CHAPTER 2

THEORY OF OPERATION

Section I. GENERAL

18. Scope

This chapter contains two sections describing theory of operation of the HERCULES monorail launcher. Section II describes the overall theory of operation of hydraulic, mechanical, and electrical functions operating as the hydraulic precharge system, the launcher-up cycle, the launcher-down cycle, and the missile hydraulic system. Section III is a detailed description of the internal operation of individual hydro-mechanical components.

19. References

A complete analysis of launcher functions in conjunction with other components of the guided missile launching set is presented in TM 9—1440—250—10/1. Schematic diagrams and theory are furnished in TM 9—1440—250—20/2 and wiring lists are provided in TM 9—1440—250—35/1.

Section II. SYSTEM OPERATION

20. General

This section provides a general theory of operation of the hydraulic precharge system, the launcher-up cycle, the launcher-down cycle, and the missile hydraulic system.

21. Hydraulic Precharge System

Prior to initial operation of the launcher after emplacement, the equilibrator accumulator (fig. 8), hydraulic surge accumulator, and compressed gas cylinder are precharged with dry air or nitrogen. Precharge procedures are found in paragraph 40. Precharge air is supplied from an external source to these components through three air filler valves on the hydraulic pumping unit. Pressure gages for the three air systems are near these air filler valves. The hydraulic oil reservoir is pressurized to 20 psi by a manually operated plug cock.

22. Launcher-Up Cycle

a. Electrical circuits for the launcher-up cycle are prepared by installing the launching-handling rail (fig. 4) on the launcher erecting beam. When the launching-handling rail is properly positioned on the erecting beam and the locking wedge relay is energized (fig. 7), circuits are prepared to initiate erecting beam wedge locking prior to erection. Electrical circuits for the hydraulic system to erect the beam are energized when the LAUNCHER ELEVATION switch on the Hercules launching section control-indicator is put in the UP position; or when the LAUNCHER switch on the launcher control-indicator is put in the UP position.

b. When the launcher erection circuit is energized, hydraulic fluid from the axial pistons pump (fig. 8) flows through a check valve and the launcher pressure fluid filter to the locking wedge solenoid valve. System pressure surges are absorbed by the hydraulic surge accumulator located between the filter and the locking wedge solenoid valve. Pressure in excess of 3500 ±100 psi is relieved to the hydraulic oil reservoir through a system safety relief valve. A deloader valve, located between the pump and the check valve, opens and bypasses pump pressure to the reservoir until a minimum of 850 ±50 psi is built up by the pump. The valve

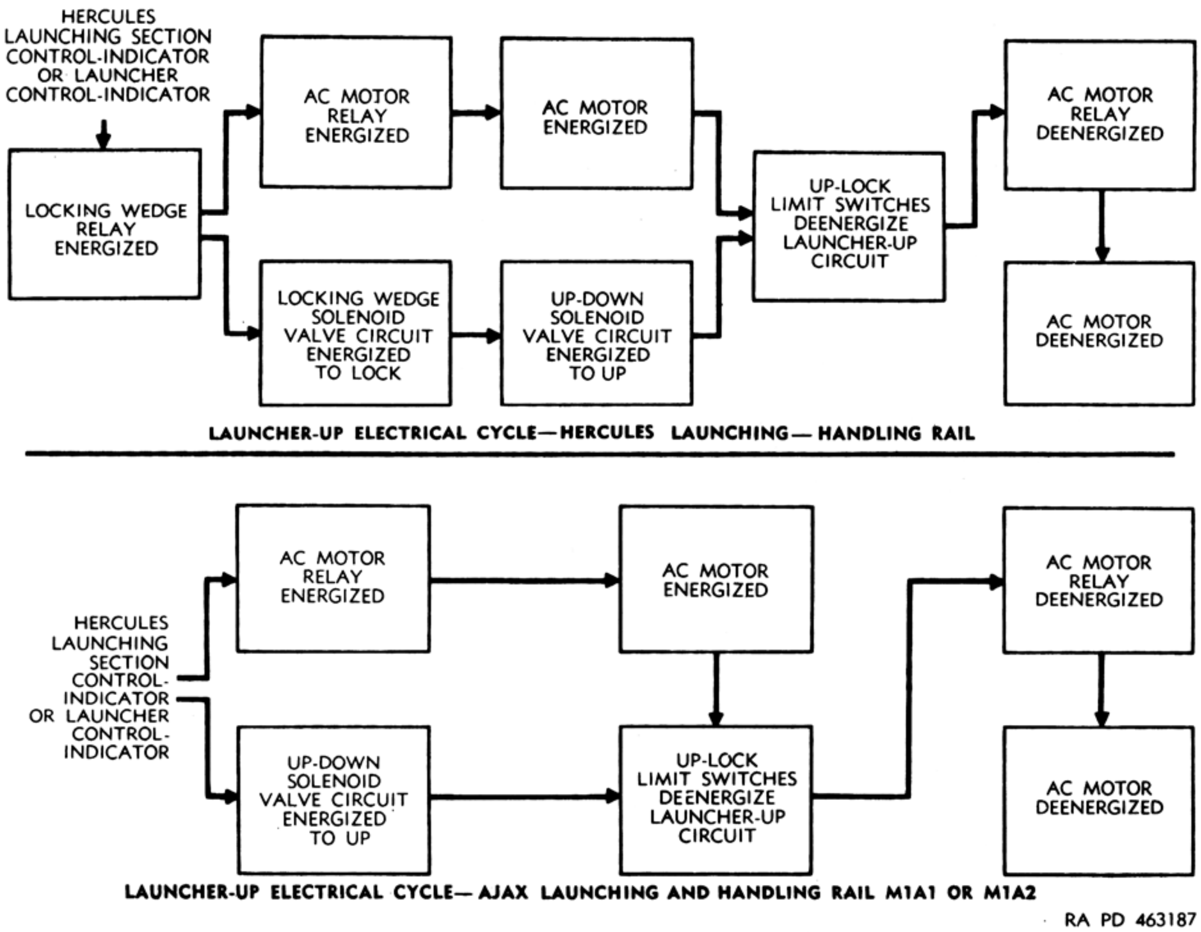


Figure 7. Launcher-up electrical cycle—block diagram.

opens again when pressure falls below 550 ±50 psi.

c. When hydraulic pump pressure is applied to the locking wedge solenoid valve, the pressure is directed through port 1 to the two locking wedge hydraulic cylinders, locking the rail to the erecting beam. Return pressure from these cylinders flows to the reservoir through the return port of the locking wedge solenoid valve. When wedge locking is completed, the closed locking wedge limit switches provide a path for energizing the up-down solenoid valve. From port 2 of this valve, hydraulic pressure flows to manifold blocks in the hydraulic panel. From the manifold blocks, pressure is distributed to accomplish two functions. First, free-flow pressure actuates the hydraulic down-lock. Second, pump pressure is applied to the front end of both power cylinders. Actuation of the down-lock releases the erecting beam hook held by the down-lock mechanism.

d. The pump and equilibrator accumulator cooperate to supply the two sources of hydraulic power which raise the erecting beam. When the hook is released, initial erection is from either one or both of these two sources. The pump pressure is directed to the power cylinders and the accumulator pressure goes to the equilibrator cylinders to continue raising of the erecting beam.

e. When a guided missile M6 is on the erecting beam, all four cylinders are required to raise the erecting beam. The equilibrator system pressure decreases rapidly as the erecting beam is raised. This is compensated by a priority valve which opens at 3,000 psi and diverts hydraulic pump pressure into the equilibrator

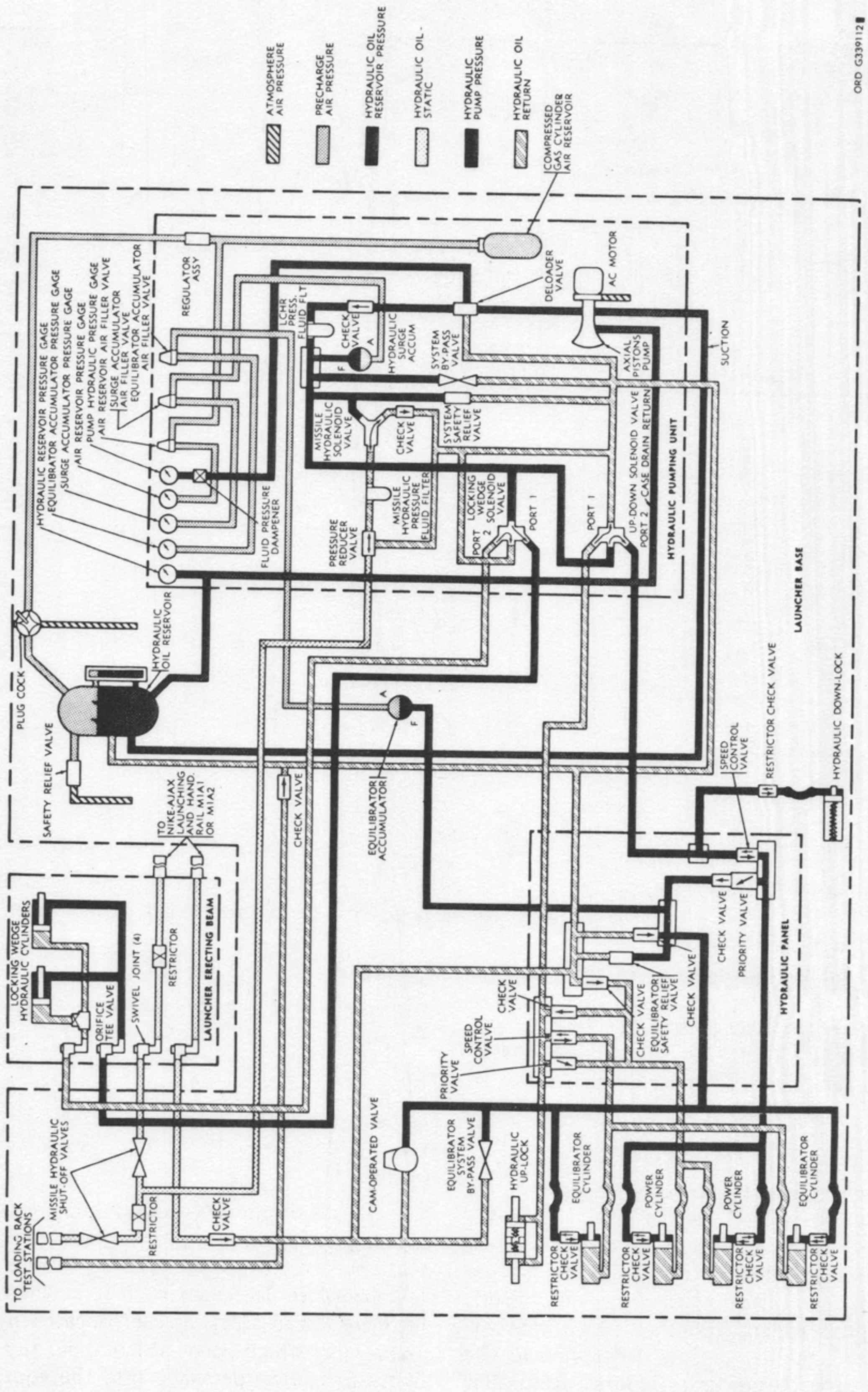


Figure 8. Launcher-up hydraulic system – schematic.

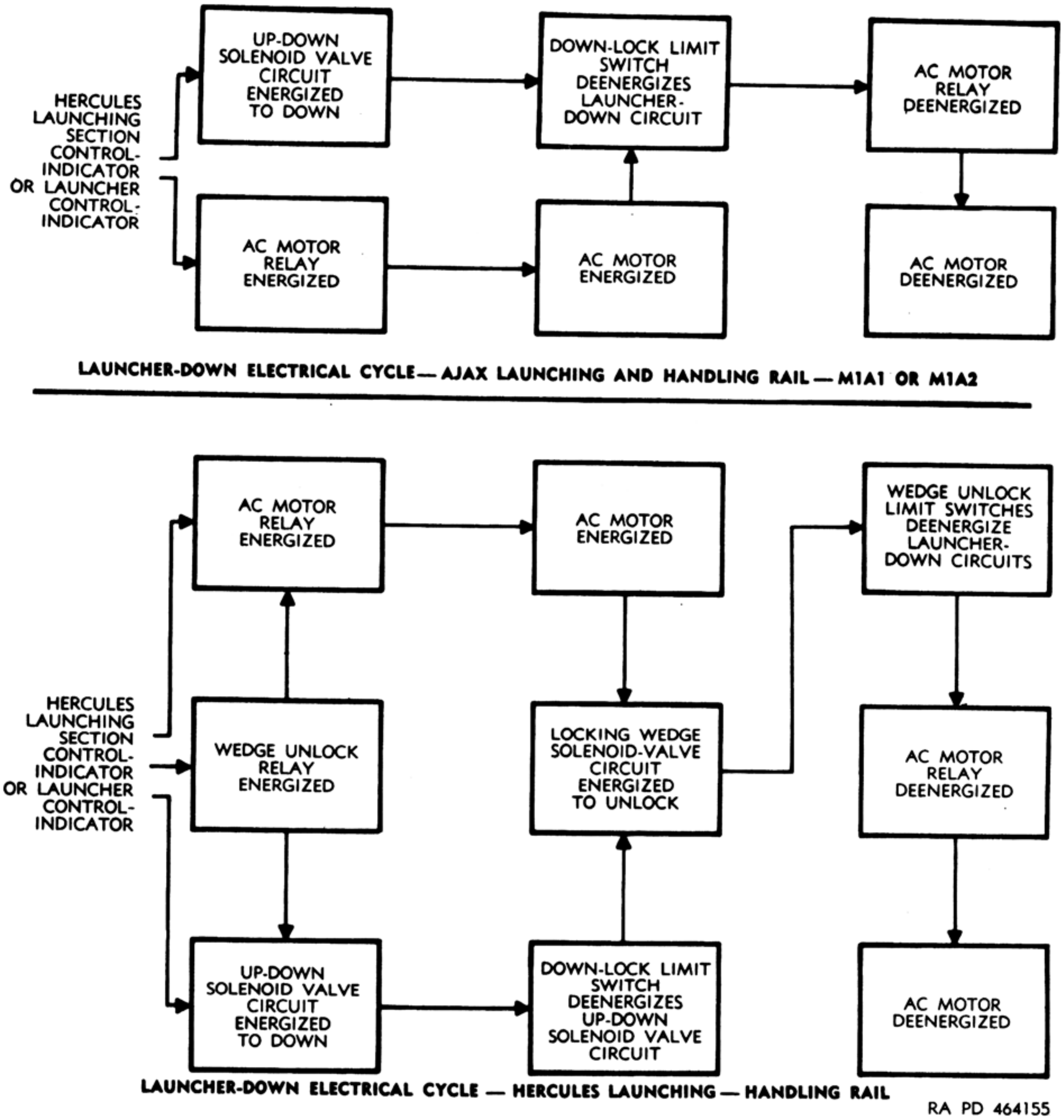


Figure 9. Launcher-down electrical cycle – block diagram.

system. The valve closes when the pump pressure drops below 2700 psi.

f. When the erecting beam is raised to approximately 70 degrees, a cam-operated valve opens and ports equilibrator accumulator pressure to the hydraulic oil reservoir. During erecting beam erection, hydraulic fluid from the rear cavities of the cylinders is ported to the reservoir.

g. When the erecting beam reaches the raised position, the hydraulic up-lock mechanically locks the launcher strut and the strut arm. The up-lock actuates the up-lock limit switches (fig. 7) and the switches deenergize the launcher-up circuits and stop the ac motor.

23. Launcher-Down Cycle

a. When the launcher-down electrical cycle (fig. 9) is initiated, the axial pistons pump (fig.

10) provides free-flow hydraulic pressure through port 1 of the up-down solenoid valve to the hydraulic up-lock. The pistons in each side of the up-lock retract and unlock the launcher strut (fig. 3) and the strut arm. At the same time, the up-down solenoid valve (fig. 10) directs restricted pressure to the rear cavities of both equilibrator cylinders.

b. As soon as hydraulic system pressure reaches 3000 psi, a priority valve ports pressure to the rear cavities of the power cylinders to assist the equilibrator cylinders in lowering the erecting beam. When the power cylinders are not needed, the rear cavities of these cylinders are filled with fluid from the pressurized hydraulic oil reservoir.

c. Return hydraulic fluid from the front cavities of the power cylinders leaves the cylinders through the internal dashpots (fig. 31). The dashpots progressively close off the return fluid as the pistons of the cylinders extend, thus increasing snubbing action. Return fluid from the cylinders then flows through a speed control valve (fig. 10). This valve prevents the rapid lowering of the erecting beam in the event of system failure of broken lines.

d. During lowering of the erecting beam down to 70 degrees, return fluid from the equilibrator cylinders is ported to the reservoir through the cam-operated valve. At 70 degrees, this valve closes and fluid flows to the equilibrator accumulator. Between 70 degrees and the down-and-locked position, the equilibrator accumulator receives return fluid which builds up to a pressure of approximately 2600 psi. Some of this pressure is lost when the precharge air cools and contracts. The remaining pressure is stored in the equilibrator accumulator to assist in the next launcher-up cycle.

e. Before the erecting beam comes down and locks, the switch trip latch (fig. 105) near the erecting beam hook actuates the down-lock limit switch assembly (fig. 86). The switch (fig. 9) energizes the locking wedge solenoid valve circuit and the locking wedge solenoid valve (fig. 10) ports hydraulic fluid to the locking wedge hydraulic cylinders. These cylinders move the locking wedges (fig. 41) to unlock the Hercules launching-handling rail from the erecting beam and to activate the wedge-unlock limit switches (fig. 9). These switches deenergize the launcher-down circuits and stop the ac motor. This completes the launcher-down cycle.

f. The wedge assemblies do not function when a Nike-Ajax launching and handling rail M1A1 or M1A2 is on the erecting beam. In this condition, the launcher-down cycle is terminated by the down-lock limit switch.

24. Missile Hydraulic System

a. The missile hydraulic system consists mainly of a missile hydraulic solenoid valve (fig. 34), the missile hydraulic pressure fluid filter, a pressure reducer valve, and two restrictors.

b. There are two pairs of quick-disconnect coupling half assemblies (figs. 201 and 208) in the missile hydraulic system. One pair is near the front end of the launcher erecting beam (fig. 34) to provide launcher hydraulic system pressure and return to the Nike-Ajax launching and handling rail M1A1 or M1A2. Another pair is located at the front left of the launcher to provide system pressure and return to each of the nine test stations (fig. 63).

c. When the MISSILE HYDR switch of the Hercules launching section control-indicator is turned to ON, or when the MISSILE HYDR switch of the launcher control-indicator is turned to ON, the ac motor (fig. 34) starts and operates the axial pistons pump. At the same time, the missile hydraulic solenoid valve ports hydraulic fluid through the missile hydraulic pressure fluid filter to the pressure reducer valve, which reduces the pressure to 2000 ± 50 psi. Fluid then passes through the two MISSILE HYDRAULIC SHUT-OFF valves and the two restrictors to the quick-disconnect couplings. Return hydraulic fluid from the missile flows through the couplings and through the check valves to the hydraulic oil reservoir.

d. When the ac motor and the missile hydraulic solenoid valve are deenergized, the motor stops and the valve closes the pressure port.

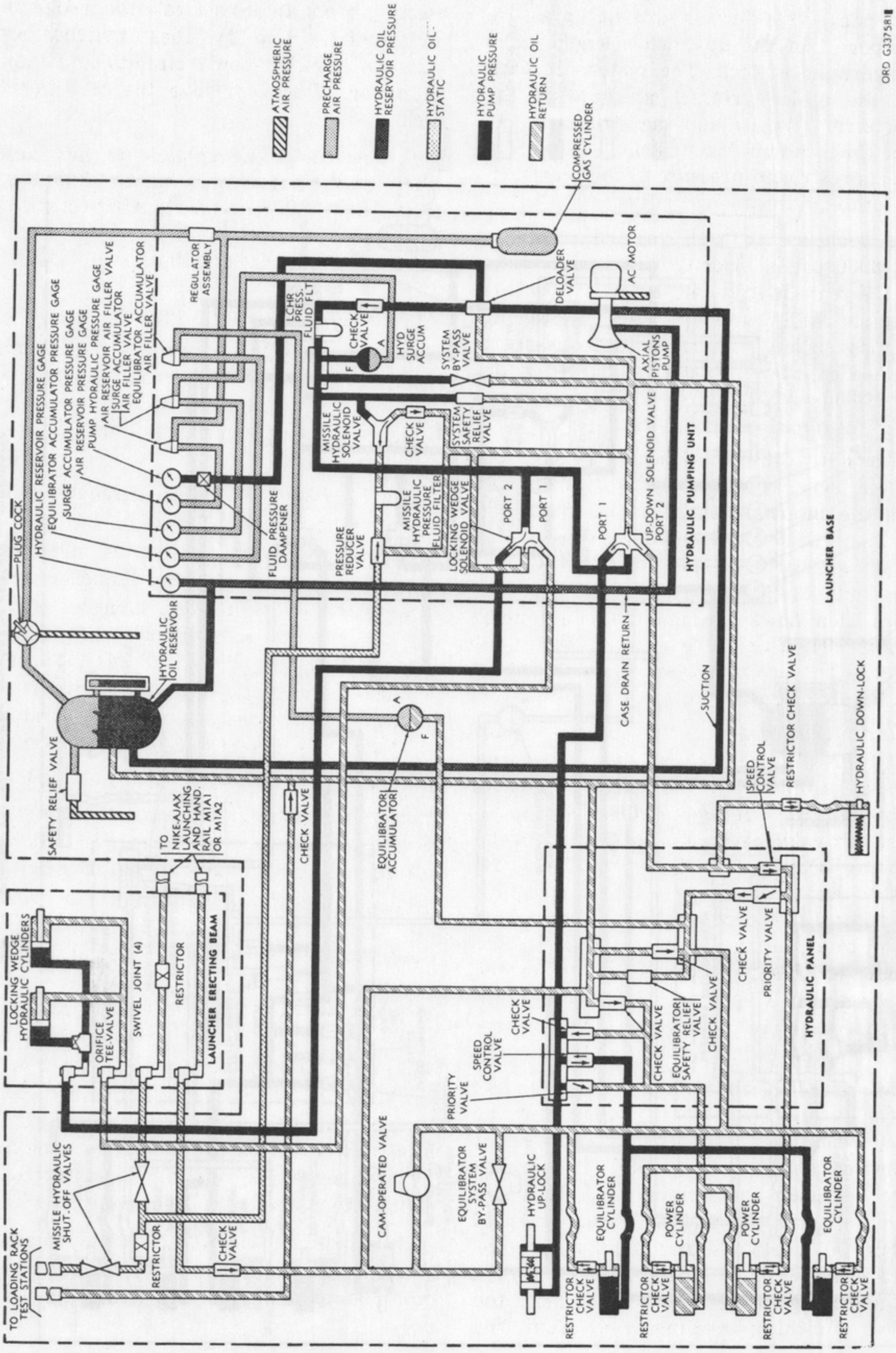


Figure 10. Launcher-down hydraulic system – schematic.

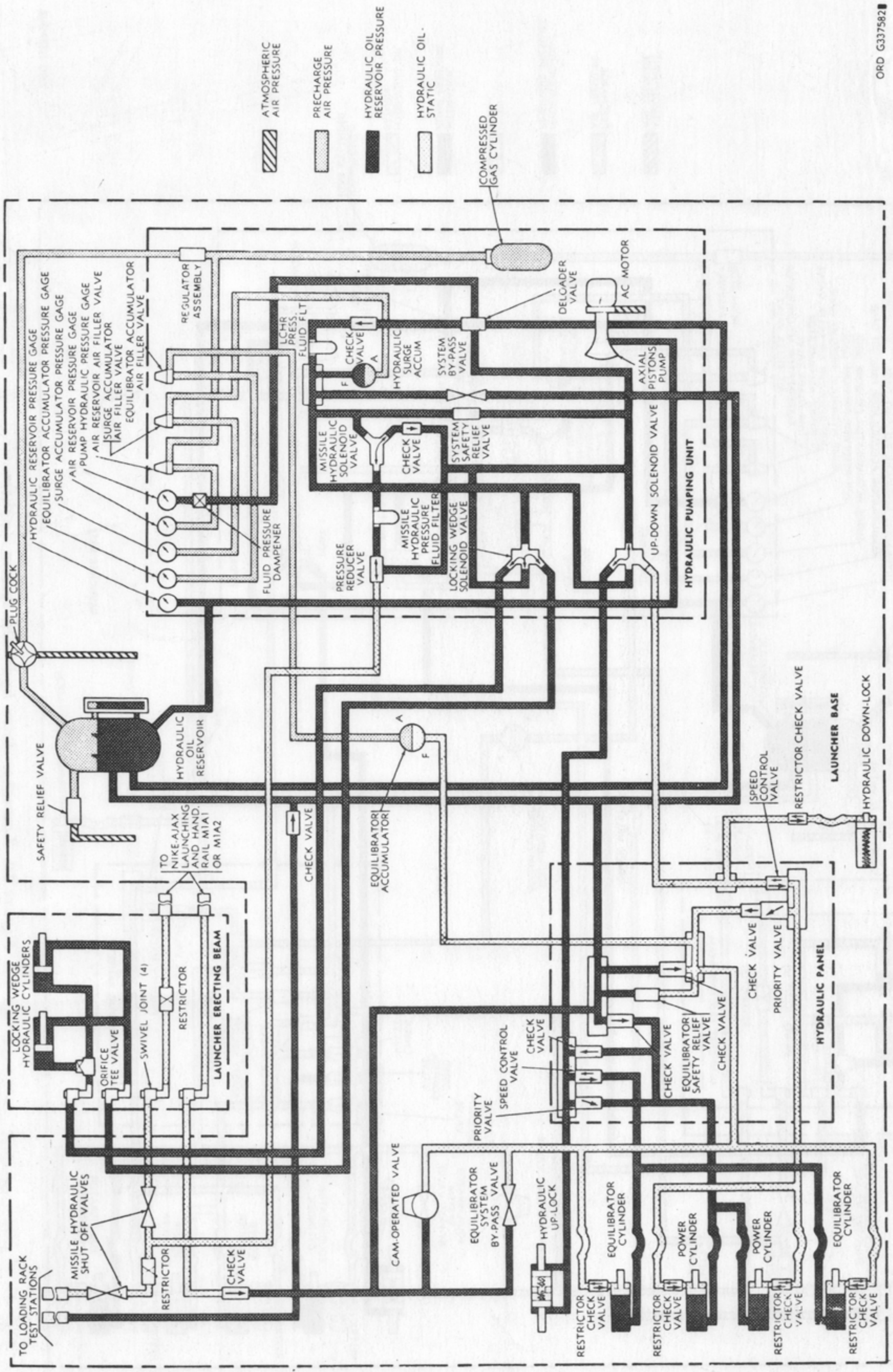
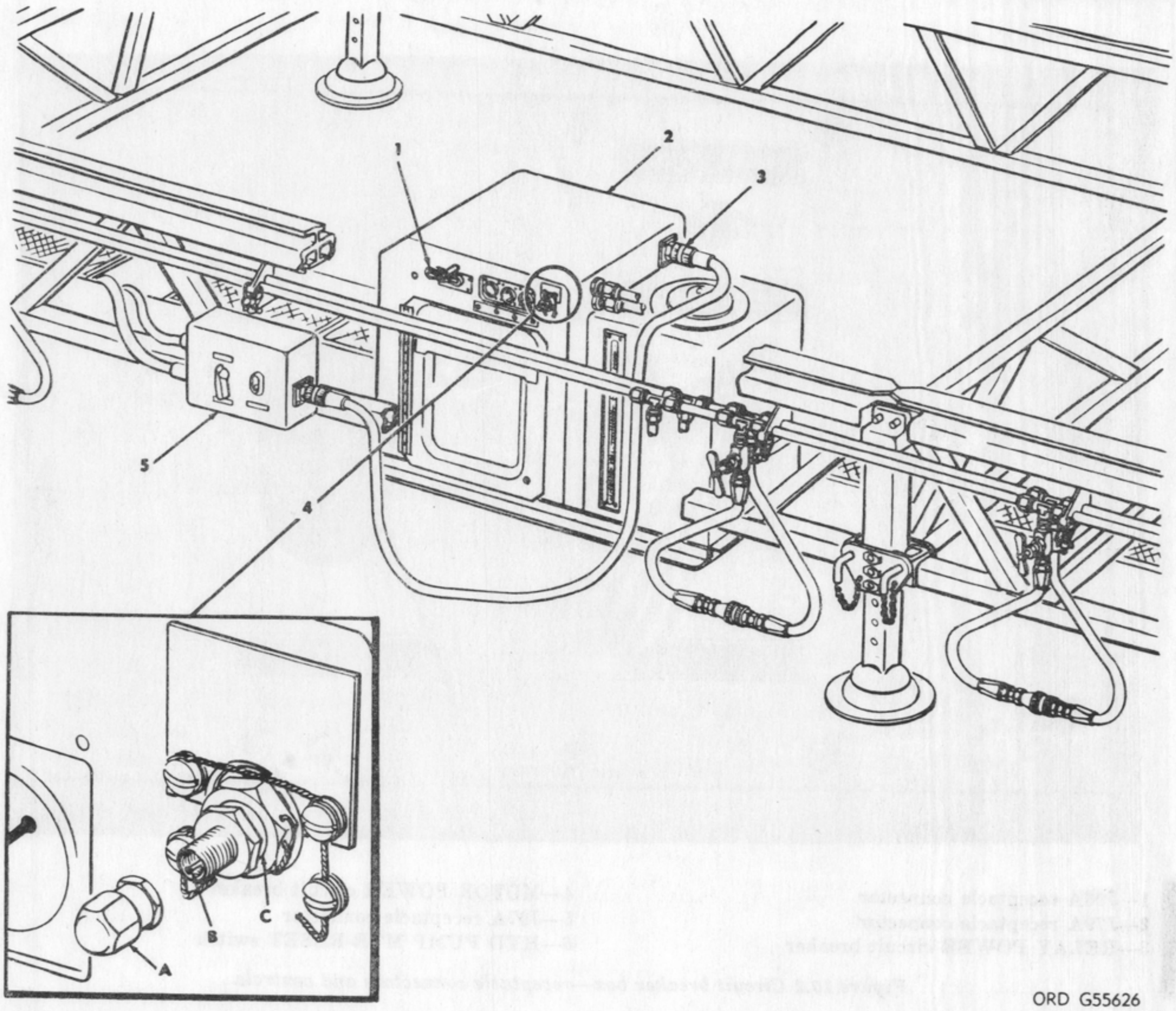


Figure 11. Hydraulic precharge system – schematic.



1—SYSTEM BLEED valve
2—Test station hydraulic pumping unit
3—J42A receptacle connector
4—Pneumatic tank valve

A—Valve cap
B—Valve stem
C—Valve breaker
5—Circuit breaker

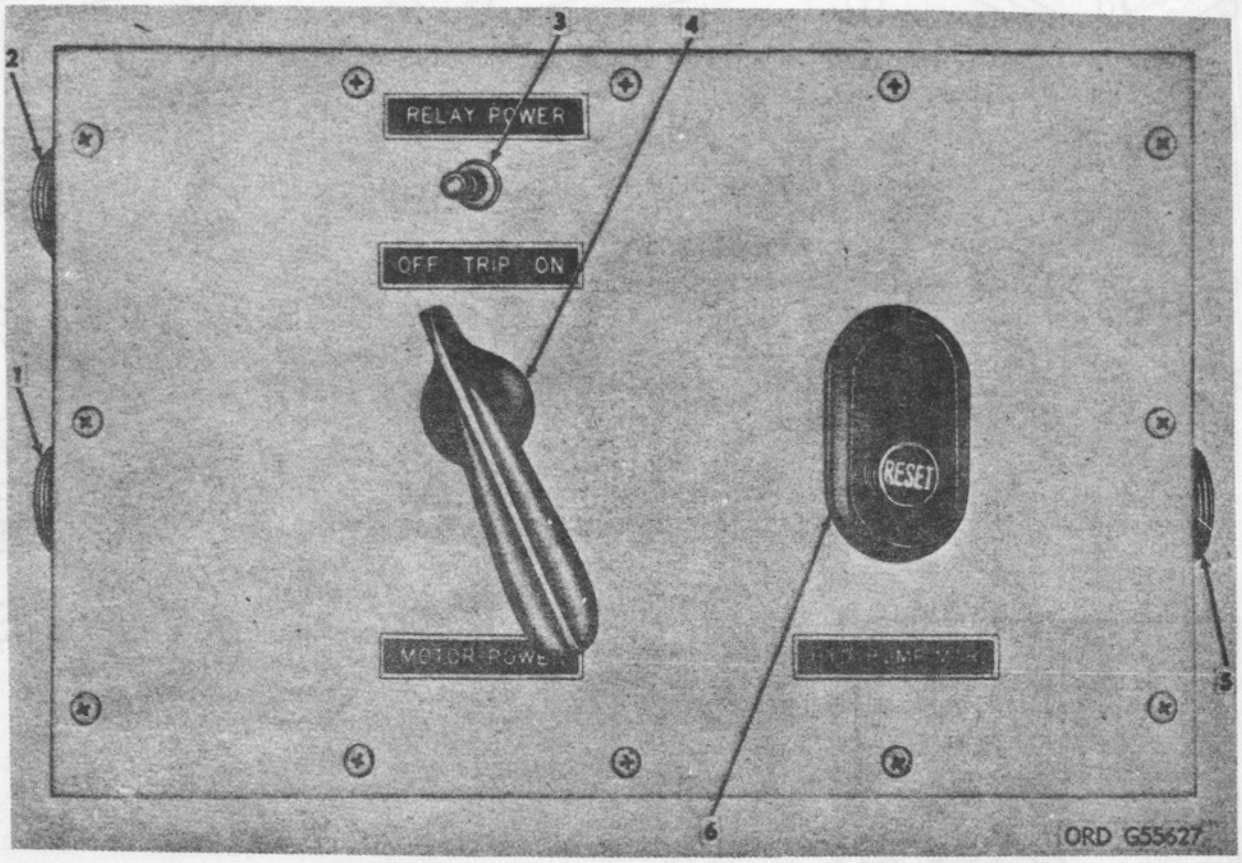
Figure 10.1 Test station hydraulic pumping unit.

24.1. (USARAL) Test Station Hydraulic System

a. Paragraph 24 is applicable except that hydraulic pressure for testing guided missiles M1 and for servicing guided missiles M6 at the test stations is supplied by the test station hydraulic pumping unit (2, fig. 10.1).

b. The hydraulic pumping unit is identical to the hydraulic power package used with AJAX launcher-loaded M22A3 but is controlled by a circuit breaker box (5, fig. 10.1). The hydraulic pumping unit is energized by placing the RELAY POWER circuit breaker (3, fig. 10.2) and the MOTOR POWER circuit breaker (4, fig. 10.2) to the ON position and depressing the HYD PUMP MTR RESET switch (6, fig. 10.2).

c. When energized, the hydraulic solenoid shutoff valve (fig. 10.3) opens and applies 208-volt, 400-cps, 3-phase power to the 7 1/2-horsepower pump motor. With the pumping unit energized, fluid flows from the reservoir to the axial piston pump which furnishes pres-



1—J96A receptacle connector
2—J79A receptacle connector
3—RELAY POWER circuit breaker
4—MOTOR POWER circuit breaker
5—J97A receptacle connector
6—HYD PUMP MTR-RESET switch

Figure 10.2 Circuit breaker box—receptacle connectors and controls.

sure to the system. From the pump, the fluid passes through a check valve which prevents any return fluid flow back to the pump. The fluid travels to the accumulator which maintains pressure in the system when the pump is not operating and dampens pump pulsations within the system. From this point fluid flows to the system bleed globe valve which is used to manually bleed fluid from the accumulator back to the reservoir to relieve system pressure. Fluid also flows from the check valve through the filter which removes foreign particles from the fluid before it enters the high pressure manifold. From the manifold the fluid travels through a pressure dampener which reduces the rate of flow to the pump hydraulic pressure gage and to the 3500 psi safety release valve which bypasses excess pressure back to the reservoir. From the manifold block, fluid flows to the pressure reducer valve, which reduces the pressure to approximately 2000 psi, for missile testing and servicing. From the pressure reducer valve, the fluid passes through a pressure dampener to the missile hydraulic test pressure gage, also through a fluid flow restrictor to the open solenoid shutoff valve and then to the missile test stations.

24.2. (USAREUR)

Refer to paragraph 24.1.

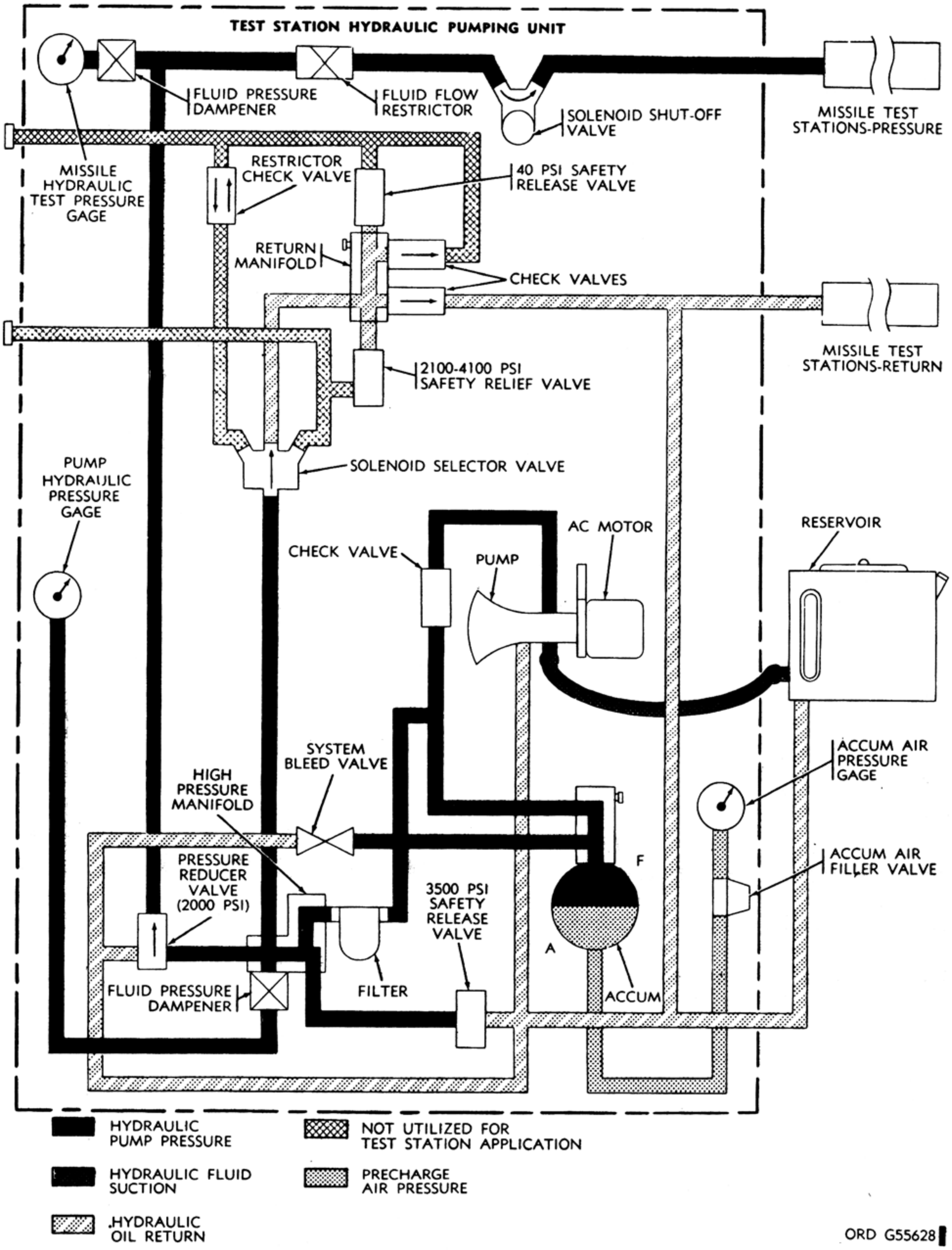


Figure 10.3. Test station hydraulic pumping unit—schematic.

Section III. FUNCTIONAL DESCRIPTION

25. General

This section provides a detailed functional description of the internal operation of mechanical and hydraulic components comprising the hydraulic precharge system, launcher erecting system, missile hydraulic system, and certain complex mechanisms. A functional description of the electrical circuits of the Hercules monorail launcher and of the NIKE-HERCULES guided missile launching set is presented in TM 9–1440–250–20/2.

26. Hydraulic Precharge System

a. Air Filler Valve.

(1) Three air filler valves (fig. 11) are located on the hydraulic pumping unit. They are used to pressurize (precharge) or to depressurize the compressed gas cylinder, the hydraulic surge accumulator, and the equilibrator accumulator. Precharging or pressurizing is done with dry air or nitrogen.

(2) When the air system in which the valve is installed requires pressurization, the valve cap (fig. 12) is removed and the gas supply hose with an air filling chuck is attached to the valve. This chuck depresses the valve core pin and opens the valve core. The filler valve is still closed, and there is no flow through it.

(3) When the ⅝-inch hexagon swivel nut is loosened approximately three-fourths of a turn, the valve core stem moves away from the valve seat. The valve is now open and air from the gas supply flows through the valve core and into the air system. Tightening the swivel nut seats the valve core system and closes the valve.

(4) When the air system in which the valve is installed requires depressurization, the valve cap and the valve core are removed. When the swivel nut is loosened approximately three-fourths of a turn, the valve opens and the air escapes.

b. Dial Indicating Pressure Gage.

(1) Five dial indicating pressure gage assemblies (fig. 148) are located on the hydraulic pumping unit. These gages (fig. 11) provide pressure readings for the hydraulic oil reservoir, equilibrator accumulator, hydraulic surge accumulator, compressed gas cylinder, and axial pistons pump.

(2) All of these gages have a Bourdon tube (fig. 13). The Bourdon tube is a curved hollow metal tube. One end of the tube is open and the other end is closed. The open end is connected to the gage port and the closed end is attached to a pointer.

(3) When air or hydraulic pressure enters through the gage port, the tube tends to straighten out. This motion is transmitted to the pointer by a movement assembly. The pointer moves and registers a pressure reading on the dial.

(4) When the pressure is released, the tube returns to its original shape and the spring moves the pointer to indicate a zero reading.

c. Compressed Gas Cylinder.

(1) The compressed gas cylinder (fig. 11) is located in the hydraulic pumping unit. When full it contains 100 cubic inches of nitrogen or air at 2000 ± 50 psi. This gas is used to pressurize the hydraulic oil reservoir.

(2) A check valve (fig. 14) on the cylinder contains a tube coupling nut, a fusible plug, and a bleed plug. When the coupling nut is tightened, the movable valve nose pushes the ball from the seat and compresses the spring. Gas then flows from the cylinder and out through the hollow valve nose.

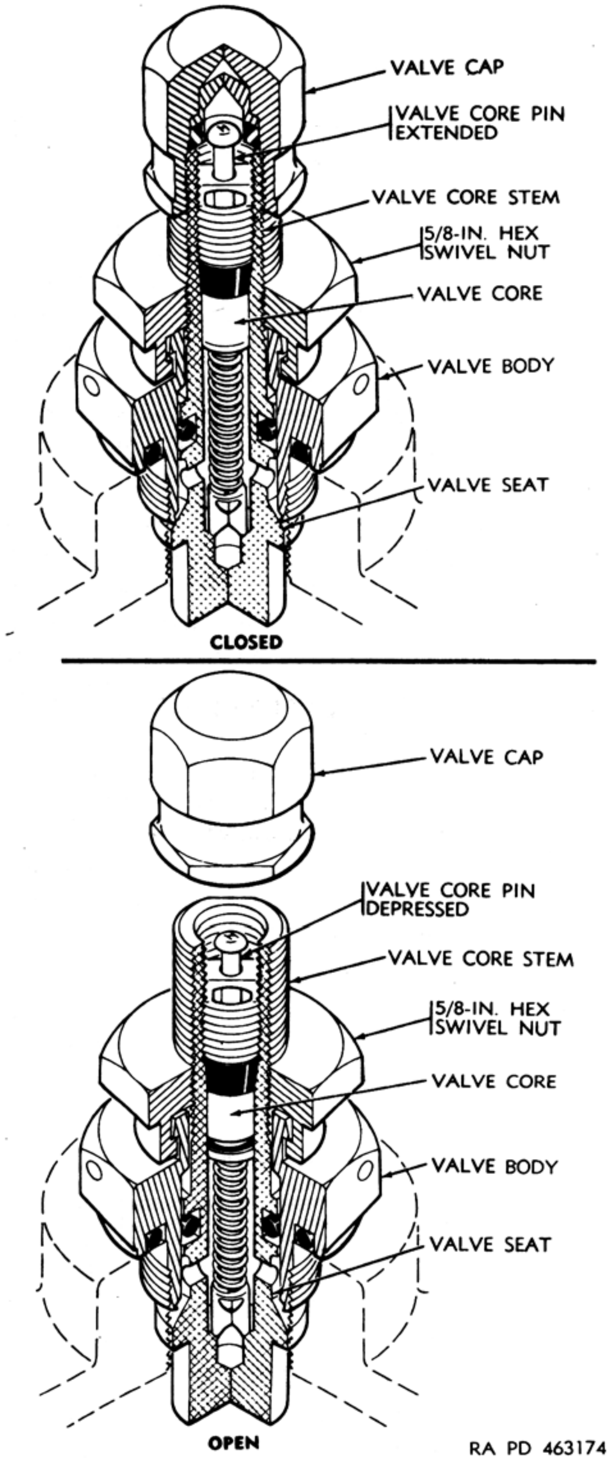


Figure 12. Air filler valve—cutaway view.

(3) When the coupling nut is loosened, the valve nose moves away from the ball and the spring forces the ball against the seat of the check valve. The ball prevents loss of pressure from the cylinder.

(4) The fusible plug and the safety disk protect the cylinder from excessive pressures. The fusible plug is a steel plug with a soft metal core; the safety disk is a thin, gold-plated metal disk. When pressure within the cylinder reaches 4000 to 4500 psi, the safety disk ruptures and the core of the fusible plug melts, permitting relief of gas pressure. The bleed plug may be opened to bleed excess pressure.

d. Regulator Assembly.

(1) The regulator assembly (fig. 15) is located in the hydraulic pumping unit. It is connected in the system between the compressed gas cylinder and the hydraulic oil reservoir. The regulator assembly is an automatic regulating two-stage adjustable type valve unit which reduces the 2000 psi output of the compressed gas cylinder to 20 ± 2 psi.

(2) The regulator assembly contains two poppets, two diaphragms, four springs and a relief valve subassembly. The poppets rest against the diaphragm bolts and against the secondary springs. The primary springs and diaphragms tend to keep the poppets unseated.

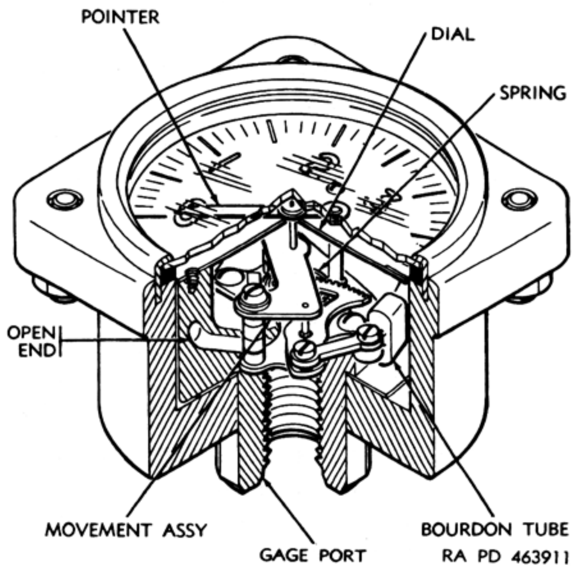


Figure 13. Dial indicating pressure gage—cutaway view.

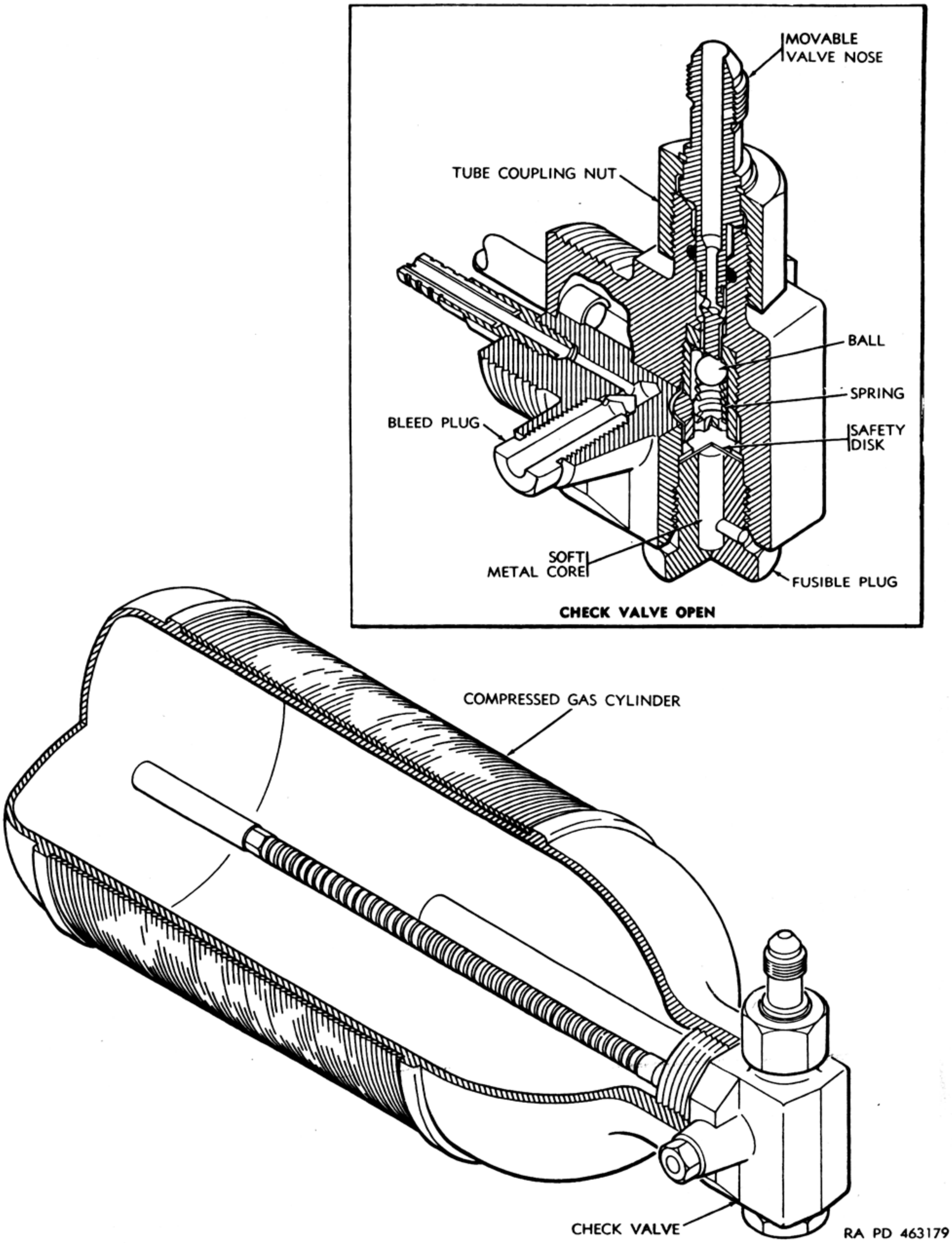


Figure 14. Compressed gas cylinder – cutaway view.

(3) When the high-pressure poppet is in open position, air passes through the restrictor and into the first-stage chamber, exerting a force against the underside of the high-pressure diaphragm. When the pressure in the chamber becomes greater than 500 psi, the diaphragm moves upwards and compresses the primary spring. The diaphragm bolt moves away from the poppet and the secondary spring seats the poppet. The restrictor is now closed and there is no air passage through it. When the pressure in the chamber drops below the regulated setting, the primary spring moves the diaphragm downwards, thus unseating the poppet and compressing the secondary spring. The high pressure poppet is now in open position and air passes through the restrictor into the first stage chamber.

(4) When the low-pressure poppet is in open position, air flows through the restrictor into the second-stage chamber and out the outlet port, exerting a force against the underside of the low-pressure diaphragm. When the pressure in the chamber becomes greater than 22 psi, the diaphragm moves upwards and compresses the primary spring. The diaphragm bolt moves away from the poppet and the secondary spring seats the poppet. The restrictor is now closed and there is no air passage through it. When the pressure in the chamber drops below the regulated setting, the primary spring moves the diaphragm downwards. The diaphragm now unseats the poppet and compresses the secondary spring. The seat is now open and air passes through the restrictor.

(5) The intermediate safety relief valve subassembly functions to relieve excessive pressure in the first-stage chamber. When pressure in the chamber exceeds 900 psi, the relief valve spring compresses and the relief valve opens. Air is vented to the atmosphere through the relief valve port. When the pressure in the chamber is reduced below 900 psi, the relief valve closes.

e. Plug Cock.

(1) The plug cock (fig. 2), mounted near the hydraulic oil reservoir, is manually operated to pressurize or depressurize the reservoir.

(2) The plug cock consists of a body (fig. 16) with four external ports and a rotor with two internal flow passages. One of the ports is permanently closed with a plug. The other three ports are: the hydraulic reservoir port, compressed gas cylinder port, and the vent port. Each port has an internal valve seat. A spring tension washer and hydraulic pressure hold each valve seat against the rotor. A handle is connected to the rotor and is spring-loaded to return to the N (neutral) position. The handle is kept in the N position by a detent.

(3) When the handle of the plug cock is rotated 45 degrees clockwise, the plug cock is in the VENT position. One passage is now alined with the hydraulic reservoir port and the vent port, permitting the reservoir to be vented.

(4) When the handle is released, a handle spring returns the handle to the N position. The internal flow passages do not aline with any ports and there is no flow.

(5) When the handle is rotated 45 degrees counterclockwise the plug cock is in the AIR position. The second flow passage now alines with the compressed gas cylinder port and the hydraulic reservoir port. Air now flows from the gas cylinder to the reservoir. Releasing the handle returns it to the N position.

f. Hydraulic Oil Reservoir.

(1) The hydraulic oil reservoir (fig. 3) is located on the front left side of the launcher base. The reservoir stores approximately 14 gallons of hydraulic fluid to supply the hydraulic pumping unit. The reservoir is pressurized with 20 psi of air from the compressed gas cylinder inside the pumping unit.

(2) A reservoir cap (fig. 17) on the filler tube is removed to provide for reservoir servicing. A fluid filter is located in the filler tube to prevent reservoir contamination by foreign matter.

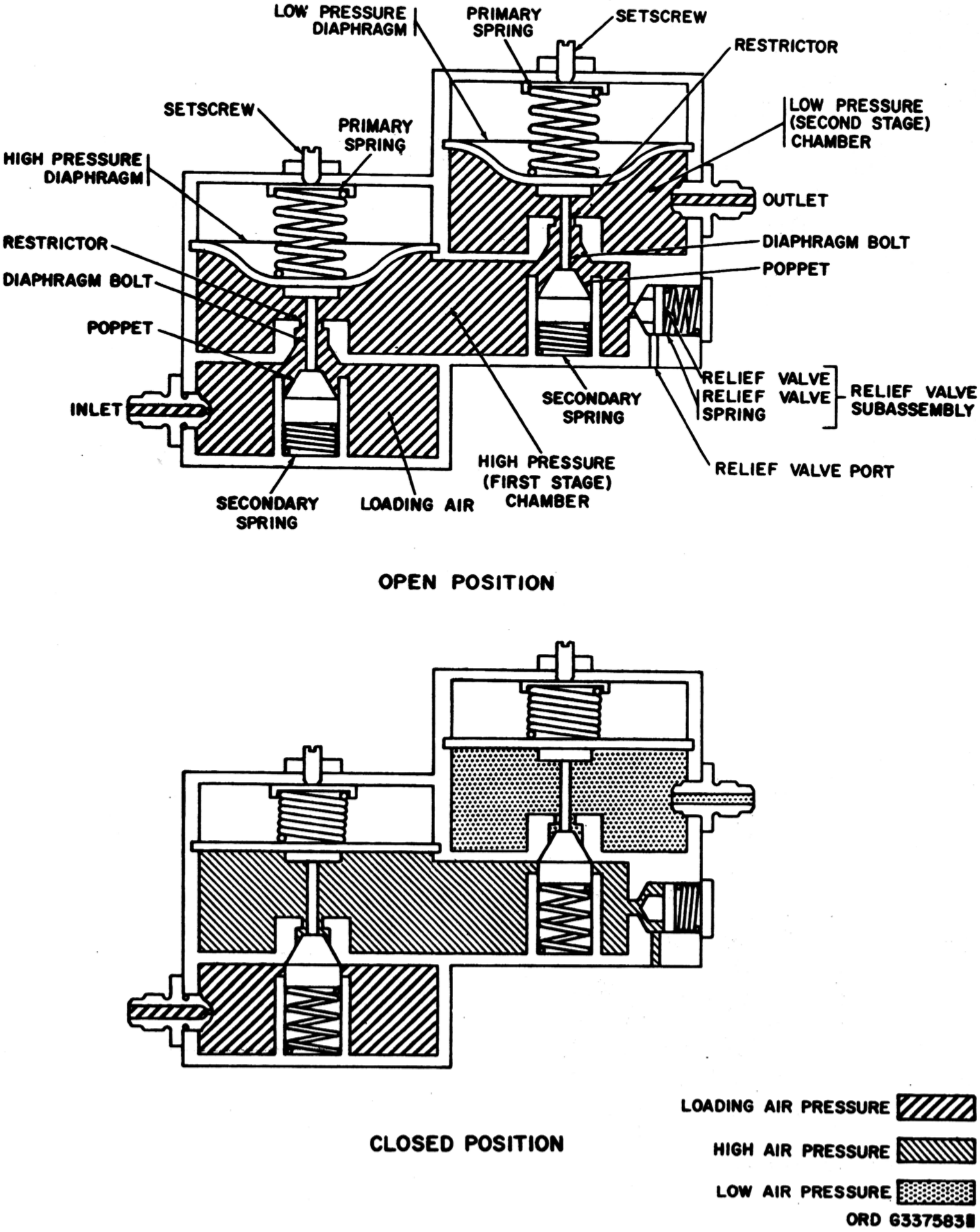


Figure 15. Regulator assembly—functional diagram.

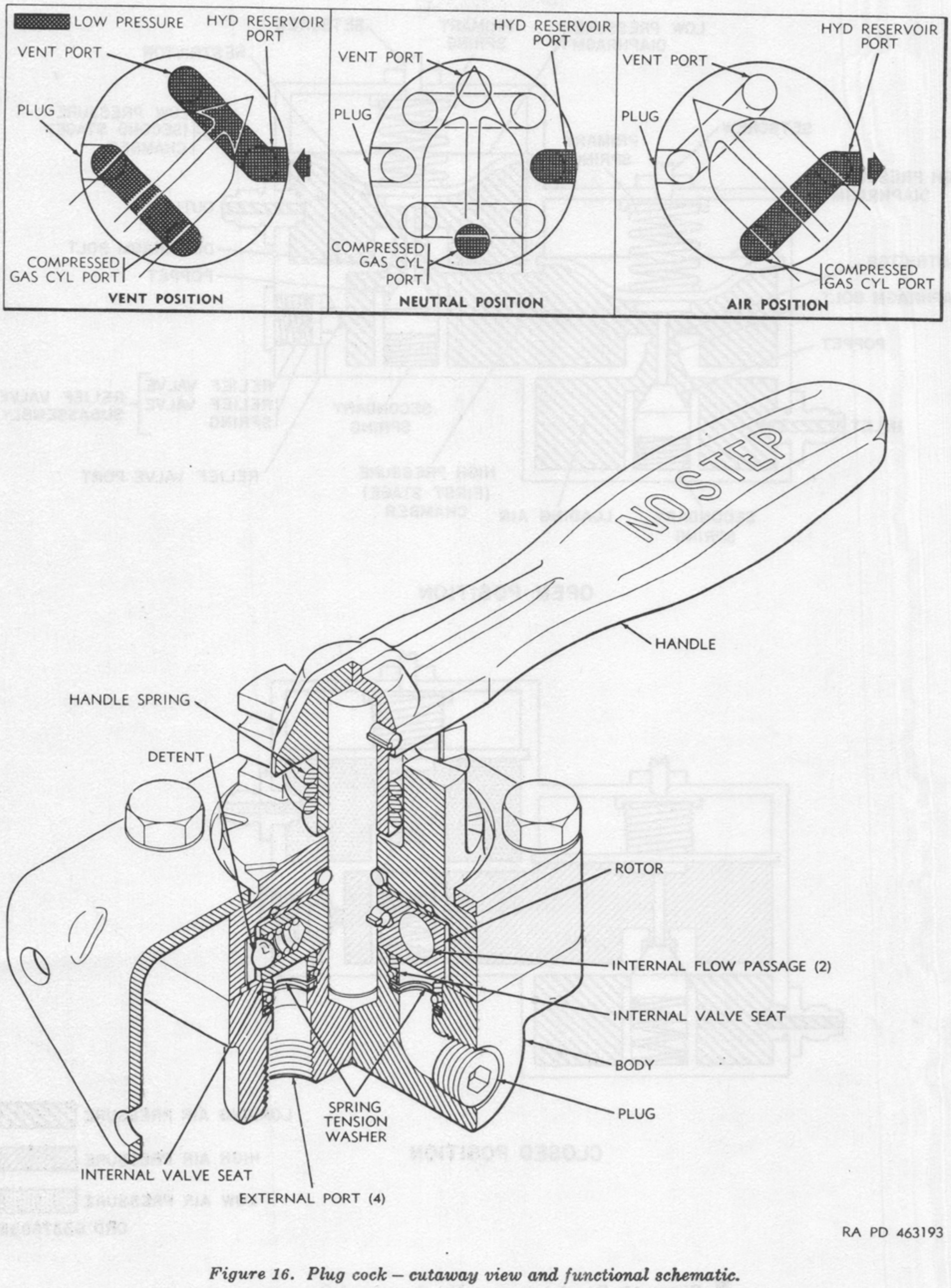


Figure 16. Plug cock – cutaway view and functional schematic.

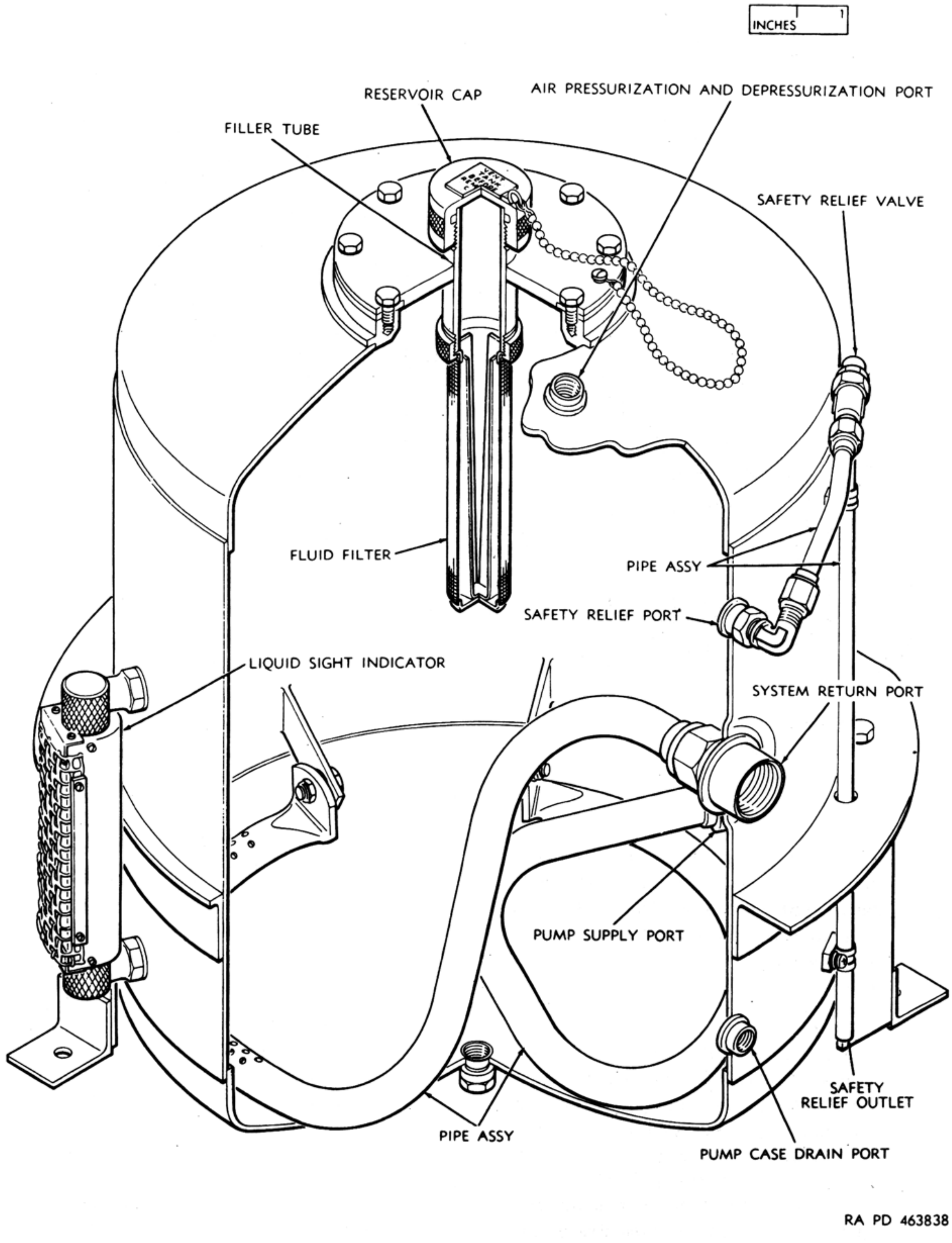


Figure 17. Hydraulic oil reservoir – cutaway view.

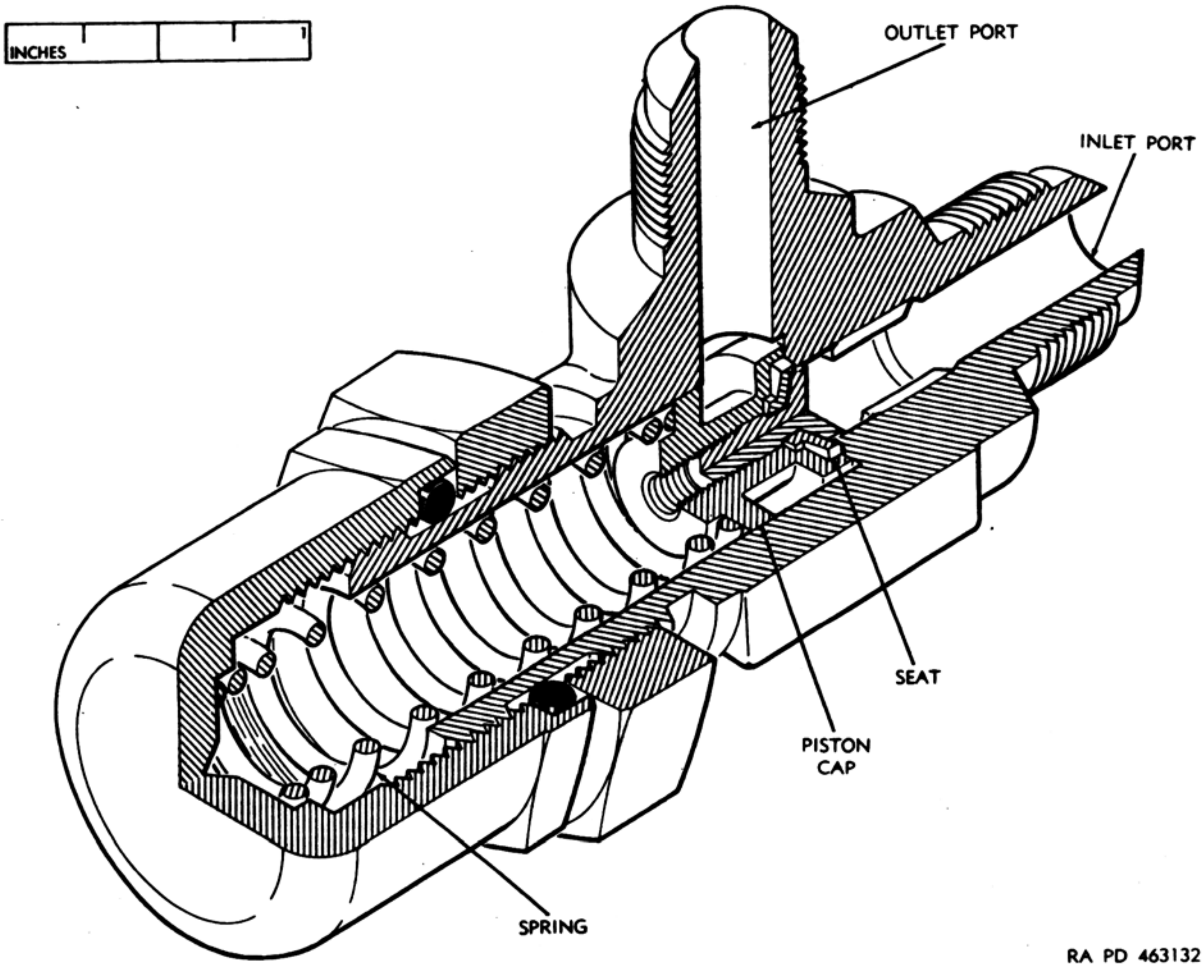


Figure 18. Safety relief valve — cutaway view.

(3) The level of the fluid in the reservoir is indicated by a liquid sight indicator. Graduations on the tube of the indicator designate the minimum and the maximum levels of fluid for launcher operation.

(4) There are five external ports on the reservoir. Two of these ports are for air pressure: one for air pressurization and depressurization of the reservoir, and one for safety relief of excess pressure through the safety relief valve. Another port is for connection to the pump case drain line. Two large ports, one for pump supply and one for system return, each lead into a perforated pipe assembly at the bottom of the reservoir.

g. Safety Relief Valve.

(1) A safety relief valve (fig. 8) is mounted on the side of the hydraulic oil reservoir. This valve protects the reservoir by relieving air pressure in excess of 50 psi. The valve contains a piston cap (fig. 18).

(2) When air pressure in the inlet port of the valve reaches 50 psi, it overcomes the spring which holds the piston cap on its seat. The piston cap then unseats and the excess pressure is relieved through the outlet port.

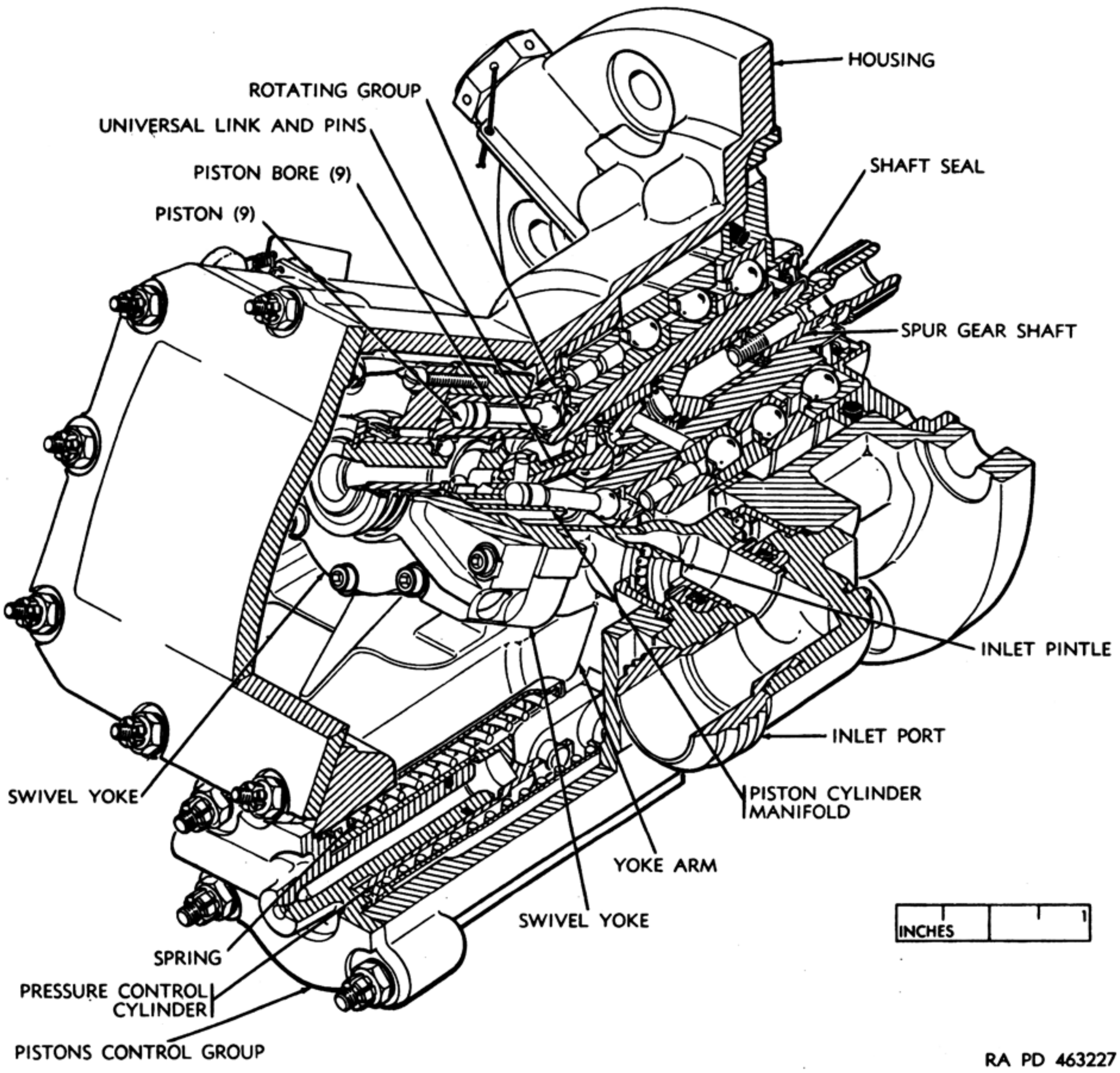


Figure 19. Axial pistons pump – cutaway view.

(3) When the pressure is reduced below 50 psi, the spring extends and reseats the piston cap. This closes the passage through the valve.

27. Launcher Erecting System

a. Axial Pistons Pump.

(1) The axial pistons pump (fig. 8) is located inside the hydraulic pumping ing unit. It provides a non-pulsating, continuous flow of hydraulic fluid at 3200 ±100 psi. This pressure is used for the operation of the launcher erecting beam, and for testing the guided missile M1 hydraulic system when the missile M1 is at the loading rack test stations. This hydraulic pressure is also used when the missile M1 and the Nike-Ajax launching and handling rail M1A1 or M1A2 are on the Hercules monorail launcher.

(2) The pump consists principally of a housing (fig. 19 and 20), a swivel

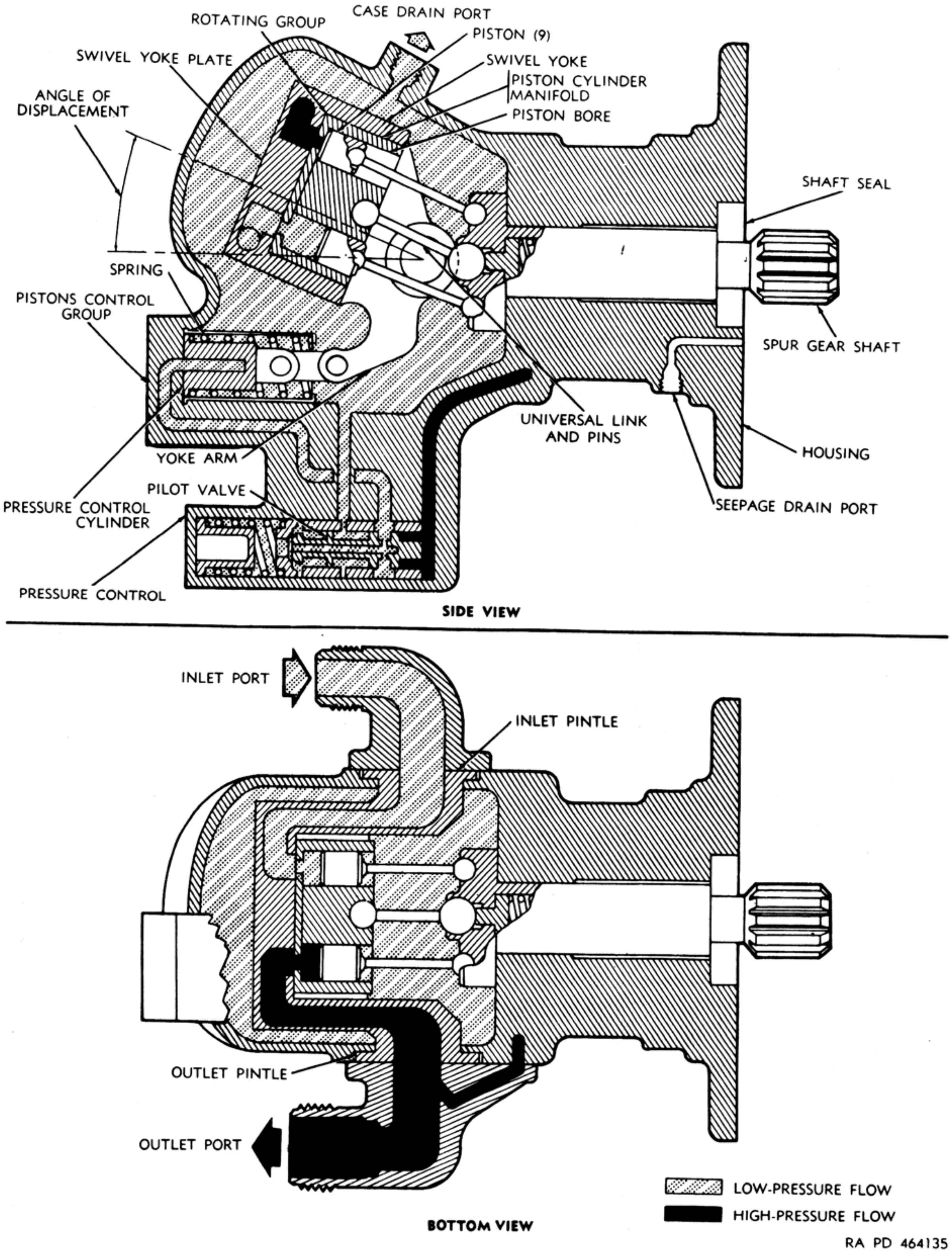


Figure 20. Axial pistons pump – functional diagram.

yoke plate, a rotating group, a swivel yoke, and a pistons control group. The rotating group rotating within the yoke, contains the nine pistons and piston bores. The yoke plate is attached to the yoke and does not rotate. It directs fluid in and out of the piston bores.

(3) The angle of displacement (fig. 20) is the angle between the spur gear shaft and the centerline of the swivel yoke when the swivel yoke is displaced upward by the yoke arm. When this angle is small, the volume of fluid leaving the pump is small. When this angle is large, the volume is large. The pistons control group changes the angle by moving the yoke arm.

(4) When the spur gear shaft is rotated, the universal link and pins, the pistons, and the piston cylinder manifold rotate with the gear shaft. When fluid enters through the inlet port, it passes through the inlet pintle, through the internal passages of the yoke and yoke plate and into the piston bores. On the first half of a revolution, the piston moves away from the yoke plate and the cylinder bores fill with fluid. On the second half of the revolution, the pistons move toward the yoke plate and fluid passes out of the bores. This fluid then passes out through the internal passages in the yoke plate and the yoke, through the outlet pintle, and out the outlet port. The pistons repeat this cycle in succession so that there is a continuous, non-pulsating flow from the pump.

(5) An internal passage in the housing connects the outlet pintle with the pressure control. When pressure increases in the outlet port, the pressure increases in the pressure control, and moves the pilot valve.

(6) The pilot valve then permits high-pressure fluid to enter the pistons control group. The spring-loaded pressure control cylinder moves inward, compresses the spring, and moves the yoke to a smaller angle of displacement. The volume output of the pump is thereby reduced. When the outlet pressure is reduced, the spring in the pistons control group moves the yoke to a larger displacement angle. The volume output of the pump is now increased.

(7) The case drain port (fig. 20) in the housing is connected to a case drain return line (fig. 34) to the hydraulic oil reservoir. This port (fig. 20) provides fluid to lubricate the internal moving parts of the pump. Hydraulic fluid that seeps past the shaft seal is drained through the seepage drain port. Fluid seepage is thus prevented from reaching the ac motor (fig. 8).

b. Deloader Valve.

(1) The deloader valve (fig. 8), located in the hydraulic pumping unit, protects the ac motor that drives the axial pistons pump, from a high starting load. The valve bypasses fluid to the hydraulic oil reservoir until the motor has attained its running speed. The valve has four ports: inlet port (fig. 21), outlet port, return port, and axial pistons pump gage port.

(2) When pressure in the valve drops below 550 $\pm$50 psi, the spring moves the piston out of the outlet sleeve. This opens a passage to the return port and the valve is now in the open position. Hydraulic fluid now passes through the holes of the inlet sleeve and the outlet sleeve and then out through the return port.

(3) When pressure in the valve increases to 850 $\pm$50 psi, the force on the piston overcomes the spring tension and moves the piston into the outlet sleeve. The piston covers the holes of the outlet sleeve and there is no flow through the return port. The valve is

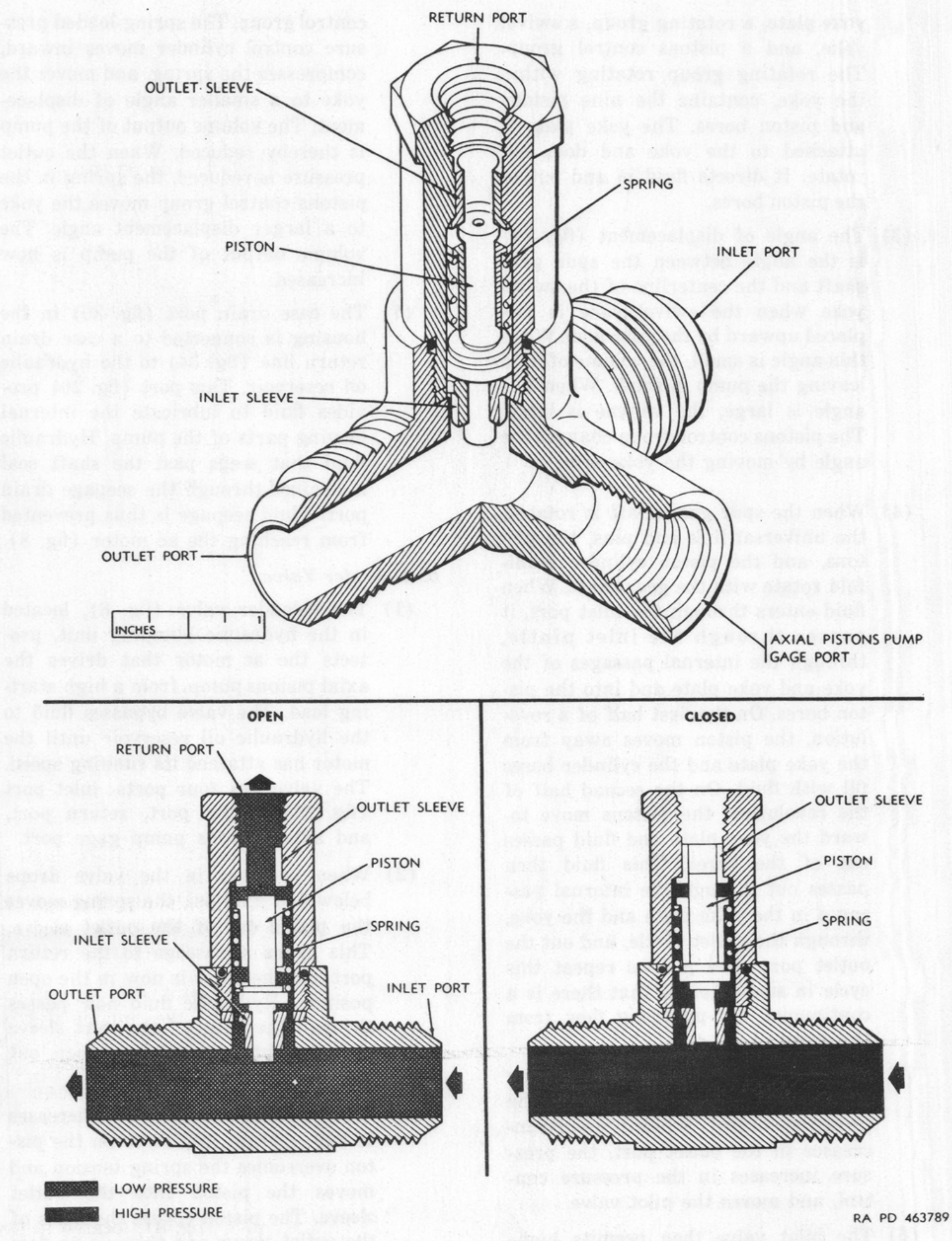


Figure 21. Deloader valve – cutaway view and functional schematic.

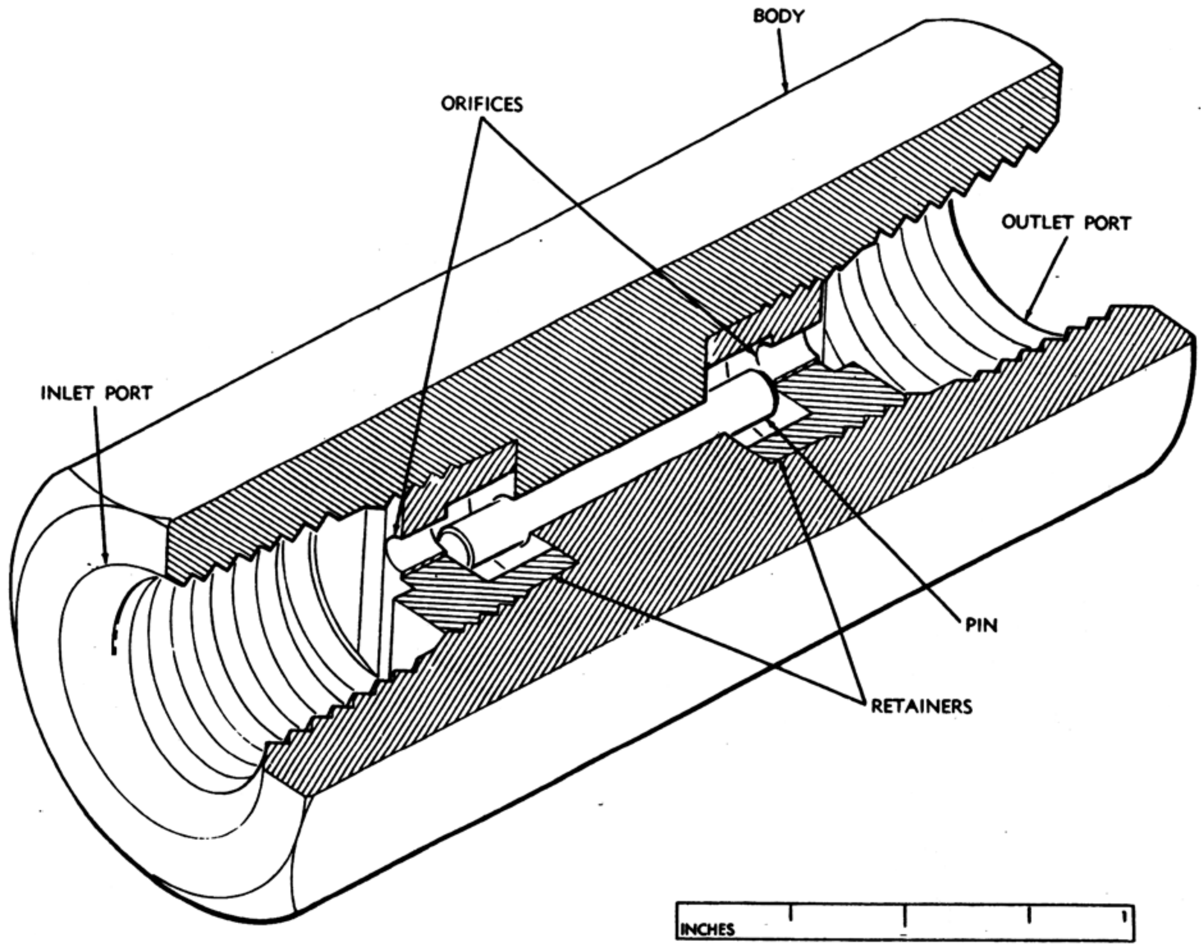


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Figure 22. Fluid pressure dampener — cutway view.

now in the closed position. The piston will remain in this position until the pressure in the valve drops below 550 ±50 Psi.

c. Fluid Pressure Dampener.

(1) The fluid pressure dampener (fig. 8), located in the hydraulic pumping unit, is connected to the PUMP HYDRAULIC PRESSURE gage. The dampener protects the gage from damage from pressure surges. It also reduces pointer fluctuation and makes the gage easier to read. The gage is attached to the outlet port (fig. 22) of the dampener.

(2) When fluid enters the inlet port, it passes through the orifice of the first retainer, around the pin, through the orifice of the other retainer, and out the outlet port.

(3) When a sudden surge of fluid enters the inlet port, the pin is forced against the retainer nearest the outlet port and partially covers the orifice of that retainer. The amount of fluid that flows out of the outlet port is then reduced.

d. Check Valve.

(1) A check valve (fig. 8), located in the hydraulic pumping unit, is connected

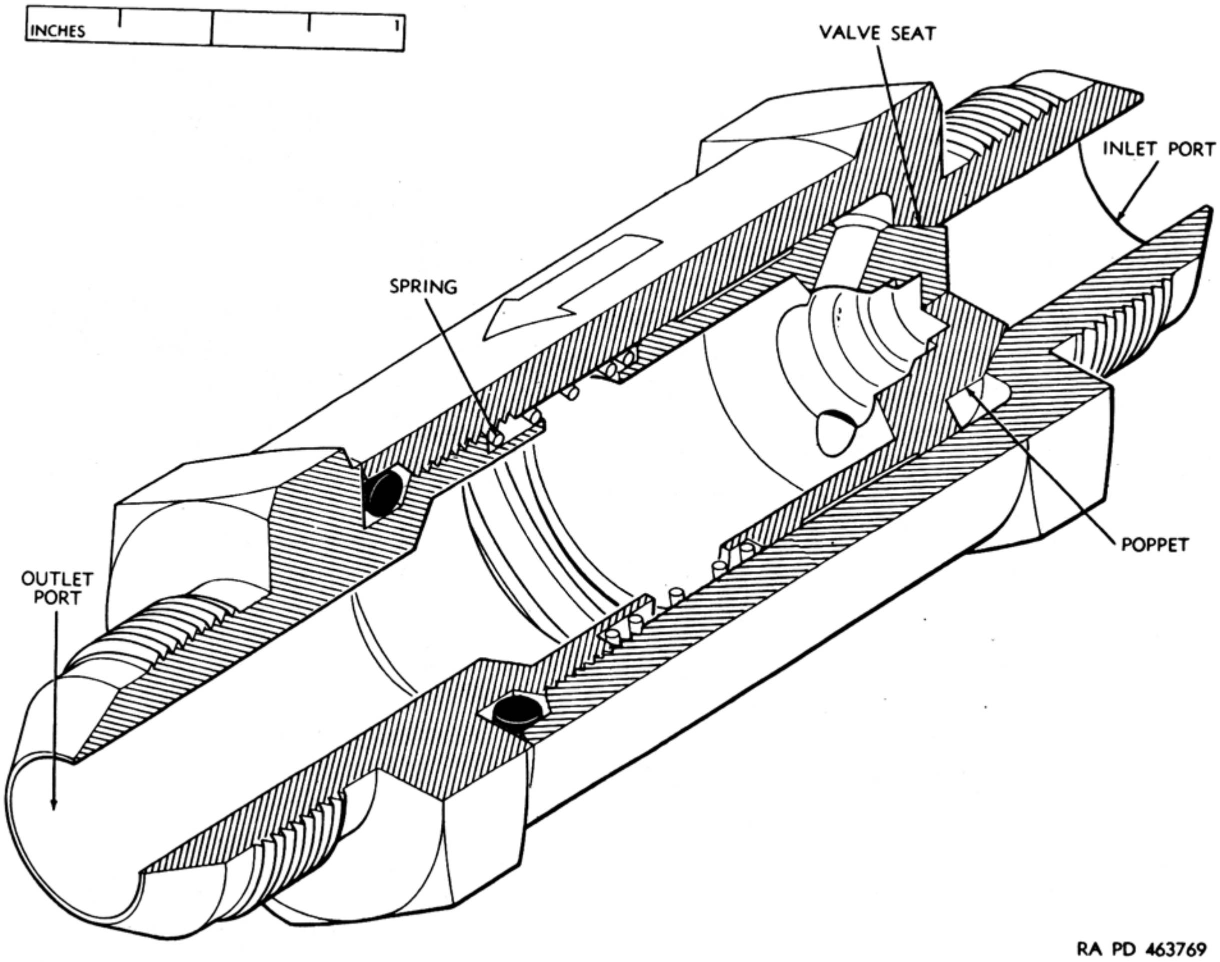


Figure 23. Check valve — cutaway view.

in the hydraulic pump pressure line. This valve permits the hydraulic surge accumulator to remain charged at 3200 psi when the axial pistons pump is not in operation. It also prevents back pressure from motorizing the pump. The valve contains a spring (fig. 23) which holds a poppet on a valve seat.

(2) When fluid under hydraulic pump pressure enters through the inlet port, this pressure overcomes the spring tension on the poppet. The poppet is lifted from its seat and fluid flows through the holes of the poppet and out the outlet port of the valve.

(3) When the pressure in the inlet port decreases, the spring seats the poppet and prevents flow reversal through the valve.

e. Pressure Fluid Filter.

(1) Two pressure fluid filters (fig. 8) are located in the hydraulic pumping unit. One filter is connected in the hydraulic pump pressure line of the axial pistons pump and is designated in maintenance paragraph 80*l* as the launcher pressure fluid filter assembly. Another identical filter is connected to the pressure line of the missile hydraulic system and is designated in maintenance paragraph 80*k* as the missile hydraulic pressure fluid filter assembly.

(2) Hydraulic fluid enters the filter through the inlet port (fig. 24) in the head and fills the space between the body and the filter element. The pressure forces the fluid through the pores of the element and removes foreign matter and impurities. The foreign matter collects on the element or falls to the bottom of the body. The filtered fluid then flows through the center of the element and out through the outlet port.

f. Hydraulic Surge Accumulator.

(1) A hydraulic surge accumulator (fig. 8) is located in the hydraulic pumping unit. The accumulator dampens pressure surges in the system. It also stores hydraulic fluid under pressure to assist the axial pistons pump when the pump is under a peak load.

(2) The accumulator has two chambers which are separated from each other by a movable piston subassembly (fig. 25). One chamber is for air and the other is for hydraulic fluid. Preformed packings on the piston subassembly prevent leakage from one chamber to the other. The concave side of the piston subassembly faces the air chamber and the flat side faces the fluid chamber. The air port is connected to the pneumatic precharge system and the hydraulic fluid port is connected to the hydraulic system.

(3) When the accumulator is initially charged with 2000 $\pm$100 psi air pressure, the pressure forces the piston subassembly to the hydraulic end of the cylinder. When fluid under pressure enters the hydraulic fluid chamber, the piston subassembly moves toward the air port. This movement further compresses the air in the air chamber until the pressure in both chambers is equal. When the launcher erecting beam (fig. 8) is being raised, the highly compressed air moves the piston subassembly (fig. 25) and forces the hydraulic fluid back into the system, thereby assisting the axial pistons pump (fig. 8). The compressed air also provides a cushion for pressure surges in the system.

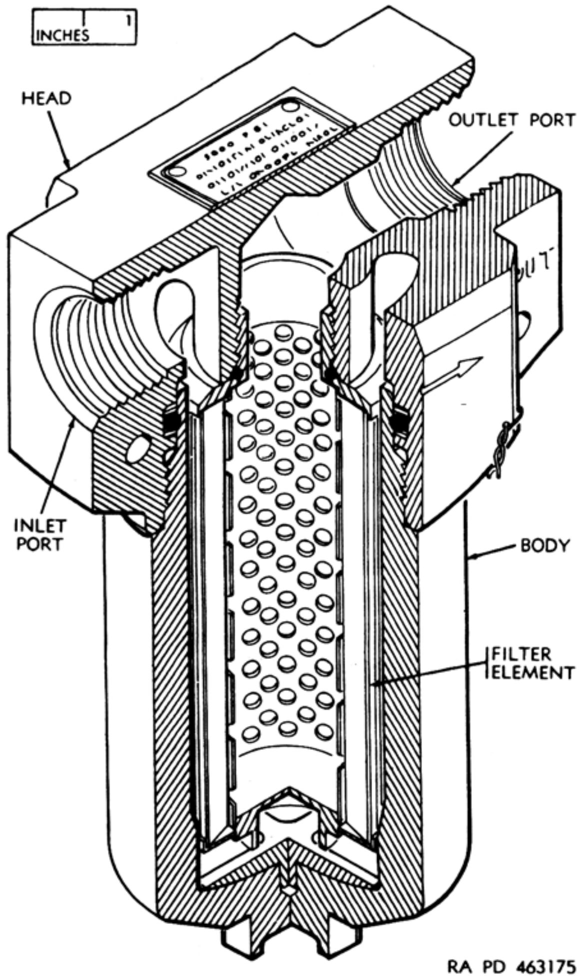


Figure 24. Pressure fluid filter — cutaway view.

g. Globe Valve.

(1) There are four globe valves (fig. 26) in the entire hydraulic system. When installed and used in their systems they are known as the SYSTEM BY-PASS valve (fig. 8), the EQUILIBRATOR SYSTEM BY-PASS valve, and two MISSILE HYDRAULIC SHUT-OFF valves.

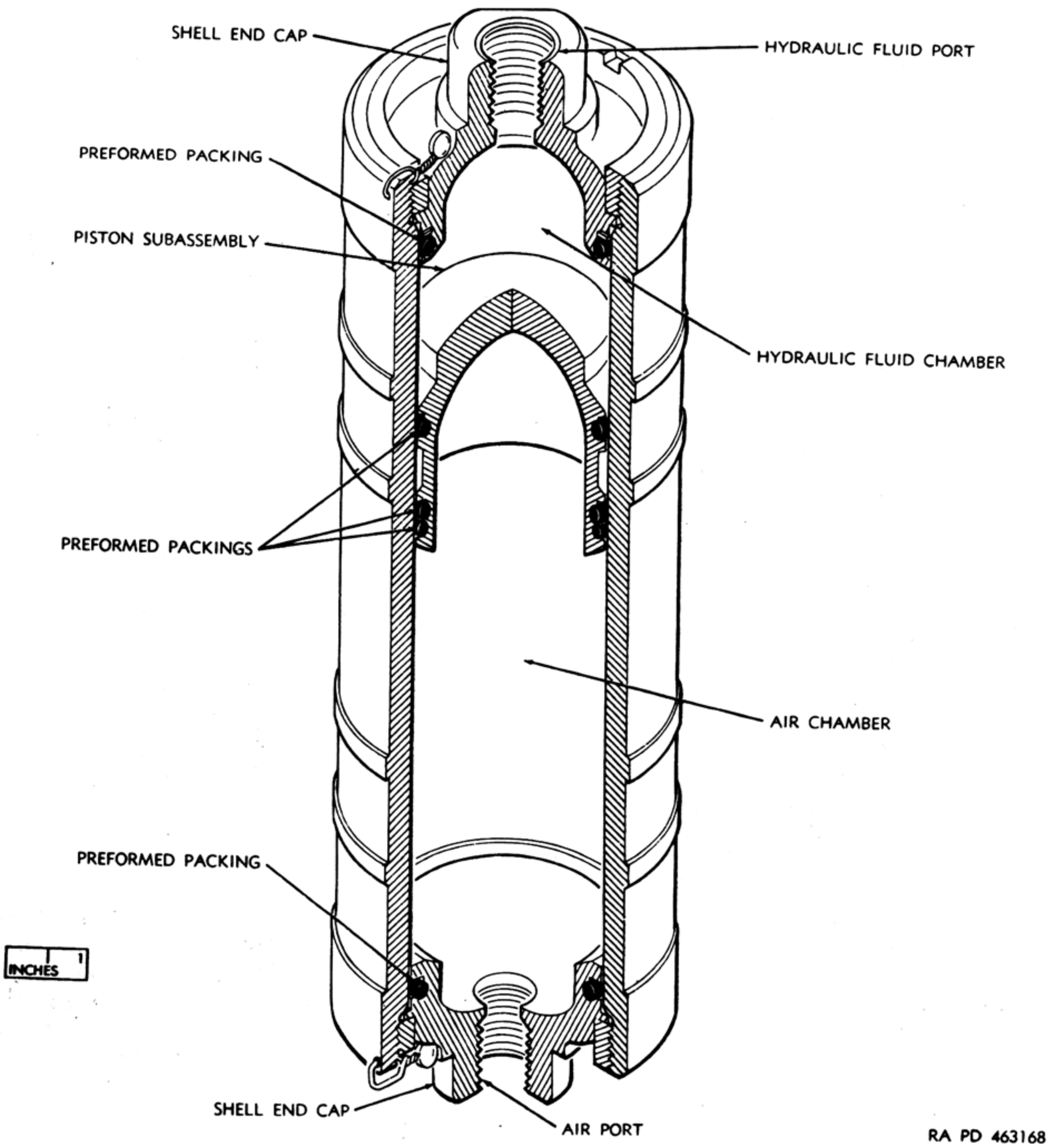


Figure 25. Hydraulic accumulator — cutaway view.

(2) The SYSTEM BY-PASS valve, located on the hydraulic pumping unit, bypasses the hydraulic surge accumulator fluid to the hydraulic oil reservoir. The EQUILIBRATOR SYSTEM BY-PASS valve, located on the left side of the launcher base, bypasses equilibrator accumulator fluid to the hydraulic oil reservoir. The MISSILE HYDRAULIC SHUT-OFF valve, located on the front left side of the launcher base, shuts off hydraulic fluid to the loading rack test stations. The other MISSILE HYDRAULIC

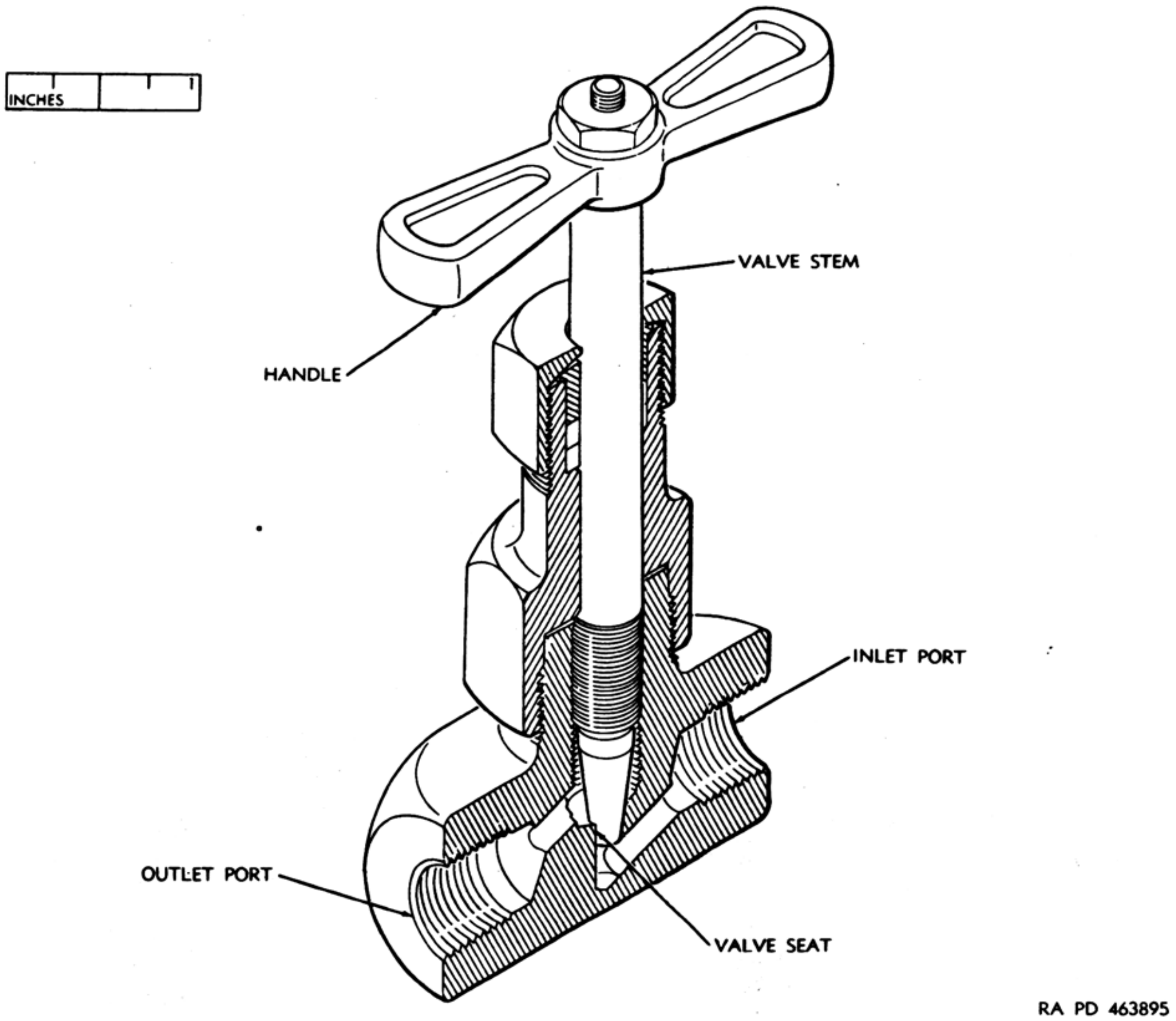


Figure 26. Globe valve – cutaway view.

SHUT-OFF valve, located on the right side of the launcher base, shuts off hydraulic fluid to the Nike-Ajax launching and handling rail M1A1 or M1A2.

(3) The globe valve (fig. 26) is a two-ported, manually operated, needle-type, valve. When the valve is open, fluid enters the inlet port, flows through the valve seat, and goes out the outlet port. A handle is attached to a valve stem which fits the valve seat. Turning the handle clockwise seats the stem and prevents flow through the valve. Turning the handle counterclockwise unseats the stem and permits flow through the valve.

h. Safety Relief Valve.

(1) Two safety relief valves are used on the Hercules monorail launcher. One relief valve is located on the hydraulic pumping unit (fig. 8) and is called the system safety relief valve. Another valve is located in the hydraulic panel and is called the equilibrator safety relief valve.

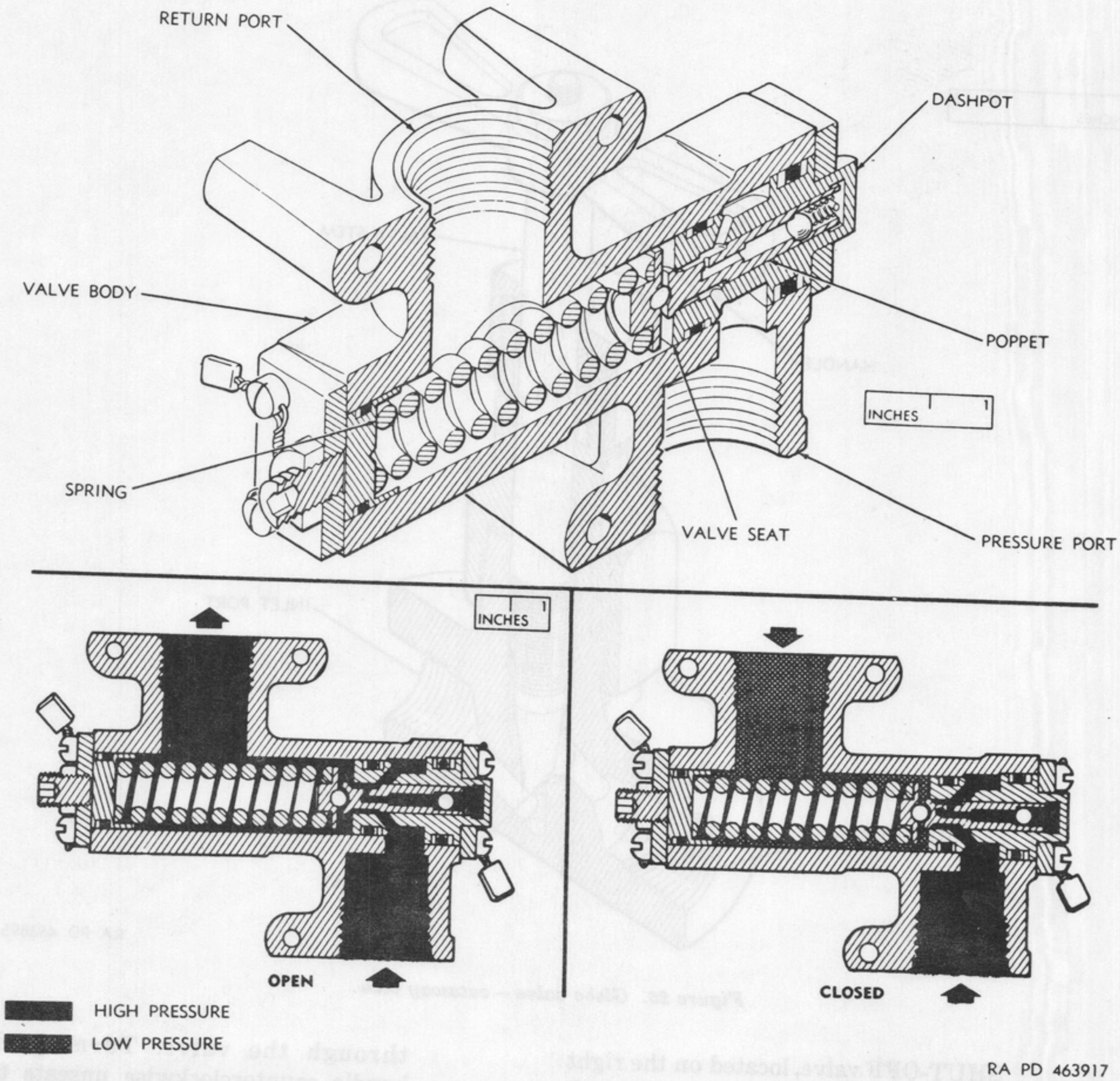


Figure 27. Safety relief valve – cutaway view.

(2) The system safety relief valve is adjusted to open at 3500 ±100 psi. It protects the hydraulic system from excessive axial pistons pump pressures by relieving them to the hydraulic oil reservoir.

(3) The equilibrator safety relief valve is adjusted to open at 3500 ±100 psi. It protects the equilibrator system from excessive pressures by relieving them to the oil reservoir.

(4) The valve body (fig. 27) has two ports: a pressure port and a return port. The pressure port is kept closed by a spring-loaded poppet. When system pressure exceeds the valve setting, the spring tension is overcome and the poppet is lifted from the valve seat. The excessive pressure then flows to the reservoir through the return port. When the system pressure decreases below the valve

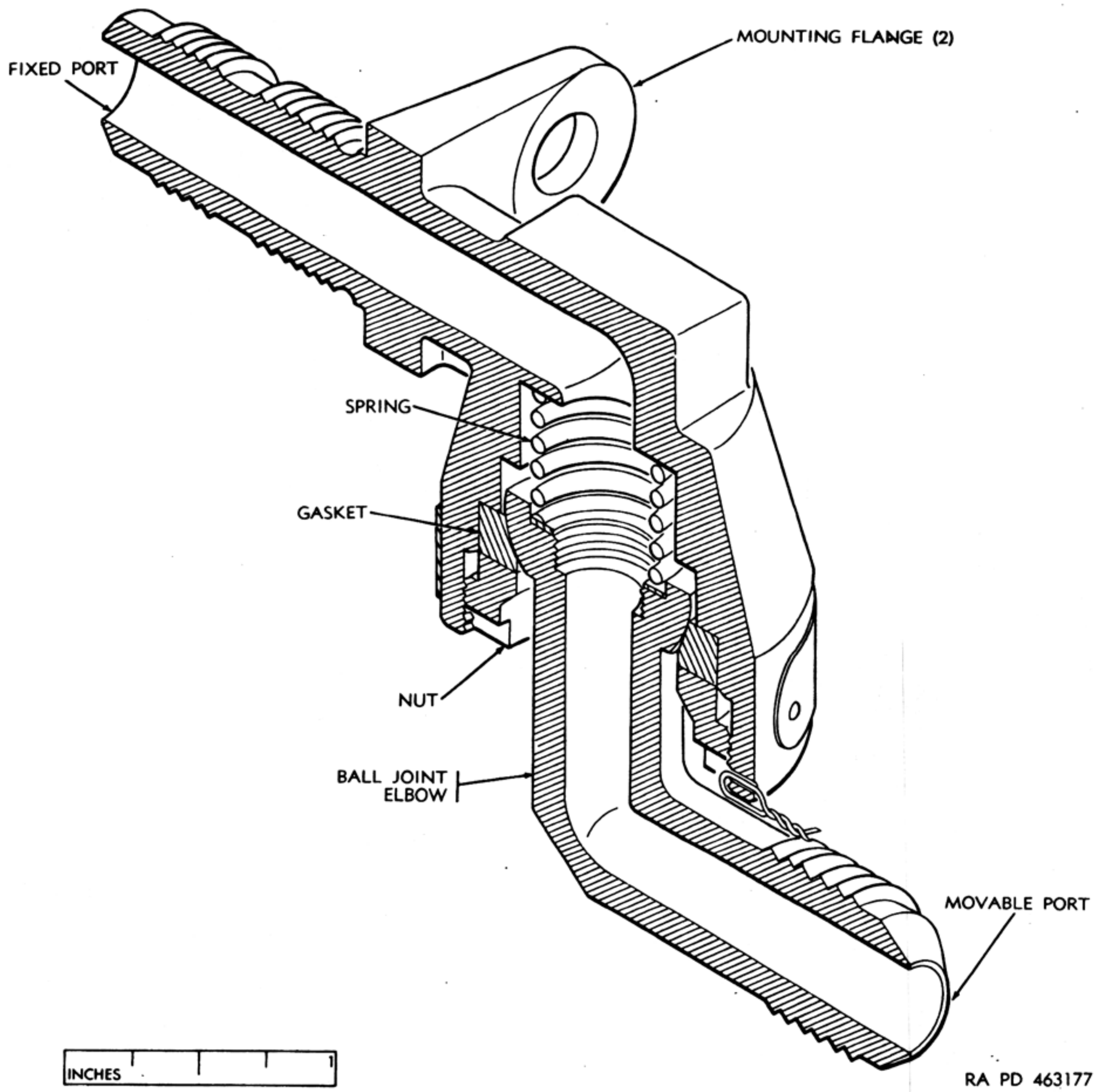


Figure 28. Swivel joint — cutaway view.

setting, the spring seats the poppet and closes the pressure port. A dash-pot prevents the poppet from seating hard.

i. Swivel Joint.

(1) A swivel joint (fig. 8) is located in each of the four hydraulic lines in the trunnion of the launcher erecting beam. These swivel joints provide an axis about which the hydraulic lines rotate when the erecting beam is raised or lowered. Each joint is mounted within the trunnion by two mounting flanges (fig. 28).

(2) The swivel joint has two ports, either of which may be used as an inlet or an outlet port. One of these ports is a fixed port, and the other is a movable port. The movable port is a ball joint elbow which is held in position

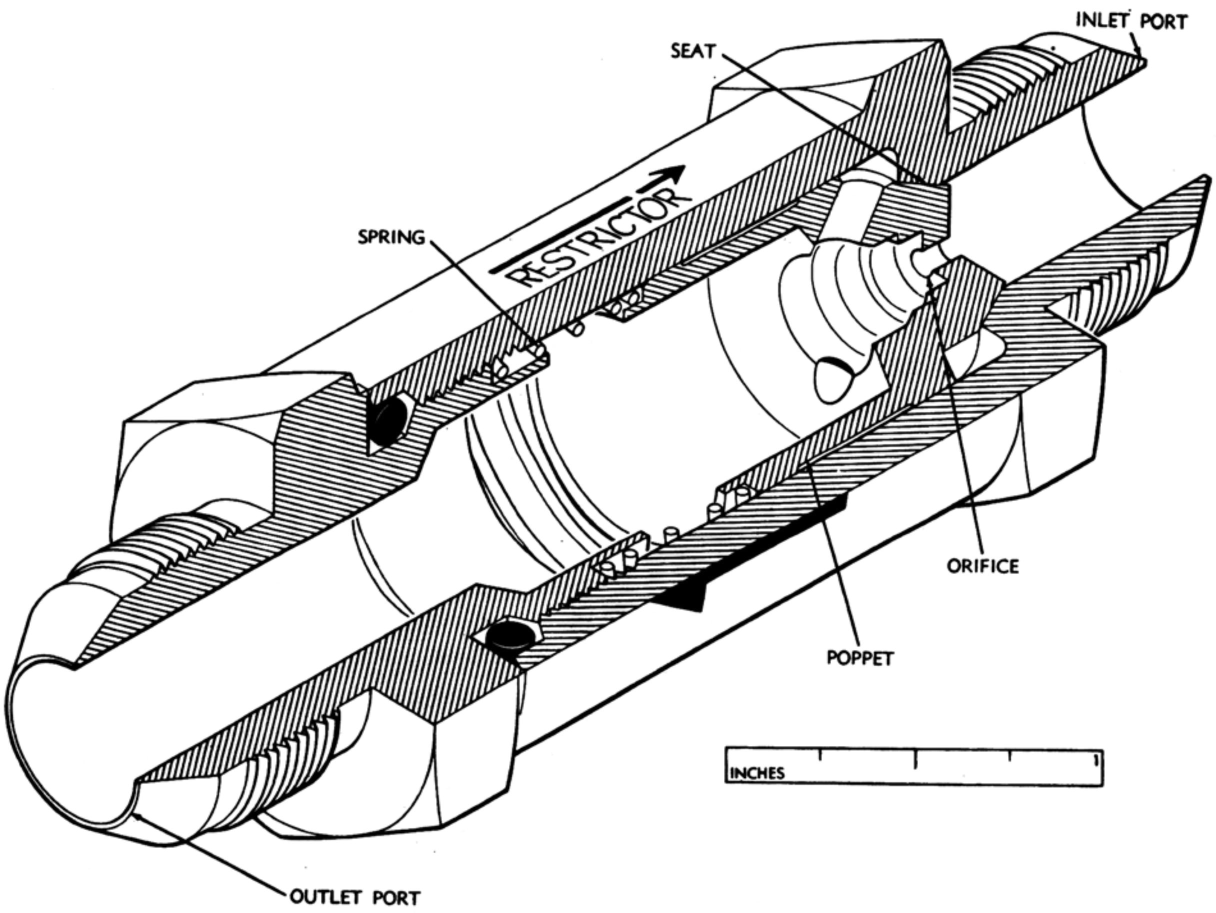


Figure 29. Speed control valve or restrictor check valve — cutaway view.

by a nut and spring. The two ports connect to tubing and the mounting flanges provide physical attachment. A gasket prevents fluid leakage from the joint.

j. Speed Control Valve.

(1) There are two speed control valves (fig. 10) in the hydraulic panel. One valve permits an unrestricted flow of hydraulic fluid under pressure to enter the rear ports of both equilibrator cylinders to lower the launcher erecting beam. A restrictor check valve in each front port retards the action of the equilibrator cylinders. When the erecting beam is being raised, hydraulic fluid from the rear ports of both equilibrator cylinders, passes through the control valve to the hydraulic oil reservoir in a restricted flow. The second valve permits an unrestricted flow of hydraulic fluid under pressure to enter the front ports of both power cylinders to raise the erecting beam. When the beam is being lowered, hydraulic fluid from the front ports of both power cylinders passes through the second valve to the hydraulic oil reservoir in a restricted flow.

Note. Figure 29 is a true cutaway view of a restrictor check valve only. The speed control valve, while its parts are physically different in size and shape, is functionally similar to this restrictor check valve.

(2) When hydraulic fluid under pressure enters the inlet port of the valve, the fluid pressure overcomes the spring tension on the poppet and raises it from the seat. Fluid then passes through both the orifice and the holes in the poppet and out the outlet port of the valve. This is the free flow condition of the valve.

(3) When fluid under pressure enters the valve through the outlet port, fluid pressure and spring tension act together to keep the poppet on its seat. When it is seated, the holes in the poppet are closed and fluid passes only through the orifice in the center of the poppet. This is the restricted flow condition of the valve.

k. Up-Cycle Priority Valve.

(1) The up-cycle priority valve (fig. 8) is located in the hydraulic panel. It is connected in the hydraulic pump pressure line of the front end of the two power cylinders. When the pressure in that line reaches 3000 ±100 psi during the launcher-up cycle, the priority valve opens and diverts additional hydraulic pressure into the equilibrator system. This permits the two equilibrator cylinders to assist in raising the launcher erecting beam.

(2) Hydraulic fluid enters the priority valve (fig. 30) through the inlet port and passes into a chamber in the cage assembly. The release poppet, when seated on the spigot, prevents further fluid flow. When the pressure in the cage assembly reaches 3000 ±100 psi, the pressure overcomes the primary spring tension on the spigot and moves the spigot toward the outlet port. The secondary spring moves the poppet and keeps it seated on the spigot through approximately two-thirds of the movement of the spigot. The poppet unseats when it reaches its maximum length of travel and when the spigot moves all the way toward the outlet port. Hydraulic fluid then flows from the chamber in the cage assembly, through the hollow center of the spigot, and out through the outlet port.

(3) When the pressure in the cage assembly decreases to 2700 ±50 psi, the primary spring moves the spigot toward the inlet port. When the spigot moves approximately one-third of that distance, the poppet seats on the spigot. Flow through the priority valve then stops and the spigot moves the remaining distance toward the inlet port.

l. Equilibrator Accumulator.

(1) The equilibrator accumulator (fig. 8) is connected in the axial pistons pump pressure line. This accumulator stores hydraulic fluid under pressure for operation of the two equilibrator cylinders. These cylinders assist the power cylinders to raise and lower the launcher erecting beam.

(2) The accumulator has two chambers which are separated from each other by a movable piston subassembly (fig. 25). One chamber is for air and the other is for hydraulic fluid. Preformed packings on the piston subassembly prevent leakage from one chamber to the other. The concave side of the piston subassembly faces the air chamber and the flat side faces the fluid chamber. The air port is connected to the pneumatic precharge system and the hydraulic fluid port is connected to the equilibrator hydraulic system.

(3) The equilibrator accumulator has a larger air and fluid capacity than the hydraulic surge accumulator (fig. 8). When the equilibrator accumulator is precharged with 600 ±50 psi air pressure, the pressure forces the piston subassembly (fig. 25) to the hydraulic fluid end of the cylinder. When hydraulic fluid under pressure is

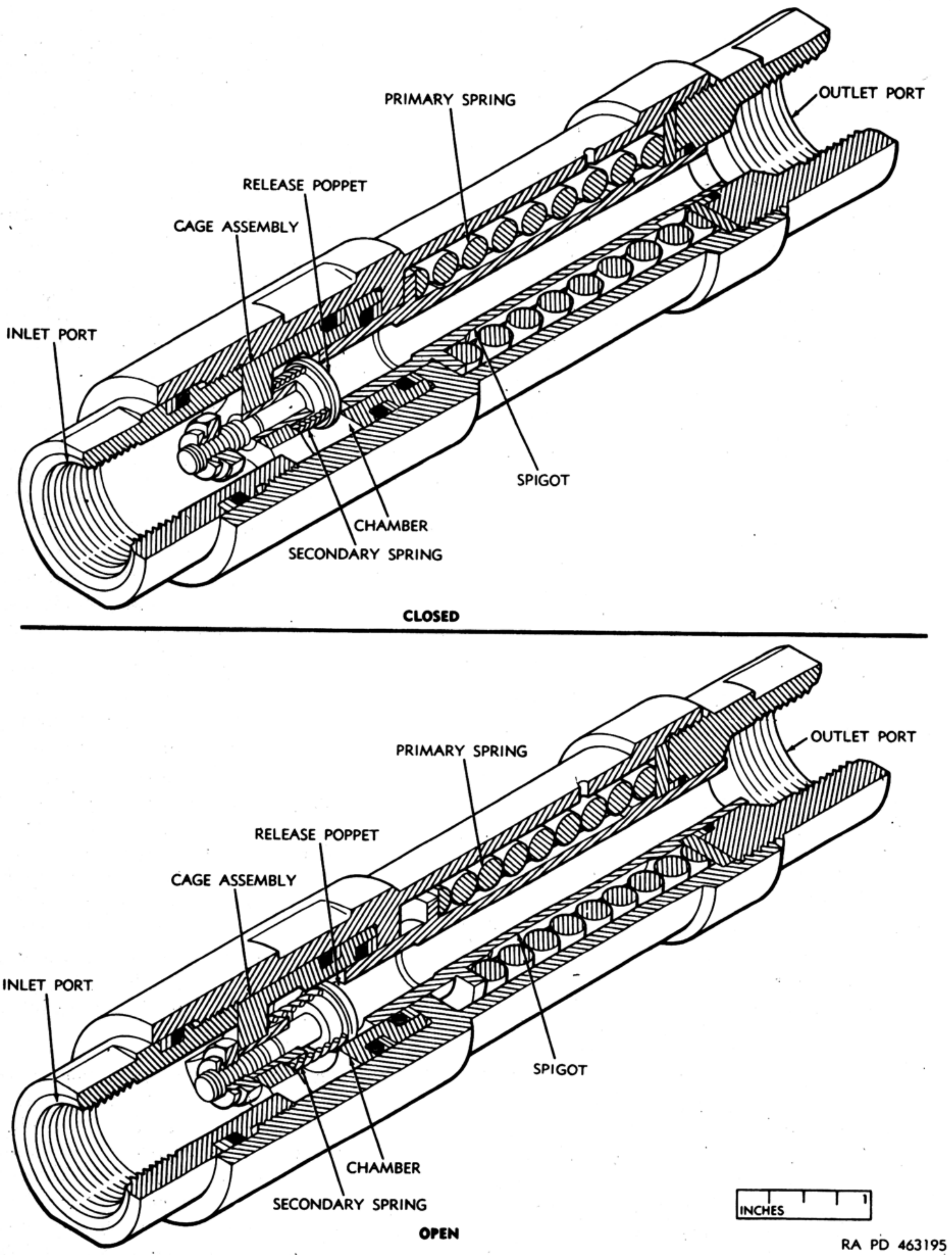


Figure 30. Priority valve — cutaway view.

forced into the accumulator by the equilibrator cylinders (fig. 8) during the launcher-down cycle, the piston subassembly (fig. 25) moves toward the air end. This movement further compresses the air in the air chamber until the pressure in both chambers is equal. When the hydraulic down-lock (fig. 8) is unlocked, the highly compressed air moves the piston subassembly and forces the hydraulic fluid back into the system and assists in raising the beam.

m. Check Valve.

(1) There are four check valves (fig. 8) in the hydraulic panel. Two of them are in the pressure lines of the equilibrator cylinders: one valve prevents pressure loss to the return system during the launcher-up cycle; the other valve prevents equilibrator accumulator pressure reversal through the priority valve.

(2) The other two check valves are in the pressure lines of the power cylinders (fig. 10) : One valve prevents the operation of the power cylinders until after the hydraulic up-lock has been unlocked for the launcher-down cycle. The other valve prevents high-pressure fluid from flowing to the hydraulic oil reservoir from the power cylinder lines during the down-cycle.

(3) Refer to *d* (2) and (3) above for the function description of a check valve.

n. Power or Equilibrator Cylinder.

(1) Two power cylinders (fig. 8) and two equilibrator cylinders are located in the launcher base. One of each type of these cylinders is located on each side of the launcher erecting beam. These four cylinders raise and lower the beam.

(2) Each cylinder has a hydraulic cylinder piston (fig. 31), a cylinder eye bolt, two dashpots, and two ports. A restrictor check valve in the front port permits a free flow of hydraulic fluid into the cylinder and a restricted flow out of it. The two dashpots retard the piston action by restricting the flow of hydraulic fluid as it leaves the cylinder.

(3) When hydraulic fluid under pressure enters through the front port, the piston moves, retracts the eye bolt, and raises the beam. This piston movement causes the fluid which is on the rear side of the piston to flow out through the rear port and into the return line of the hydraulic oil reservoir (fig. 8). When the piston (fig. 31) nears the end of its retraction stroke, the erecting beam orifice cylinder of the internal dashpot seats over the rear port and permits the hydraulic fluid to bleed through the rear port slowly.

(4) When hydraulic fluid under pressure enters through the rear port, the piston moves, extends the eye bolt, and lowers the beam. This piston movement causes the fluid which is on the front side of the piston to flow out through the front port and into the return line of the reservoir (fig. 8). When the piston (fig. 31) nears the end of its extension stroke, the sleeve of the external dashpot seats over the front port and permits hydraulic fluid to bleed through the port slowly.

o. Cam-Operated Valve.

(1) The cam-operated valve (fig. 8), located on the launcher base, is connected in the pressure line of the equilibrator cylinders. This valve is actuated by a cam on the secondary trunnion (fig. 2) so that the valve opens when the launcher erecting beam is above 70 degrees elevation. When the valve opens, hydraulic fluid in the equilibrator system is ported to the hydraulic oil reservoir.

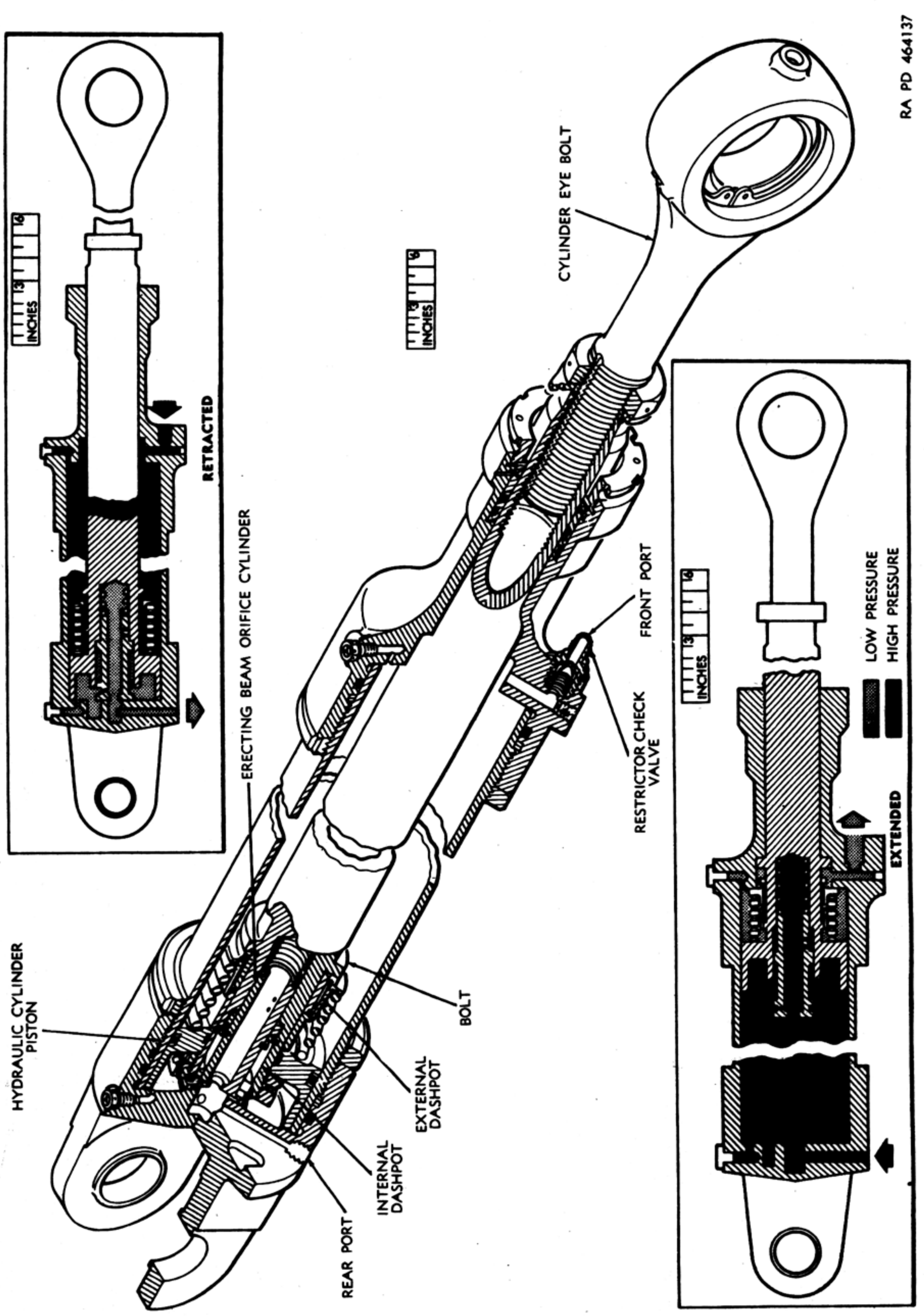


Figure 31. Power or equilibrator cylinder – cutaway view.

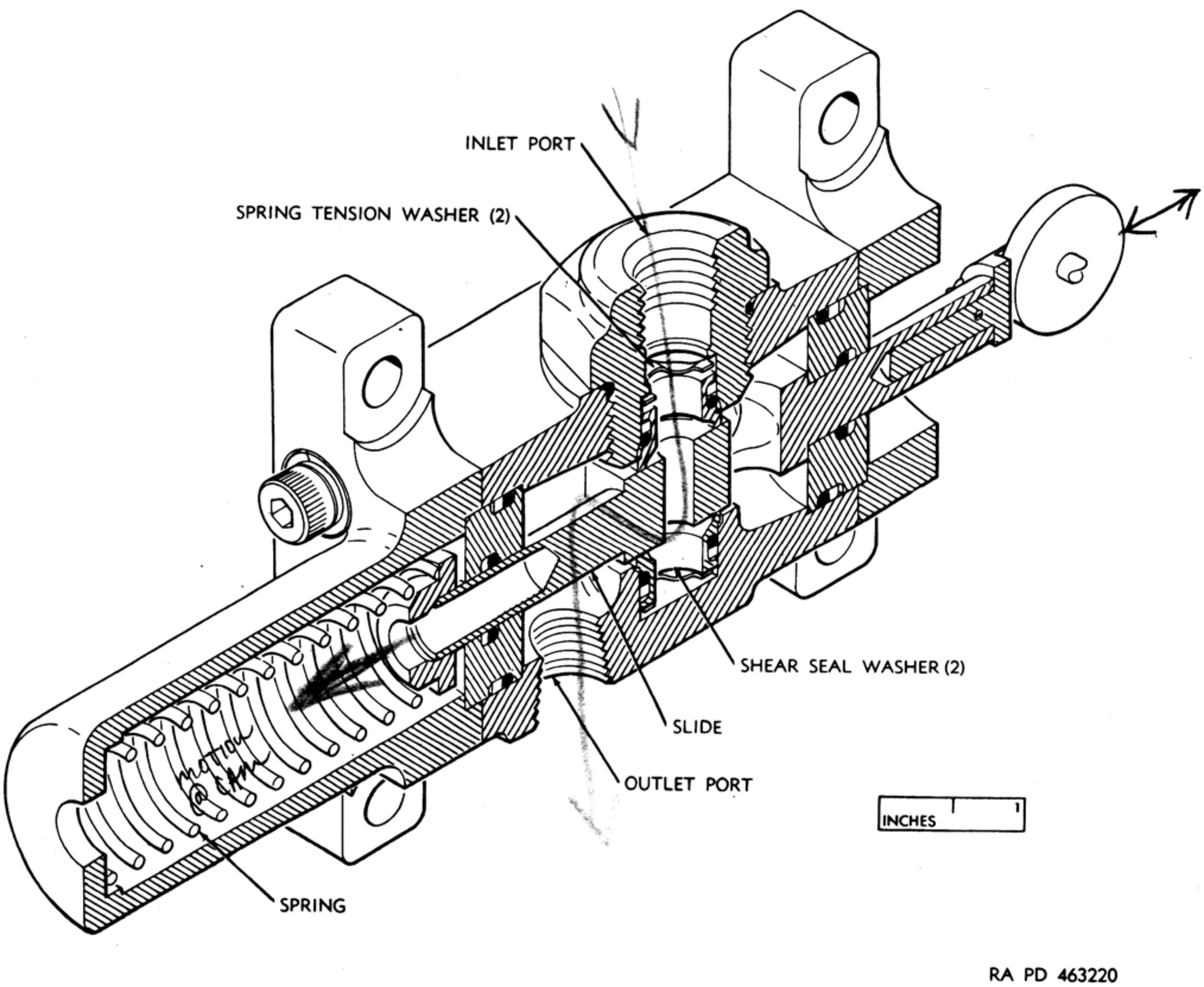


Figure 32. Cam-operated valve — cutaway view.

(2) The valve is spring-loaded so that the slide (fig. 32) extends its full length. In this position, the ports are closed and there is no flow through the valve.

(3) When the slide is operated by the cam of the secondary trunnion (fig. 2), the spring (figs. 32 and 33) is compressed and the passages in the slide are alined with the inlet and the outlet ports. Hydraulic fluid then flows from the inlet port, through the slide, and out through the outlet port. Internal leakage around the shear seal washers (fig. 32) is prevented by spring tension washers which hold the shear seal washers against the slide.

(4) When the cam of the trunnion no longer holds the slide in the retracted position, the spring extends the slide and closes the ports. Fluid no longer flows through the valve.

~~*p. Down-Cycle Priority Valve.*~~

(1) ~~The down-cycle priority valve~~ (fig. 10), ~~located in the hydraulic panel,~~ is connected in the pressure line of the rear ports of the power cylinders.

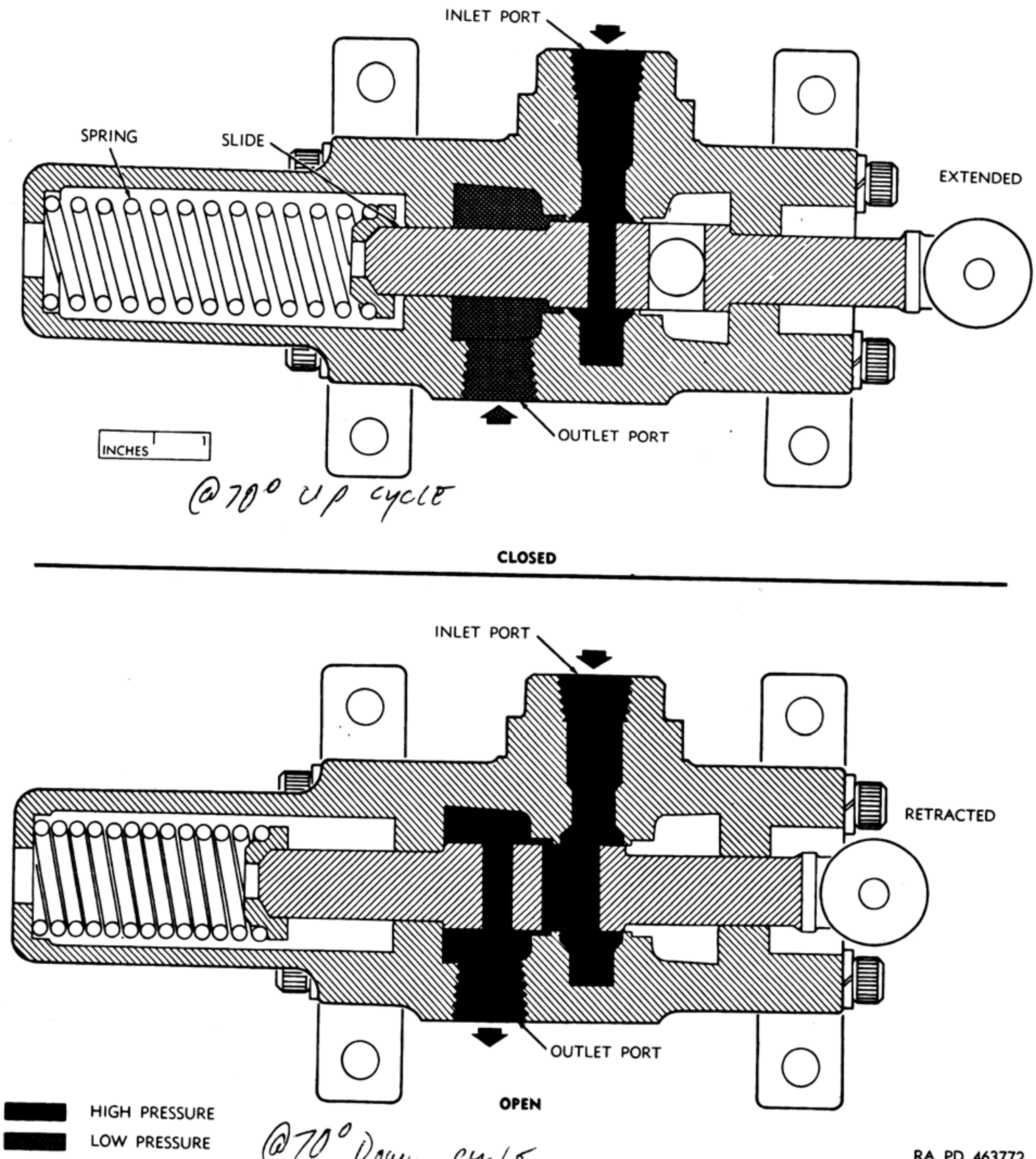


Figure 33. Cam-operated valve – functional diagram.
EQUICABRATOR System only

@70°

~~When the pressure in that line reaches 3000 ±50 psi during the launcher-down cycle, the priority valve opens and diverts hydraulic pressure into the power cylinders.~~ This enables the power cylinders to assist the equilibrator cylinders to lower the erecting beam.

(2) Refer to *k* (2) and (3) above for the functional description of a priority valve.

open @ 3000 ±50
closes @ 2700 ±50

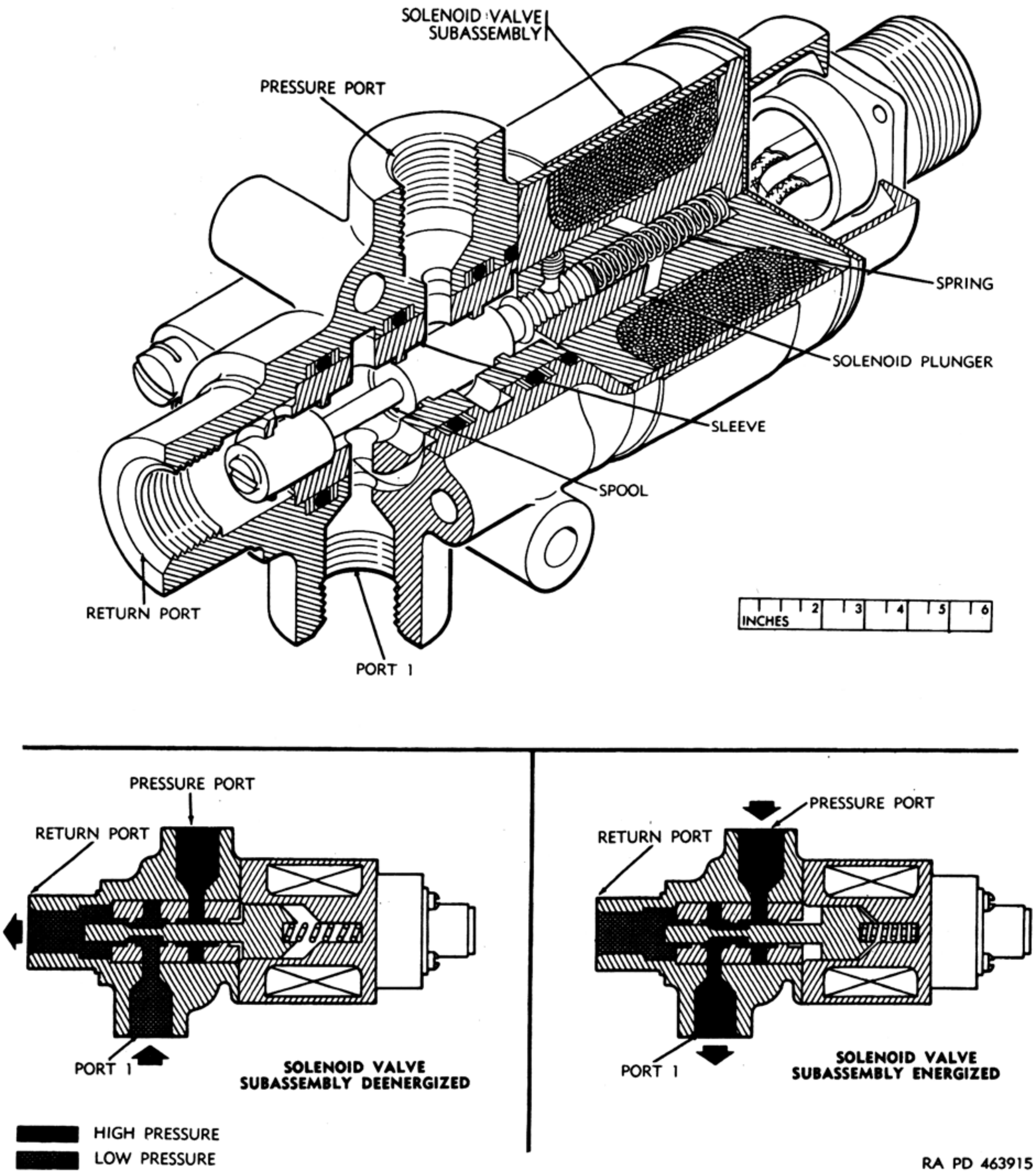


Figure 35. Missile hydraulic solenoid valve – cutaway view.

28. Missile Hydraulic System

a. Missile Hydraulic Solenoid Valve.

(1) The missile hydraulic solenoid valve (fig. 34) is located in the hydraulic pumping unit. The direction of fluid flow within the valve is controlled by a solenoid (fig. 35) that moves a spool within a sleeve. When the solenoid is energized, the valve (fig. 34) ports hydraulic fluid under pressure to the Nike-Ajax launching and han-

dling rail M1A1 or M1A2, and to the loading rack test stations. When it is deenergized, there is no fluid flow through the valve.

(2) When the solenoid valve subassembly (fig. 35) is deenergized, a spring moves the solenoid plunger and the spool toward the return port. The pressure port closes; port 1 and the return port are open and interconnected.

(3) When the valve subassembly is energized, the solenoid plunger and the spool move away from the return port. The spring is compressed and the return port closes. The pressure port and port 1 open. Fluid under pressure now enters the valve through the valve through the pressure port and flows out through port 1.

b. Missile Hydraulic Pressure Fluid Filter.

(1) The missile hydraulic pressure fluid filter (fig. 34), located in the hydraulic pumping unit, is connected in the hydraulic pump pressure line of the missile hydraulic system. This filter supplements the launcher pressure fluid filter in the pressure line of the axial pistons pump.

(2) Refer to paragraph 27*e* for a functional description of this filter.

c. Pressure Reducer Valve.

(1) The pressure reducer valve (fig. 34), located in the hydraulic pumping unit, is connected in the hydraulic pump pressure line of the missile hydraulic system. The valve reduces the pressure in the hydraulic system to 2000 +50 psi.

(2) When hydraulic fluid below 2000 psi enters the inlet port (figs. 36 and 37), it flows through the shuttle holes to the hollow center of the shuttle and goes out the outlet port.

(3) When the pressure in the outlet port exceeds 2000 ±50 psi, this pressure acts on the end of the shuttle and moves the shuttle toward the spring. The spring is compressed and the shuttle opens a path through the sleeve to the return port. Fluid flows from the inlet port to both the outlet port and the return port.

(4) When the pressure at the outlet port decreases, the spring moves the shuttle toward the outlet port. The shuttle closes the passage through the sleeve to the return port and permits fluid to flow from the inlet port to the outlet port.

(5) The spring tension on the shuttle controls the outlet pressure of the valve. The tension can be adjusted by turning the adjustment screw.

d. Check Valve.

(1) A check valve (fig. 34) is connected in each of the two missile hydraulic oil return lines. One check valve is near the right side of the main trunnion and the other is near the hydraulic oil reservoir. The check valves prevent flow reversals in the lines.

(2) Refer to paragraph 27*d* (2) and (3) for a functional description of a check valve.

e. Restrictor.

(1) There are two restrictors (fig. 34) in the missile hydraulic system. One restrictor, located on the front left side of the launcher base, is connected to the hydraulic pump pressure line of the loading rack test stations. The other restrictor, located in the launcher erecting beam, is connected to the pump pressure line of the Nike-Ajax launching and handling rail M1A1 or M1A2. The restrictors provide a smooth and restricted flow of fluid for the Nike-Ajax guided missile M1 operational checks.

(2) Either port (fig. 38) of the restrictor may be used as the inlet or outlet,

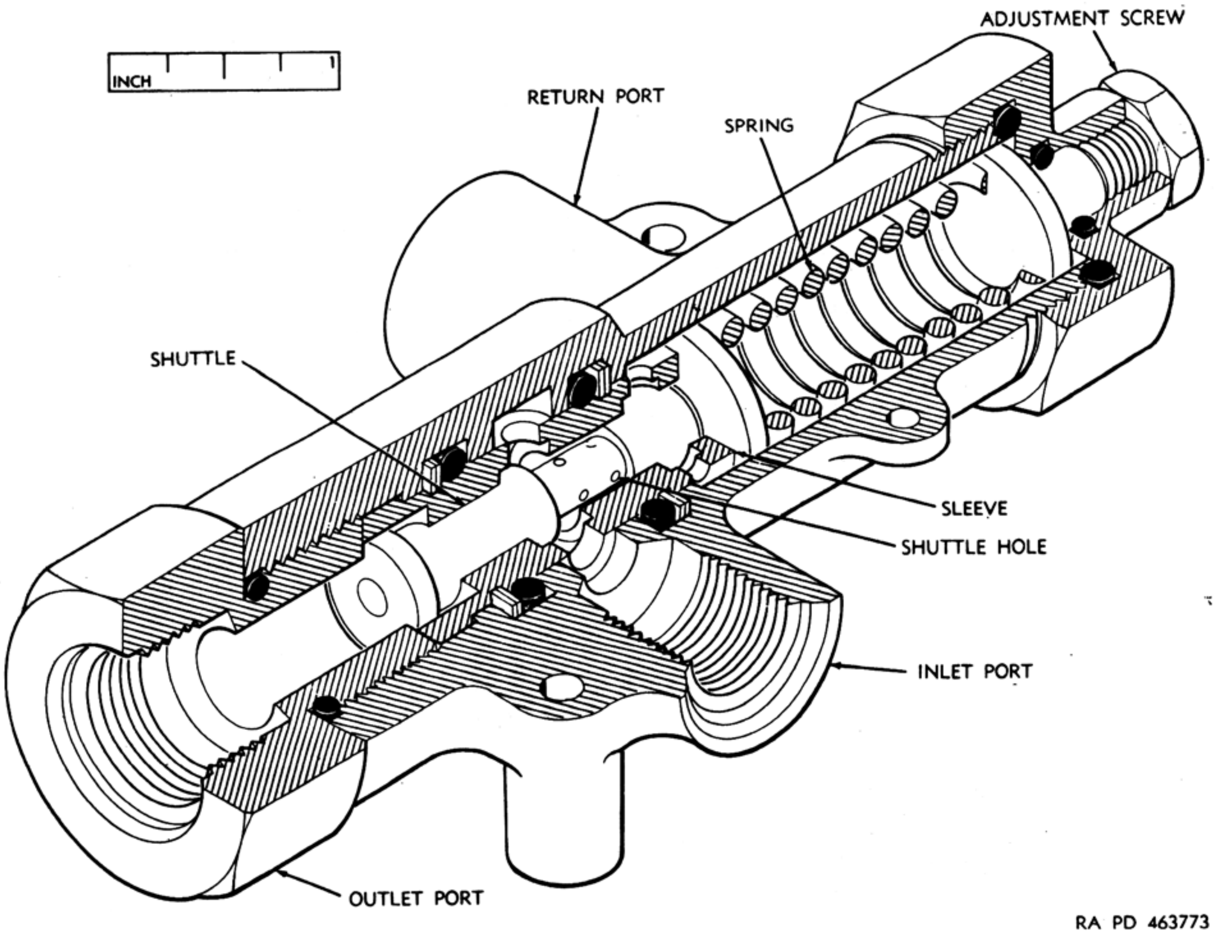


Figure 36. Pressure reducer valve — cutaway view.

since flow through the restrictor is restricted in both directions. When hydraulic fluid enters either port, it flows into the filter housing surrounding the filter element. The hydraulic fluid then passes through the wall of the filter element and through the center of the filter element to the orifice. After passing through the orifice, the hydraulic fluid goes through another filter element before reaching the other port.

f. MISSILE HYDRAULIC SHUT-OFF Valve.

(1) There are two MISSILE HYDRAULIC SHUT-OFF valves (figs. 34 and 60). One valve, located on the front left side of the launcher base, shuts off hydraulic fluid to the loading rack test stations. The other valve, located on the right side of the launcher base, shuts off hydraulic fluid to the Nike-Ajax launching and handling rail M1A1 or M1A2.

(2) For a functional description of this globe valve, refer to paragraph 27*g* (3).

g. Restrictor Check Valve.

(1) A restrictor check valve (fig. 34) mounted on the outside of the hydraulic pumping unit, is connected in series with the hydraulic down-lock. This valve permits a free flow of fluid under pressure to pass through it to unlock the down-lock. After the down-lock unlocks, fluid flow in the valve

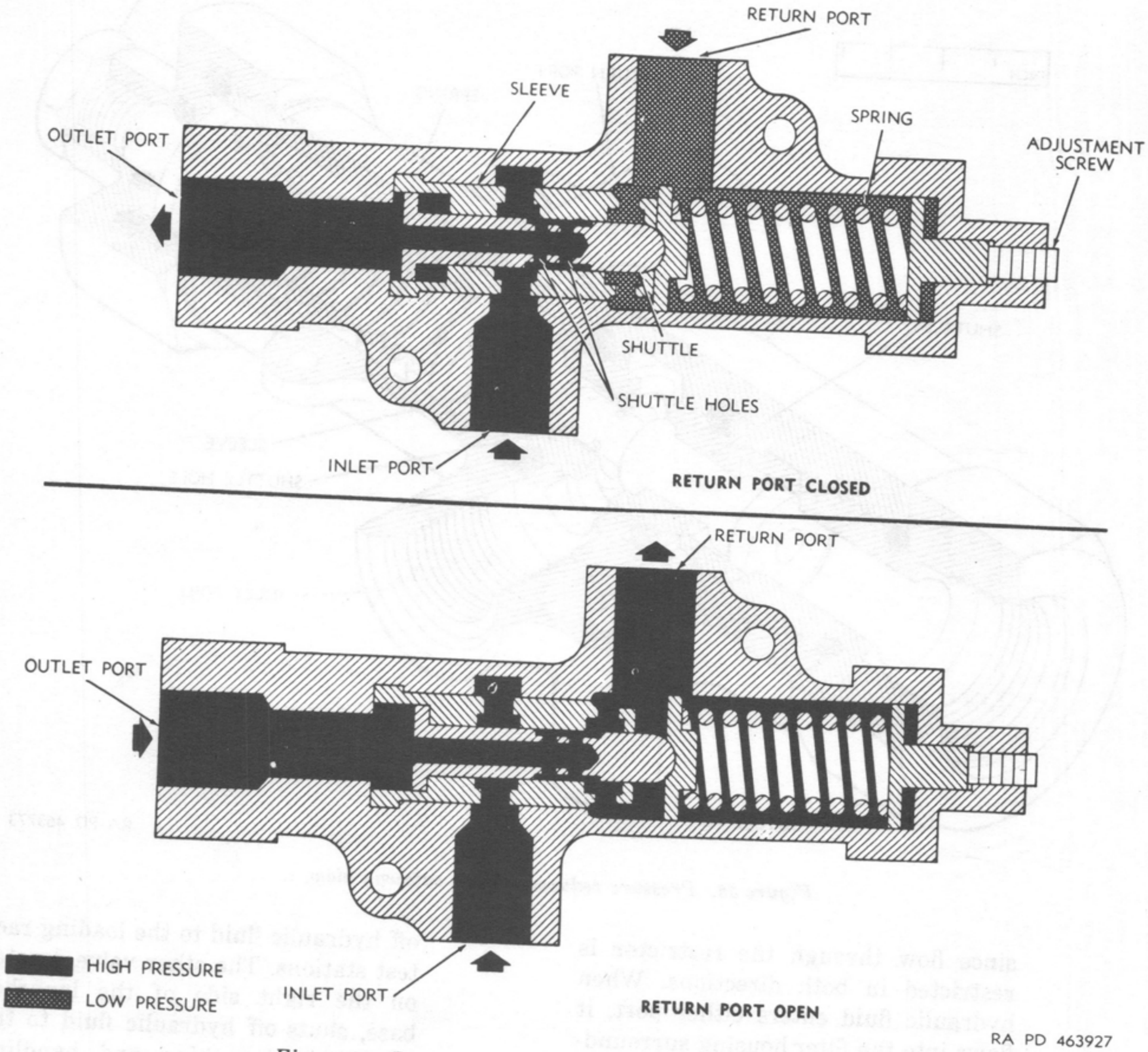


Figure 37. Pressure reducer valve — functional diagram.

reverses and passes from the down-lock to the hydraulic oil reservoir in a restricted flow. The restrictor check valve prevents the down-lock from accidentally locking the erecting beam hook (fig. 39) immediately after the hydraulic pressure has been relieved in the hydraulic pump pressure line (fig. 8). This delay gives the beam hook (fig. 39) time to raise clear of the latch clevis group.

(2) For a functional description of this restrictor check valve (fig. 29), refer to paragraph 27*j* (2) and (3).

29. Complex Mechanical Mechanisms

a. Down-Lock Mechanism.

(1) The down-lock mechanism (fig. 39), located on the front of the launcher base, holds the launcher erecting beam in the down-and-locked position. This mechanism consists of the hydraulic down-lock and the latch clevis group.

Mech-lock

Hyd-unlock

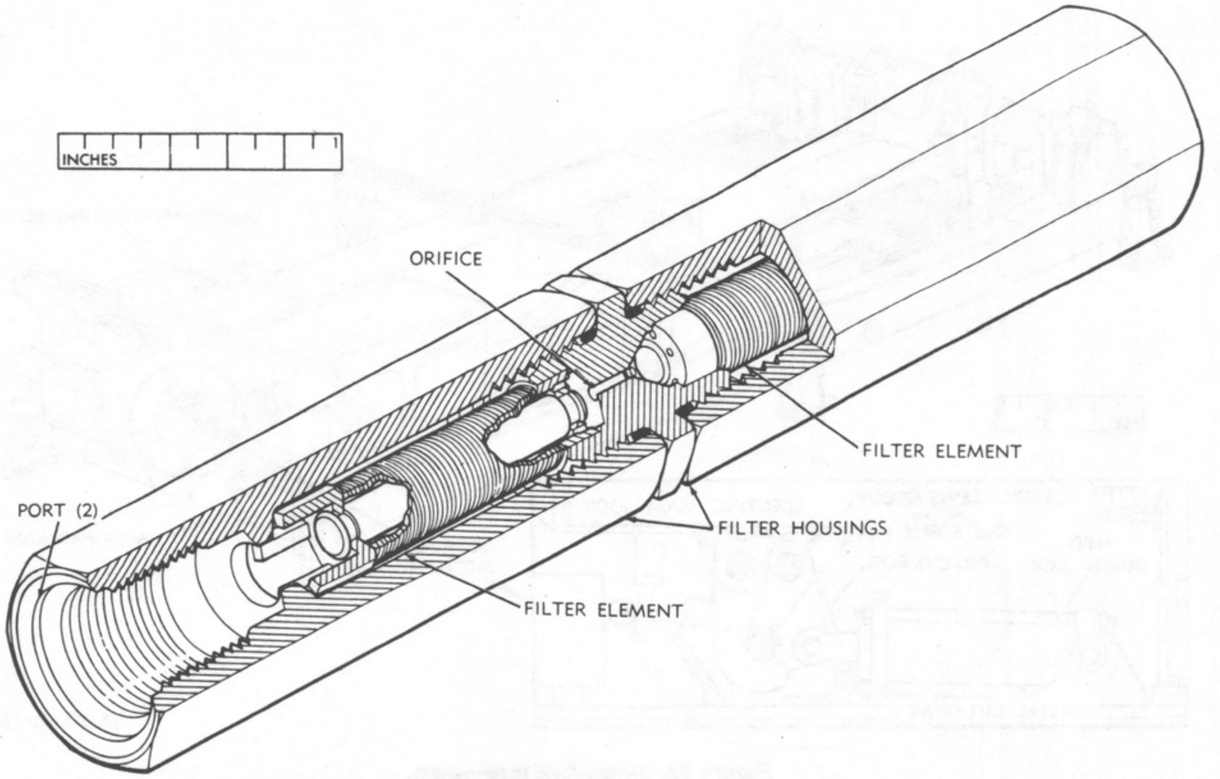


Figure 38. Restrictor — cutaway view.

(2) The piston (fig. 40) inside the down-lock is attached to the hydraulic cylinder rod, and the rod is connected to the clevis group (fig. 39). A headless straight pin in the clevis group engages the erecting beam hook on the launcher erecting beam, holding the beam down.

(3) The down-lock (fig. 40) is a single-acting hydraulic cylinder. The piston and rod are held in the normal extended position by a helical compression spring. At the beginning of the launcher-up cycle, hydraulic pressure through the port retracts the piston, and the rod moves the clevis group (fig. 39) and releases the beam hook. This piston movement also compresses the spring (fig. 40). When hydraulic pressure to the down-lock is relieved after the erecting beam is up and locked, the spring extends the rod. At the end of the launcher-down cycle, the down-lock mechanism (fig. 39) provides a latching action to engage the beam hook. The beam hook is held down and locked by the extended clevis group.

b. Wedge Groups.

(1) The forward wedge group (fig. 41) and rear wedge group in the launcher erecting beam lock the Hercules launching-handling rail to the erecting beam.

(2) Each wedge group consists of a hydraulically operated locking wedge, a locking wedge adjuster, and a locking wedge hydraulic cylinder. The wedge adjuster rides on the upper surface of the locking wedge. When the locking wedge moves to the rear of the erecting beam, the wedge adjuster rises and its upper face contacts a T-track on the bottom of the

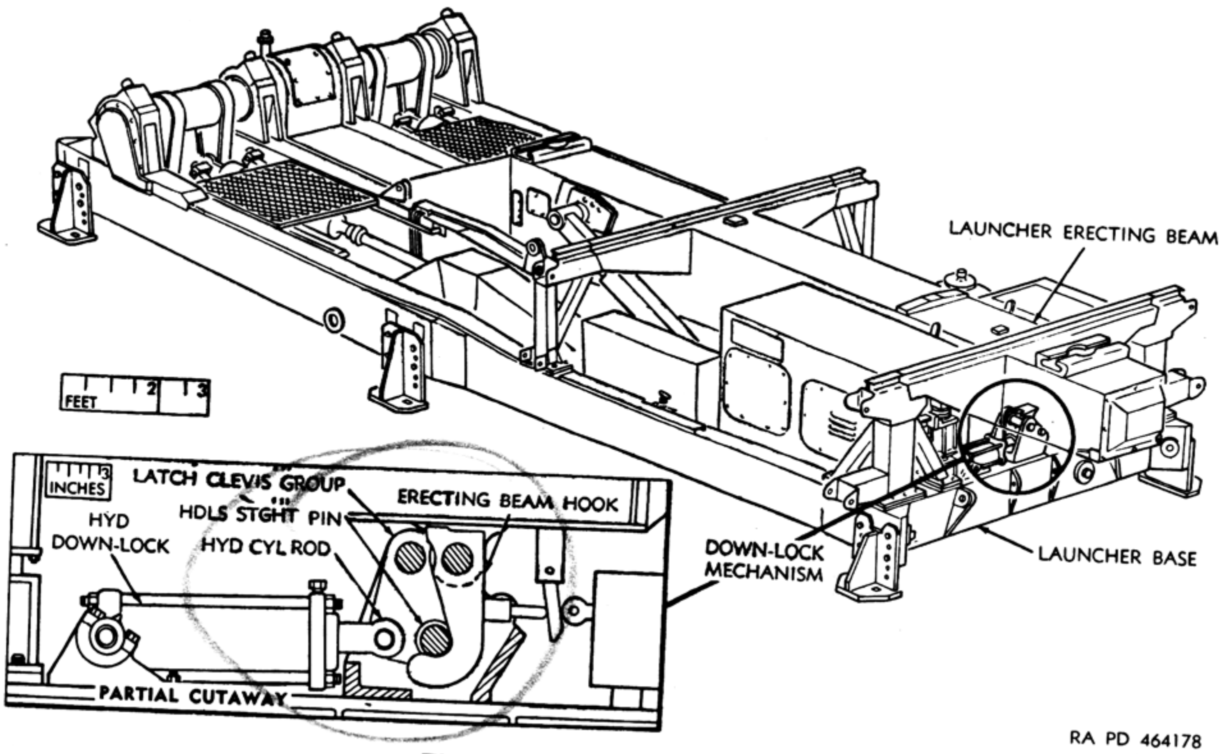


Figure 39. Down-lock mechanism.

rail. The wedge adjuster raises the rail and locks it against the under surface of the locking lugs of the erecting beam.

(3) The locking wedge hydraulic cylinders actuate the locking wedges. Each cylinder is a double-acting cylinder with a piston (fig. 42) and an actuating shaft. There is a rear port in the end cap and a front port in the multiple connector. When hydraulic fluid under pressure enters the cylinder sleeve through the front port, the piston moves toward the rear. The fluid on the rear side of the piston returns to the hydraulic oil reservoir through the rear port. When hydraulic fluid enters the sleeve through the rear port, the piston moves toward the front. The hydraulic fluid on the front side of the piston returns to the reservoir, through the front port.

c. Nike-Ajax Indexing Pins (fig. 43).

(1) There are two indexing pins and two rail lock switches on the launcher erecting beam for the Nike-Ajax launching and handling rail M1A1 or M1A2. These pins are located in the center of the front and rear outrigger tracks.

(2) When the pins are depressed by the rail, the front and rear Ajax rail lock switches are activated.

d. Hydraulic Up-Lock.

(1) The hydraulic up-lock (fig. 2), located between the knees formed by the launcher strut (fig. 3) and the strut arms, locks the launcher erecting beam in the up position.

(2) The up-lock (fig. 2) contains two ports (fig. 44) which permit hydraulic fluid to enter it. There are two pistons in the up-lock and each one is connected to a cylinder locking nut. These pistons are held in the extended position by two helical compression springs within the uplock. When hydraulic fluid under pressure

LOCKS - MECHANICALLY
UNLOCKS - HYDRAULICLY

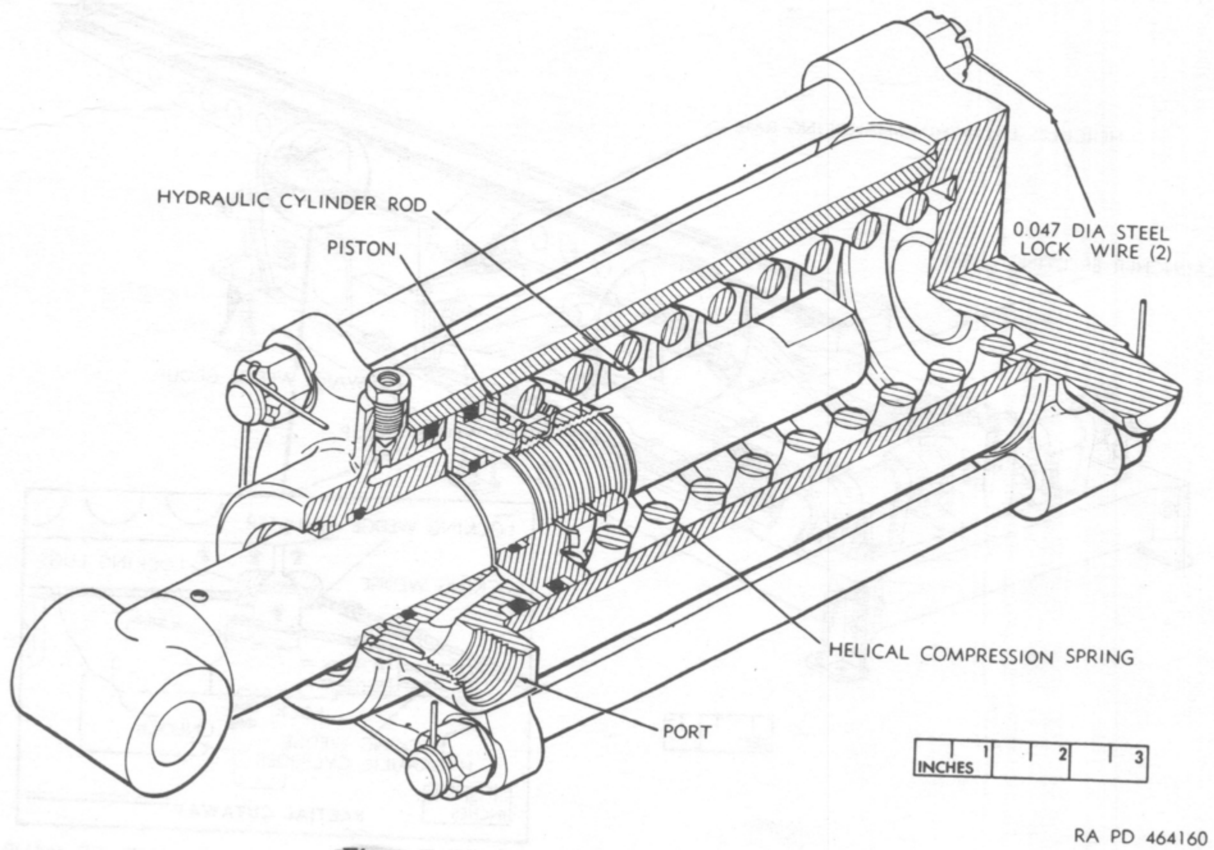


Figure 40. Hydraulic down-lock – cutaway view.

enters the up-lock through the two ports, the pistons move inward toward the center of the hydraulic strut box cylinder; the springs are compressed, and the locking nuts disengage from the strut arms (fig. 3). When hydraulic pressure in the up-lock is relieved to the reservoir through the two ports (fig. 44), the springs move the pistons and the locking nuts outward. The locking nuts engage the strut arms (fig. 3) in the up-and-locked position. The strut box cylinder (fig. 44) contains two bleeder valves for air bleeding.

e. Up-Down Solenoid Valve. NOT REPAIRABLE

(1) The up-down solenoid valve (fig. 34) is located in the hydraulic pumping unit. The direction of fluid flow within the valve is controlled by two solenoids (figs. 45 and 46). When one of the solenoids is energized, the valve ports hydraulic fluid under pressure to the power and equilibrator cylinders (fig. 34) to raise the launcher erecting beam. When the other solenoid (figs. 45 and 46) is energized, the valve ports hydraulic fluid under pressure to the cylinders (fig. 34) to lower the beam. With both solenoids (figs. 45 and 46) de-energized, fluid from the rear cavities of the four cylinders (fig. 34) and from the hydraulic up-lock is ported to the hydraulic oil reservoir.

(2) When solenoid 1 (figs. 45 and 46) is energized, its actuating pin positions the ball on the pressure seat and prevents fluid from the pressure port from entering chamber 1. Hydraulic fluid from the pressure port flows

CONTROL FLUID FLOW to:
1) DOWN LOCK
2) UP LOCK
3) HYDRAILIC CYLINDERS

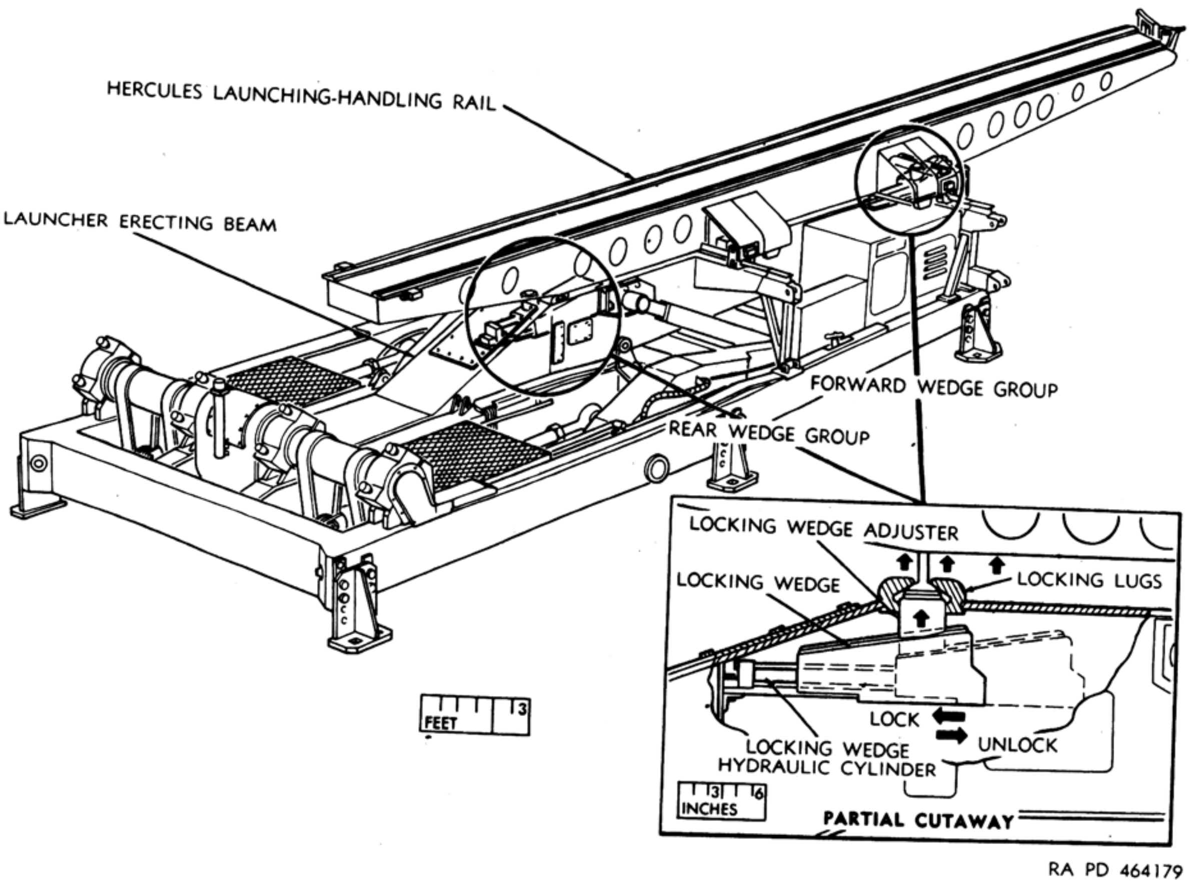


Figure 41. Wedge groups.

through the other pressure seat, which is open, through the internal passages in the valve body, and enters chamber 2. The fluid pressure in chamber 2 moves the piston toward chamber 1. With the piston in this position, the passages between the pressure port and port 1, and the passages between port 2 and the return port, are opened. Fluid enters the solenoid valve through the pressure port and flows out through port 1. Fluid also enters the valve through port 2 and flows out through the return port.

(3) When solenoid 2 is energized, its actuating pin positions the ball on the pressure seat and prevents fluid from the pressure port from entering chamber 2. Hydraulic fluid from the pressure port flows through the other open pressure seat, through the passages in the valve body, and enters chamber 1. The fluid pressure in chamber 1 moves the piston toward chamber 2. With the piston in this position, the passages between the pressure port and port 2, and the passages between port 1 and return port, are opened. Fluid enters the solenoid valve through the pressure port and flows out through port 2. Fluid also enters the valve through port 1 and flows out through the return port.

(4) When both solenoids are deenergized, the actuating pins move away from the balls and fluid from the pressure port forces the balls away from the pressure seats. Fluid passes through

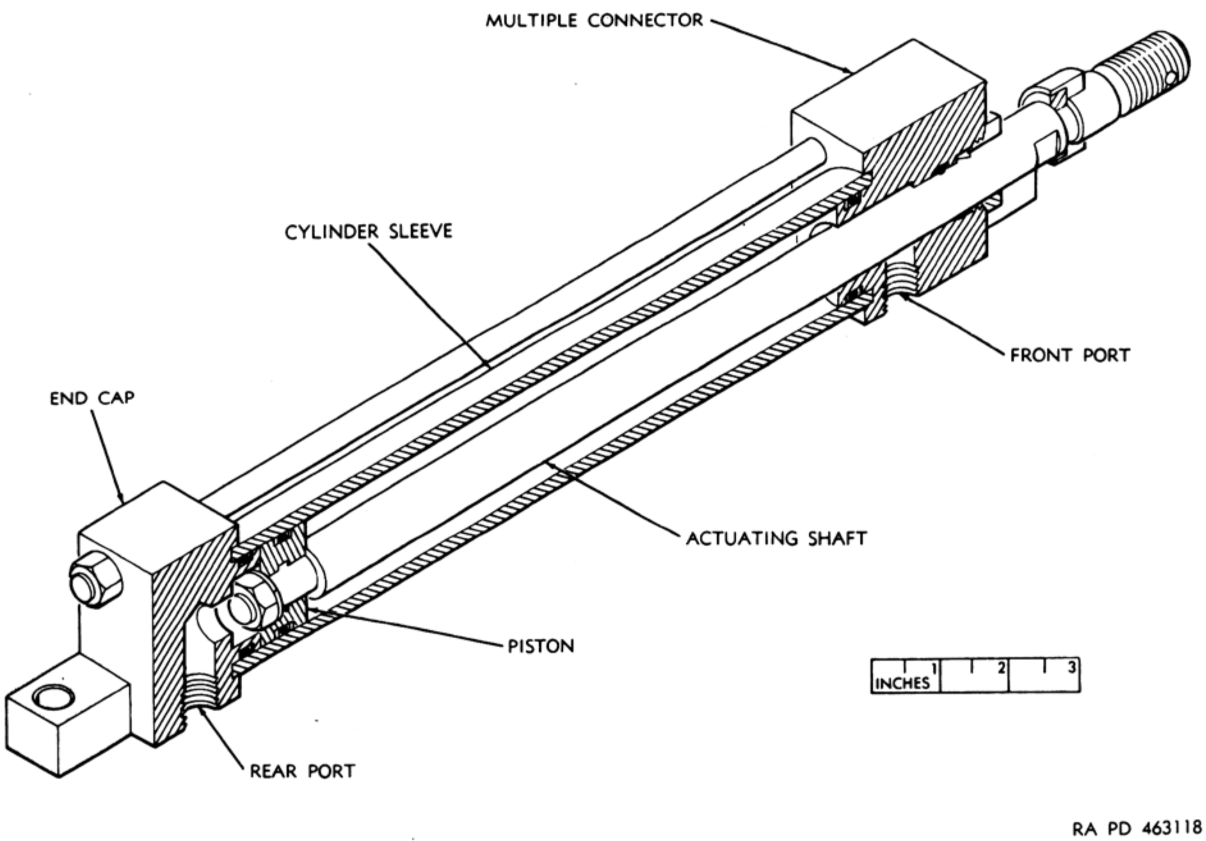


Figure 42. Locking wedge hydraulic cylinder — cutaway view.

the passages in the seats and enters chambers 1 and 2. The hydraulic forces on the piston are equal and the springs center the piston in the valve. With the piston in this position, only the passage between port 1 and the return port, is opened. Fluid enters the solenoid valve through port 1 and flows out through the return port.

f. Locking Wedge Solenoid Valve.

(1) The locking wedge solenoid valve (fig. 34) is located in the hydraulic pumping unit. This valve ports fluid under pressure to the locking wedge hydraulic cylinders to unlock or lock the locking wedges (fig. 41). The direction of fluid flow within the valve is controlled by two solenoids (figs. 47 and 48).

(2) When solenoid 1 is energized, its actuating pin positions the ball on the pressure seat and prevents fluid from the pressure port from entering chamber 1. Hydraulic fluid from the pressure port flows through the filter, through the opened pressure seat, through the passage in the valve body, and enters chamber 2. The fluid pressure in chamber 2 moves the shuttle toward chamber 1. With the shuttle in this position, the passages between the pressure port and port 1, and the passages between port 2 and the return port, are opened. Fluid enters the valve through the pressure port and flows out through port 1. Fluid also enters the valve through port 2 and flows out through the return port.

(3) When solenoid 2 is energized, its actuating pin positions the ball on the pressure seat and prevents fluid from

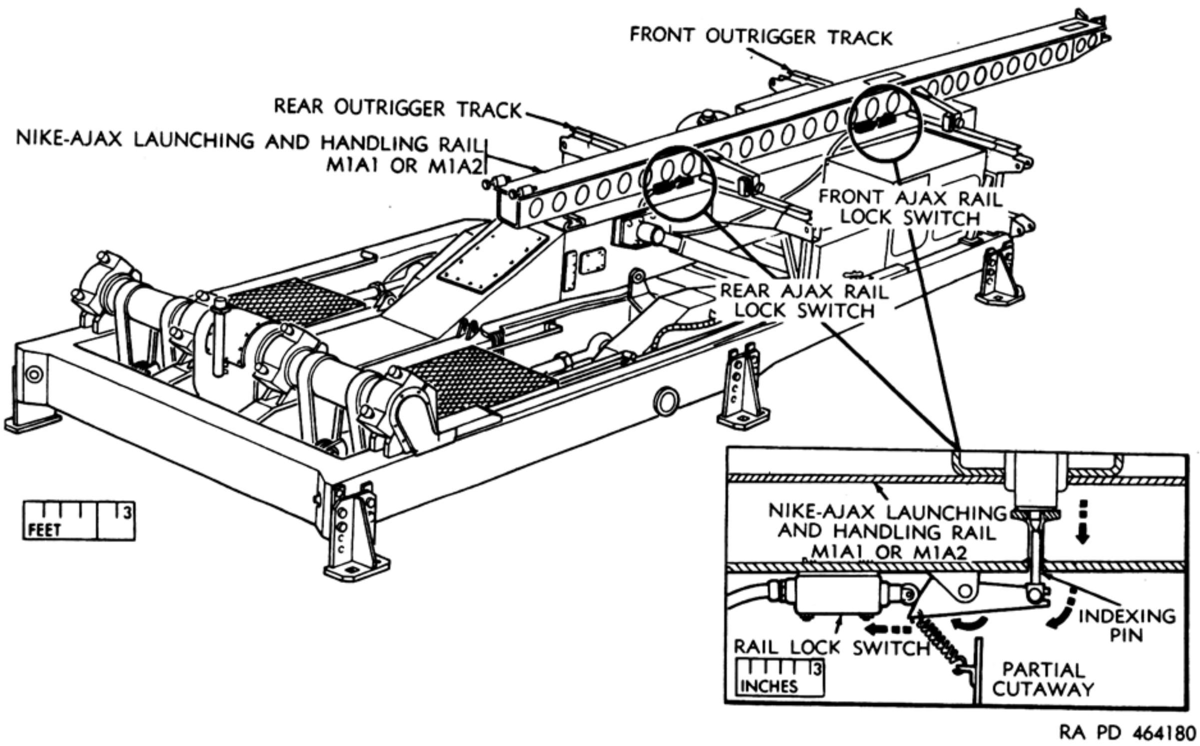


Figure 43. Nike-Ajax indexing pins.

the pressure port from entering chamber 2. Hydraulic fluid from the pressure port flows through the filter, through the opened pressure seat, through the passage in the valve body, and enters chamber 1. The fluid pressure in chamber 1 moves the shuttle toward chamber 2. With the shuttle in this position, the passage between the pressure port and port 2, and the passage between port 1 and the return port, is opened. Fluid enters the solenoid valve through the pressure port and flows out through port 2. Fluid also enters the valve through port 1 and flows out through the return port.

(4) When both solenoids are deenergized, the actuating pins move away from the balls, and fluid from the pressure port forces the balls away from the pressure seats. Fluid passes through the passages in the seats and enters chambers 1 and 2. The hydraulic forces on the shuttle are now equal and the springs center the shuttle in the valve. With the shuttle in this position, the passage between port 1 and the return port, and the passage between port 2 and the return port, are opened. Fluid enters the solenoid valve through port 1 and port 2, and flows out through the return port.

28.1. (USARAL) Missile Hydraulic System

a. Paragraph 28 is applicable except that the missile hydraulic system described in paragraph 28 is not utilized to supply hydraulic pressure to the test stations.

b. At the Hercules USARAL launching set the test station hydraulic pumping unit (2, fig. 10.1) provides hydraulic pressure to the test stations. For a functional description of the components within the hydraulic pumping unit refer to TM 9-5017-5.

28.2. (USAREUR) Missile Hydraulic System

Refer to paragraph 28.1.

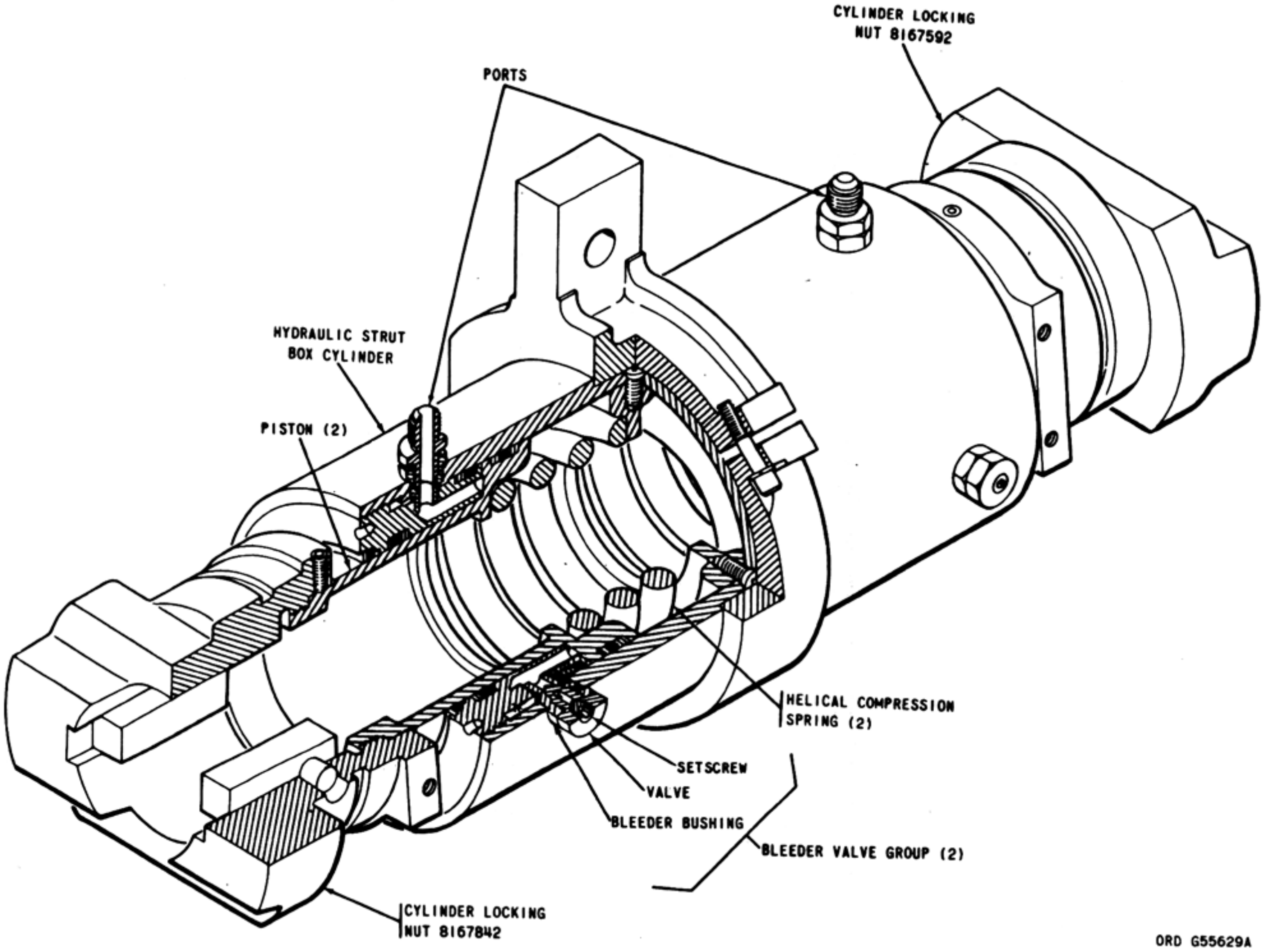
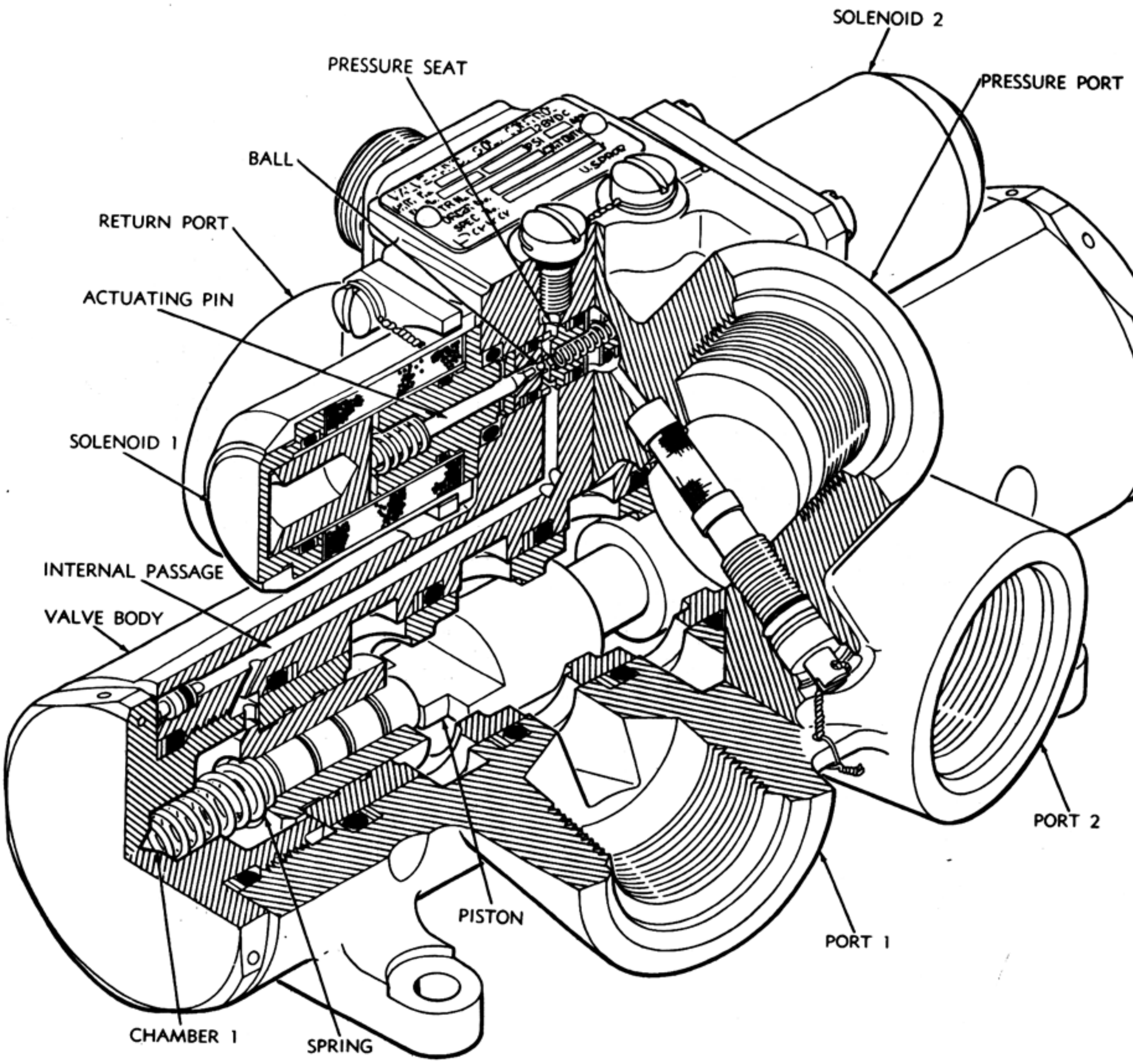


Figure 44. Hydraulic up-lock — cutaway view.



SOLENOIDS DEENERGIZED

RA PD 463172

Figure 45. Up-down solenoid valve – cutaway view.

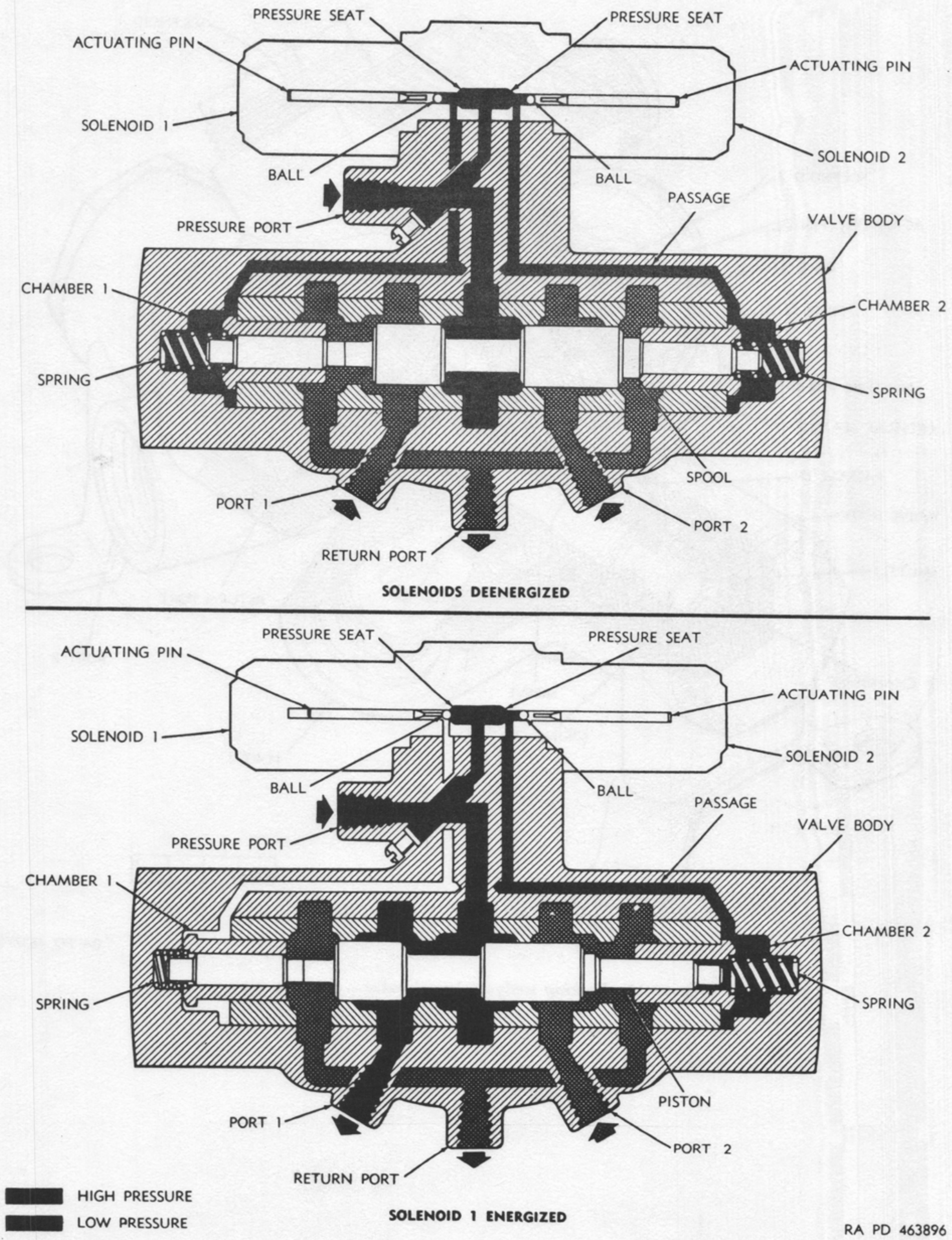


Figure 46. Up-down solenoid valve – functional diagram.

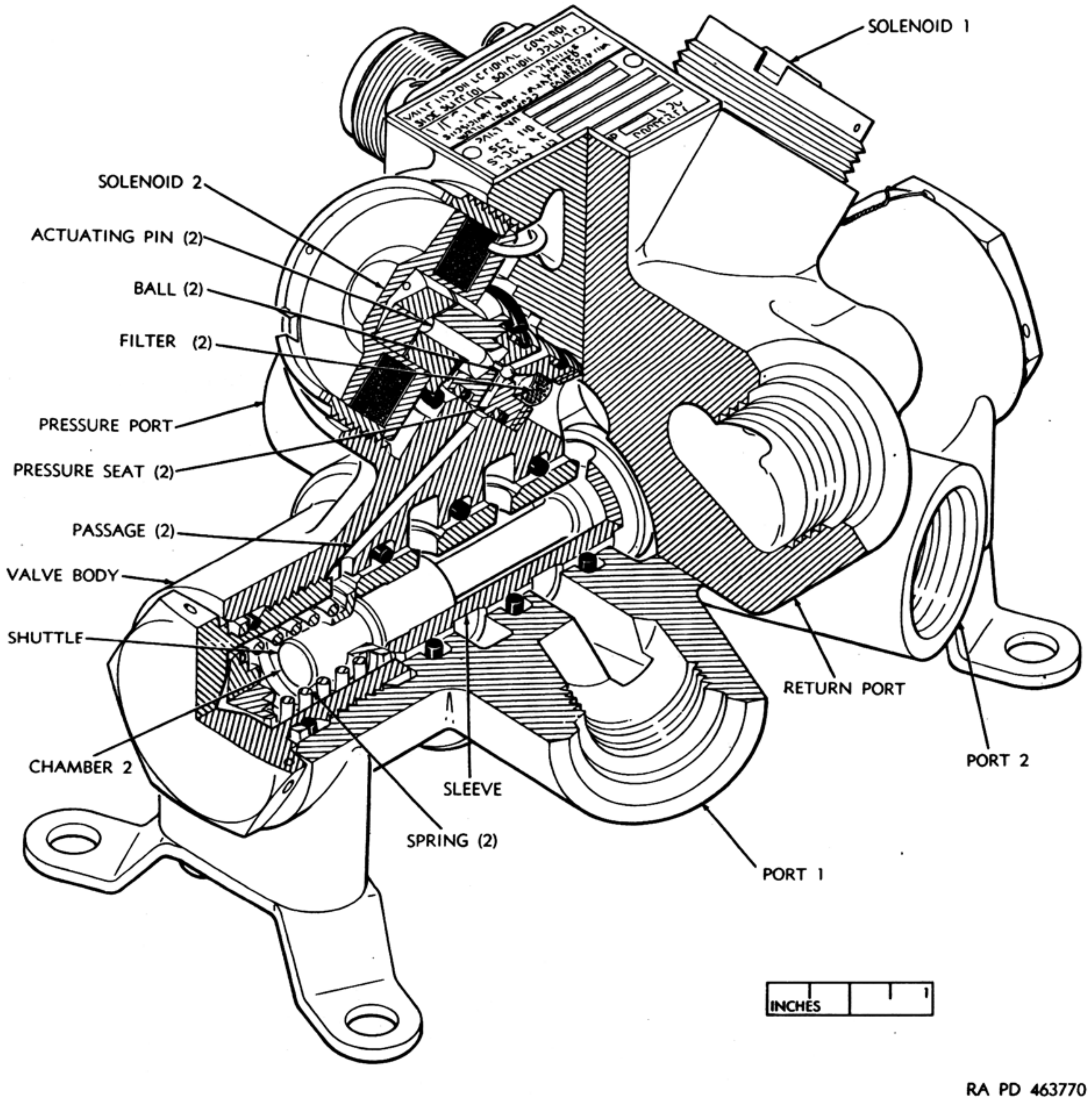


Figure 47. Locking wedge solenoid valve – cutaway view.

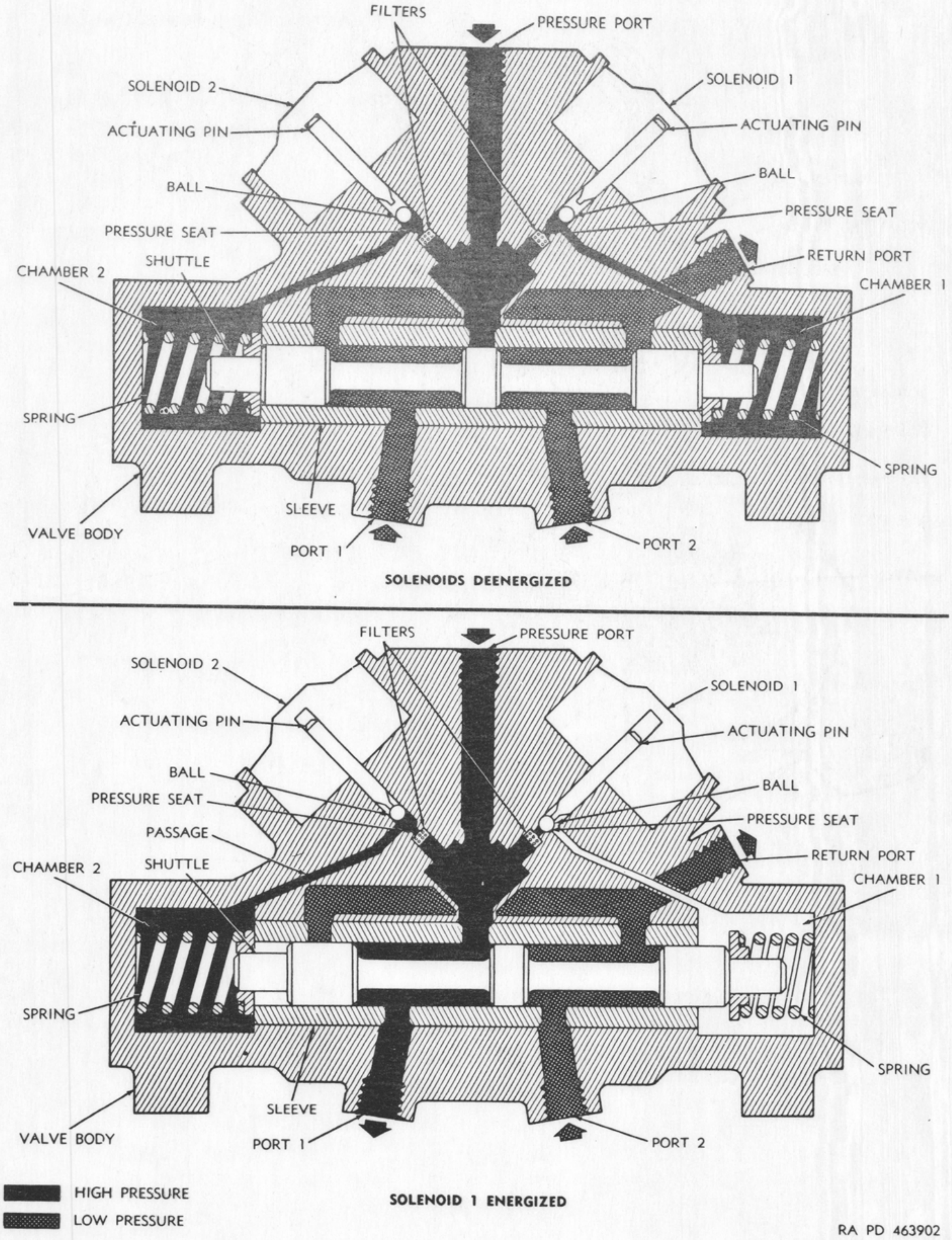


Figure 48. Locking wedge solenoid valve – functional diagram.