BETTIS
A Galveston-Houston Company

ACTUATOR CONTROL SYSTEMS

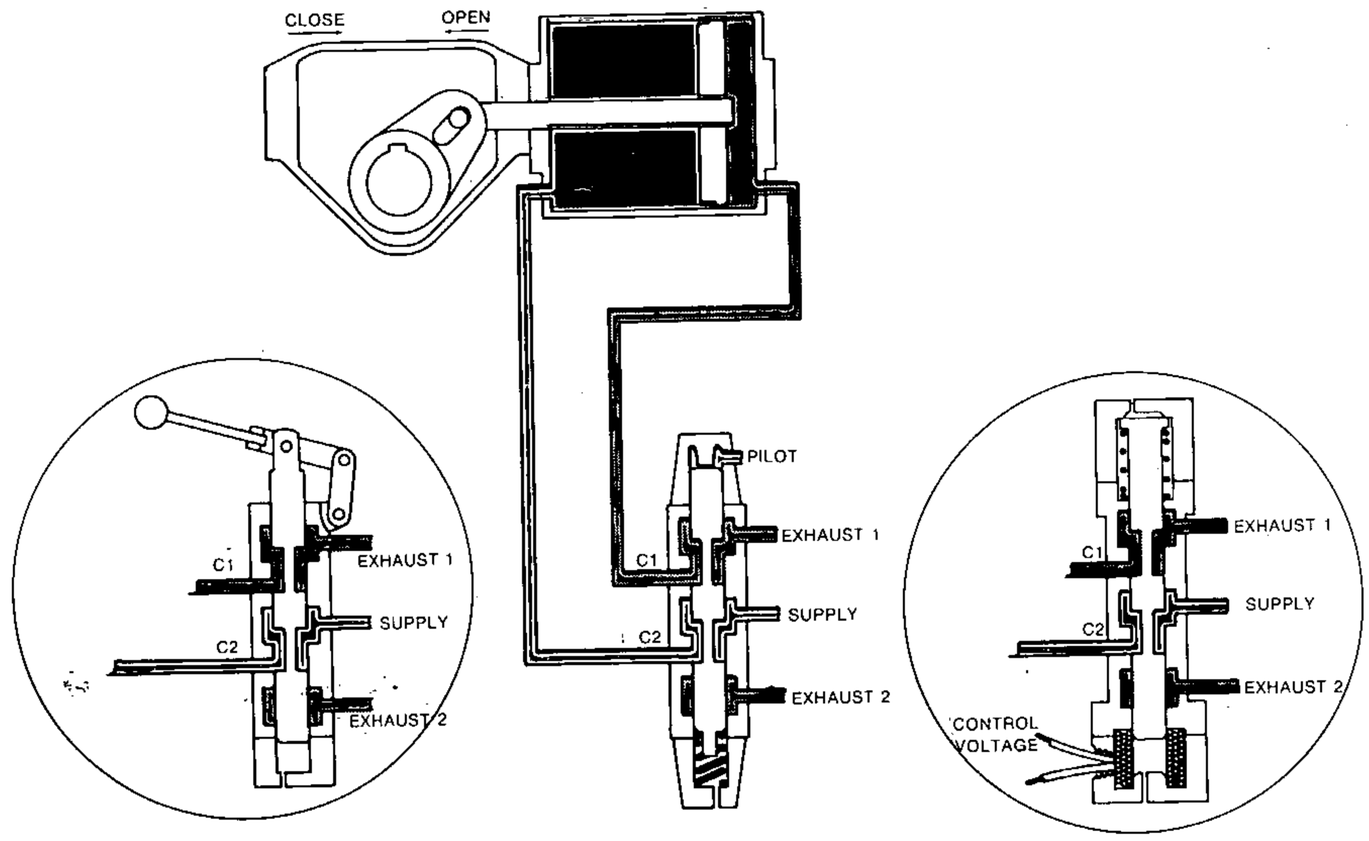
CONTROL SYSTEMS

This catalog provides a listing of standard systems which may be used with Bettis actuators. Brief operational descriptions and a consistent color code accompany each multi-color cutaway illustration. Though other types are available, for consistency of illustration, spool type control valves are shown throughout this catalog.

CONTENTS

DOUBLE ACTING ACTUATOR WITH 4-WAY CONTROL VALVE

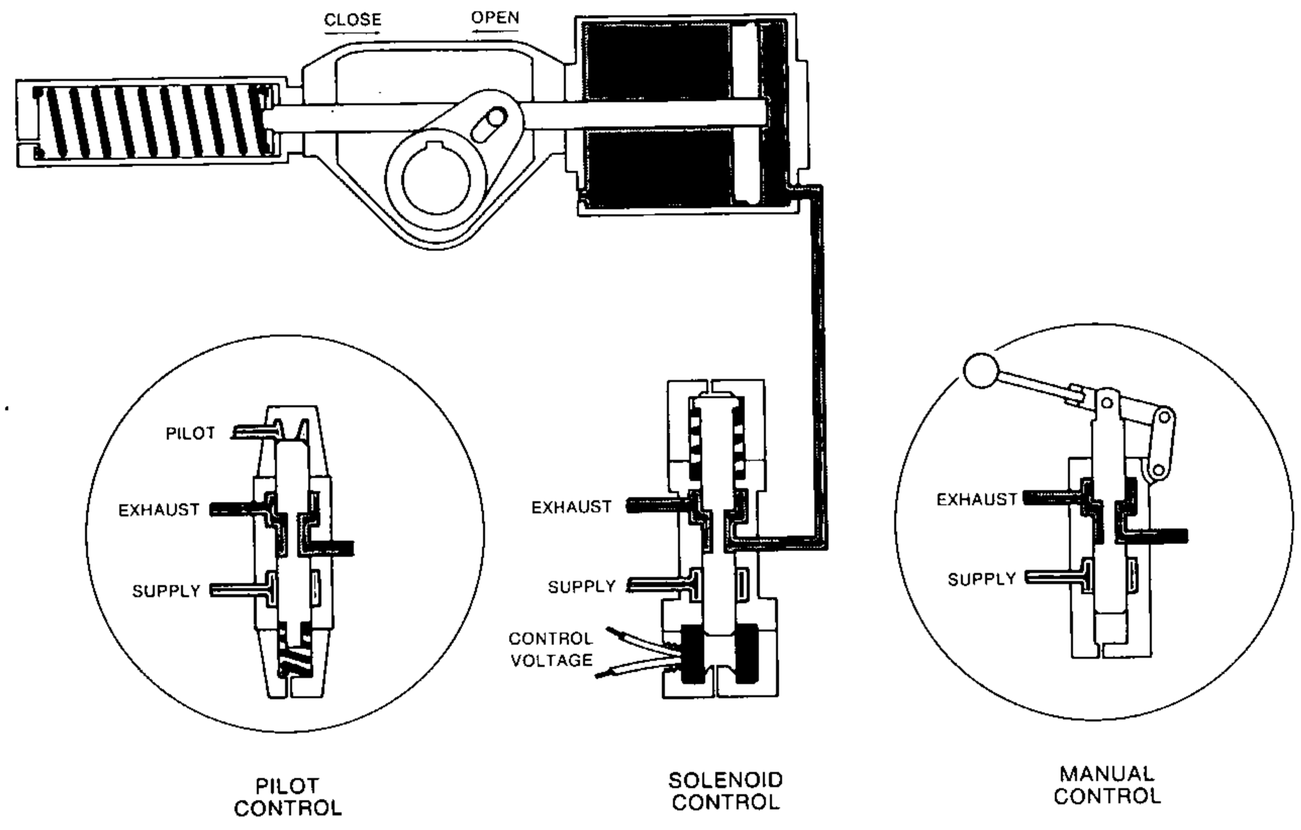
Figure 1 illustrates the simple on-off control function. Power gas pressure is applied against one side of the actuator piston and simultaneously exhausted from the opposite side. The 4-way control valve reverses the pressure and exhaust flow paths. Loss or cancellation of control signal to the pilot or solenoid operated, spring return valve allows the valve to return to its normal position as shown. Unless otherwise specified C1 and C2 lines are connected to the actuator to "fail-close" upon loss or cancellation of control signal, provided power gas is still available. Three common control valve configurations are shown. Many variations and modifications of these controls are available.



MANUAL CONTROL | PILOT CONTROL | SOLENOID CONTROL

SPRING RETURN ACTUATOR WITH 3-WAY CONTROL VALVE

Figure 2 Spring Return Actuator assembly arrangement is determined by the customer "Fail-open" or "Fail-close" upon loss of power gas (air) requirements. All spring return actuator and control assemblies are arranged to "fail-close" (clockwise) on loss of power gas and loss or cancellation of control signal unless otherwise specified. Three common control valve configurations are shown. Many variations and modifications of these controls are available.



PILOT CONTROL | SOLENOID CONTROL | MANUAL CONTROL

High Pressure

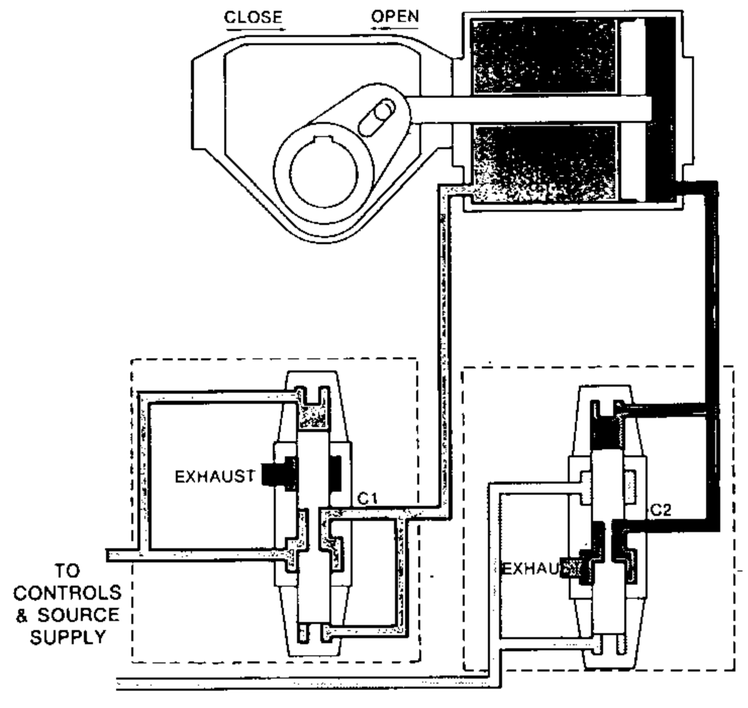
Reduce Pressure

Exhaust

Signal

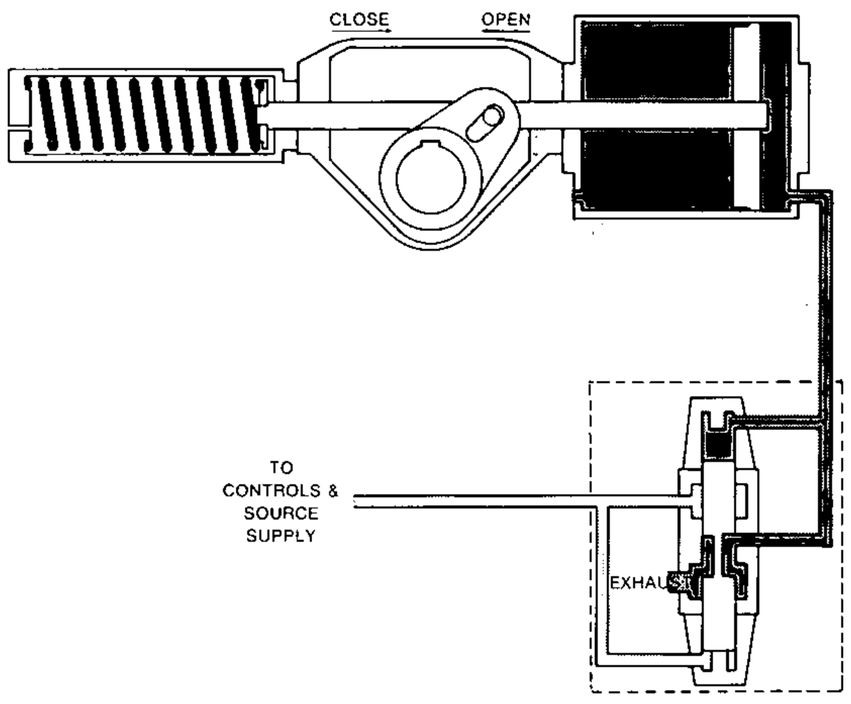
DOUBLE ACTING ACTUATOR WITH QUICK EXHAUST VALVE

Figure 3 Where long lengths of piping from the supply source to the actuator are necessary, a noticeable pressure drop will occur resulting in longer operating times. To overcome this or when fast operation is desirable, quick exhaust valves are installed in the cylinder pressure port to vent the cylinder exhaust directly to atmosphere. The control valve (not shown) vents the power supply, immediately causing the quick exhaust valve inlet port pressure to drop below the cylinder port pressure. The resulting pressure differential across the quick exhaust valve causes the valve diaphragm or spool to shift, creating a large capacity flow path from cylinder to exhaust port. This action quickly exhausts the compressed gas from the cylinder permitting a faster stroke. The quick exhaust valve has no significant effect on the inlet gas flow. Multi-cylinder actuators may require one quick exhaust valve installed adjacent to each cylinder to sufficiently decrease operating time. Proper valve selection and installation may reduce operating time to approximately 5 seconds or less per application.



SPRING RETURN ACTUATOR WITH QUICK EXHAUST VALVE

Figure 4 Where long lengths of piping from the supply source to the actuator are necessary, a noticeable pressure drop will occur resulting in longer operating times. To overcome this or when fast operation is desirable, quick exhaust valves are installed in the cylinder pressure port to vent the cylinder exhaust directly to atmosphere. The control valve (not shown) vents the power supply, immediately causing the quick exhaust valve inlet port pressure to drop below the cylinder port pressure. The resulting pressure differential across the quick exhaust valve causes the valve diaphragm or spool to shift, creating a large capacity flow path from cylinder to atmosphere. This action quickly exhausts the compressed gas from the cylinder permitting a fast spring (fail-mode) stroke. The quick exhaust valve has no significant effect on the speed of the pressure stroke. Multi-cylinder actuators may require one quick exhaust valve installed adjacent to each cylinder to significantly decrease operating time. Proper valve selection and installation may reduce exhaust stroke time to approximately 5 seconds or less per application.

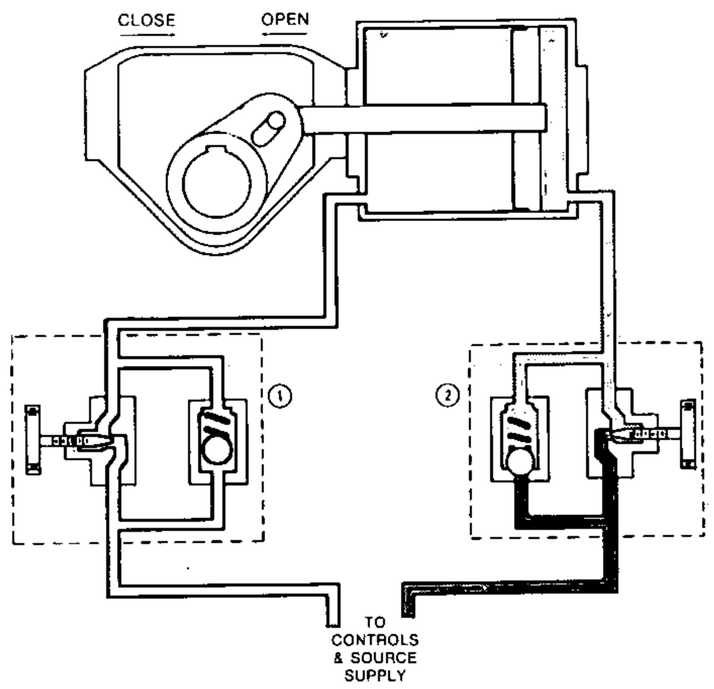


DOUBLE ACTING ACTUATOR WITH PNEUMATIC SPEED CONTROL

Figure 5 Speed control valves are used to provide adjustable pneumatic control of actuator operating times. This method of control provides satisfactory delayed operating times. The typical speed control valve allows essentially free power gas flow in one direction and adjustable, controlled flow in the opposite direction. Where possible, the valve should be installed to control cylinder exhaust gas flow. (Control of the inlet flow may cause a series of erratic motions during the stroke).

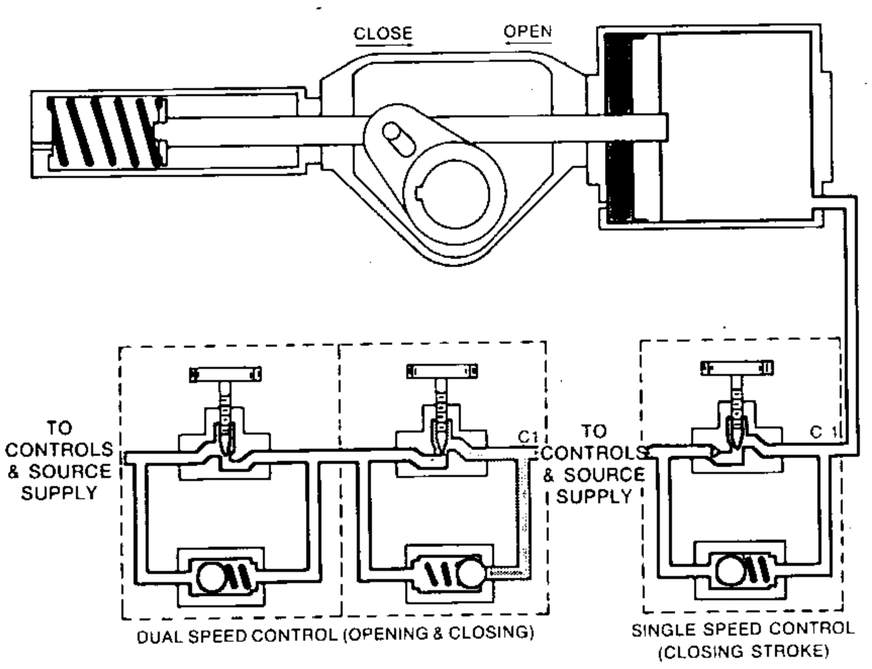
During opening stroke of the actuator, power gas flows freely through the integral ball check of valve (2). Valve (1) restricts the exhaust gas flow. The speed controls are individually adjustable to provide equal or different opening and closing times.

Figure 5 denotes the closing stroke of the actuator. Power gas is flowing freely through the integral ball check of valve (1) into the actuator cylinder. The integral ball check of valve (2) is closed causing the exhaust gas to be metered through the adjustable orifice. Restricting the flow of exhaust gas increases the operating time of the actuator.



SPRING RETURN ACTUATOR WITH PNEUMATIC SPEED CONTROL

Figure 6 Speed control valves are used to provide adjustable pneumatic control of actuator operating times. This method of control normally provides satisfactory operation where delayed cycle time is required. The typical speed control valve allows essentially free power gas flow in one direction and adjustable, controlled flow in the opposite direction. Where possible, the valve should be installed to control cylinder exhaust gas flow. (Control of the inlet flow may causes a series of erratic motions during the stroke.) Two speed control valves installed in the supply line, controlling the flow in opposite directions, provide individual adjustment of opening and closing operating time.



High Pressure

Reduce Pressure

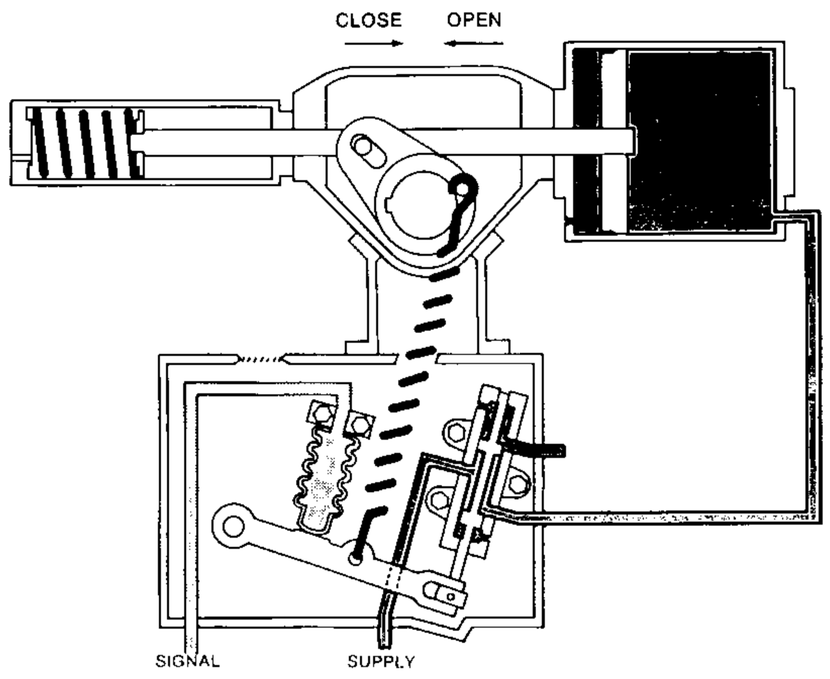
Exhaust

Signal

SPRING RETURN ACTUATOR WITH PNEUMATIC POSITIONER

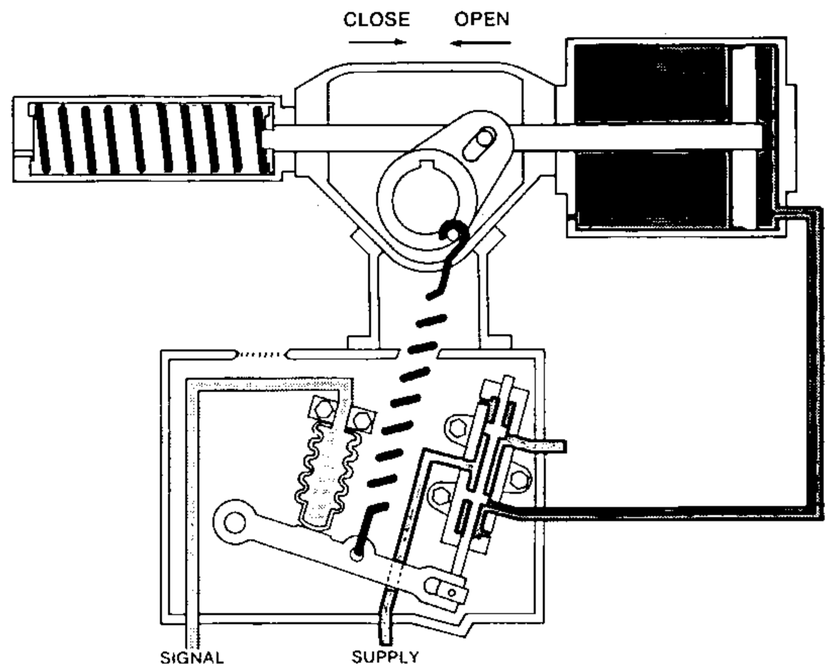
The typical pneumatic positioner for single-acting, spring return actuators is specialized type of pilot operated, spring loaded 3-way (or 4-way with one outlet port plugged) control valve with a feedback mechanical linkage mechanism attached to the actuator yoke. The positioner translates a variable signal pressure into a control pressure and precisely positions a valve actuator from 0° to 90°, depending on the input signal pressure. Typical signal pressure ranges are 3 to 15 psig; 3 to 27 psig; or 6 to 30 psig. The feedback linkage mechanism balances the variable signal pressure to the positioner against the spring force generated for a given actuator travel position. Assume the actuator positioner assembly is designed to be fully closed at a signal pressure of 3 psi and full open at 15 psi.

Figure 7 denotes an increasing signal pressure applied to the positioner diaphragm.



SPRING RETURN ACTUATOR WITH PNEUMATIC POSITIONER

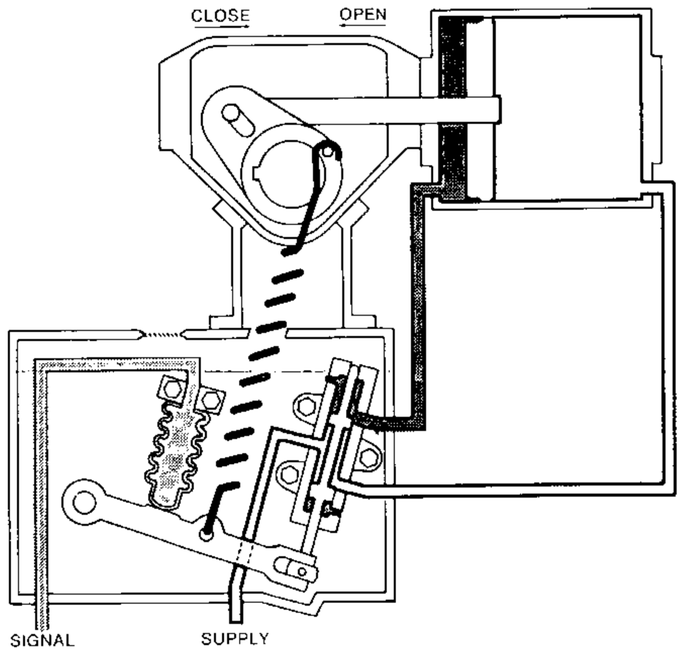
Figure 7A denotes a decreasing signal pressure and power gas being vented causing the actuator to close. The control valving within the positioner applies power air to the cylinder until the yoke has rotated to a precise location. The precise degree of rotation is the point at which the rotation of the yoke, when converted to a pull force, reaches the magnitude that balances the signal pressure applied to the positioner diaphragm. When a balanced force condition exists, between the diaphragm and spring, power gas flow is blocked and the yoke rotation stops. Any change in signal pressure will unbalance the forces within the positioner; shift positioner valving; and either increase or bleed the pressure to the actuator power piston, thus rotating the yoke (valve stem) in direct relation to a change in signal pressure.



DOUBLE ACTING ACTUATOR WITH PNEUMATIC POSITIONER

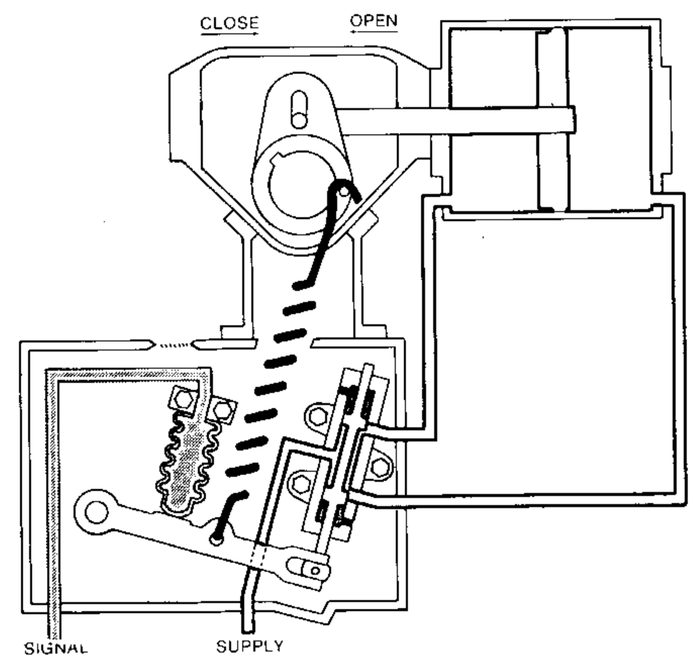
The typical pneumatic positioner for double acting actuators is a specialized type of pilot operated, spring loaded 4-way control valve with a feedback mechanical linkage mechanism attached to the actuator yoke. The positioner translates a variable signal pressure into a control pressure and precisely positions a valve actuator from 0° to 90°, depending on the input signal pressure. Typical signal pressure ranges are 3 to 15 psig; 3 to 27 psig, or 6 to 30 psig. The feedback linkage mechanism balances the variable signal pressure to the positioner against the spring force generated for a given actuator travel position. Assume the actuator positioner assembly is designed to be fully closed at a signal pressure of 3 psi and fully open at 15 psi.

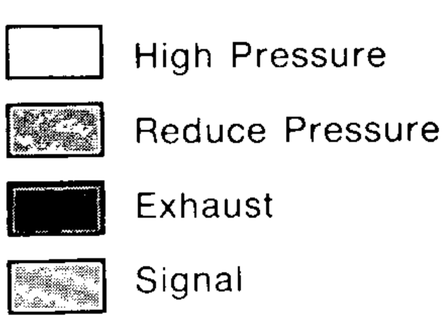
Figure 8 indicates increasing signal pressure and power gas flow causing actuator to open.



DOUBLE ACTING ACTUATOR WITH PNEUMATIC POSITIONER

Figure 8A denotes signal pressure of 9 psi applied to the positioner diaphragm. The control valving within the positioner diaphragm. The control valving within the positioner bleeds and applies power air to the appropriate cylinder port until the yoke has rotated to a precise location. The precise degree of rotation is the point at which the rotation of the yoke, when converted to a pull force, reaches the magnitude that balances the 9 psi signal pressure applied to the diaphragm. When a balanced force condition exists, between the diaphragm and spring, power gas flow is equally applied to both sides of the piston and the yoke rotation stops. Any change in signal pressure will unbalance the forces within the positioner; shift positioner valving; and simultaneously increase the pressure on the side of the actuator power piston and bleed the other, thus rotating the yoke (valve stem) in direct relation to a change in signal pressure.

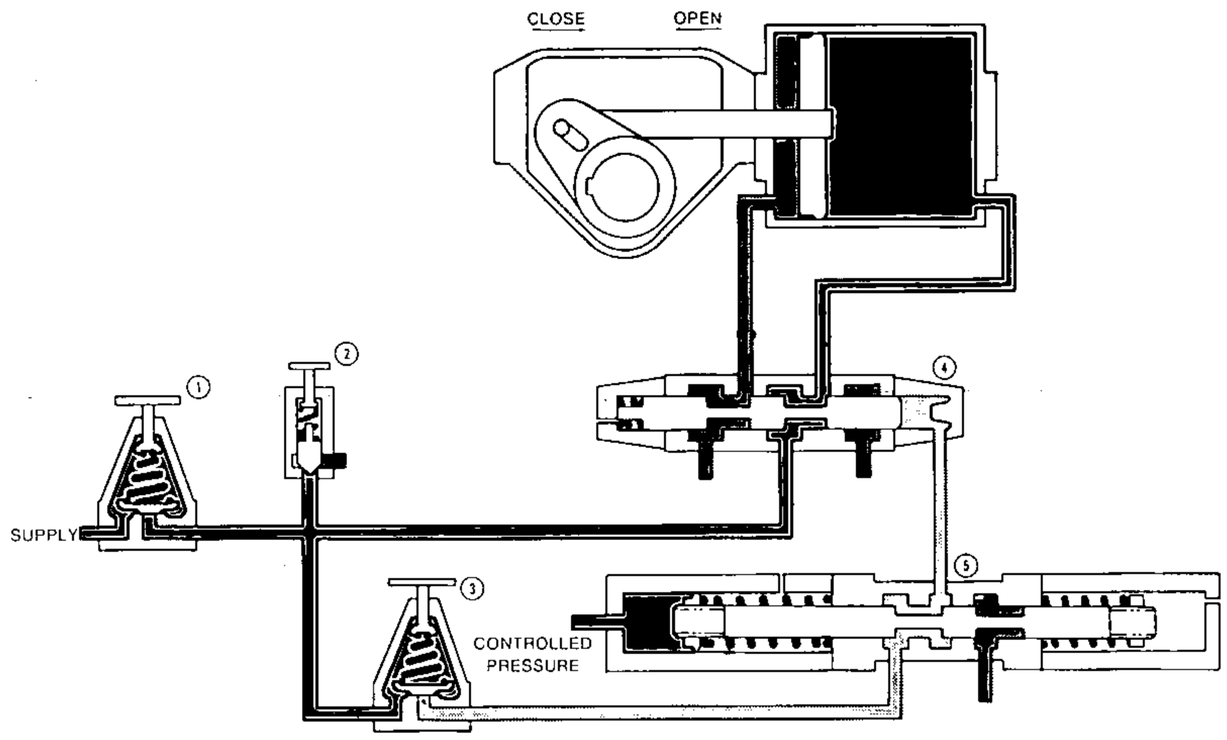




DOUBLE ACTING ACTUATOR WITH HI-LO SHUT DOWN

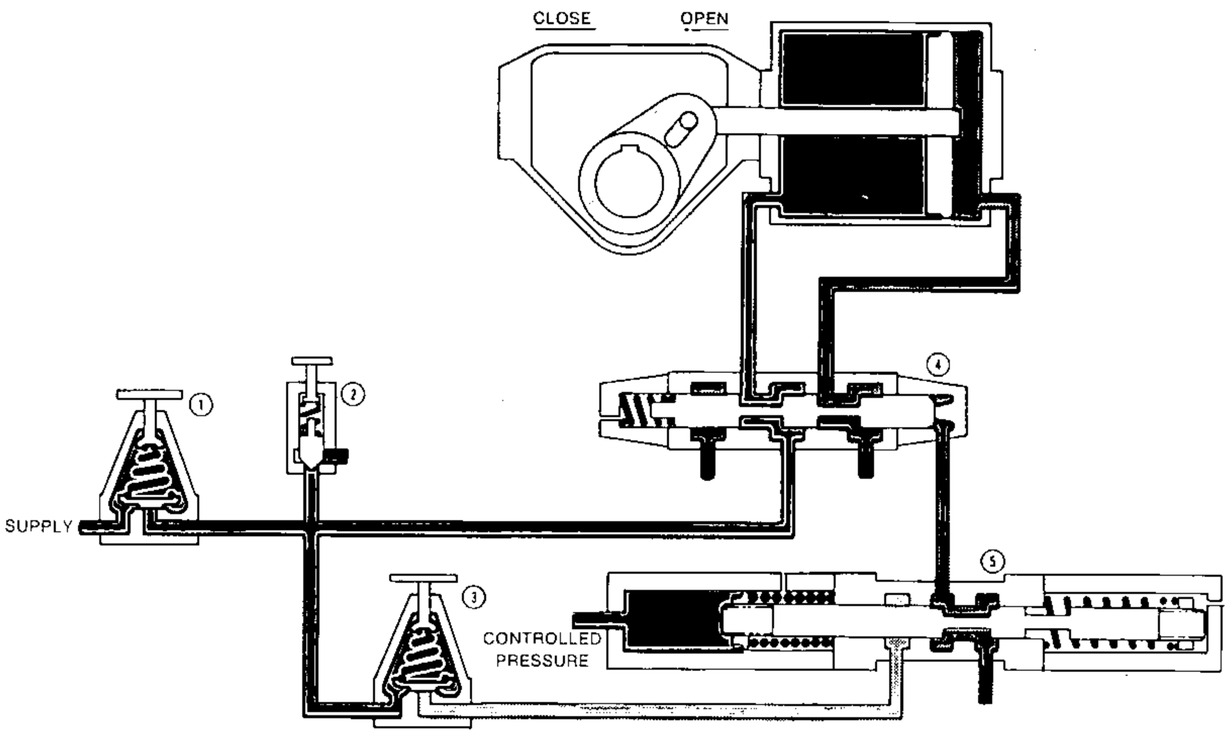
Many installations provide power gas to the actuator directly from the pipe line or vessel being controlled.

Figure 9 illustrates a system in the normal or open position assembled to "fail-close" should a pressure condition being sensed becomes either higher or lower than the predetermined limits. The supply regulator (1) reduces supply pressure to acceptable limits of the controls and actuator. A relief valve (2) protects the components from overpressure should the regulator (1) malfunction. An instrument regulator (3) further reduces the pilot pressure to the 4-way pilot operated, spring return valve (4). Sensing pressures within predetermined limits center the Hi-Lo pilot valve (5) spool directing pilot pressure to energize the 4-way valve (4). The energized 4-way (4) valve directs power gas causing the actuator to open.



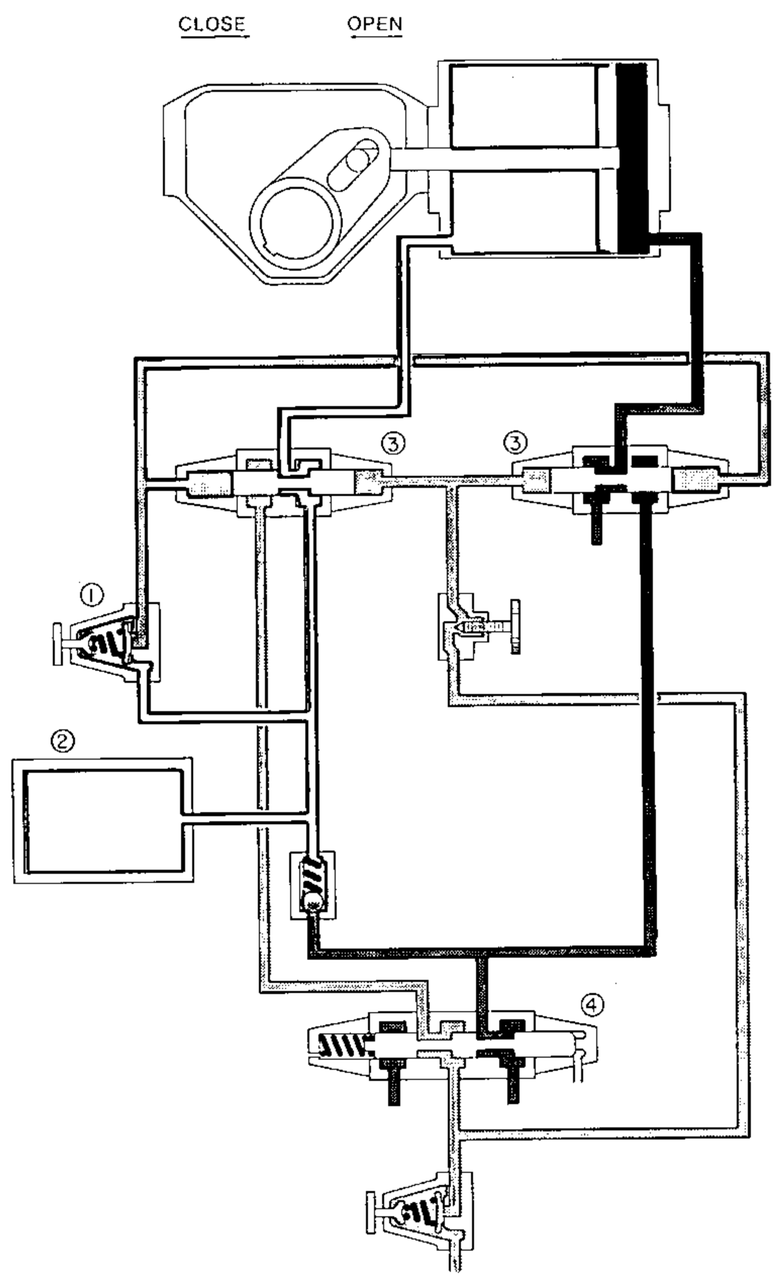
DOUBLE ACTING ACTUATOR WITH HI-LO SHUT DOWN

Figure 9A illustrates a "fail-close" condition. Sensed line pressure exceeding the maximum predetermined limit shifts the Hi-Lo pilot valve (5) spool to de-energize the 4-way valve (4) pilot. The spool of the 4-way valve shifts to direct power gas causing the actuator to close. Sensing pressure less than the minimum predetermined limit also causes the 4-way valve pilot to be exhausted causing the actuator to close as described.



DOUBLE ACTING ACTUATOR WITH TYPE 1-A AFS SYSTEM (FAIL MODE)

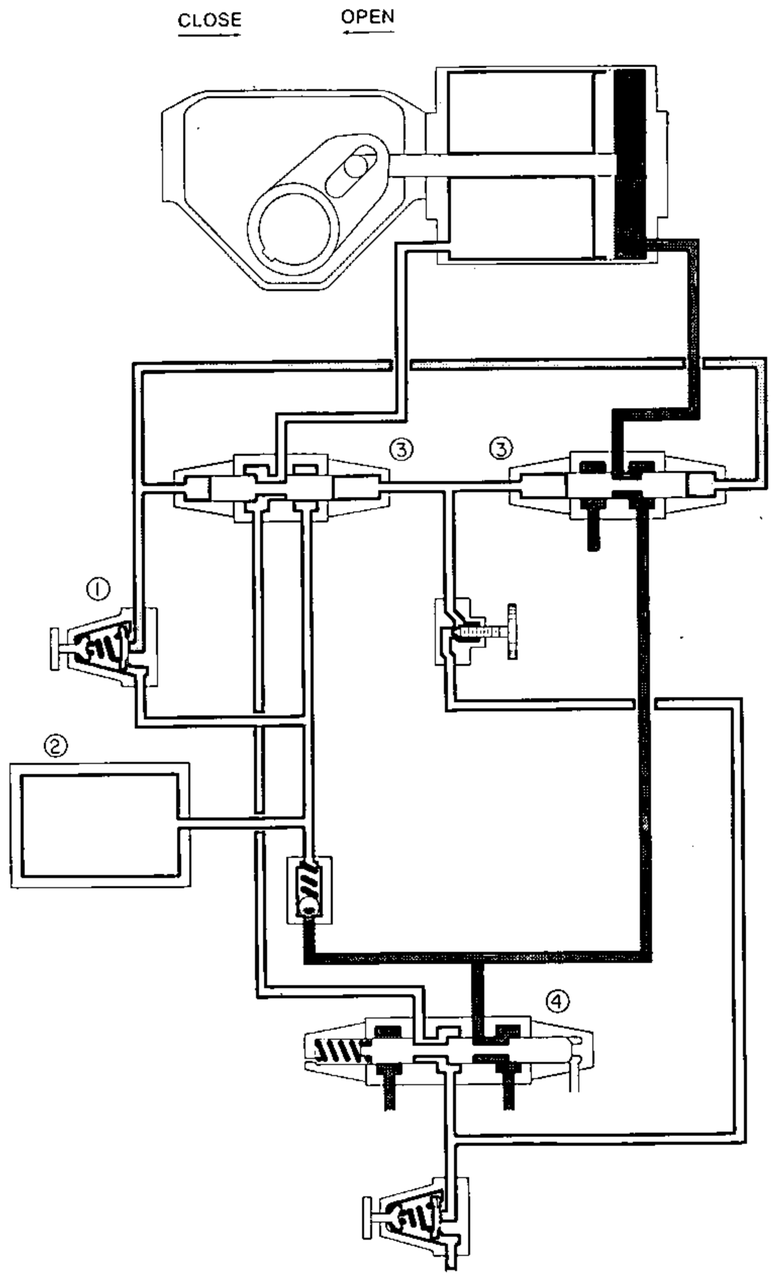
Figure 10 illustrates the double acting actuator with Type 1-A AFS system in the "fail mode," arranged to "fail-close" as the supply decreases to a predetermined pressure. As power air pressure falls below set pressure regulator (1) setting, pressure from reservoir (2) causes 3-way pilot valves (3) to shift, using air from reservoir to stroke actuator to failure position. Restoration of power air returns 3-way valves to original position when power air pressure is higher than set pressure. Actuator may then be operated normally with 4-way control valve (4).



DOUBLE ACTING ACTUATOR WITH TYPE 1-A AFS SYSTEM (NORMAL)

Figure 11 illustrates the double acting actuator with Type 1-A AFS system in the normal or "non-failed" position.

4-way control valve (4) may have any type of operator (solenoid, pilot, manual, diaphragm, etc.).



Set Pressure

High Pressure

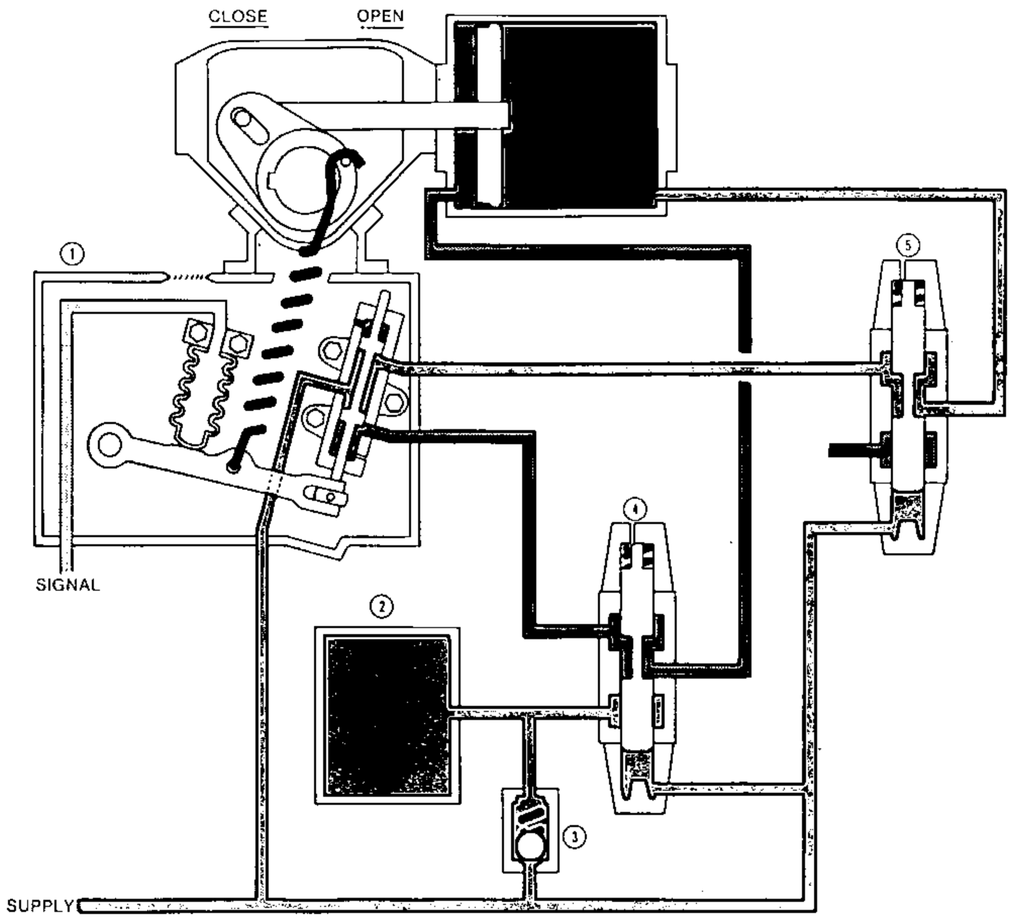
Reduce Pressure

Exhaust

Signal

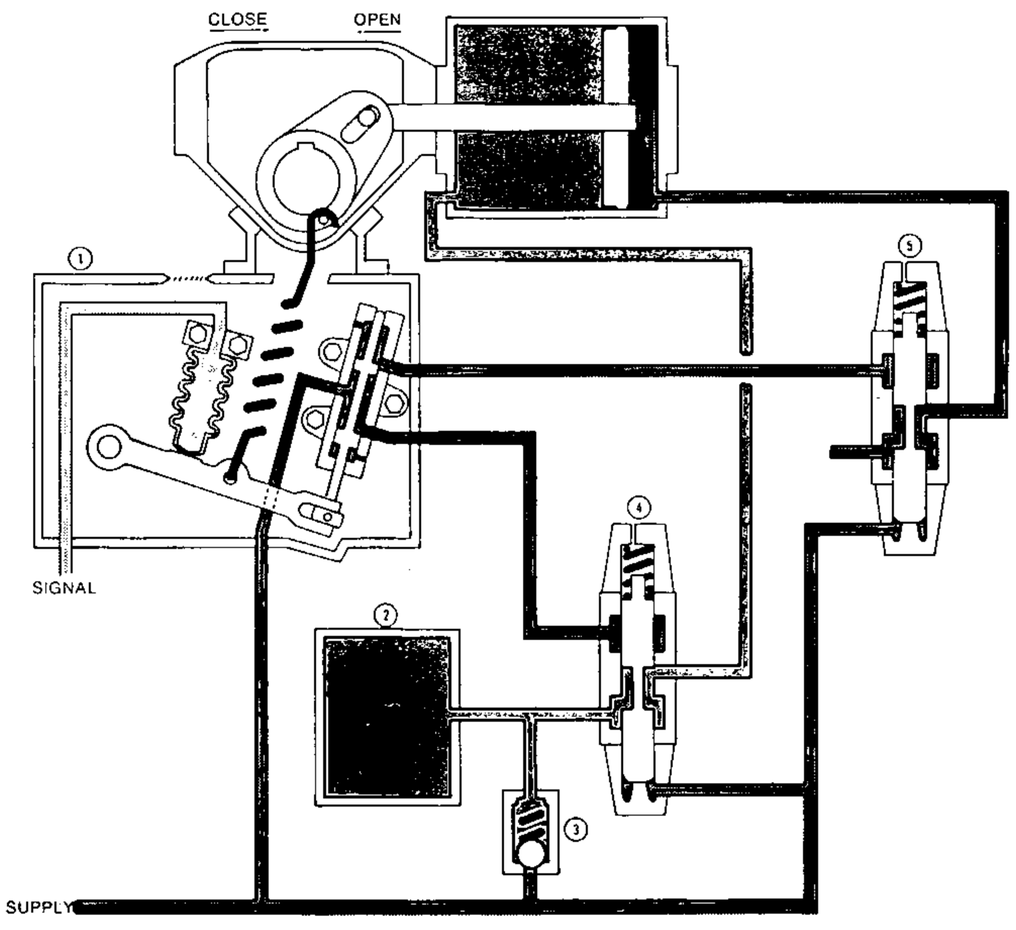
DOUBLE ACTING ACTUATOR WITH TYPE III AFS SYSTEM

Figure 12 illustrates the double acting actuator with pneumatic positioner in the operating mode arranged to "fail-close" upon complete loss of supply pressure. The supply pressure energizes the pilots of the 3-way valves (4 and 5), and pressurizes the reservoir (2) by flowing through the check valve (3). The 3-way valves (4 and 5) are open during normal operation. Supply pressure enters the positioner and modulating control functions continue as described in Figure 8.



DOUBLE ACTING ACTUATOR WITH TYPE III AFS SYSTEM

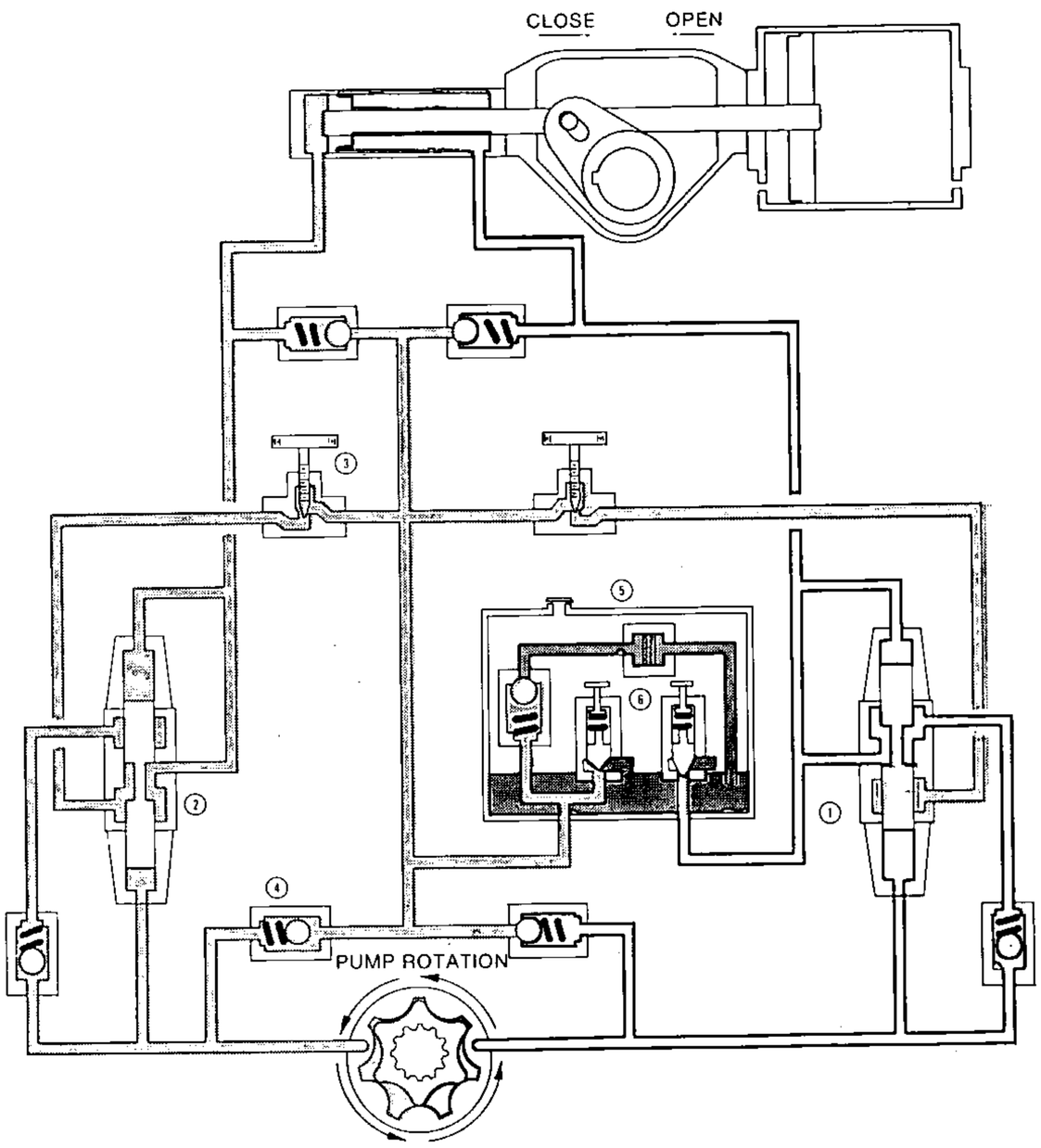
Figure 12A illustrates the "fail-close" mode. Supply pressure has diminished allowing the 3-way valves (4 and 5) to return to the failure position. The check valve (3) maintains pressure in the reservoir (2). The 3-way valves (4 and 5) block the output from the positioner and simultaneously exhaust the opening cylinder and release the reservoir (2) pressure into the closing cylinder. Upon restoration of the supply pressure, the system automatically resumes modulating control.



DOUBLE ACTING ACTUATOR WITH M4 HYDRAULIC MANUAL CONTROL (OPEN)

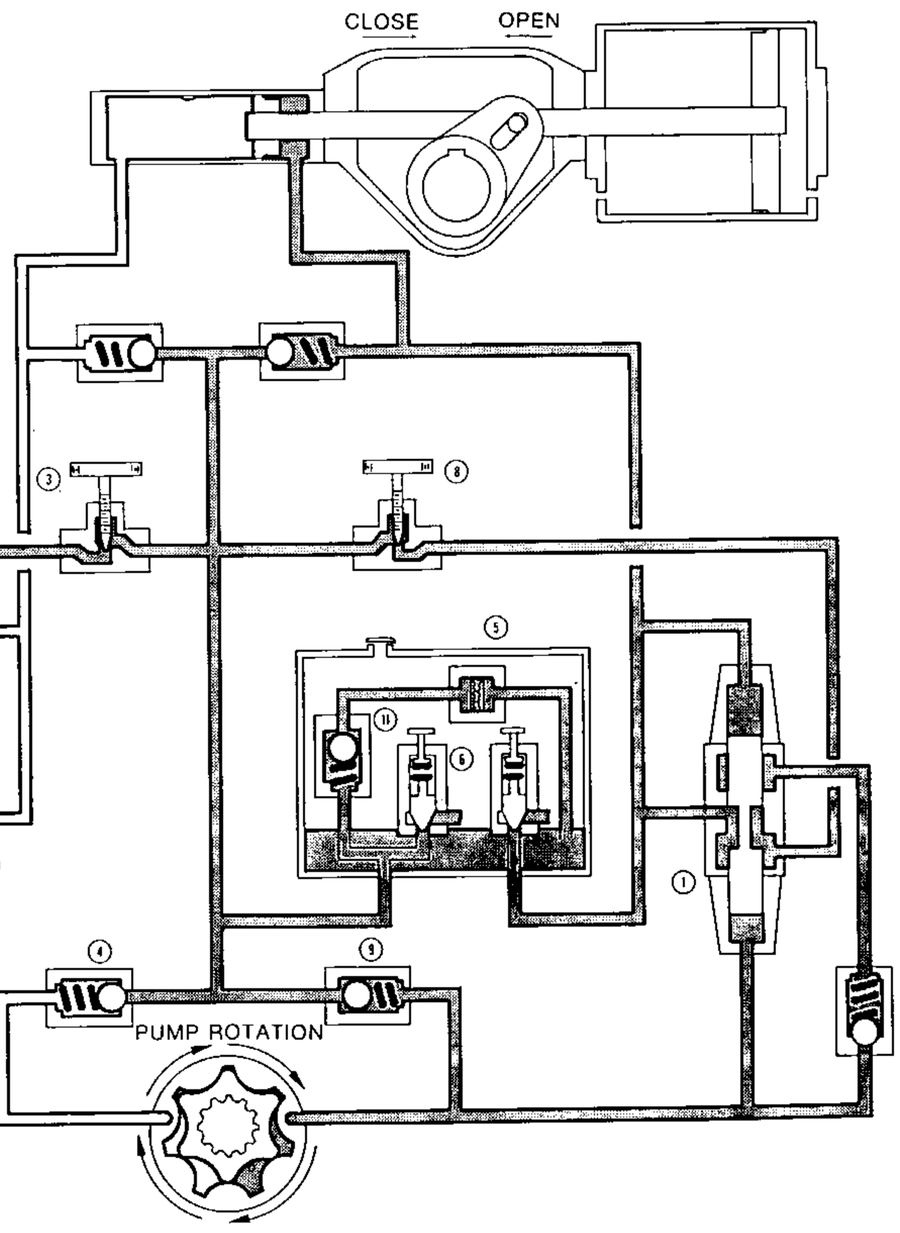
The M4 override system is a compact modular design utilizing a bidirectional rotary pump which disengages during power operation. The system includes individually adjustable speed controls and a small reservoir necessitated by the differential volume of the hydraulic cylinder due to the piston rod.

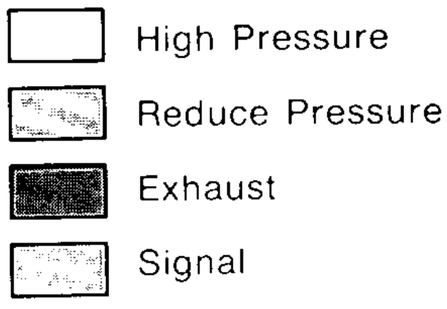
Figure 13 illustrates manual opening. The pump handwheel is rotated counterclockwise to generate fluid pressure. Shuttle valve (1) shifts as shown due to pilot pressure and allows hydraulic fluid to flow into the cylinder. Fluid being displaced from the cylinder positions the spool of shuttle valve (2) as shown and flows through the shuttle valve (2), speed control (3) and check valve (4), and enters the pump suction port. Excess fluid enters the reservoir (5) through low pressure relief (6).



DOUBLE ACTING ACTUATOR WITH M4 HYDRAULIC MANUAL CONTROL (CLOSE)

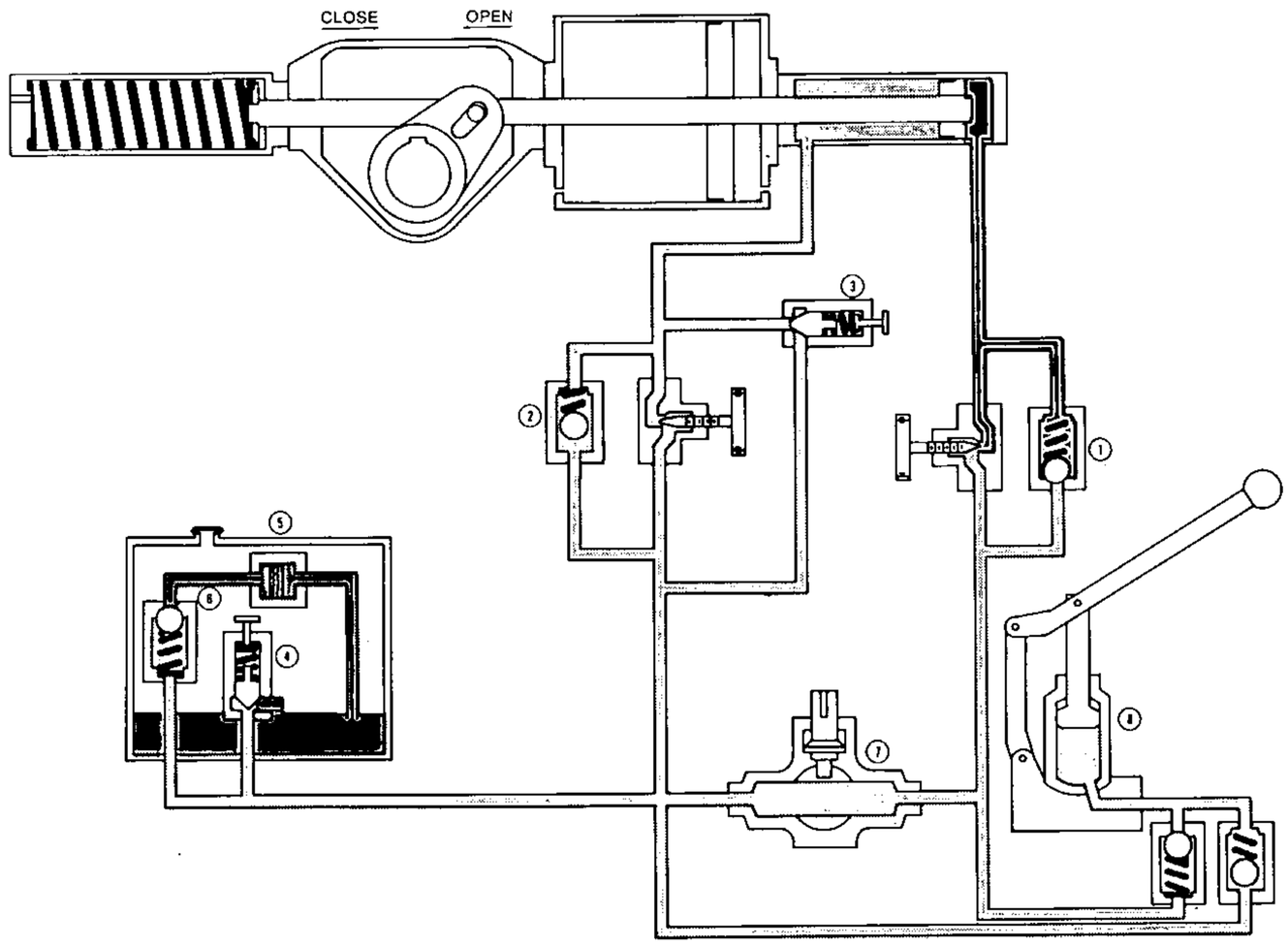
Figure 13A denotes manual closing. The handwheel is rotated clockwise causing pressure to be applied to pilot of the shuttle valve (2), flow through check valve (7) and shuttle valve (2) to enter the hydraulic cylinder. Pressure being exerted by displaced fluid from the cylinder positions the spool of the shuttle valve (1) as shown. Fluid passes through the shuttle valve (1), speed control (8), and check valve (9) to enter pump suction. Make-up oil from the reservoir enters the pump suction by passing through filter (10) and check valves (11 and 9).





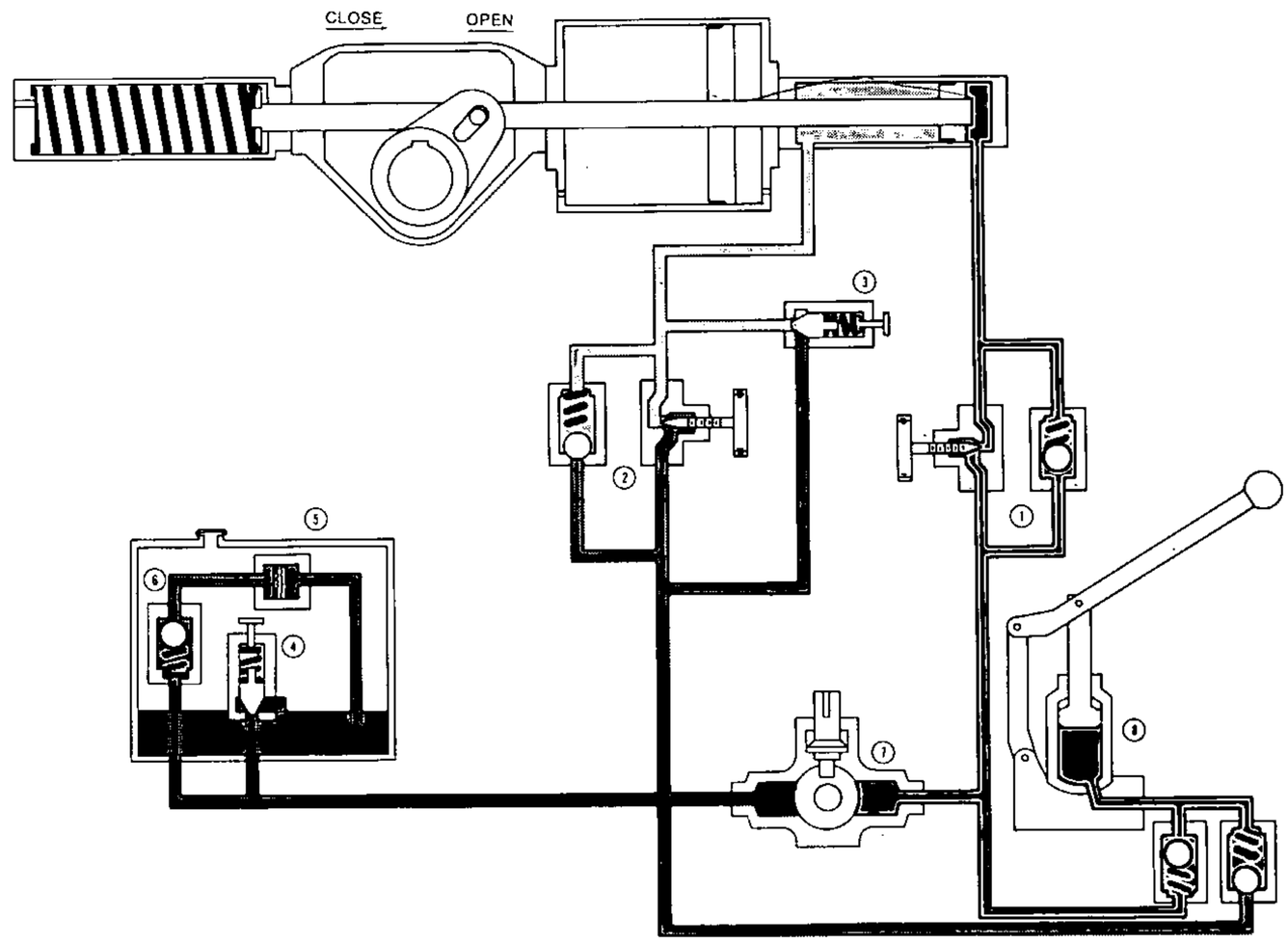
SPRING RETURN ACTUATOR WITH M7 HYDRAULIC MANUAL CONTROL

Figure 14 illustrates the spring return actuator and M7 hydraulic override system being operated by power gas. The hydraulic fluid block valve (7) must remain open during power operation. Speed controls function as described in Figure 15.



SPRING RETURN ACTUATOR WITH M7 HYDRAULIC MANUAL CONTROL

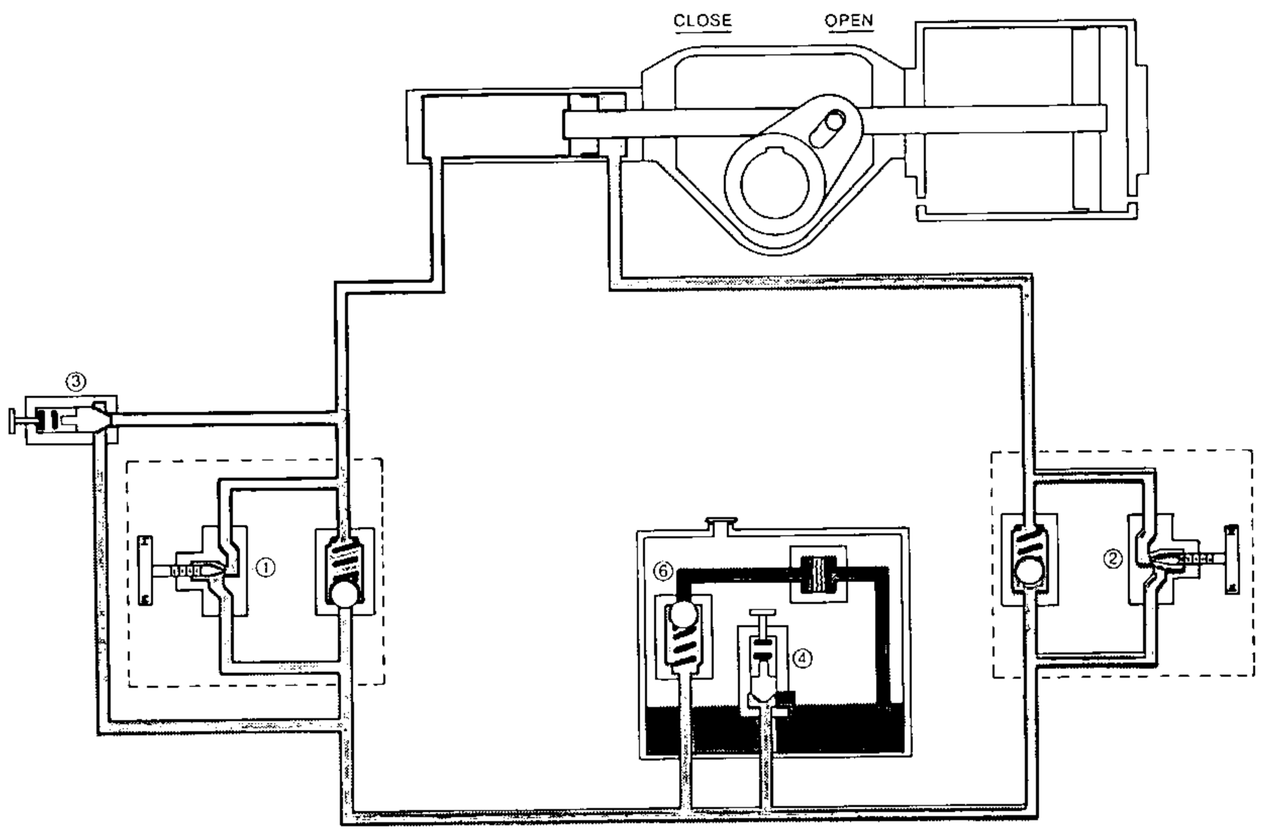
Figure 14A denotes manual operation. The block valve (7) is closed. Operation of the pump (8) forces fluid into the hydraulic cylinder compressing the spring to open. Release of the hydraulic fluid pressure by opening block valve (7) allows the operator to close.



DOUBLE ACTING ACTUATOR WITH M8 HYDRAULIC SPEED CONTROL

The M8 hydraulic speed control utilizes an auxilliary hydraulic cylinder to achieve operating speeds slower than those obtained with pneumatic controls, Figures 5 and 6.

Figure 15 illustrates the actuator being opened by power gas. Hydraulic fluid displaced from the hydraulic cylinder enters speed control valve (1). The integral ball check valve blocks free flow causing the fluid to pass through the adjustable orifice. Restricting the flow through this orifice increases the operating time. Excess hydraulic fluid being displaced from the cylinder, due to differential volume caused by the piston rod, enters the reservoir through a low pressure relief valve (4).



DOUBLE ACTING ACTUATOR WITH M8 HYDRAULIC SPEED CONTROL

Figure 15A illustrates the closing operation. The integral ball check of speed control valve (2) blocks free flow causing the fluid to pass through the adjustable orifice. Make-up oil required to fill the outboard end of the hydraulic cylinder is drawn from the reservoir (5) through the check valve (6).