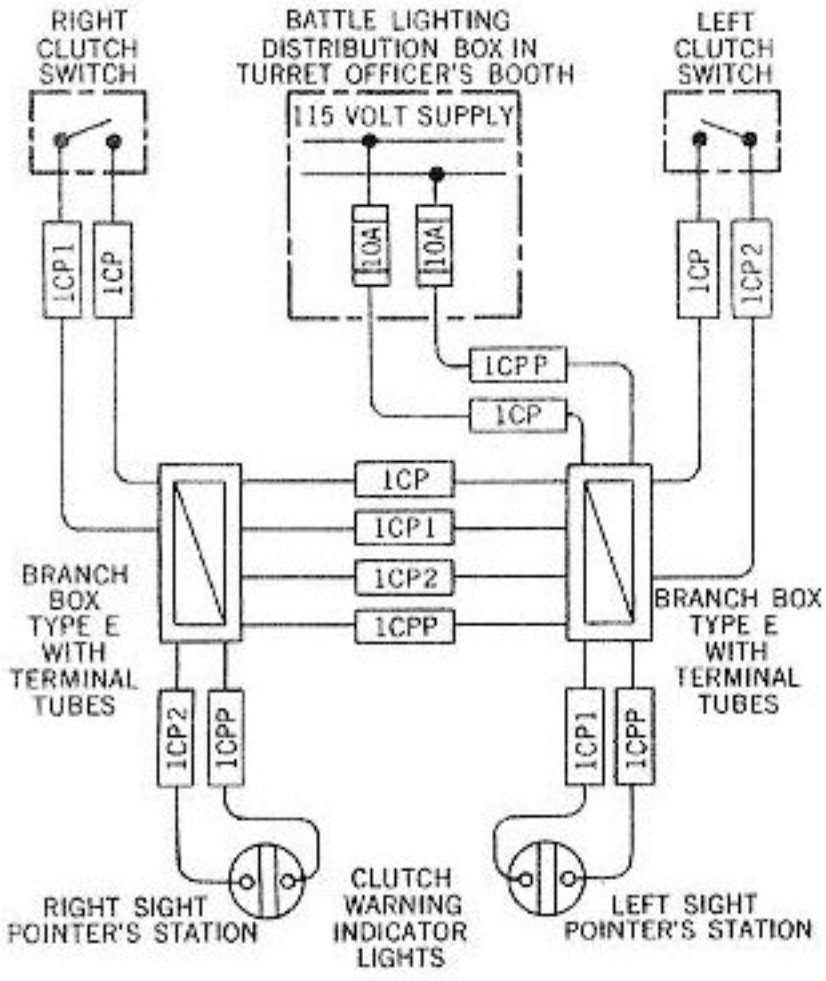


Figure 15-37. Sight Pointer's Clutch Indicator Circuit CP. Elementary Wiring Diagram

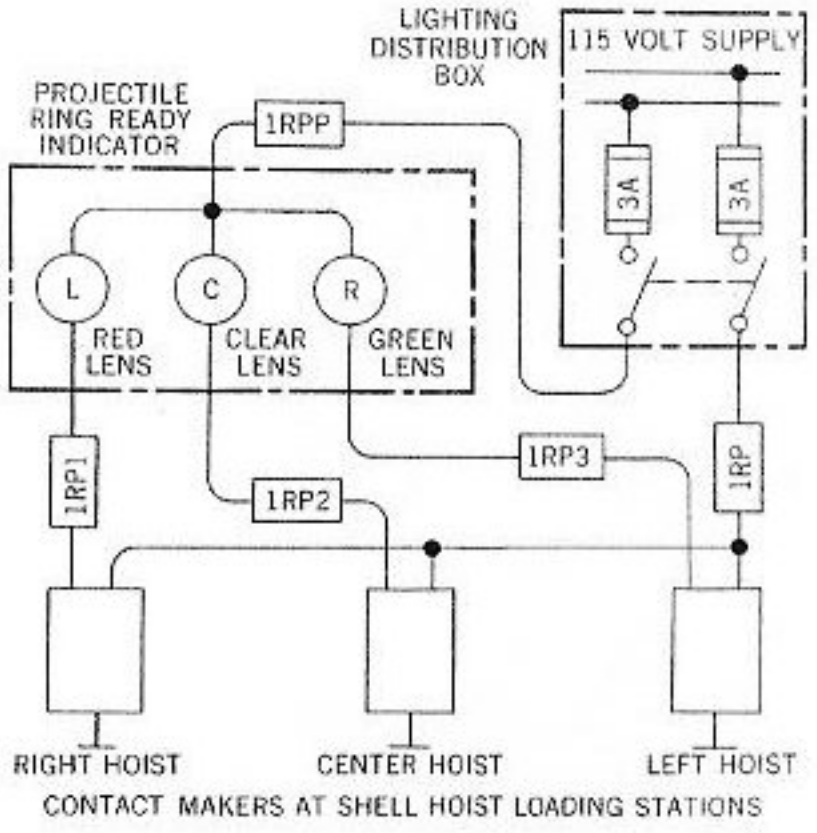


Figure 15-38. Projectile Ring Ready Light Circuit RP. Wiring Diagram

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

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

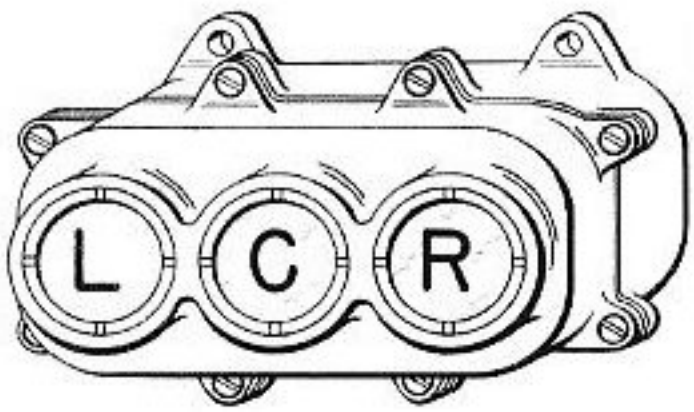


Figure 15-39. Projectile Ring Ready Indicator

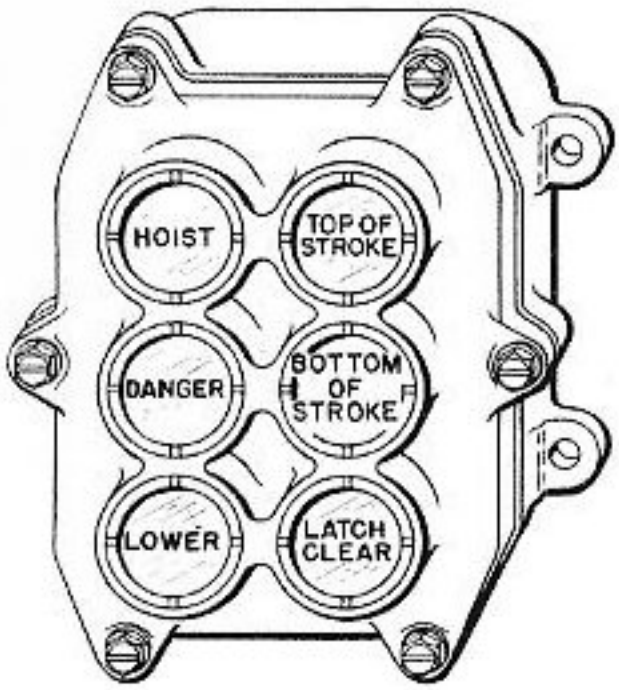


Figure 15-40. Projectile Hoist Interlock Indicator

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

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

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

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

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

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

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

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

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

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

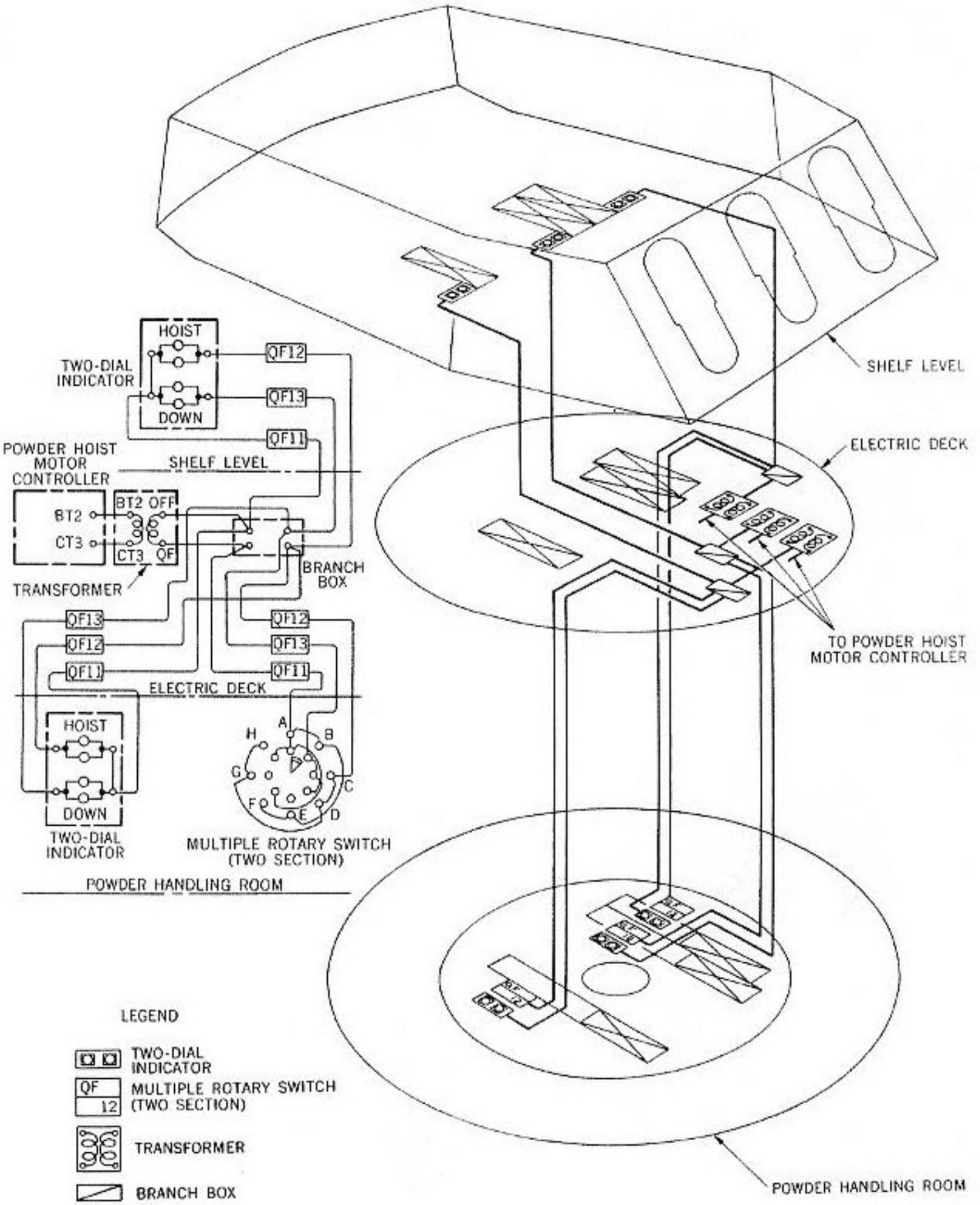


Figure 15-41. Powder Hoist Signal Indicator Circuit QF. Isometric and Elementary Wiring Diagram

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

Circuit description. Each circuit consists of the following components:

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

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

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

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

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

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

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

Circuit description. Circuit Q comprises the following elements:

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

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

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

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

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

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

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

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

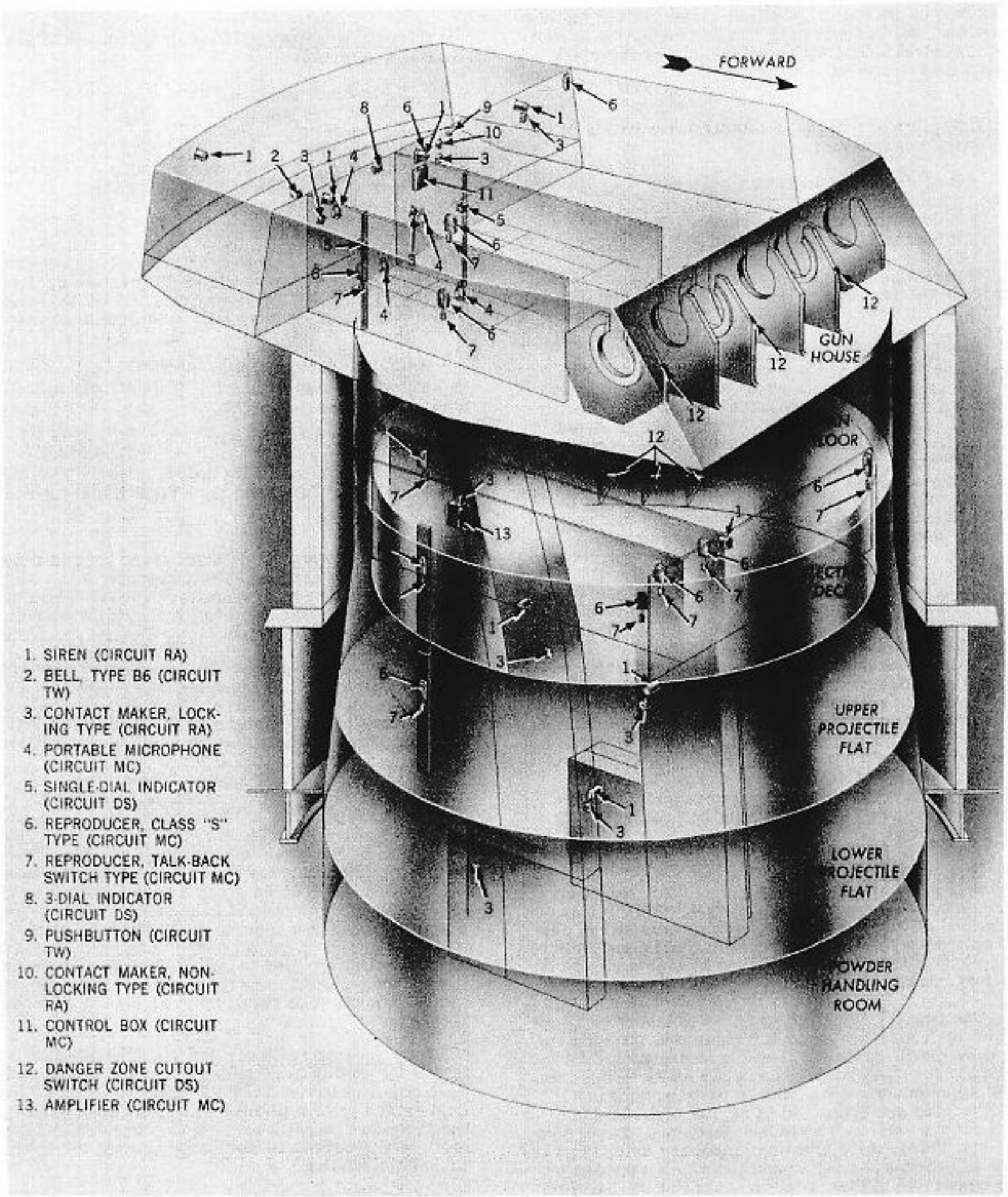


Figure 15-42. Turret Interior Communications System, General Arrangement

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

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

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

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

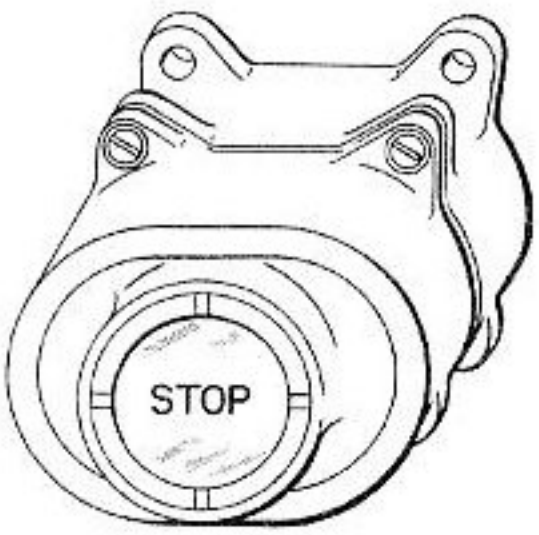


Figure 15-43. Depression and Train Stop Indicator, Gun Captain's Station

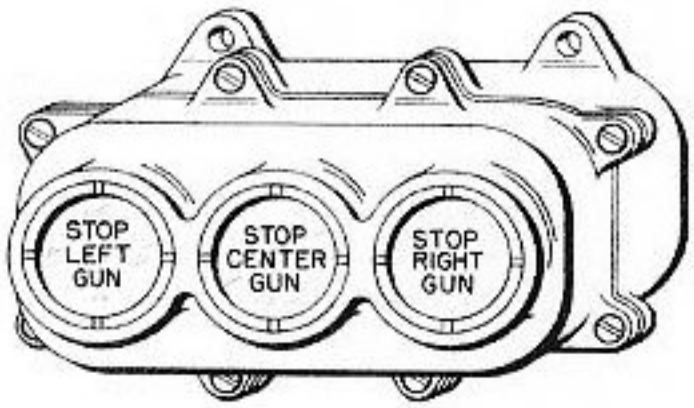


Figure 15-44. Depression and Train Stop Indicator, Turret Officer's Station

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

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

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

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

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

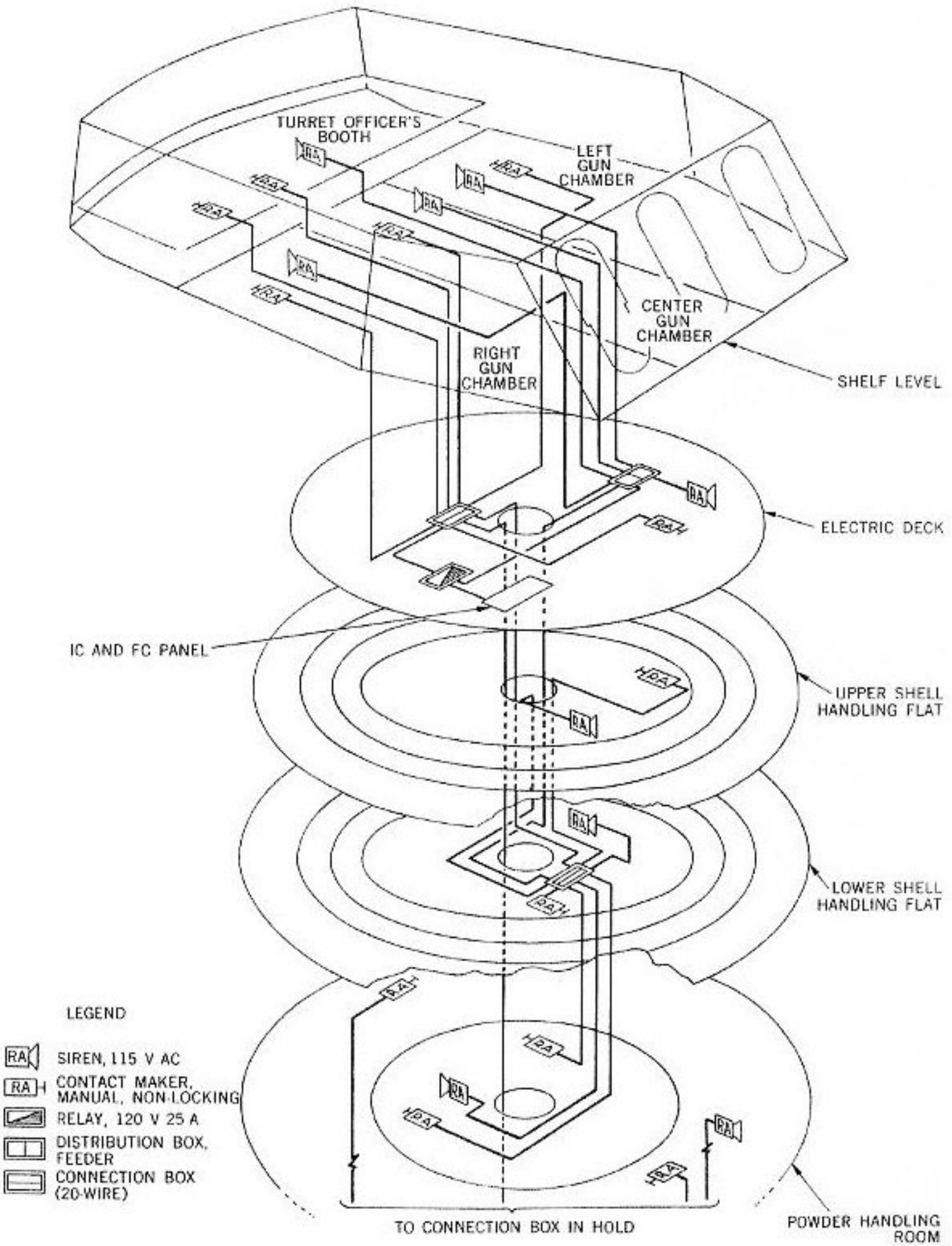


Figure 15-45. Intra-Turret Emergency Alarm Circuit RA. Isometric Diagram

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

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

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

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

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

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

Interior communications system

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

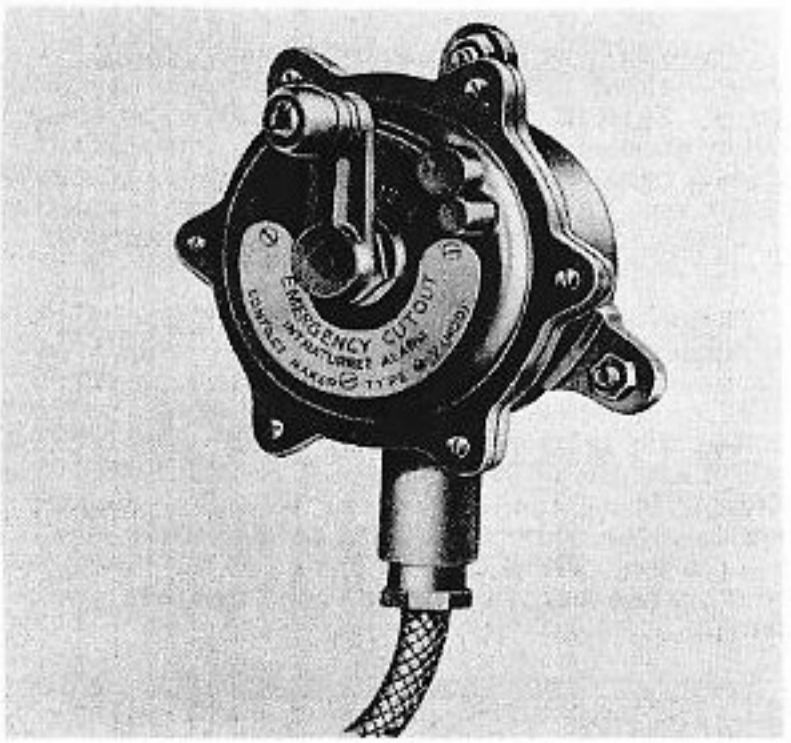


Figure 15-46. Emergency Alarm Contact Maker

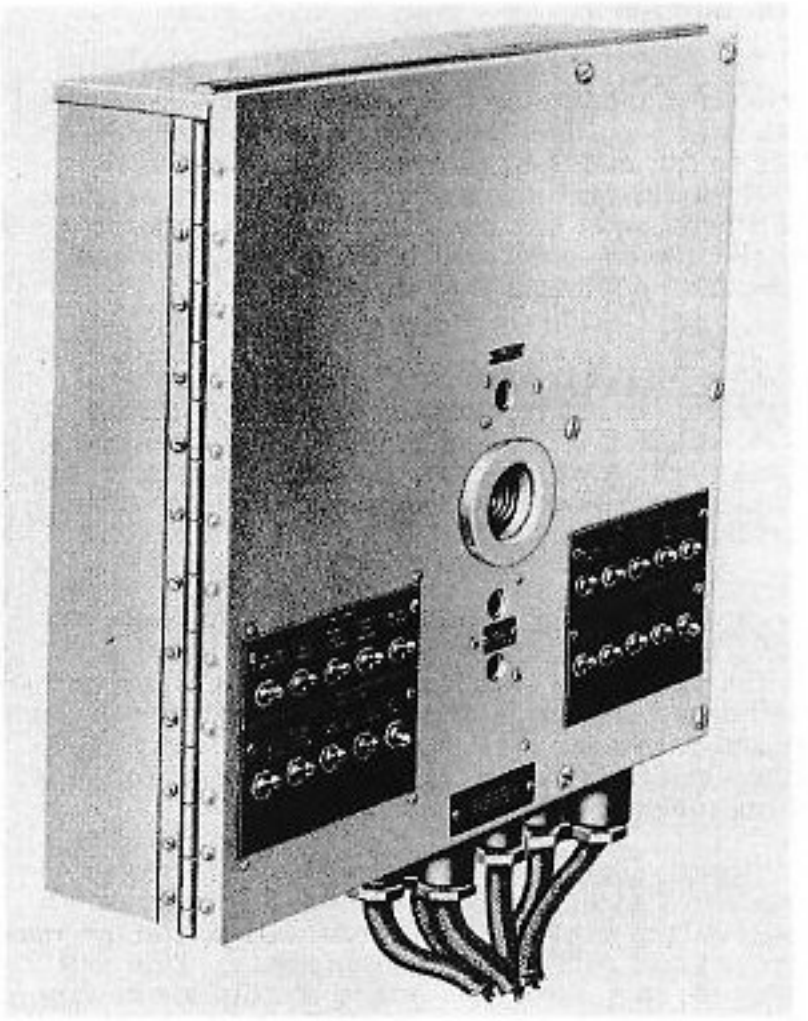


Figure 15-47. Transmitter Control Box

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

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

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

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

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

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

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

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

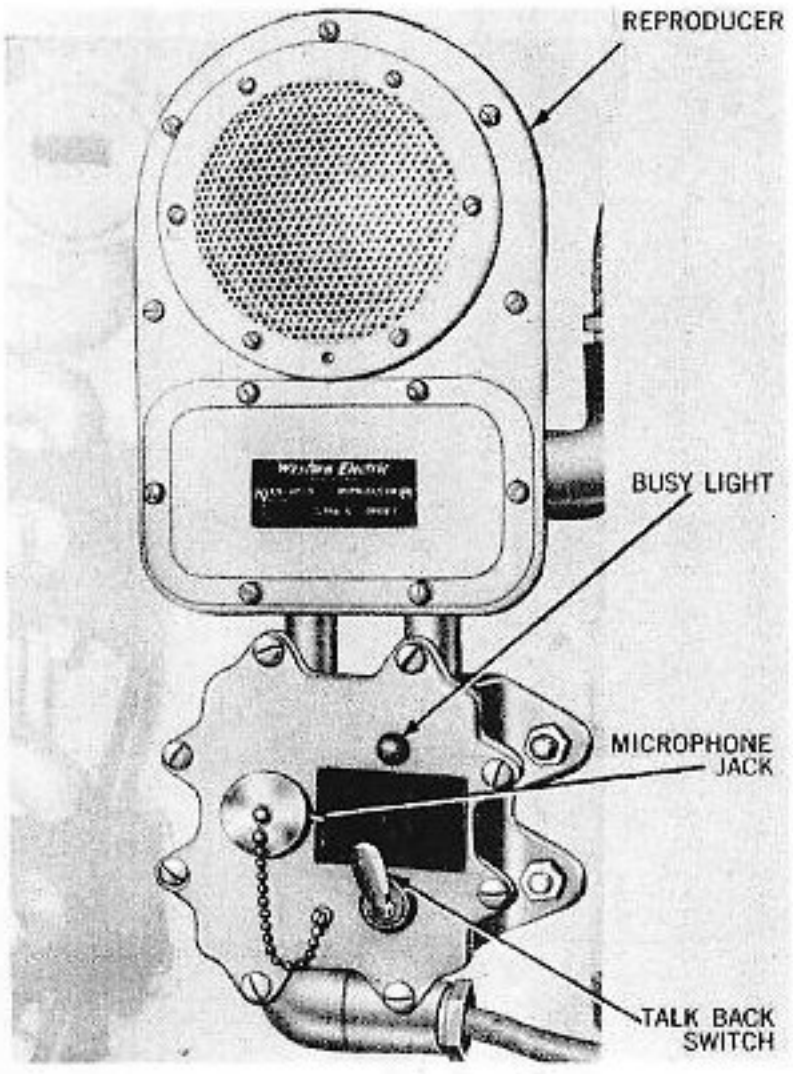


Figure 15-48. Talk-Back Type Reproducer

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

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

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

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

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

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

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

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

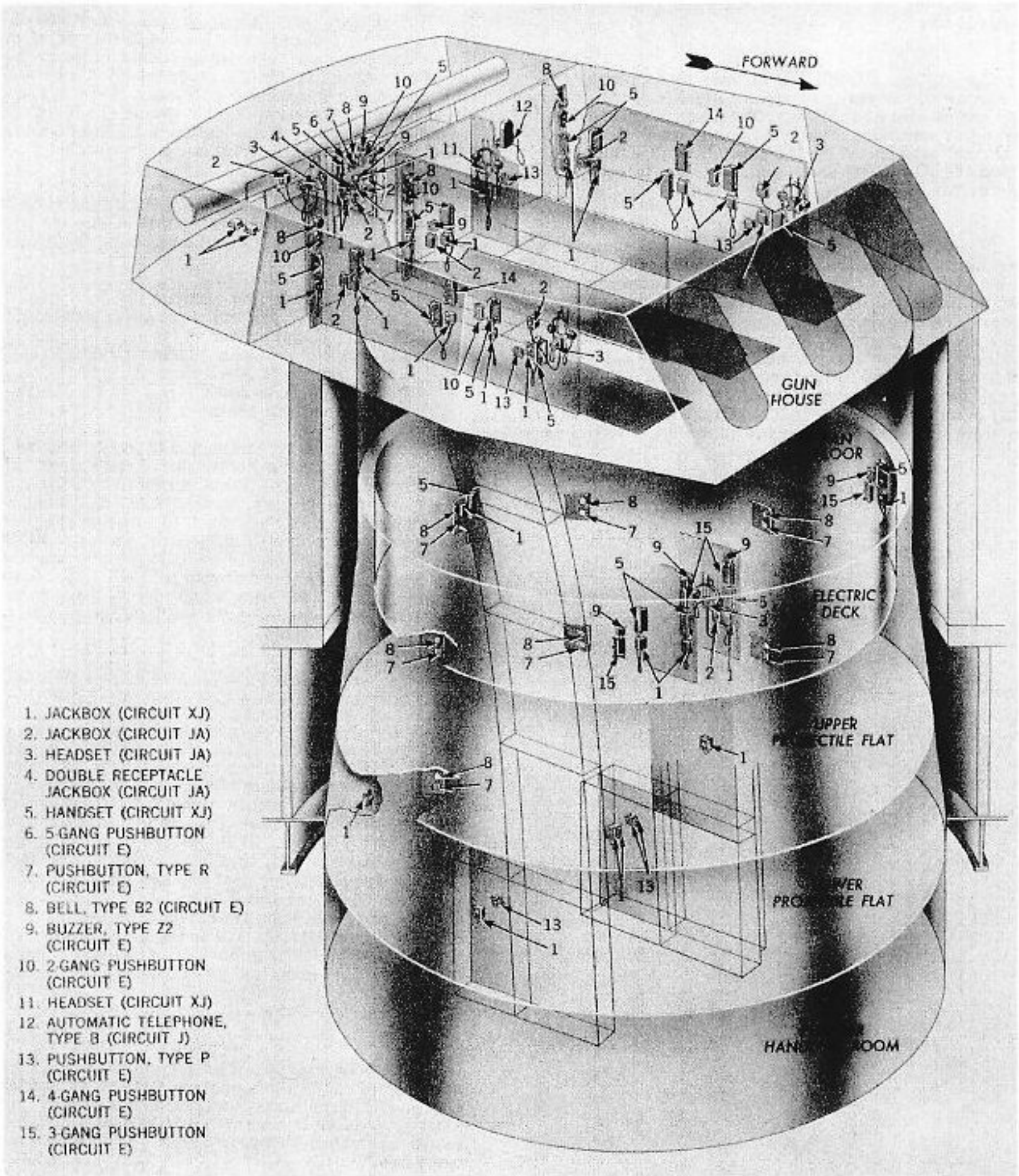


Figure 15-49. Turret General Communications System. General Arrangement

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

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

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

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

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

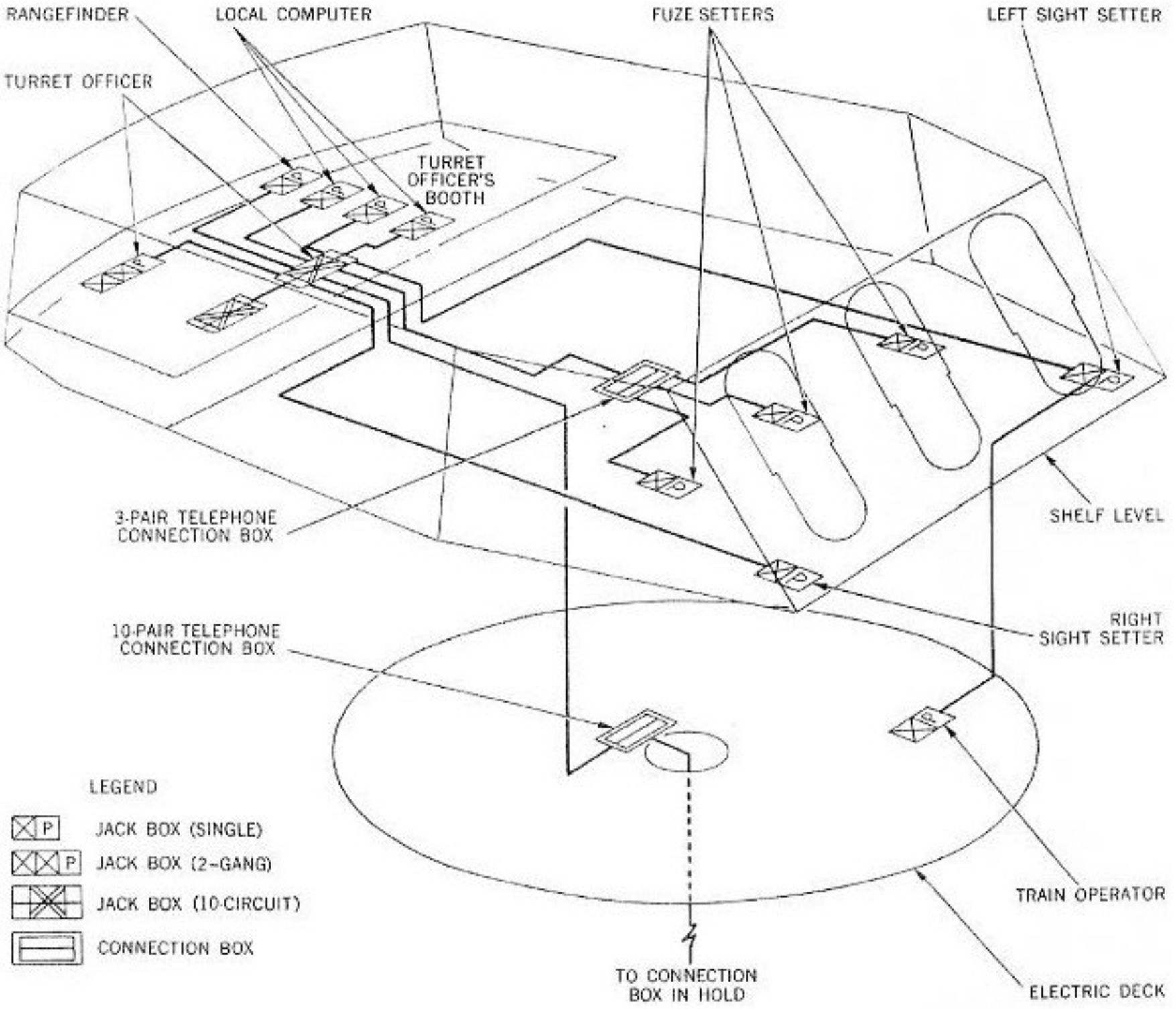


Figure 15-50. Battle Telephone Circuit JA. Isometric Diagram

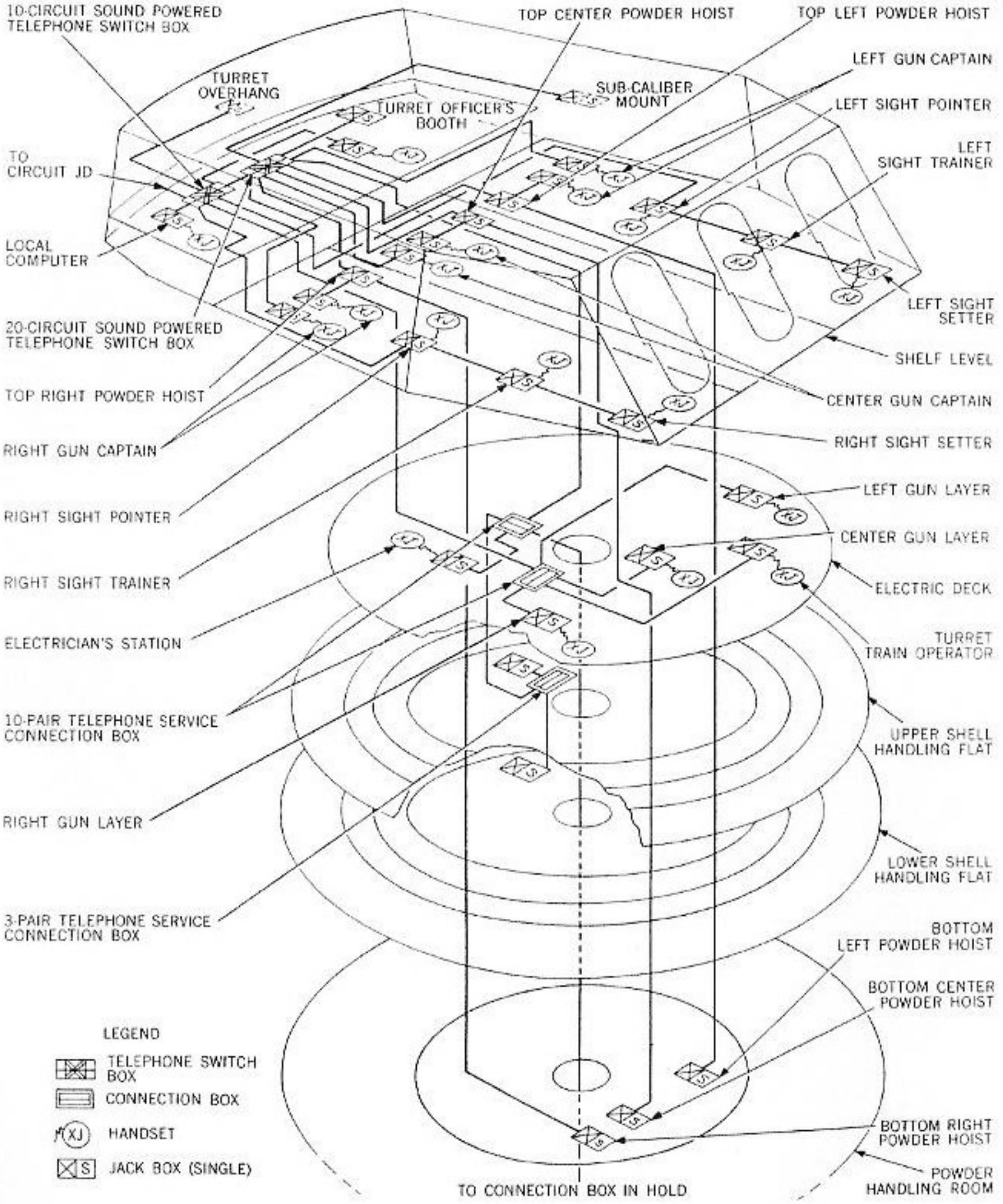


Figure 15-51. Supplementary Telephone Circuit XJ. Isometric Diagram

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

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

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

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

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

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

CIRCUIT XJ

STATION INTERCONNECTION FACILITIES

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

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

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

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

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

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

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

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

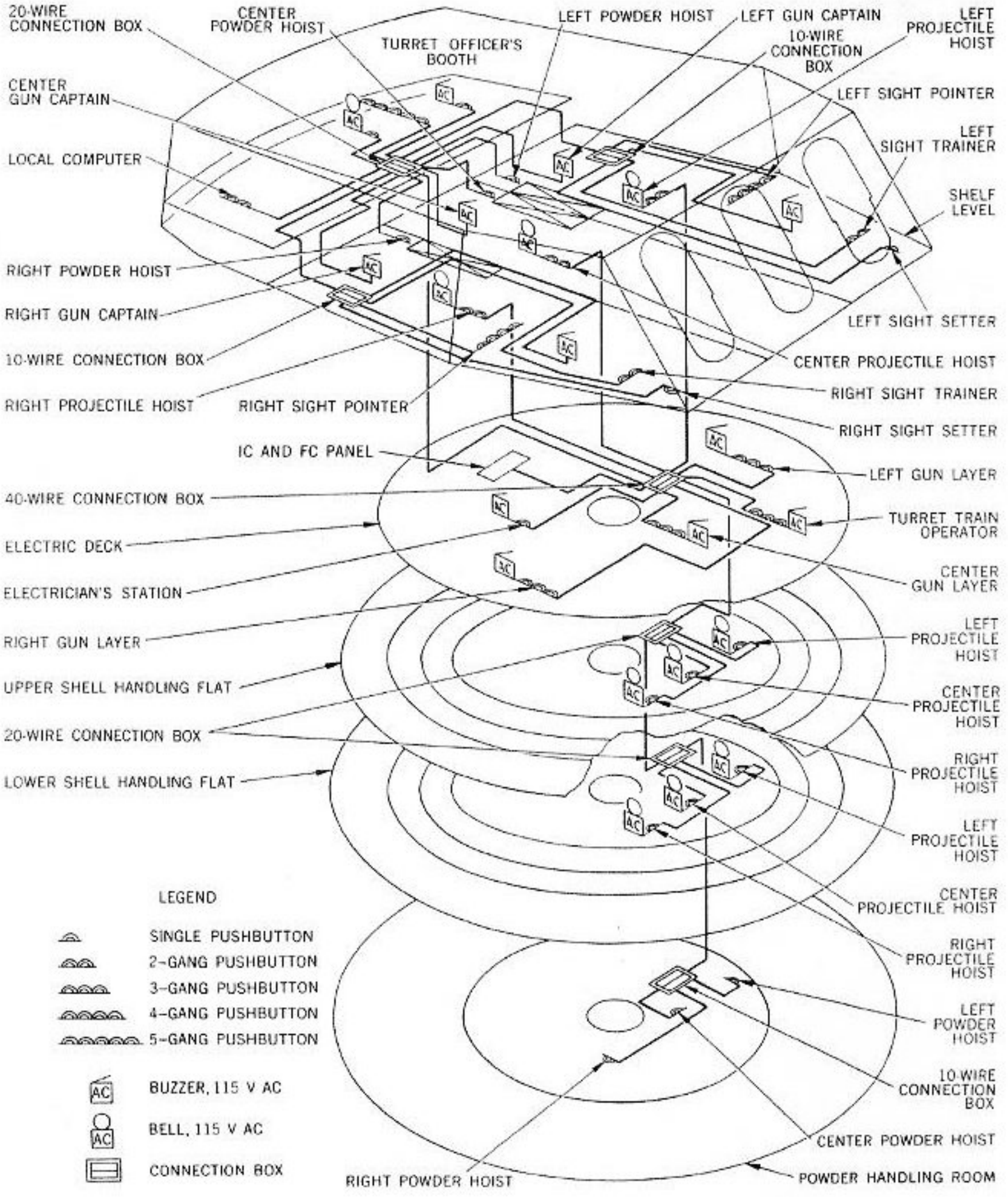
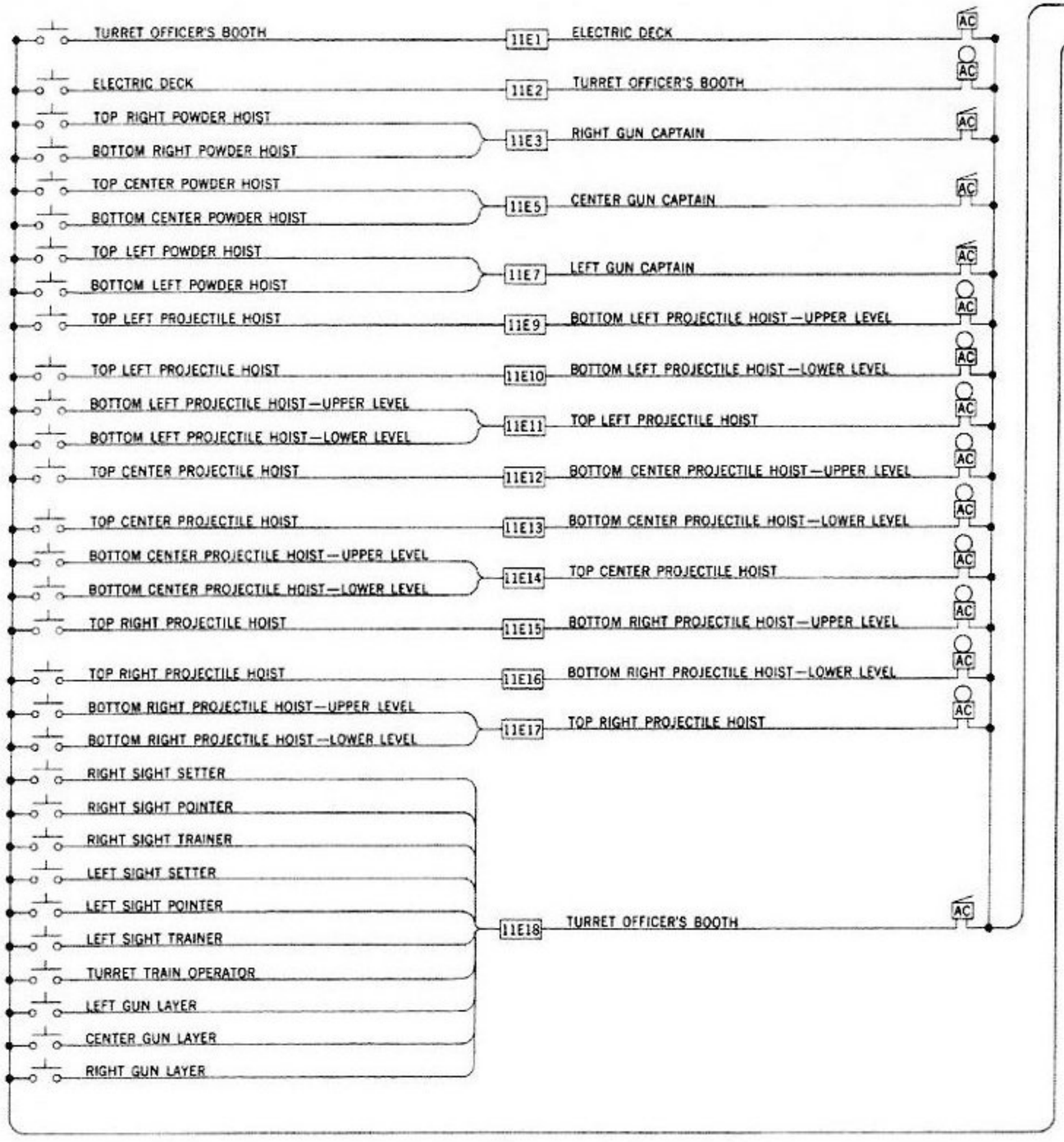


Figure 15-52. Sound Powered Telephone and Voice Tube Call Bell Circuit E. Isometric Wiring Diagram



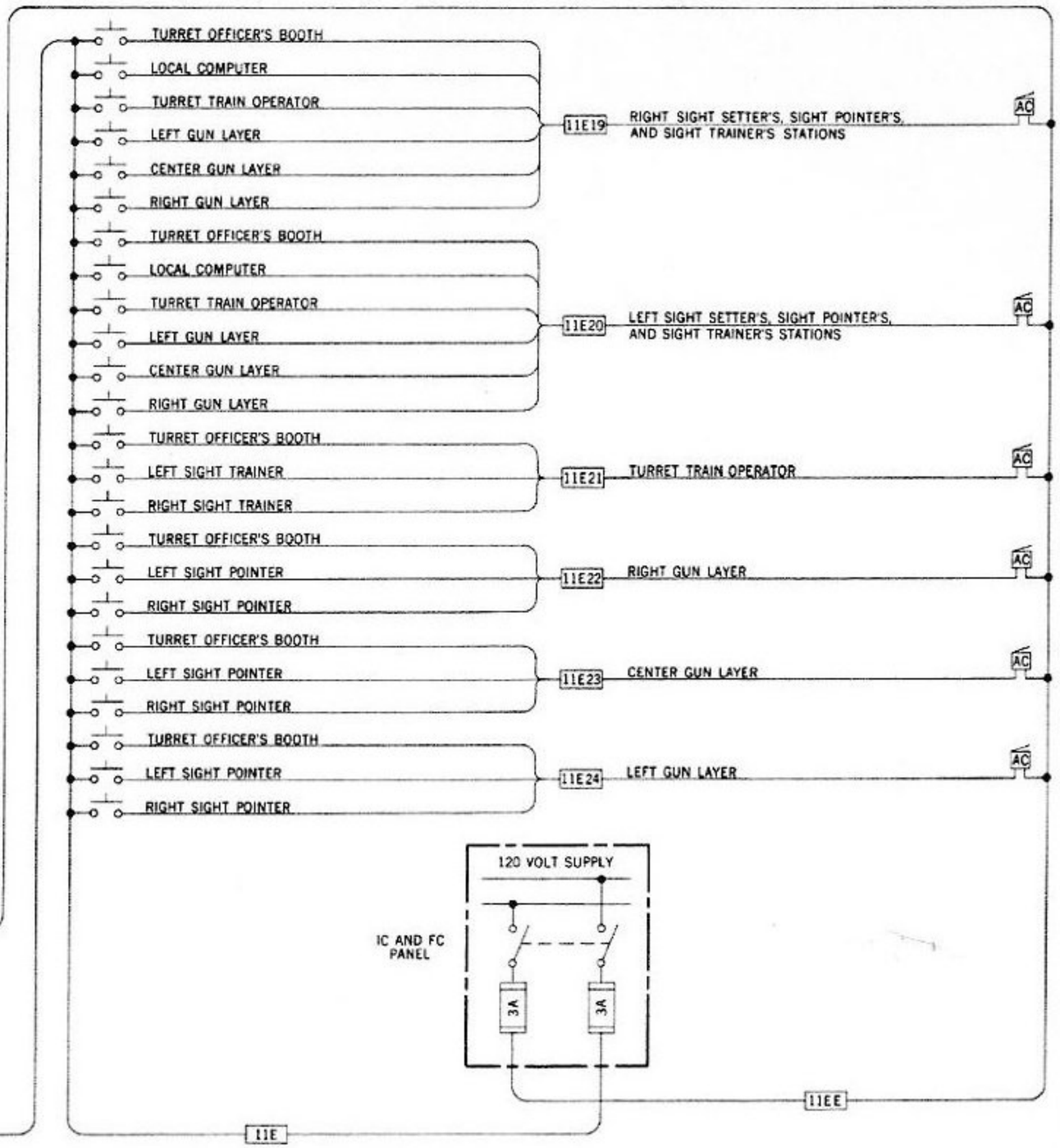


Figure 15-53. Sound Powered Telephone and Voice Tube Call Bell Circuit E. Elementary Wiring Diagram

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

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

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

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

Lighting system

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

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

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

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

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

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

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

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

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

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

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

Magazine sprinkling system (electric)

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

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

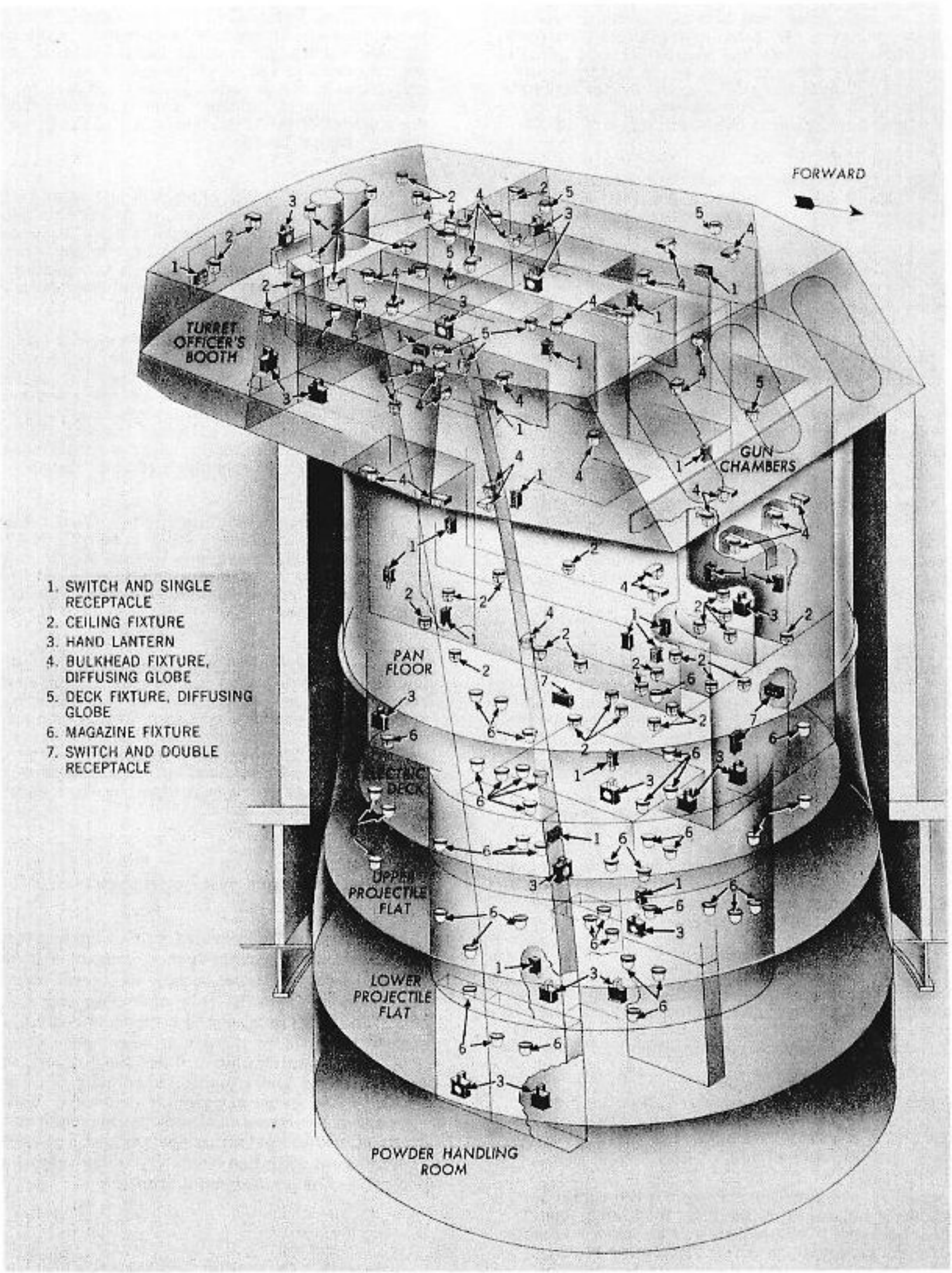


Figure 15-54. Turret Illumination, General Arrangement

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

Electrically Controlled Sprinkling System
Power Supply

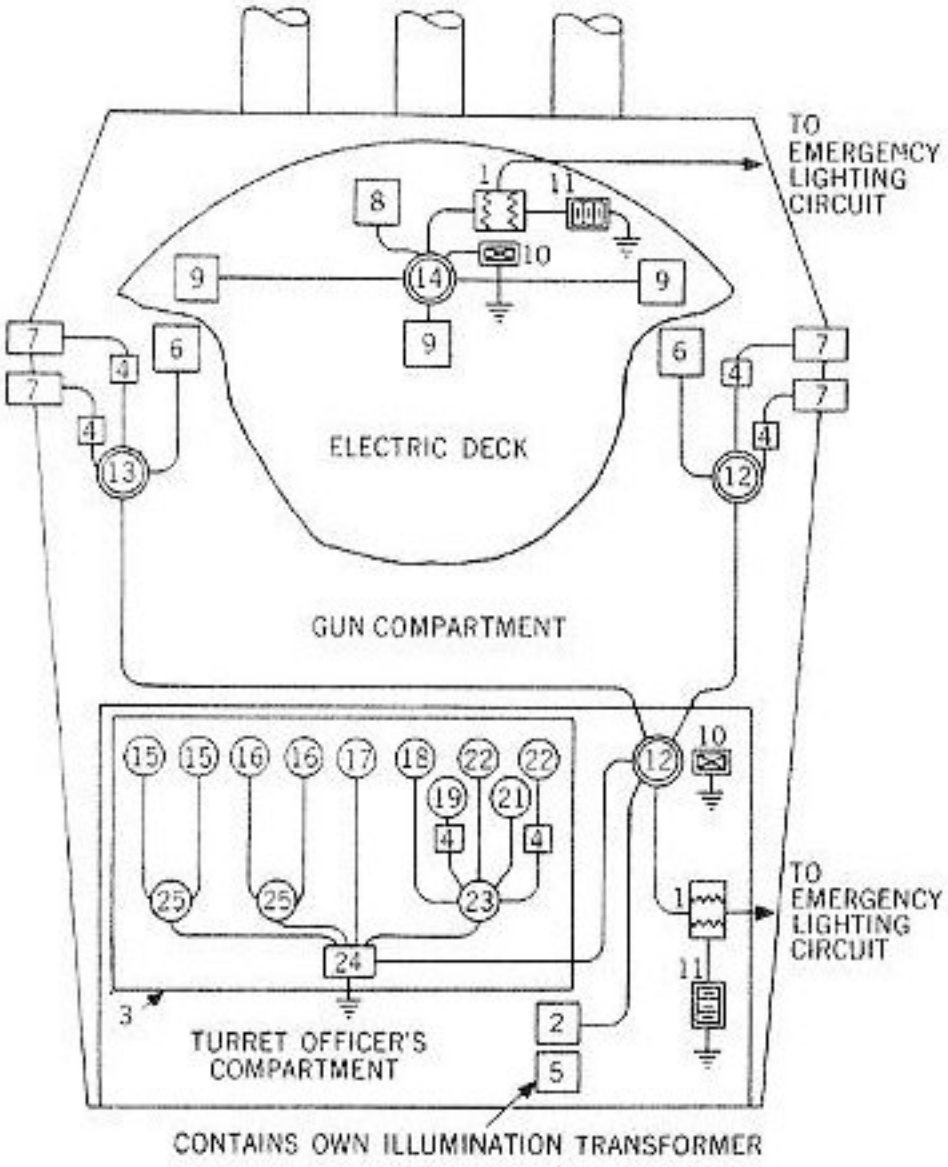
Turret	Main Switchboard	Emergency Switchboard
I	1	Forward
II	1	Forward
III	4	After

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

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

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

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



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

Figure 15-56. Instrument Lighting Arrangements

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

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

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

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

Turret ventilating equipment

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

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

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

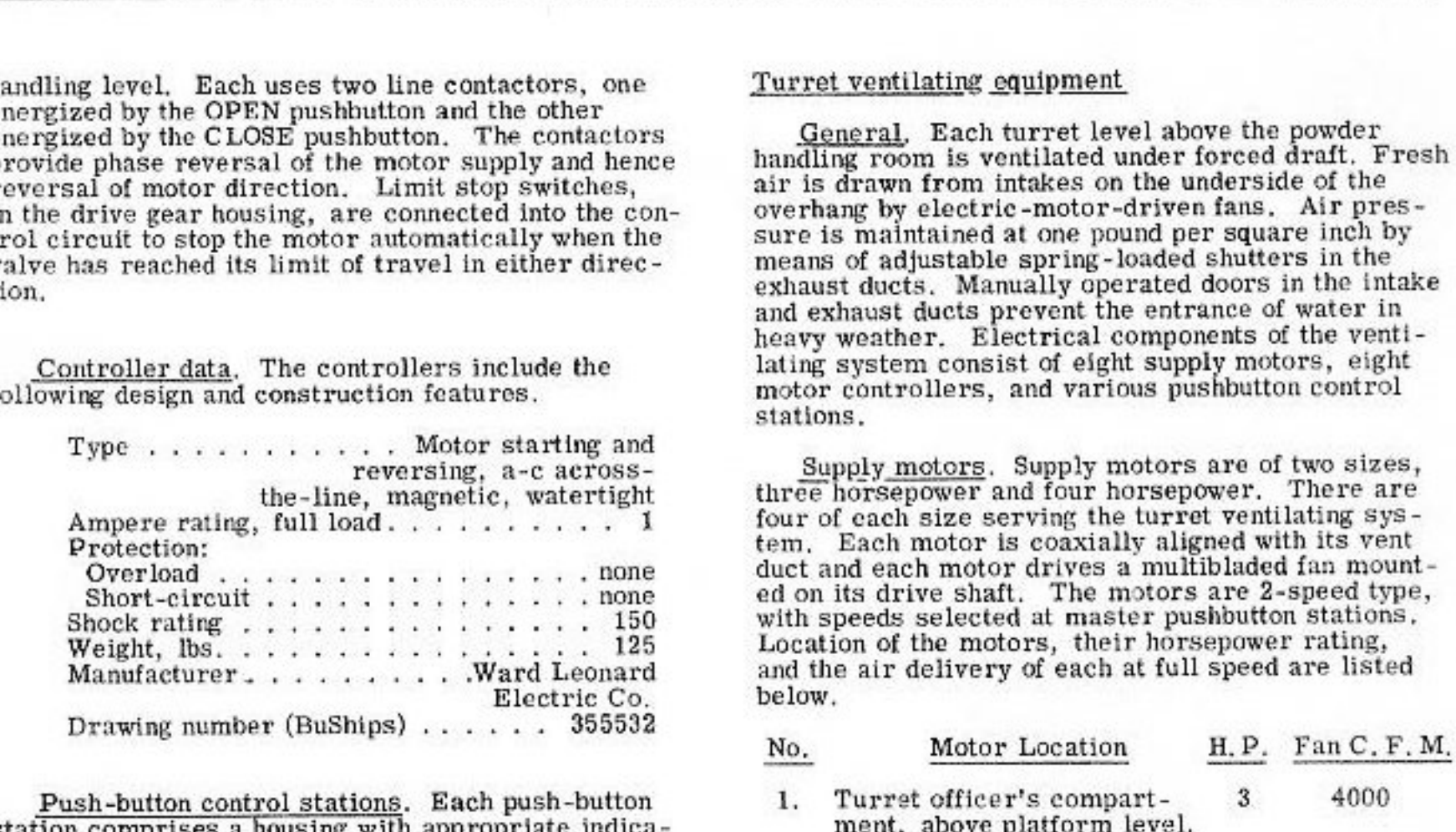


Figure 15-57. Electrically Controlled Sprinkler System. Elementary Wiring Diagram

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

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

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

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

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

* At 1200 rpm

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

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

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

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

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

INSTRUCTIONS

General

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

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

Trouble analysis

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Maintenance

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

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

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

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

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

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

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

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

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

CAUTION: Do not overgrease motors.

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

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

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

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

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

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

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

4. Check the breech firing lock terminal for looseness.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Chapter 16

TURRET AUXILIARY INSTALLATIONS

INTRODUCTION

General

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

DESCRIPTION

Power supply

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

Illumination supply

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

Ventilating system

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

4000 Cubic Feet Per Minute Sets

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

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

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

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

6000 Cubic Feet Per Minute Sets

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

LEGEND FOR FIGURE 16-1.

4000 Cubic Feet per Minute Sets

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

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

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

11. Intake and supply trunk
15. Air supply duct

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

1. Intake and supply trunk
55. Air supply duct

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

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

6000 Cubic Feet per Minute Sets

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

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

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

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

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

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

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

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

Allied Equipment

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

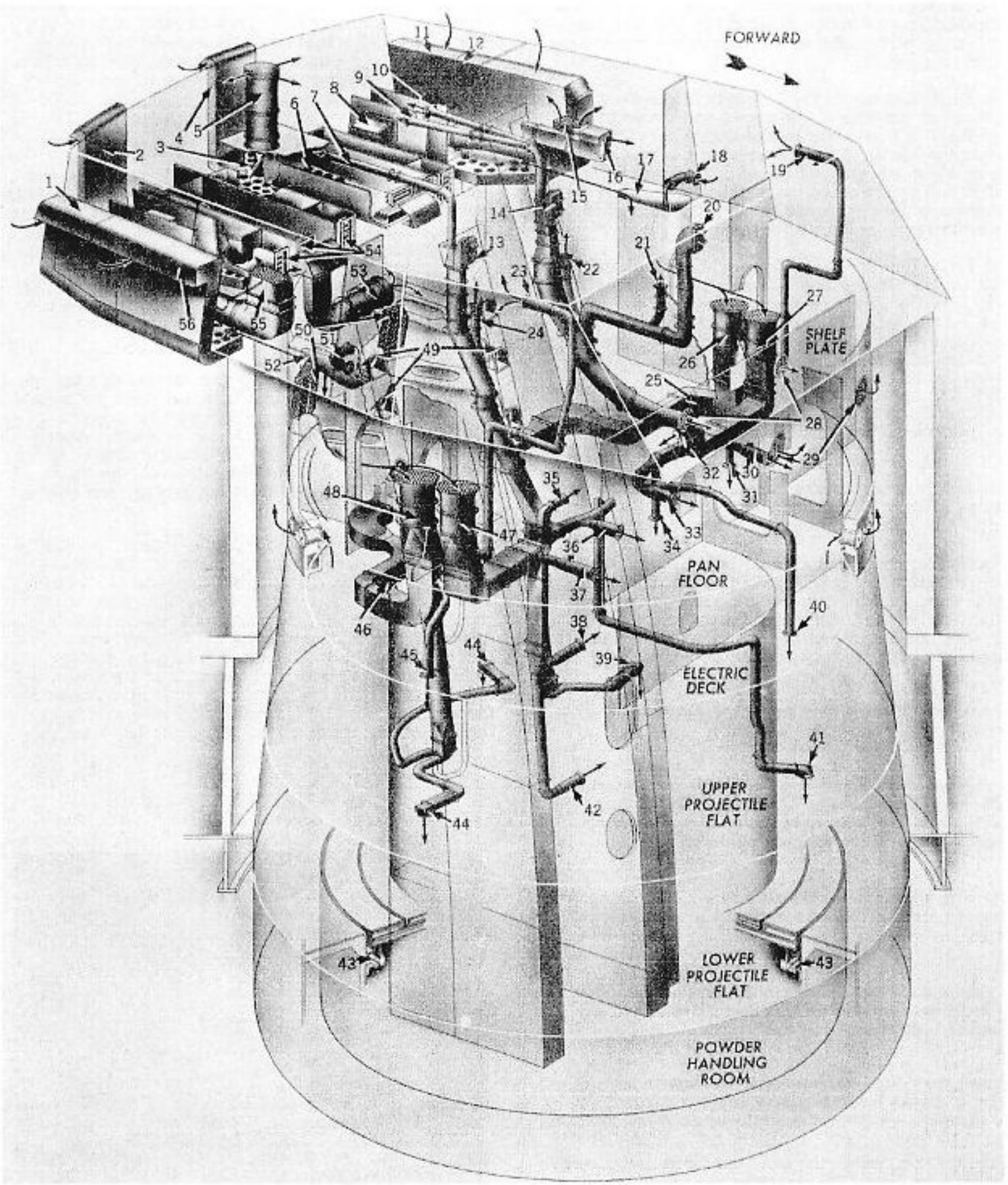


Figure 16-1. Turret Ventilating Systems. General Arrangement

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

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

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

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

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

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

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

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

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

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

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

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

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

Sprinkling system

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

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

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

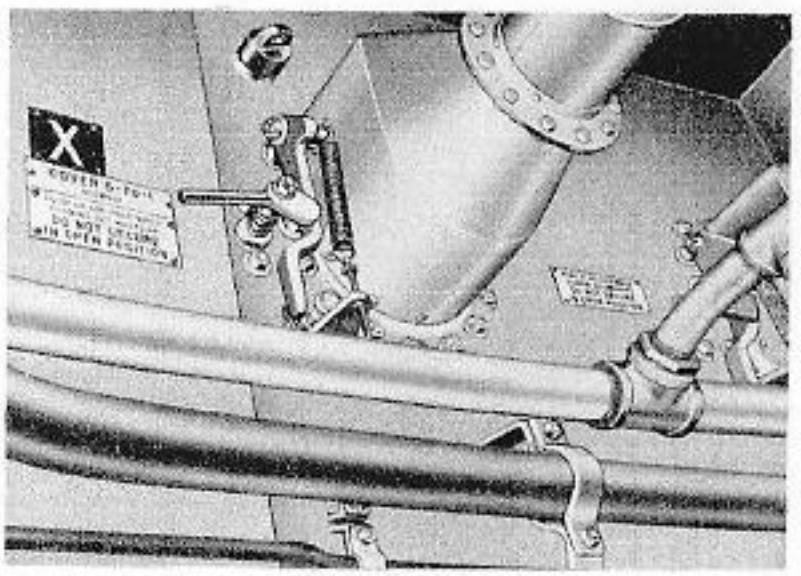
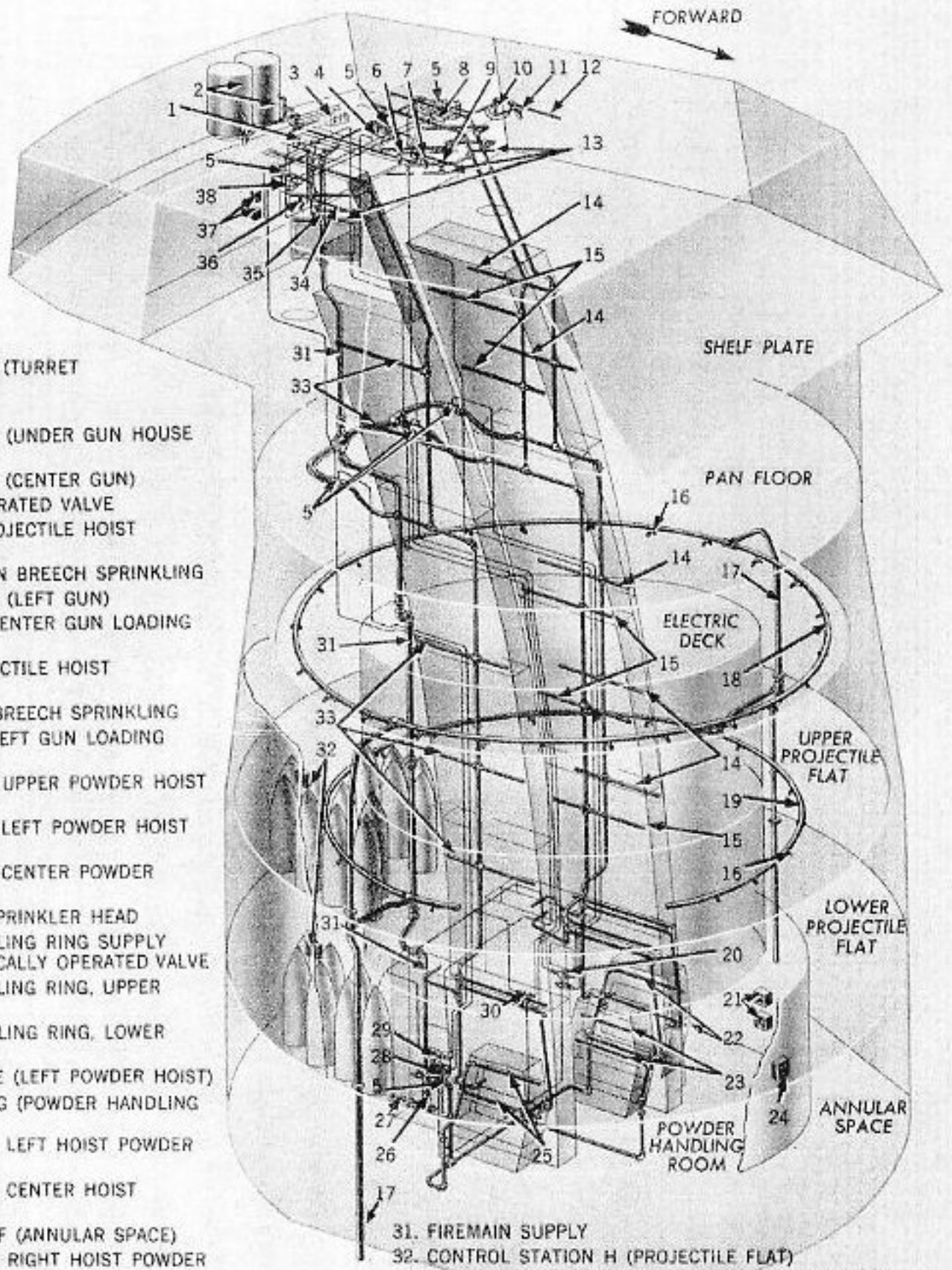


Figure 16-2. Ventilating System Air Exhaust Shutter, General Arrangement



1. CONTROL STATION A (TURRET OFFICER'S BOOTH)
2. SPRINKLING TANKS
3. CONTROL STATION B (UNDER GUN HOUSE OVERHANG)
4. CONTROL STATION C (CENTER GUN)
5. HYDRAULICALLY OPERATED VALVE
6. NOZZLE, CENTER PROJECTILE HOIST SPRINKLING
7. NOZZLE, CENTER GUN BREECH SPRINKLING
8. CONTROL STATION C (LEFT GUN)
9. PERFORATED PIPE, CENTER GUN LOADING TRAY SPRINKLING
10. NOZZLE, LEFT PROJECTILE HOIST SPRINKLING
11. NOZZLE, LEFT GUN BREECH SPRINKLING
12. PERFORATED PIPE, LEFT GUN LOADING TRAY SPRINKLING
13. PERFORATED PIPES, UPPER POWDER HOIST DOOR SPRINKLING
14. PERFORATED PIPES, LEFT POWDER HOIST TRUNK
15. PERFORATED PIPES, CENTER POWDER HOIST TRUNK
16. SPRINKLING RING SPRINKLER HEAD
17. PROJECTILE SPRINKLING RING SUPPLY PIPE FROM ELECTRICALLY OPERATED VALVE
18. PROJECTILE SPRINKLING RING, UPPER PROJECTILE FLAT
19. PROJECTILE SPRINKLING RING, LOWER PROJECTILE FLAT
20. CONTROL STATION E (LEFT POWDER HOIST)
21. CONTROL STATION G (POWDER HANDLING ROOM)
22. PERFORATED PIPES, LEFT HOIST POWDER TRAYS
23. PERFORATED PIPES, CENTER HOIST POWDER TRAYS
24. CONTROL STATION F (ANNULAR SPACE)
25. PERFORATED PIPES, RIGHT HOIST POWDER TRAYS
26. GLOBE VALVE, FIREMAIN SUPPLY
27. HOSE CONNECTION, FIREMAIN SUPPLY
28. CONTROL STATION D (POWDER HANDLING ROOM)
29. CONTROL STATION E (RIGHT POWDER HOIST)
30. CONTROL STATION E (CENTER POWDER HOIST)
31. FIREMAIN SUPPLY
32. CONTROL STATION H (PROJECTILE FLAT)
33. PERFORATED PIPES, RIGHT POWDER HOIST TRUNK
34. PERFORATED PIPE, RIGHT GUN LOADING TRAY SPRINKLING
35. NOZZLE, RIGHT GUN BREECH SPRINKLING
36. NOZZLE, RIGHT PROJECTILE HOIST SPRINKLING
37. CONTROL STATION I (TURRET OFFICER'S BOOTH)
38. CONTROL STATION C (RIGHT GUN)

Figure 16-3. Turret Sprinkling System. General Arrangement

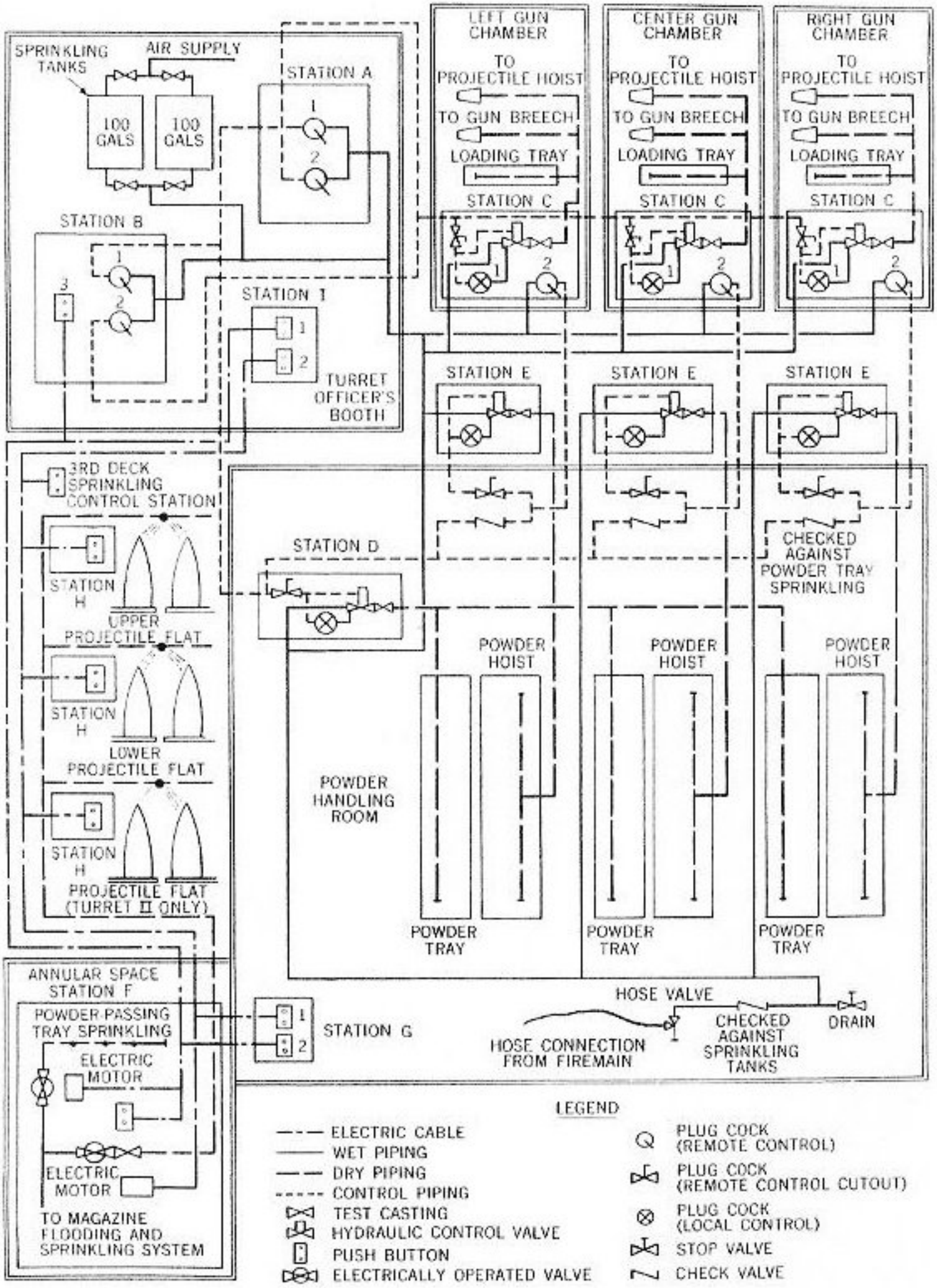


Figure 16-4. Turret Sprinkling System. Schematic Diagram

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

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

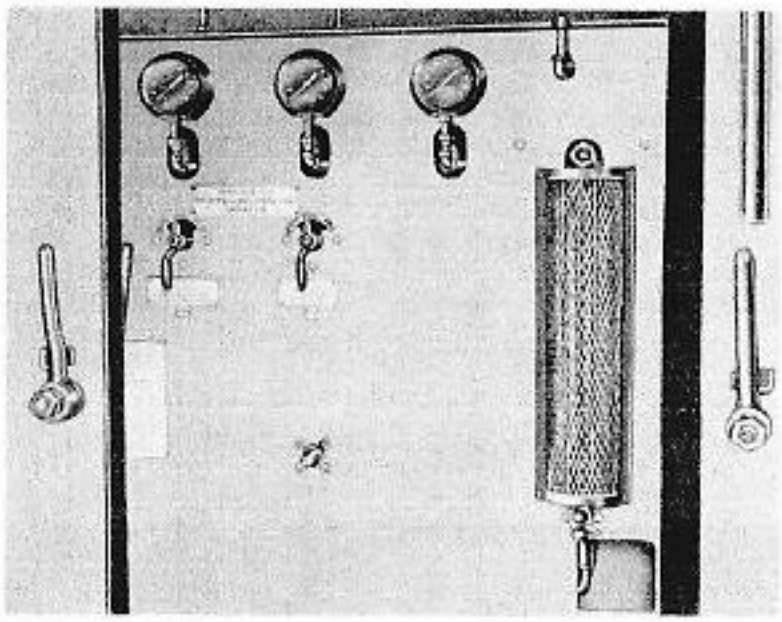


Figure 16-5. Magazine Sprinkling Control Station in Annular Space. General Arrangement

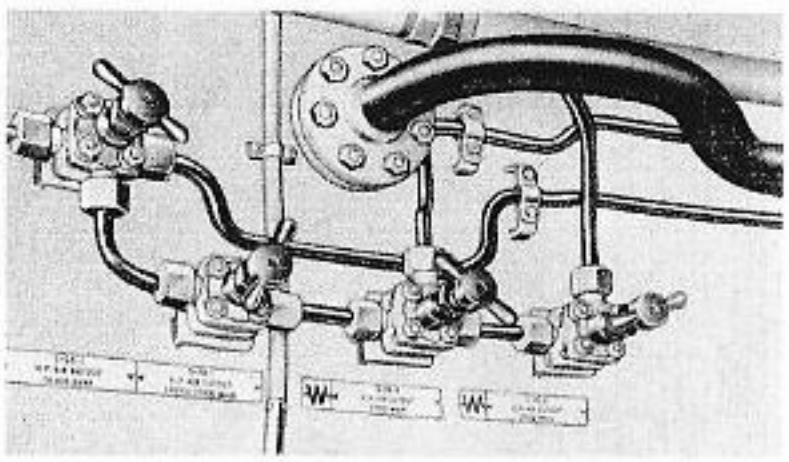


Figure 16-7. High Pressure Air System, Cutout Valves. Lower Projectile Flat, General Arrangement

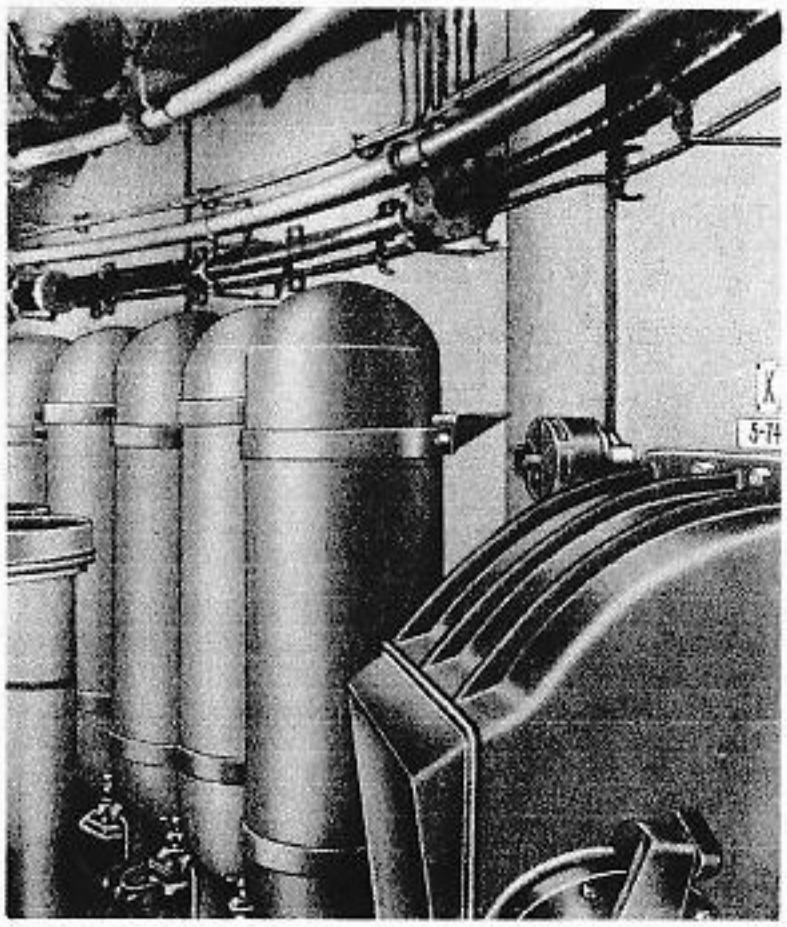


Figure 16-6. High Pressure Air Bottles in Annular Space. General Arrangement

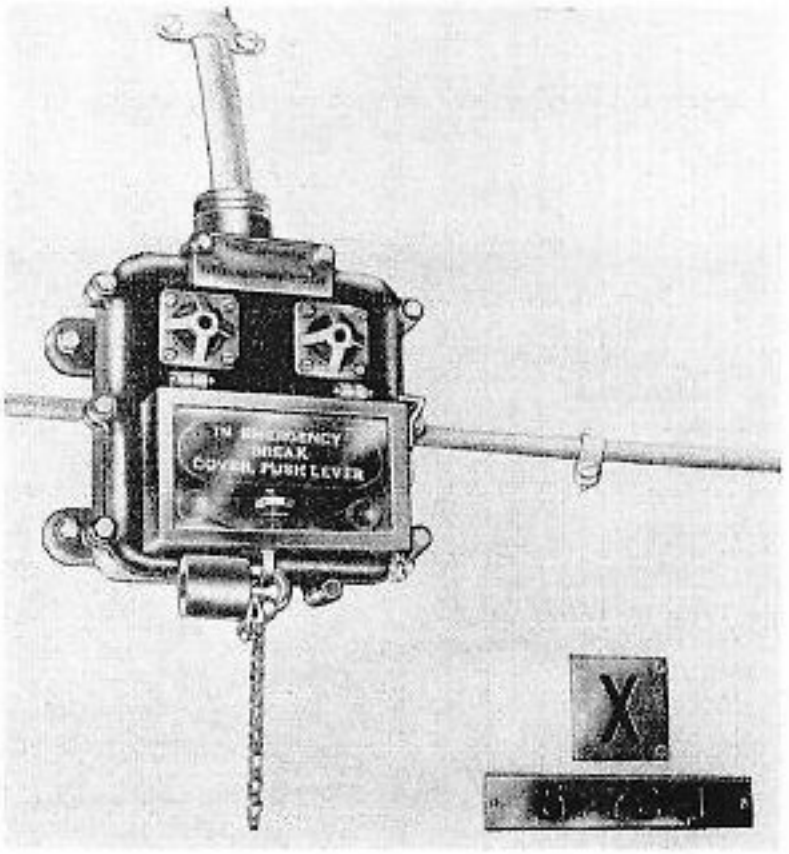


Figure 16-8. Turret Sprinkling Control Station F

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

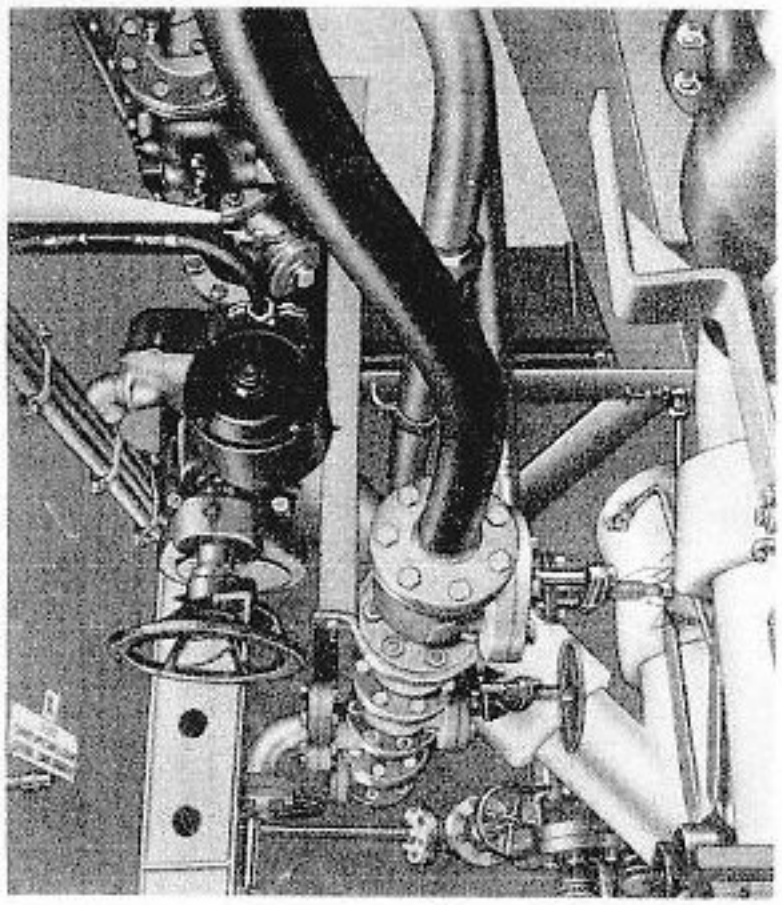


Figure 16-9. Sprinkling System Components in Annular Space

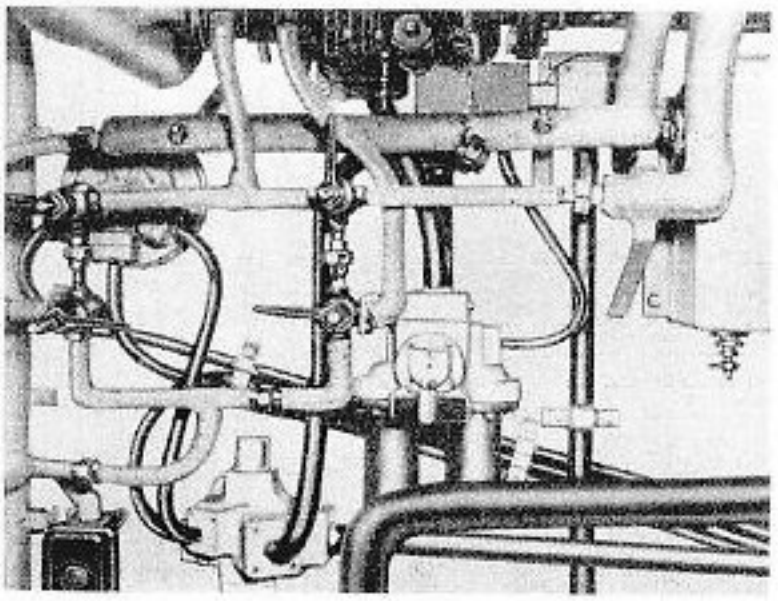


Figure 16-10. Sprinkling System Components on Electric Deck

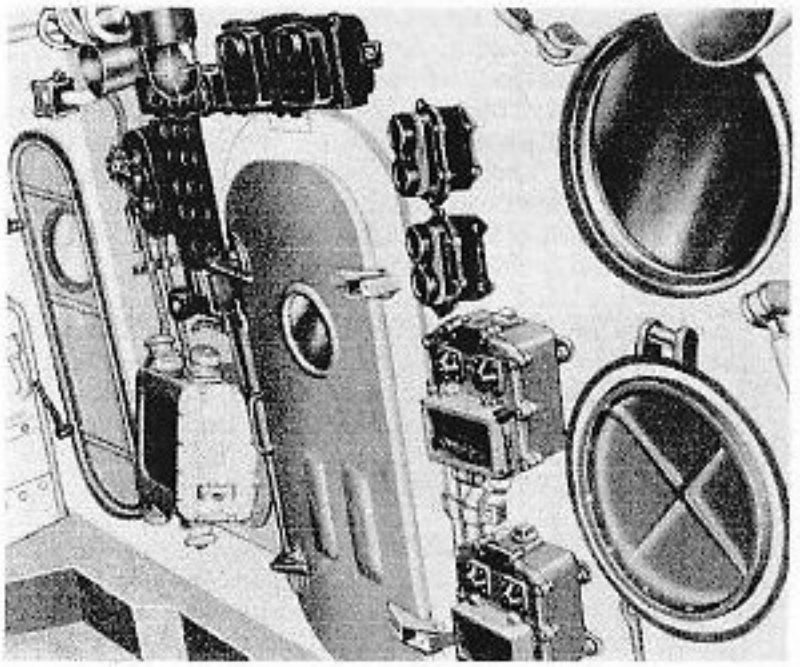


Figure 16-11. Turret Sprinkling Control Station I

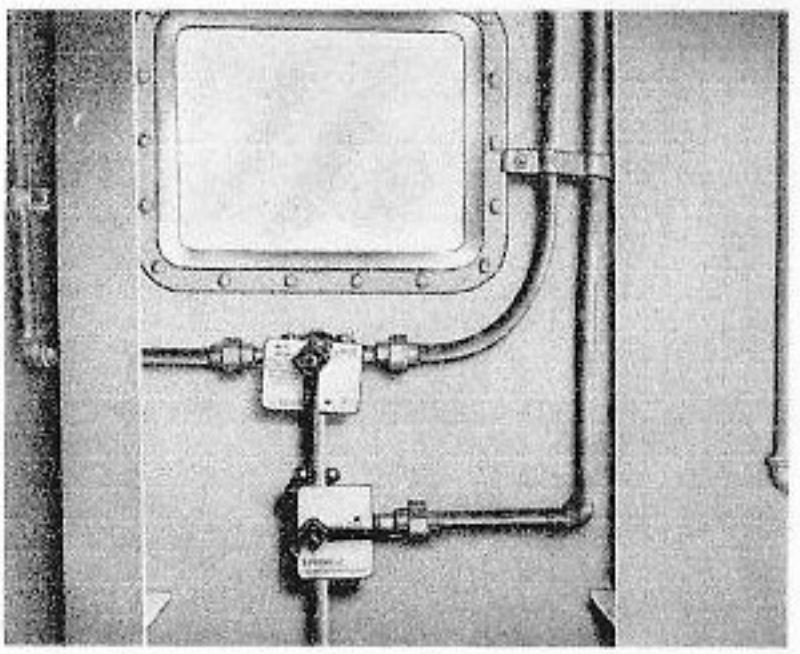


Figure 16-12. Turret Sprinkling Control Station E

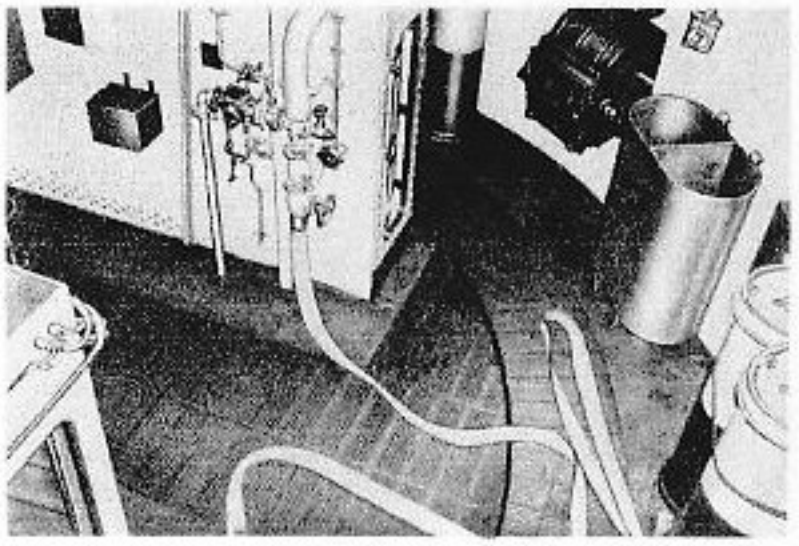


Figure 16-13. Firemain Connection in Rotating Structure

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

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

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

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

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

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

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

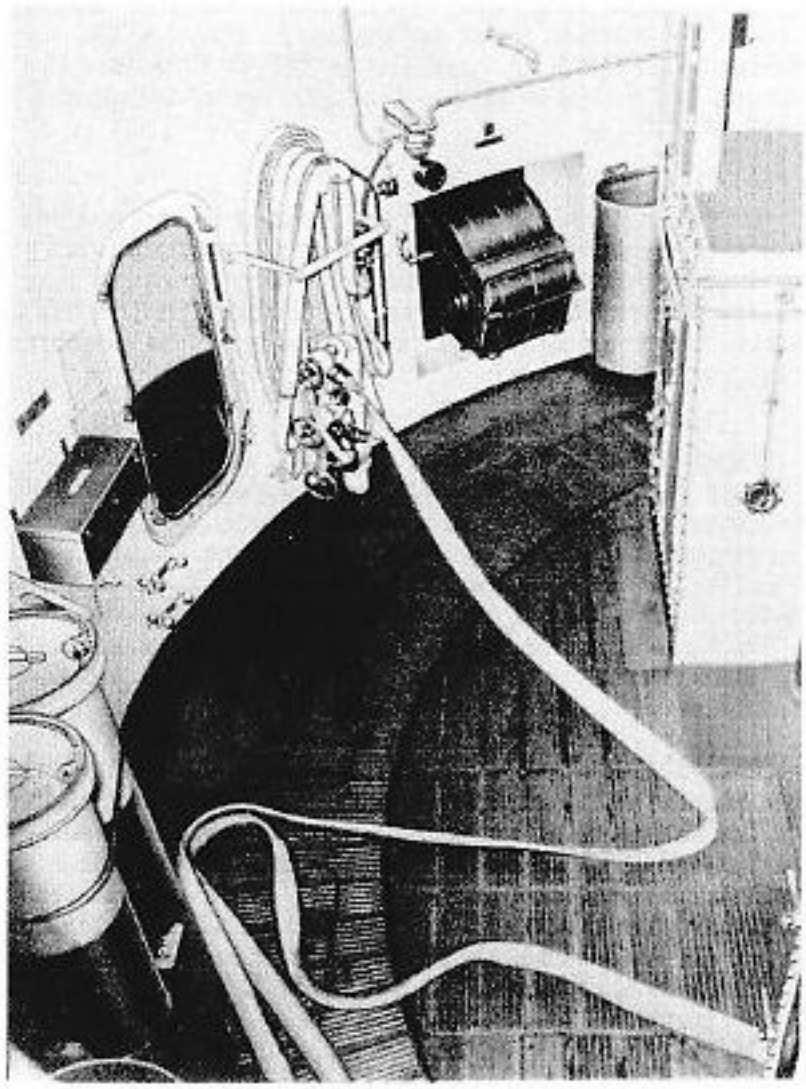


Figure 16-14. Firemain Connection in Non-rotating Structure

the three powder hoists. Valve 2 controls gun room sprinkling. Turning the handle to SPRINKLE permits water to flow into the projectile hoist, gun breech, and loading tray in each gun room.

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

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

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

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

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

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

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

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

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

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

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

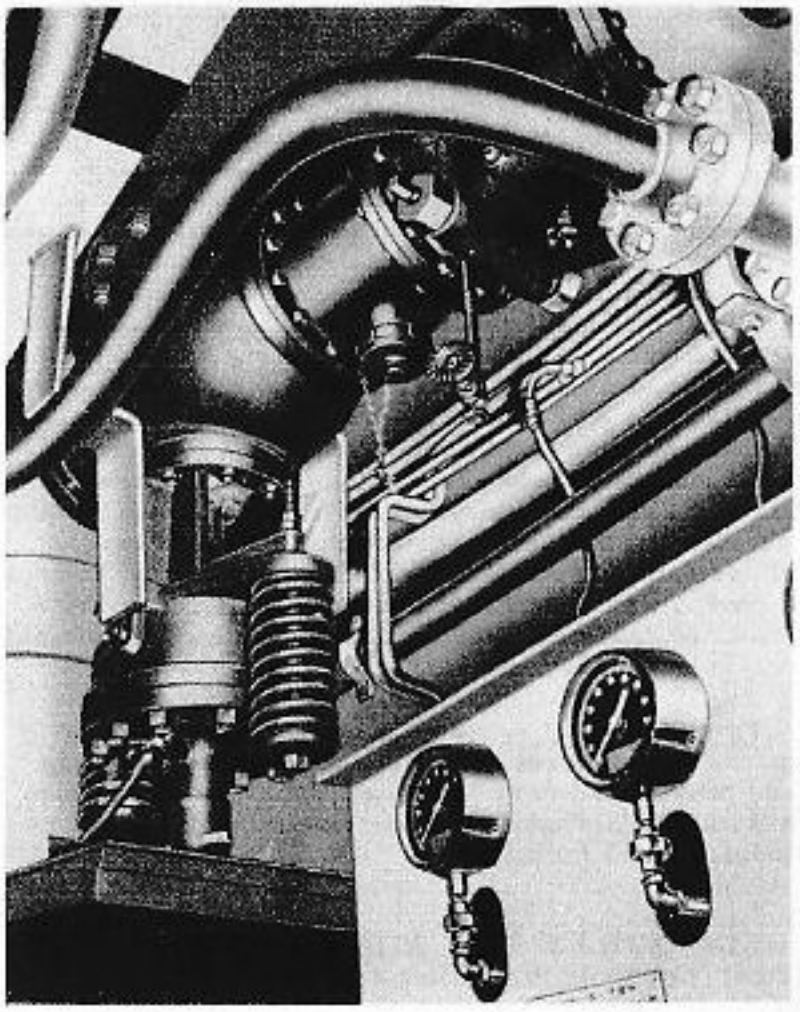


Figure 16-15. Electrically Operated Sprinkling Control Valve

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

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

Counterrecoil air charging system

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

Chapter 17

HYDRAULIC EQUIPMENT INSTRUCTIONS

GENERAL

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

Purpose of instructions

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

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

INSTALLATION INSTRUCTIONS

Initial installation

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

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

Overhauled installation

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

Special fitting, cleanliness

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

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

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

Spare hydraulic equipment

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

Partial installations

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

Threading pipe

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

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

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

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

Flanged pipe fitting

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

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

Flared pipe fitting

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

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

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

Cleaning pipe

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

Copper pipe.

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

Alternatively, copper pipe may be cleaned as follows:

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

Steel Pipe.

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

Alternatively, steel pipe may be cleaned as follows:

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

Making pipe connections

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

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

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

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

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

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

Pipe connection test

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

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

Shaping and securing pipes

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

Filling hydraulic drive systems

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

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

Procedure for initial period of operation

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

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

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

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

MAINTENANCE INSTRUCTIONS

General

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

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

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

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

Daily exercise

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

Hydraulic fluid

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

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

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

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

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

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

Hydraulic system service maintenance

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Precautions for hydraulic system dismantling and servicing

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

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

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

Chapter 18

LUBRICATION INSTRUCTIONS

GENERAL INSTRUCTIONS AND INFORMATION

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

Turret lubrication facilities

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

Selection of lubricants

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

TABLE OF PRESCRIBED LUBRICANTS

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

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

Adulterants

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

PRINCIPLES OF GOOD LUBRICATING PRACTICE

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

Function

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

Frequency

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

Distribution

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

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

Lubrication of antifriction bearings

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

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

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

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

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

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

Excessive lubrication

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

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

Cleanliness

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

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

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

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

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

Preservation

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

Substitution

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

Temperature variations

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

LUBRICATION CHARTS

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

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

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

Detailed lubrication features

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Chapter 19

TOOLS AND ACCESSORIES

GENERAL DESCRIPTION

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

Special equipment

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

Standard equipment

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

Identities

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

Types

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

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

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

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

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

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

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

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

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

INSTRUCTIONS

General

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

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

Operating precautions

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

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

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

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

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

Storing

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

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

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

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

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

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

The preservative material must be applied immediately after cleaning.

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

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

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

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

TABLE 19-1. GUN TOOLS AND ACCESSORIES

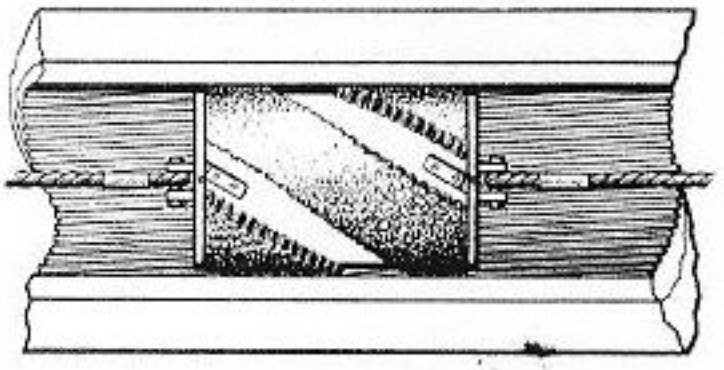
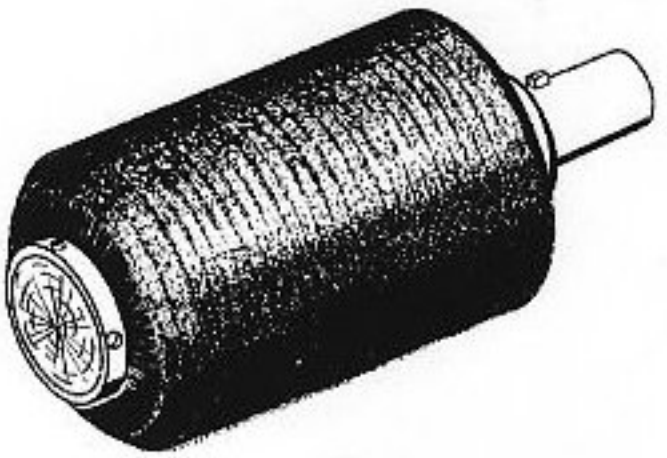
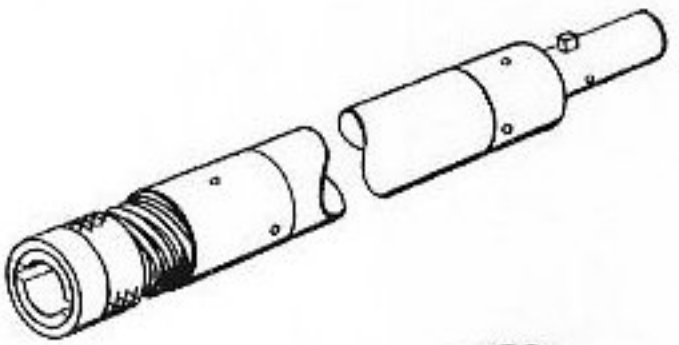
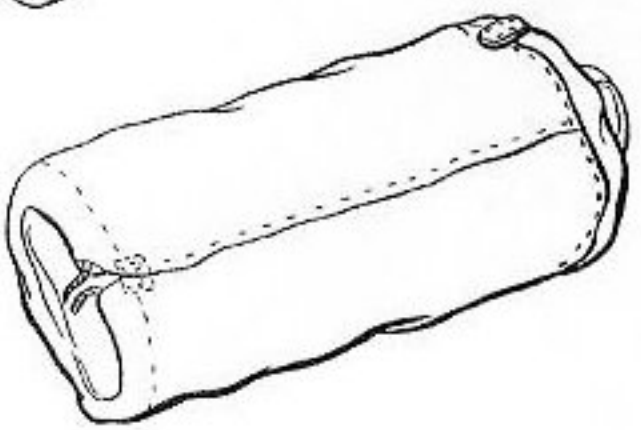
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Bristle sponge (bore)	8-Z-854	Clean the bore of the gun	
Bristle sponge (chamber)	8-Z-823	Clean the powder chamber	
Section handle	8-Z-825	With bore lapping head or similar accessories	
Bristle sponge canvas cap (bore)	8-Z-855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

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

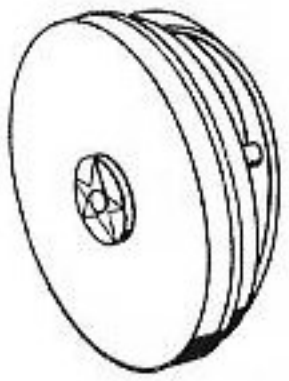
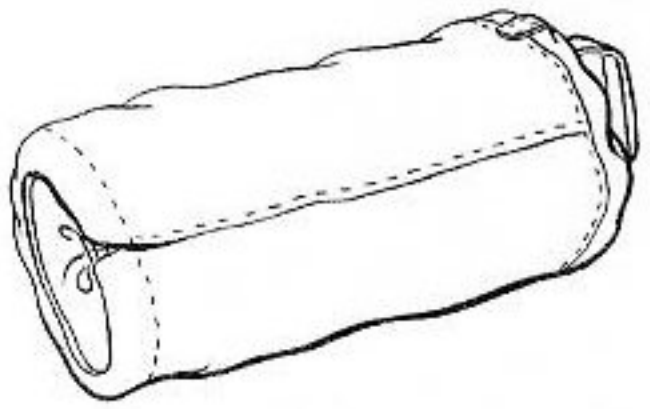
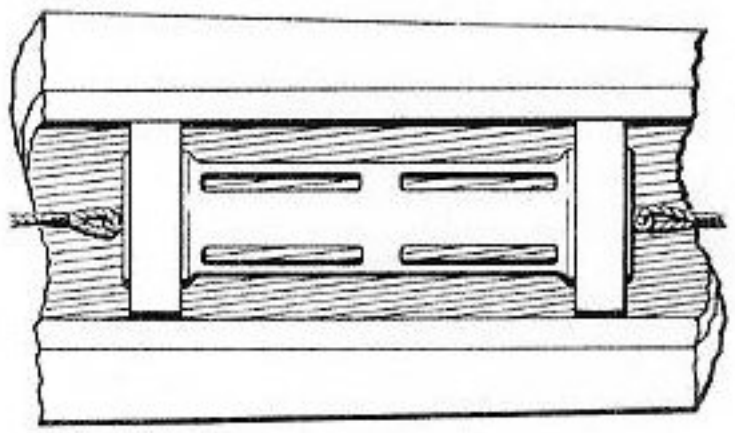
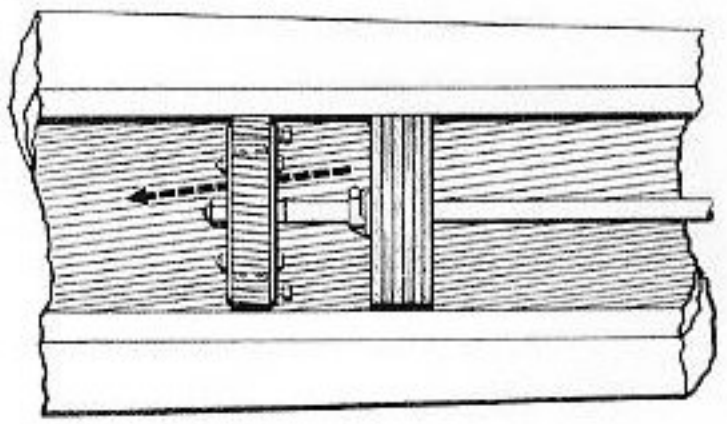
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Tompion	49830	To seal the muzzle end of the bore when the gun is not in use	
Bristle sponge canvas cap (chamber)	8-Z-849	Protect bristle sponge (8-Z-823) when not in use	
Bore plug gage	52120	Check gun bore for constrictions	
Bore lapping head	SK.12032	Clean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

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

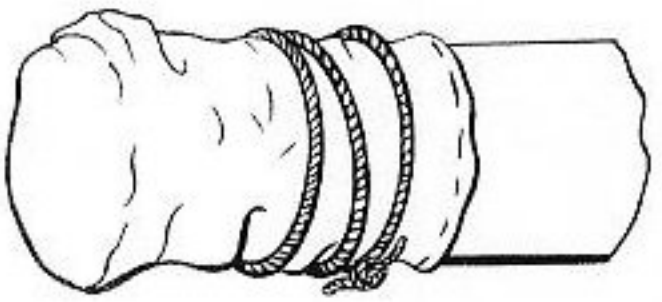
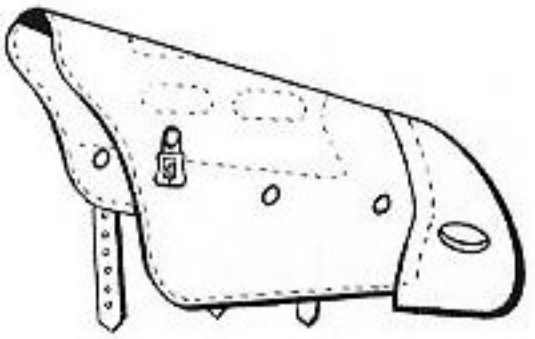
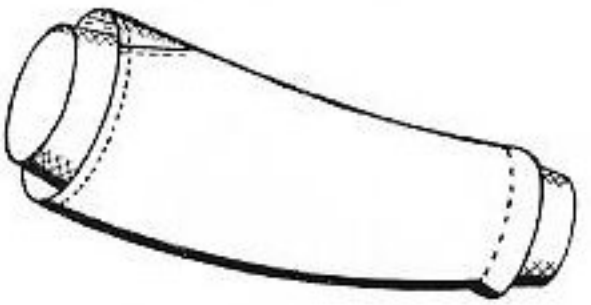
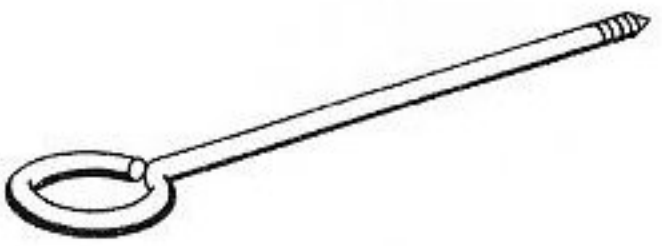
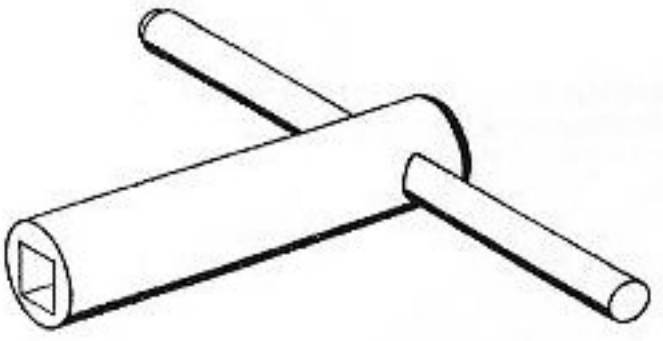
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Canvas cap	Fabricate locally	In addition to tompion to cover gun muzzle	
Gun captain's (base) sleeve	440598	To protect gun captain's arm when wiping mushroom after firing	
Gun captain's (cover) sleeve	440599	To protect gun captain's arm when wiping mushroom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

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

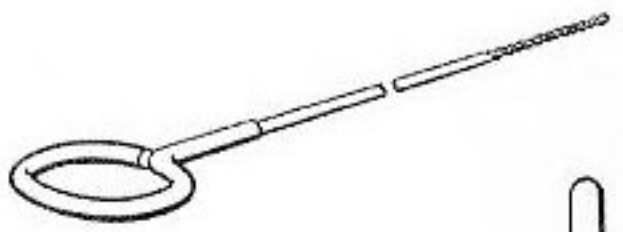
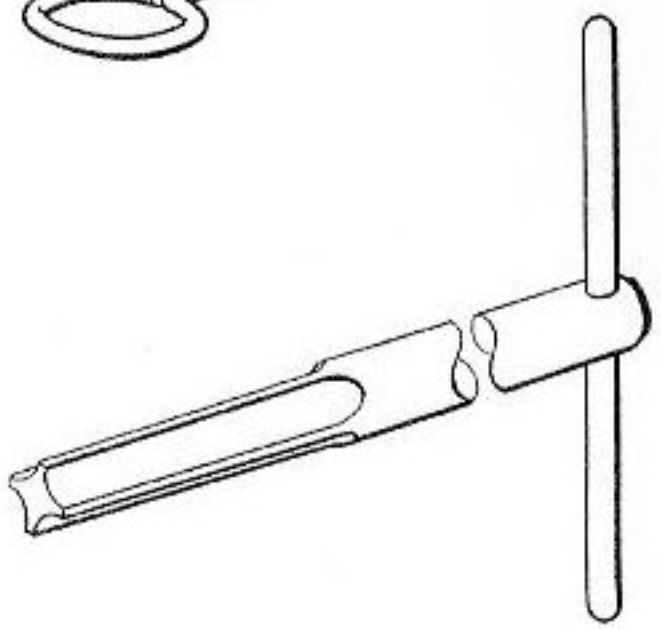
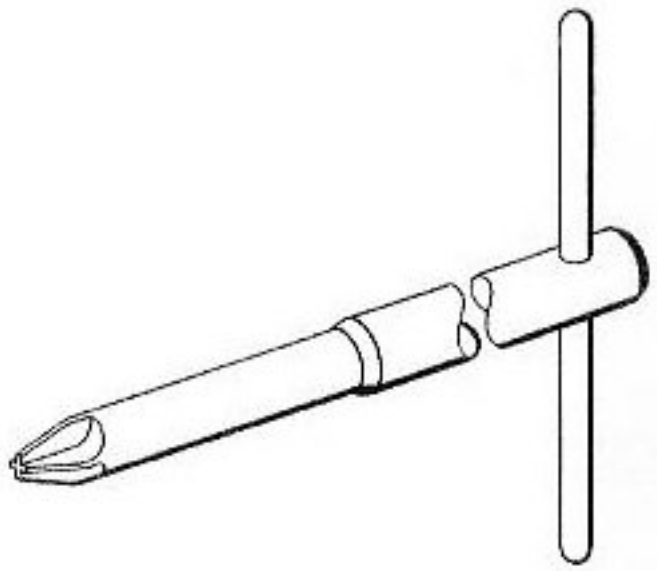
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Vent cleaner and priming bit	8-Z-901-9	Cleaning the hole drilled through the mushroom and stem	
Primer seat cleaner	8-Z-901-10	Cleaning the primer seat (mushroom stem)	
Primer vent cleaner	8-Z-901-12	Cleaning the mushroom vent hole	
Handle for primer seat and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

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

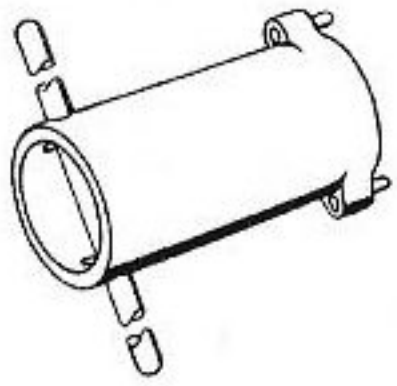
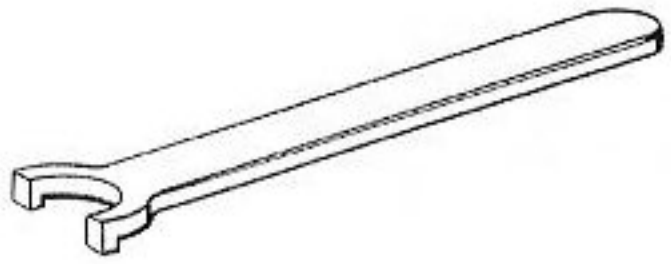
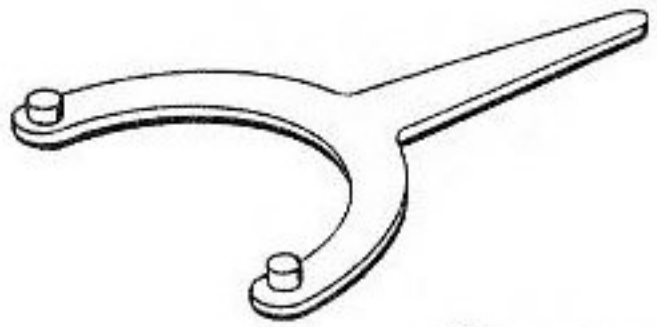
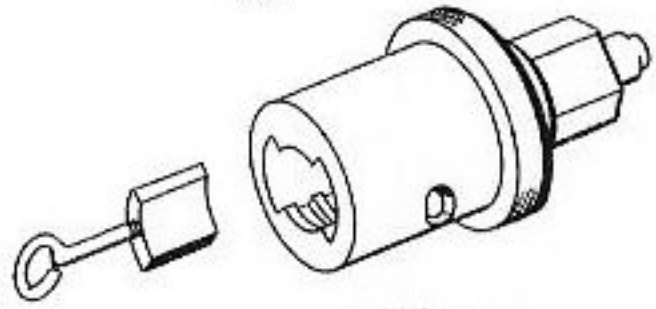
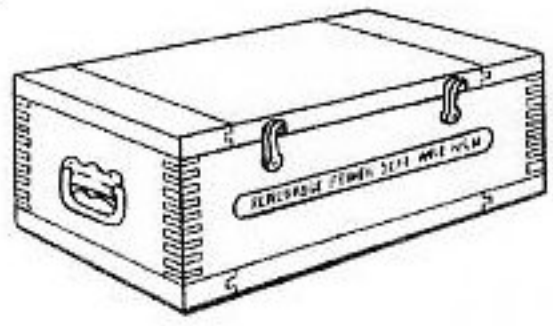
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Wrench for mushroom nut	8-Z-905-2	Tighten and loosen nut on end of mushroom stem	
Spanner wrench, face type	8-Z-918-4		
Spanner wrench, face type	8-Z-918-5		
Removable primer seat wrench	8-Z-922	Removing and replacing mushroom primer seat	
Removable primer seat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

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

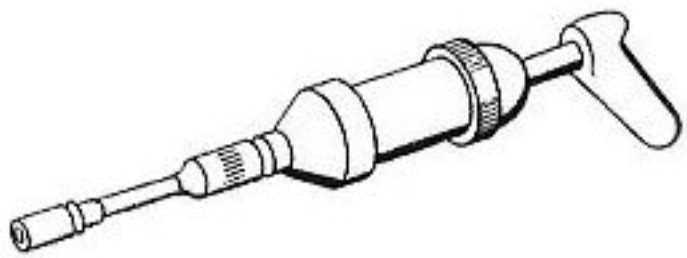
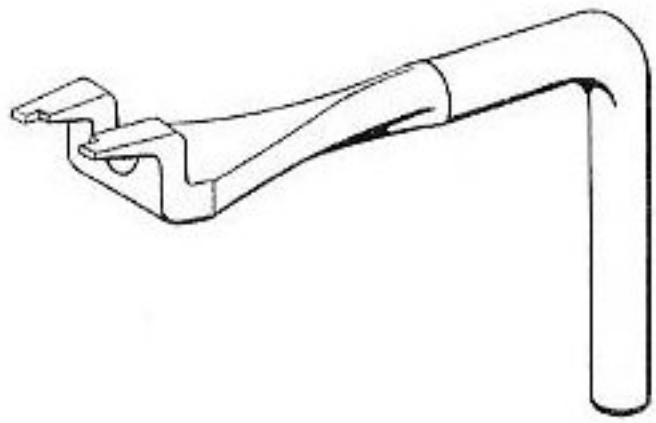
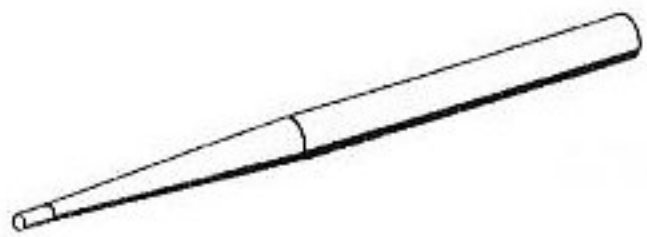
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Packing gun	8-Z 966	Sealing air duct in screw box liner	
Hydraulic grease gun	12-Z-339	Gun lubrication	
Mushroom stem protecting cap	26563-2	Protect mushroom stem when firing lock is removed	
Firing lock tools:			
Spanner wrench	8-Z-910-8	Removal of firing pin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

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

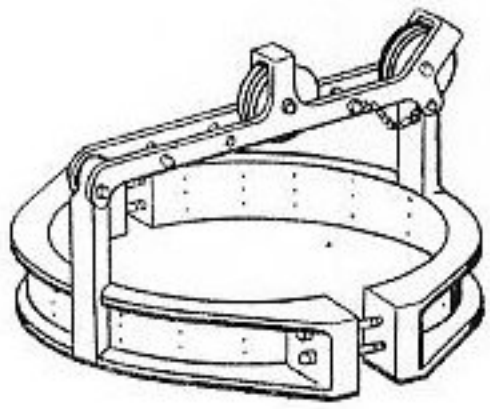
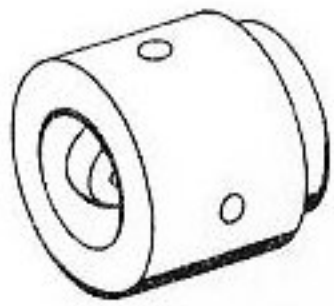
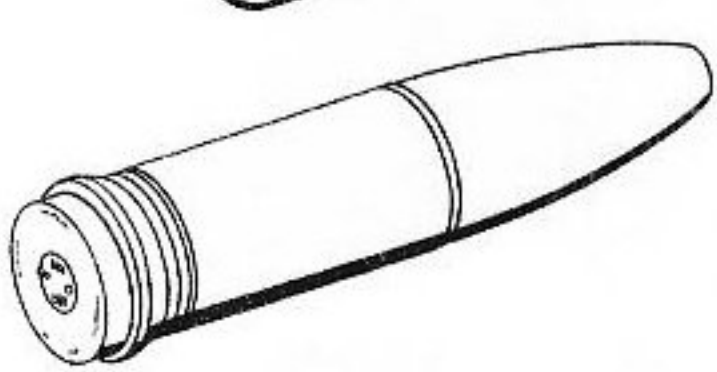
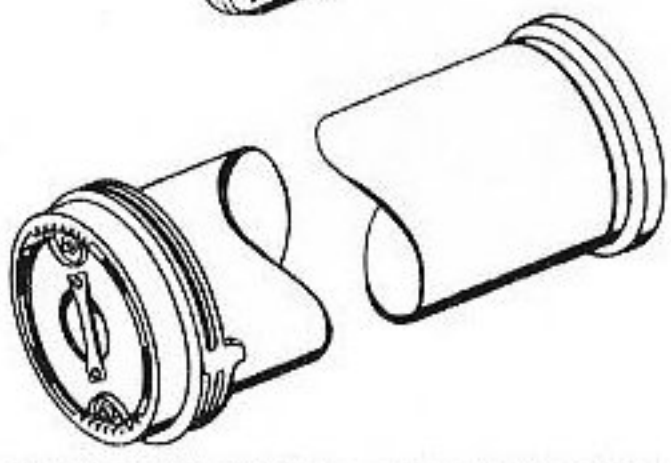
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Exercise accessories:			
Muzzle sheave rig, backing out rammer	236161	Remove drill projectiles seated in the gun	
Backing out rammer	236162	Remove drill projectiles seated in the gun	
16-inch Drill Projectile Mk 2	267650	Turret practice	
Drill powder bag	245791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

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

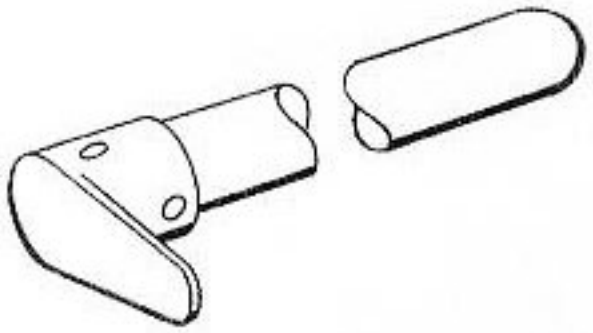
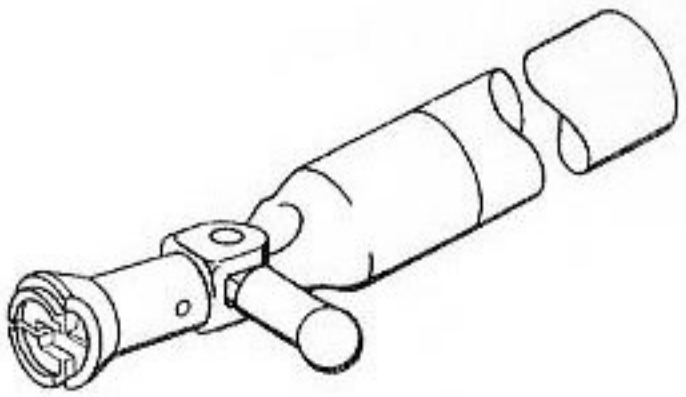
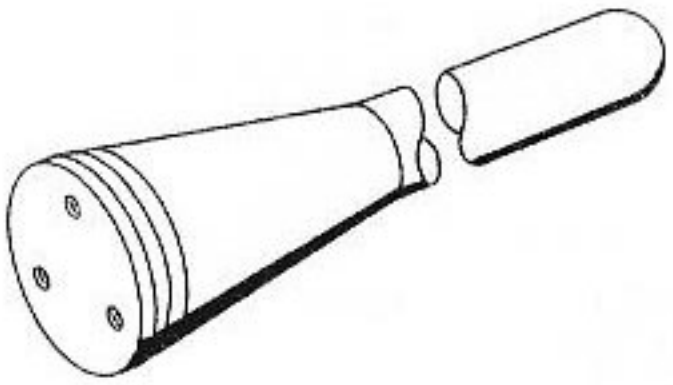
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Powder unloading tool	49401	To remove powder bags from powder tanks or gun chamber	
Repriming	8-Z-931	Insert primers, live, or dummy, in firing lock	
Hand rammer	8-Z-883	Seat projectiles, live or dummy, in gun	
Shell eye bolt Mk 2	66346	Pulling projectiles,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

TABLE 19-2. SLIDE TOOLS AND ACCESSORIES

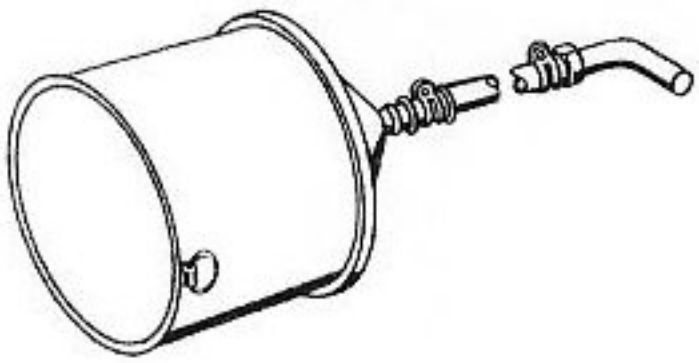
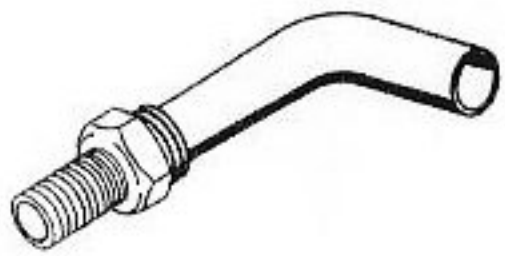
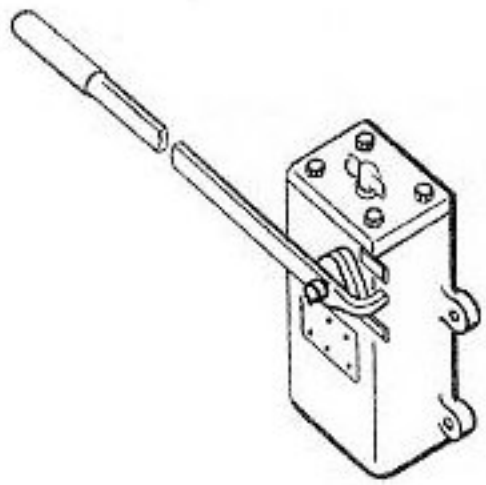
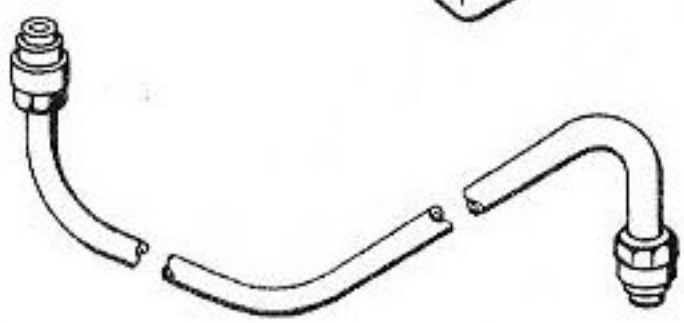
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Recoil system charging tools:			
Funnel assembly	8-Z-801		
Funnel adapter	8-Z-801-3		
Liquid charging pump	118218	Charging counterrecoil liquid system	
Portable air pipes (123 inches long)	232385-1	Charging counterrecoil pneumatic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

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

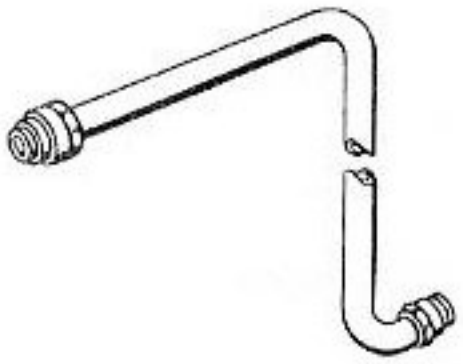
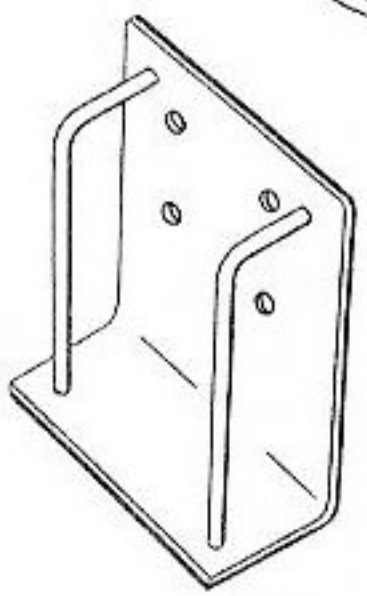
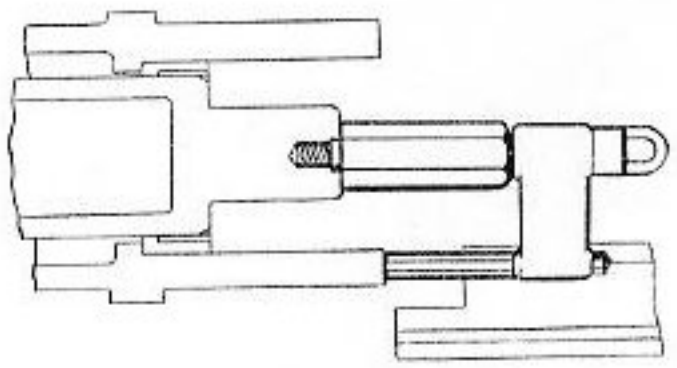
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Portable liquid pipes (93.50 inches long)	232384-1	Charging counterrecoil liquid system	
Liquid pump gage assembly	164698	Liquid pressure gage for charging pump	
Liquid pump stand	118768	Stand for liquid charging pump	
<u>Slide servicing tools</u>:			
Counterrecoil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

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

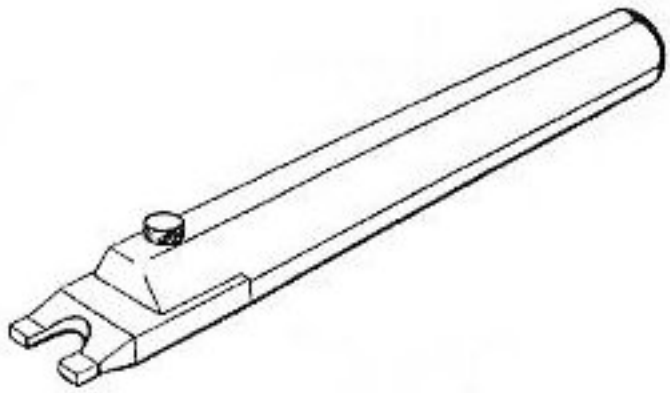
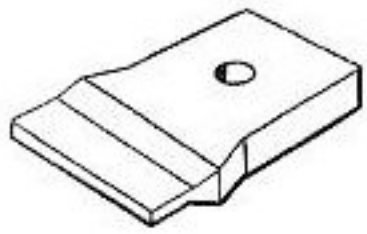
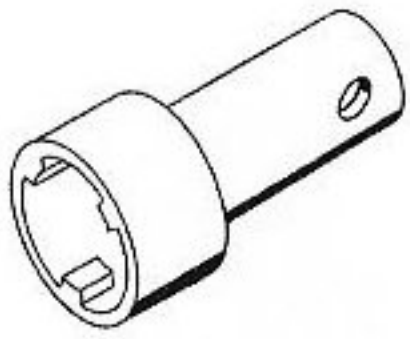
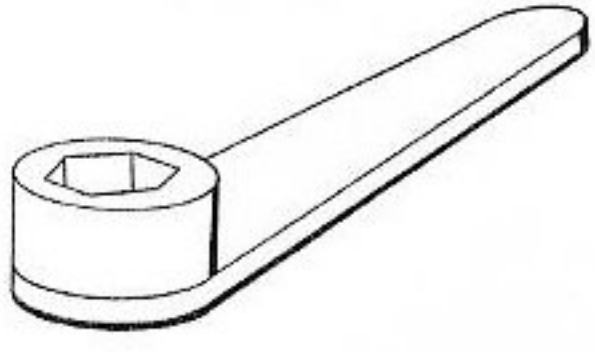
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Special screw driver assembly	8-Z-909-5, 7, 8	General maintenance and repair work	
Screw driver blade (1.50 inches wide)	8-Z-909-9	Used with handle of screw driver assembly	
Socket spanner wrench	8-Z-948-1	Tighten or loosen counterrecoil valve assembly gland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

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

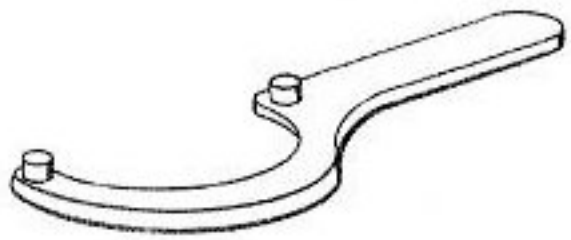
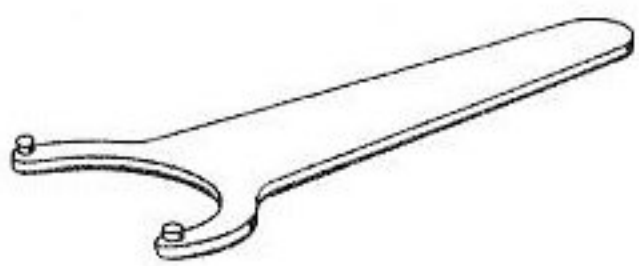
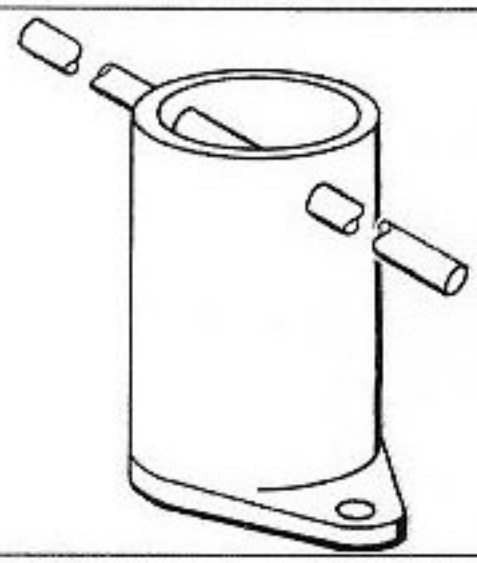
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Spanner wrench, hook type (7.375 inches radius)	8-Z-955-2	Tighten or loosen recoil cylinder piston rod nut	
Spanner wrench, hook type (8.375 inches radius)	8-Z-955-3	Tighten or loosen recoil cylinder head nut	
Face spanner wrench	8-Z-955-6	Tighten or loosen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

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

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

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

TABLE 19-3. ELEVATING GEAR TOOLS AND ACCESSORIES

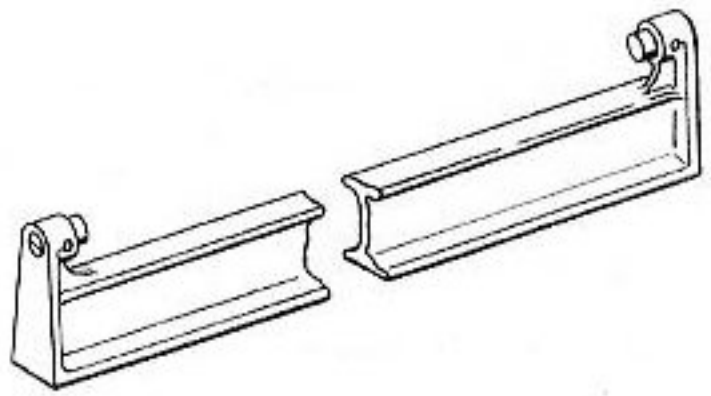
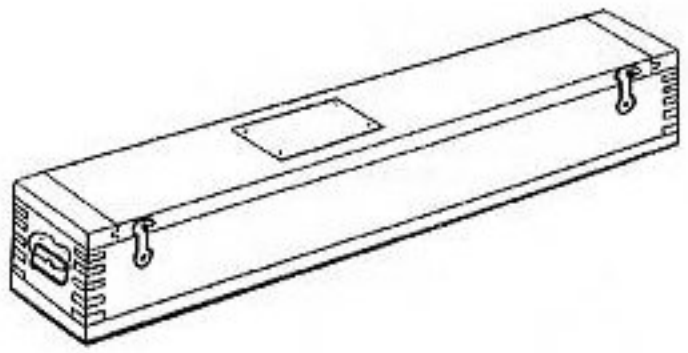
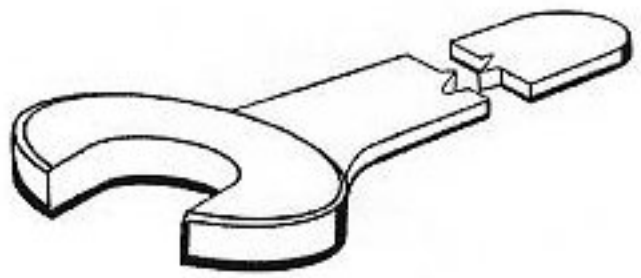
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Tram	8-Z-934	To locate precisely the gun position in train and elevation	
Tram test gage	8-Z-935	To check the tram	
Tram and test gage box	8-Z-1215	To hold the tram and test gages when they are not in use	
Maintenance tools: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

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

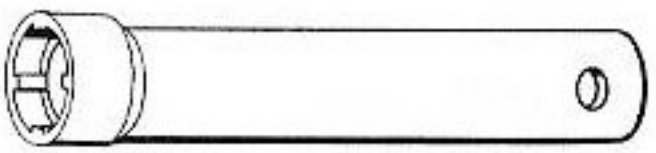
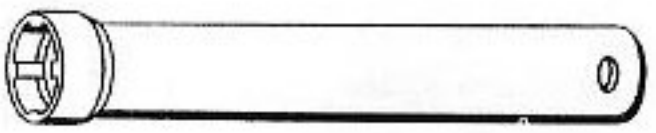
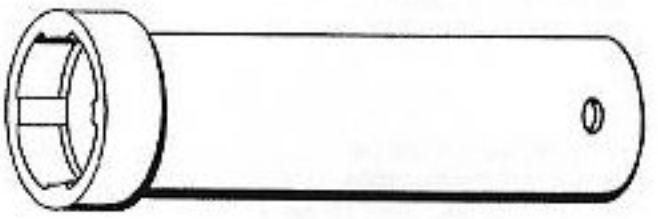
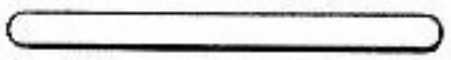
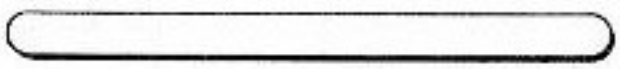
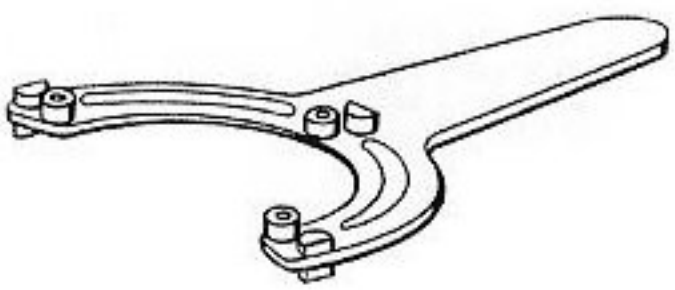
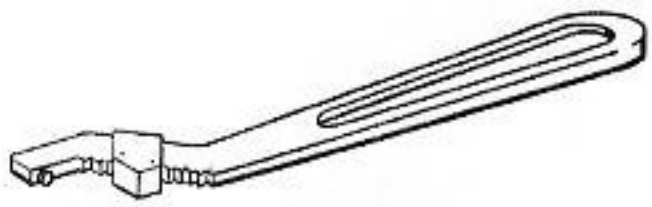
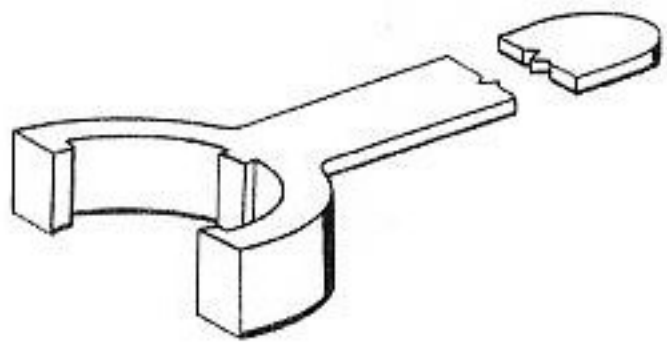
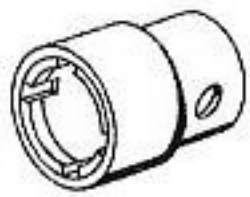
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Socket wrench (for ball bearing locknuts 1-3/4 inches)	8-Z-943-7	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing locknuts 3-5/8 inches)	8-Z-943-15	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing locknuts 5-7/16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

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

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

TABLE 19-4. TRAINING GEAR TOOLS AND ACCESSORIES

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

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

TABLE 19-5. PROJECTILE HOIST TOOLS AND ACCESSORIES

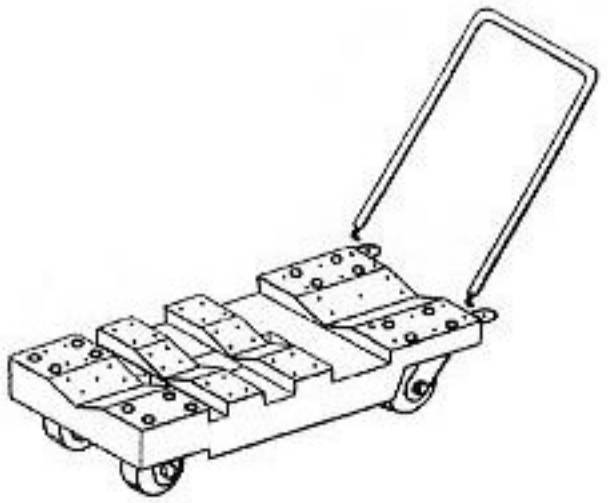
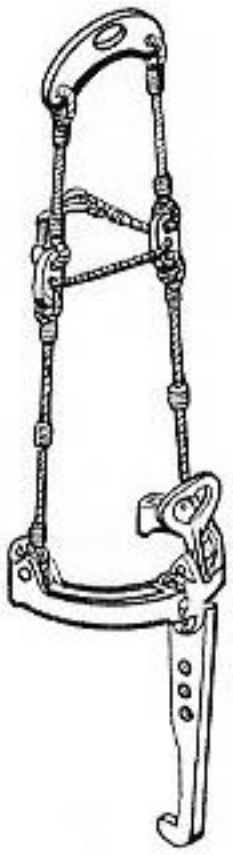
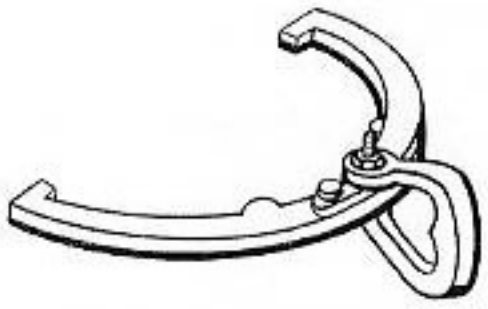
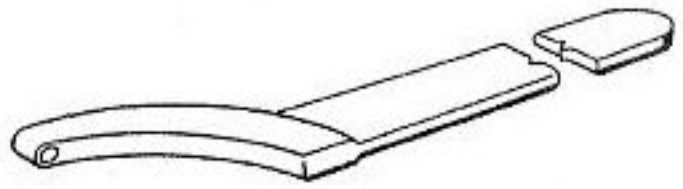
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES Projectile handling equipment:			
Projectile truck	SK 140109	Handling projectiles	
Projectile Carrier Mk 3 Mod 1	242653	For projectile stowage handling	
Handling tongs	242657	Handling projectiles in passageways (use with 16-inch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

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

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

TABLE 19-6. RAMMER TOOLS AND ACCESSORIES

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

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

TABLE 19-7. POWDER HOIST TOOLS AND ACCESSORIES

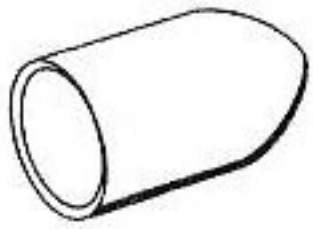
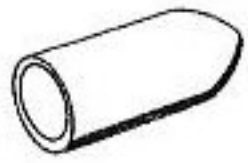
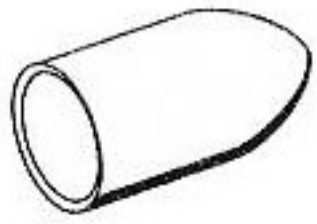
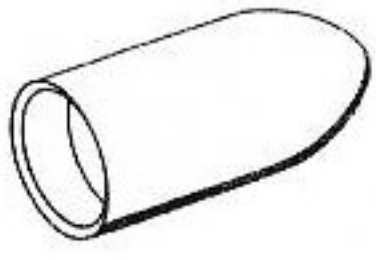
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Oil seal leader	274347-4	To protect the oil seal, when reassembling the the piston in the brake cylinder	
Oil seal leader	274349-2	To protect the oil seals when reassembling the safety car stop release valve and the latch and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

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

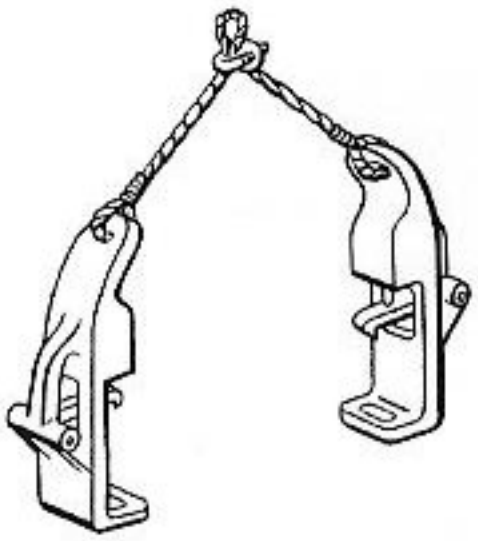
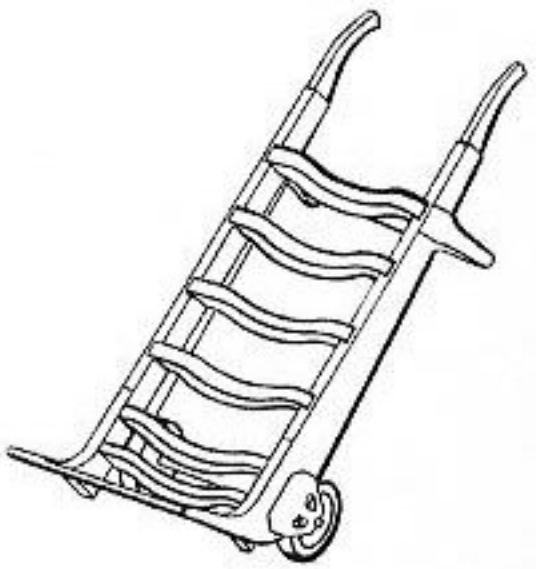
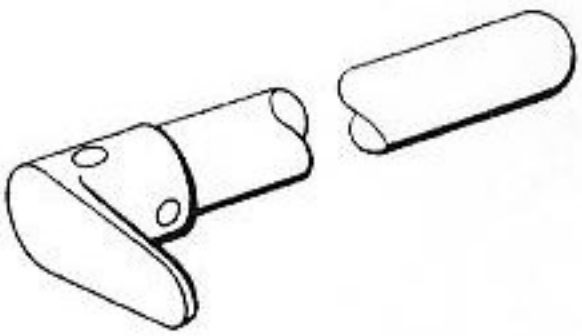
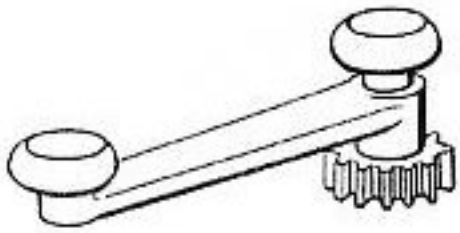
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Powder handling equipment:			
Powder Tank Carrier Mk 2 Mod 0	SK 140116	For powder stowage handling	
Powder Tank Truck Mk 1 Mod 0	SK 84701	Handling powder tanks	
Powder unloading tool	49401	To remove powder bags from powder tanks	
Powder tank opening tool	204245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

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

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

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

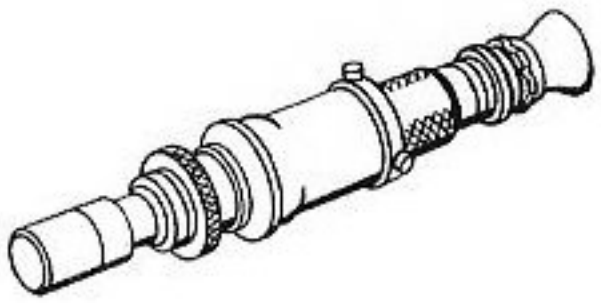
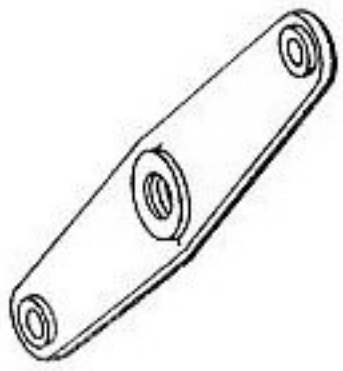
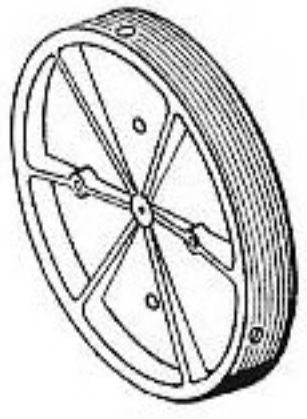
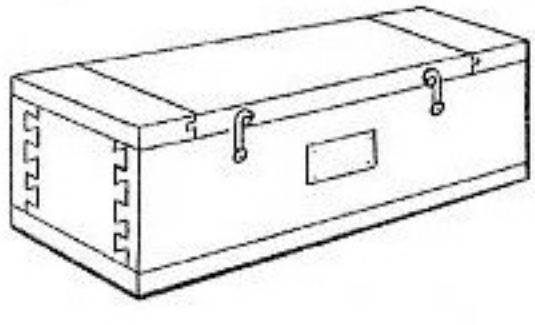
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Testing accessories:			
Telescope (bore sight assembly, breech end)	233261	Ensure the maintenance of correct alignment of the lines-of-sight of the telescopes with respect to the bore axis	
Telescope holder (bore sight assembly,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

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

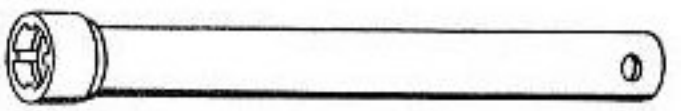
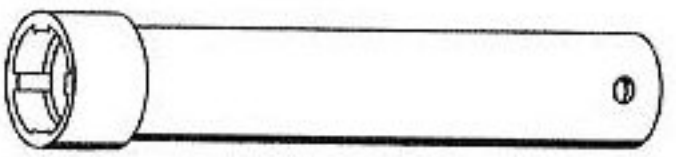
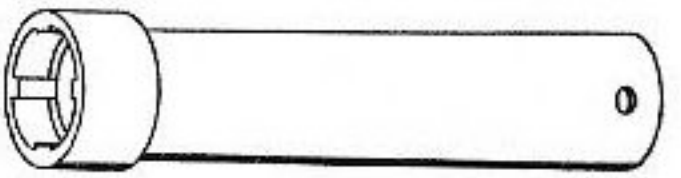
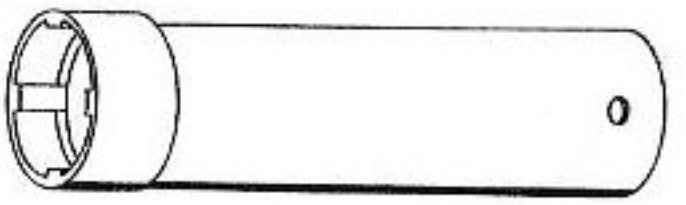
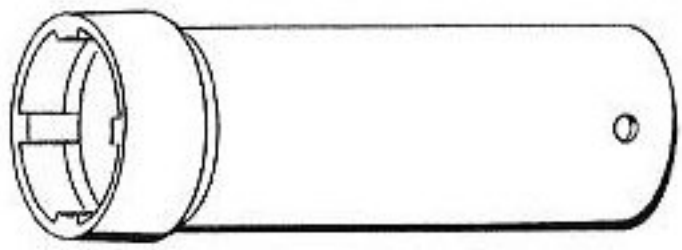
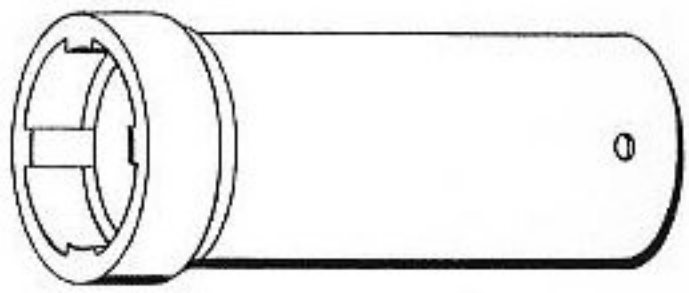
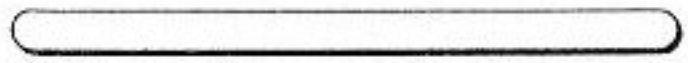
TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Maintenance tools:			
Socket wrench (for ball bearing locknuts, 3/4 inch)	8-Z-943-1	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing locknuts, 7/8 inch)	8-Z 943-2	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing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

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

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

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

Appendix 1

GENERAL TURRET DATA

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

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

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

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

Appendix 2

ORDNANCE DATA

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

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

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

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

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

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

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

Appendix 2 - cont'd.

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

Appendix 3

INDEX OF ASSEMBLIES

16-INCH TURRET ASSEMBLY NO. 84

TURRET I - USS IOWA

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

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

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

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

16-INCH TURRET ASSEMBLY NO. 85

TURRET II - USS IOWA

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

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

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

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

Appendix 3 - cont'd.

16-INCH TURRET ASSEMBLY NO. 86

TURRET III - USS IOWA

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

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

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

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

16-INCH TURRET ASSEMBLY NO. 87

TURRET I - USS NEW JERSEY

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

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

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

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

Appendix 3 - cont'd.

16-INCH TURRET ASSEMBLY NO. 88

TURRET II - USS NEW JERSEY

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

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

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

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

16-INCH TURRET ASSEMBLY NO. 89

TURRET III - USS NEW JERSEY

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

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

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

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

Appendix 3 - cont'd.

16-INCH TURRET ASSEMBLY NO. 90

TURRET I - USS MISSOURI

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

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

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

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

16-INCH TURRET ASSEMBLY NO. 91

TURRET II - USS MISSOURI

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

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

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

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

Appendix 3 - cont'd.

16-INCH TURRET ASSEMBLY NO. 92

TURRET III - USS MISSOURI

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

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

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

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

16-INCH TURRET ASSEMBLY NO. 93

TURRET I - USS WISCONSIN

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

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

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

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

Appendix 3 - cont'd.

16-INCH TURRET ASSEMBLY NO. 94

TURRET II - USS WISCONSIN

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

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

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

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

16-INCH TURRET ASSEMBLY NO. 95

TURRET III - USS WISCONSIN

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

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

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

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

Appendix 4

SAFETY PRECAUTIONS

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

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

EXTRACTS FROM NAVORD INSTRUCTIONS 5100.1

General

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

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

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

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

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

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

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

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

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

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

Ammunition Handling and Stowage

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

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

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

No relaxation of vigilance shall ever be permitted.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Service of guns, including ammunition supply

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(2) Keep the breech mechanism fully closed.

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

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

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

(2) Unhook the firing lanyard, if detachable.

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

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

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

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

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

TURRET GENERAL PRECAUTIONS

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

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

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

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

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

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

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

ORDNANCE EQUIPMENT PRECAUTIONS

Personnel Danger

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Equipment Casualty

Gun equipment precautions

PREPARATION PRECAUTIONS

Check recuperator air pressure and differential fluid.

Check recoil cylinder fluid level.

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

Remove the muzzle covers and tompions.

Disengage and stow the gun locking device.

Release the slide securing pin.

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

FIRING PRECAUTIONS

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

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

MISFIRE PRECAUTIONS

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

STOWING PRECAUTIONS

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

Always seat the slide securing pin.

Always install tompions or canvas covers on gun muzzles.

MISCELLANEOUS PRECAUTIONS

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

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

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

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

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

Ammunition handling equipment precautions.

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

When hoisting projectiles always hold the hoist

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Gun laying equipment precautions.

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

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

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

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

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

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

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

Training gear equipment precautions.

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

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

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

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

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

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

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

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

Fire control equipment precautions.

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

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

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

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

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

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

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

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

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

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