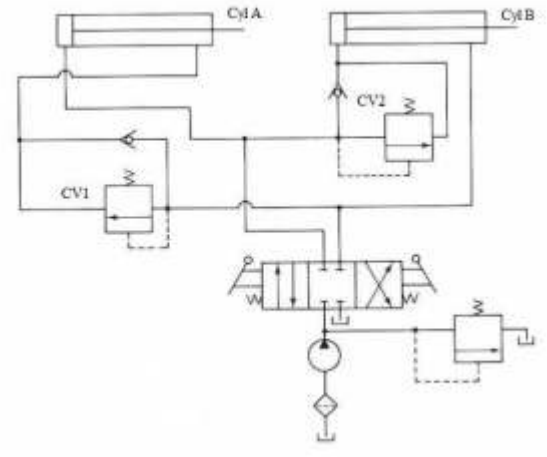
Sequencing circuit



In many applications, it is necessary to perform operations in a definite order. Hydraulic cylinders can be operated sequentially using a sequence valve. Figure 1.7 shows that two sequence valves are used to sequence the operation of two double-acting cylinders. This sequence of cylinder operation is controlled by sequence valves. This hydraulic circuit can be used in a production operation such as drilling. Cylinder A is used as a clamp cylinder and cylinder B as a drill cylinder. Cylinder A extends and clamps a work piece. Then cylinder B extends to drive a spindle to drill a hole. Cylinder B retracts the drill spindle and then cylinder A retracts to release the work piece for removal. The sequence of operation realized by the circuit shown in Figure 4.8 is: Step A – Extend Cylinder A (To clamp the work piece) Step B – Extend Cylinder B while holding pressure on Cylinder A (To perform drilling operation) Step C – Retract Cylinder B (To retract the spindle after drilling) Step D – Retract Cylinder A (To unclamp the work piece) When the DCV is shifted into its left envelope mode, the cylinder A extends completely. When the pressure reaches the pressure setting of sequence valve (SV1), the valve opens and fluid flow is allowed to the cylinder B as a result cylinder B extends. If the DCV is then shifted into its right envelope mode cylinder B retracts fully, and then the cylinder A retracts. Hence this sequence of cylinder operation is controlled by the sequence valves. The spring cantered position of the DCV locks both cylinders in place.

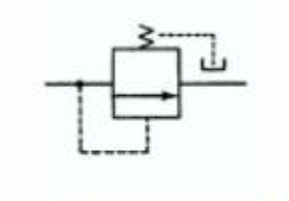


Fig 3.24 Graphical symbol

Counterbalance Valve The schematic of counterbalance valve is shown in Figure 3.21. These normally closed valves are primarily used to maintain the back pressure and to prevent a load from failing. The counterbalance valves can be used as breaking valves for decelerating heavy loads. These valves are used in vertical presses, lift trucks, loaders and other machine tools where position or hold suspended loads are important. Counterbalance valves work on the principle that the fluid is trapped under pressure until pilot pressure overcomes the pre-set value of spring force. Fluid is then allowed to escape, letting the load to descend under control. This valve is normally closed until it is acted upon by a remote pilot pressure source. Therefore, a lower spring force is sufficient. It leads to the valve operation at the lower pilot pressure and hence the power consumption reduces, pump life increases and the fluid temperature decreases.

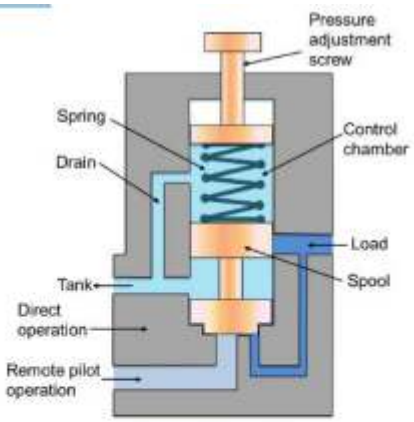
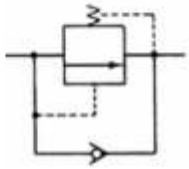
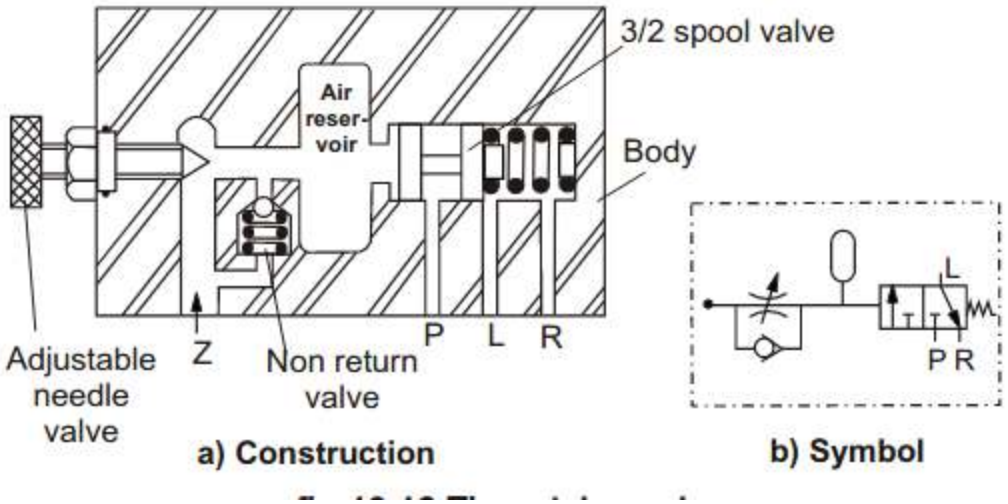


Figure 3.21 Counter balance valve

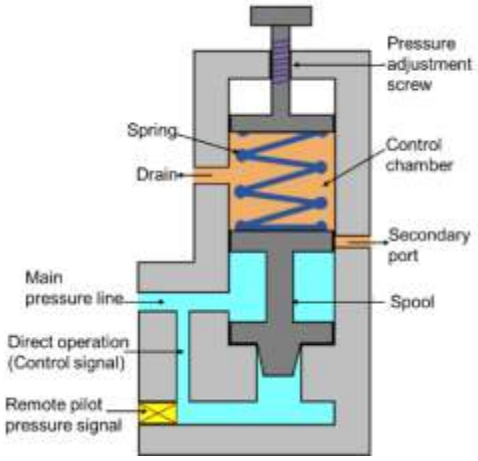


6.

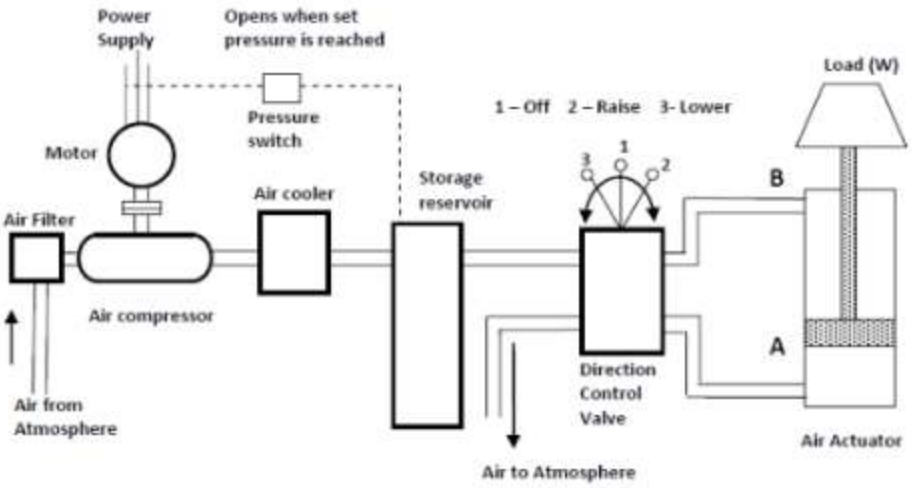


time delay valve is a combination valve used to set the operation time as per the requirement. The time delay can be increased or decreased by adjusting the flow through the non-return flow control valve. The change invariably increases or decreases the time taken to fill and pilot actuates the direction control valve.

5. Pressure Sequence Valve The primary function of this type of valve is to divert flow in a predetermined sequence. It is used to force two actuators to operate in sequence. A sequence valve is a pressure-control valve that may be of direct-pilot or remote-pilot operated type.



Sequence valve Schematic of the sequence valve is shown in Figure 3.23. Its construction is similar to the direct relief valve. It consists of the two ports; one main port connecting the main pressure line and another port (secondary port) is connected to the secondary circuit. The secondary port is usually closed by the spool. The pressure on the spool works against the spring force. When the pressure exceeds the preset value of the spring; the spool lifts and the fluid flows from the primary port to the secondary port. For remote operation; the passage used for the direct operation is closed and a separate pressure source for the spool operation is provided in the remote operation mode.



1. High effectiveness

Many factories have equipped their production lines with compressed air supplies and movable compressors. There is an unlimited supply of air in our atmosphere to produce compressed air. Moreover, the use of compressed air is not restricted by distance, as it can easily be transported through pipes. After use, compressed air can be released directly into the atmosphere without the need of processing.

2. High durability and reliability

Pneumatic components are extremely durable and cannot be damaged easily. Compared to electromotive components, pneumatic components are more durable and reliable.

3. Simple design

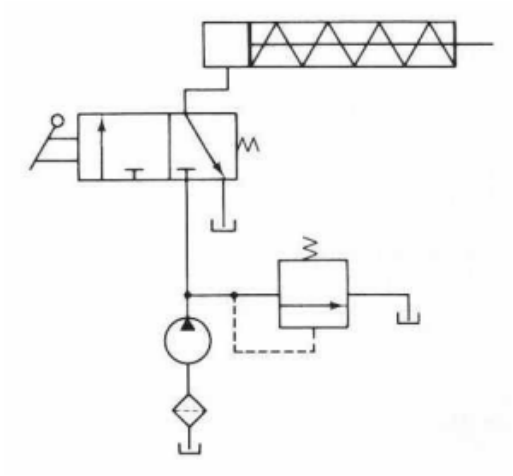
The designs of pneumatic components are relatively simple. They are thus more suitable for use in simple automatic control systems.

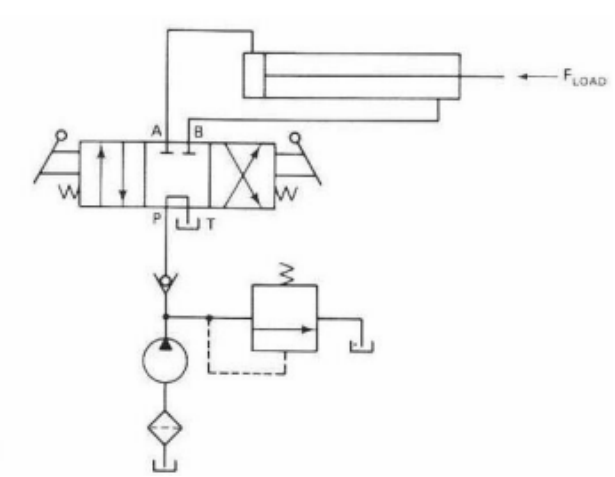
4. Quick exhaust valve,

A quick exhaust valve is a typical shuttle valve. The quick exhaust valve is used to exhaustthe cylinder air quickly to atmosphere. Schematic diagram of quick exhaust valve is shown inFigure 4.8. In many applications especially with single acting cylinders, it is a commonpractice to increase the piston speed during retraction of the cylinder to save the cycle time.The higher speed of the piston is possible by reducing the resistance to flow of the exhaustingair during the motion of cylinder. The resistance can be reduced by expelling the exhaustingair to the atmosphere quickly by using Quick exhaust valve.

b) time delay valve

the cylinder retracts as oil flows from port P through port B. Oil in the blank end is returned to the tank via the flow path from port A to port T.





3.

Functions of components

1. Air filters are used to filter out the contaminants from the air.

2. Air cooler are used to reduce the temperature of the compressed air.

3. Compressor is used to compress the fresh air drawn from the atmosphere.

4. External power supply (Motor) is used to drive the compressor.

5. Storage reservoir is used to store a given volume of compressed air.

6. Control valves are used to control the direction, flow rate and pressure of compressed air.

7. Pneumatic actuator converts the fluid power into mechanical power to perform useful work.

8. Piping system carries the pressurized air from one location to another.

Expression for the Cylinder Extending Speed

The total flow rate Q_T entering the blank end of the cylinder is given by

$Q_T = Q_P + Q_r$

Where Q_P is the pump flow rate and is Q_r the regenerative flow or flow from the rod end.

Hence, Pump flow rate,

$= Q_P = Q_T — Q_r$

But the total flow rate acting on the blank rod end is given by

$Q_P = A_P V_{ext}$

Similarly, the flow rate from the rod end is given by

$Qr = (A_P — A_r) V_{ext}$

So pump flow rate is

$Q_P = A_P V_{ext} — (A_P — A_r) V_{ext}$

$Q_P = A_r V_{ext}$

The extending speed of the piston is given as

$V_{ext} = Q_P / A_r$

Thus, a small area provides a large extending speed. The extending speed can be greater than the retracting speed if the rod area is made smaller. The retraction speed is given by

$V_{et} = Q_P / A_P — A_r$

The ratio of extending and retracting speed is given as

$V_{ext} / V_{et} = Q_P / A_r / Q_P / A_P — A_r$

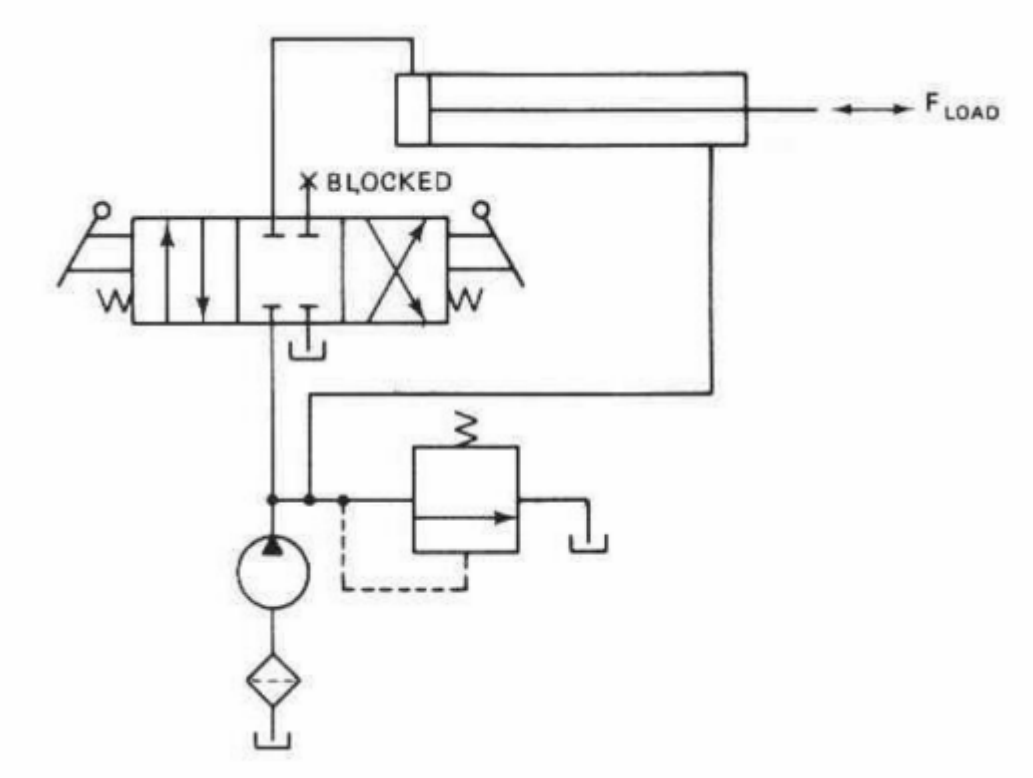
$= A_P — A_r / A_r$

$= (A_P / A_r) — 1$

When the piston area equals two times the rod area, the extension and retraction speeds are equal. In general, the greater the ratio of the piston area to rod area, the greater is the ratio of the extending speed to retraction speed.

2. Hydraulic circuit A hydraulic circuit is a group of components such as pumps, actuators, control valves, conductors and fittings arranged to perform useful work. It gives us an idea about how these components are interconnected. There are three important considerations in designing a hydraulic circuit: 1. Safety of machine and personnel in the event of power failures. 2. Performance of given operation with minimum losses. 3. Cost of the component used in the circuit. Control of a Single-Acting Hydraulic Cylinder Figure 4.1 Control of a single-acting cylinder. Figure 4.1 shows that the control of a single-acting, spring return cylinder using a threeway two-position manually actuated, spring offset direction-control valve (DCV). In the spring offset mode, full pump flow goes to the tank through the pressure-relief valve (PRV). The spring in the rod end of the cylinder retracts the piston as the oil from the blank end drains back into the tank. When the valve is manually actuated into its next position, pump flow extends the cylinder. After full extension, pump flow goes through the relief valve. Deactivation of the DCV allows the cylinder to retract as the DCV shifts into its spring offset mode. Control of a Double-Acting Hydraulic Cylinder The circuit diagram to control double-acting cylinder is shown in Fig. 4.2. The control of a double-acting hydraulic cylinder is described as follows: 1. When the 4/3 valve is in its neutral position (tandem design), the cylinder is hydraulically locked and the pump is unloaded back to the tank. 2. When the 4/3 valve is actuated into the flow path, the cylinder is extended against its load as oil flows from port P through port A. Oil in the rod end of the cylinder is free to flow back to the tank through the four-way valve from port B through port T. 3. When the 4/3 valve is actuated into the right-envelope configuration,

1. Figure 4.3 shows a regenerative circuit that is used to speed up the extending speed of a double-acting cylinder. The pipelines to both ends of the hydraulic cylinder are connected in parallel and one of the ports of the 4/3 valve is blocked by simply screwing a thread plug into the port opening. During retraction stroke, the 4/3 valve is configured to the right envelope. During this stroke, the pump flow bypasses the DCV and enters the rod end of the cylinder. Oil from the blank end then drains back to the tank through the DCV. When the DCV is shifted in to its left-envelope configuration, the cylinder extends as shown in Fig. 1.3.The speed of extension is greater than that for a regular double-acting cylinder because the flow from the rod end regenerates with the pump flow QP to provide a total flow rate QT.



3	Sketch and explain structure of pneumatic control system. Name three reasons for considering the use of pneumatics instead of hydraulics.	10	CO1	L2
4	Sketch and explain construction and principle of working of i) Quick exhaust valve ii) Time delay valve.	10	CO2	L2
5	Describe the working principle along with graphic symbol of the following : a)Sequence valve and b)Counter balance valve	10	CO2	L2
6	Design a hydraulic sequencing circuit used in a drilling machine for clamping work piece and drilling a hole.	10	CO2	L3

CI CCI

HOD

Note: Answer any 5 question

Question #	Description	Max. MARKS	
1	➢ Explain briefly the principle involved in regenerative circuit and obtain an expression for the speed of actuator.. ➢ **Sketch** ➢ **Explanation**	**5M** **5M**	10M
2	Explain with suitable circuits how single acting and double acting cylinders are controlled.. ➢ **Sketch** ➢ **Explanation**	**5M** **5M**	10M
3	Sketch and explain structure of pneumatic control system. Name three reasons for considering the use of pneumatics instead of hydraulics. ➢ **Sketch** ➢ **Explanation**	**5M** **5M**	10M
4	➢ Sketch and explain construction and principle of working of i) Quick exhaust valve ii) Time delay valve.**Sketch** ➢ **Explanation**	**5M** **5M**	10M
5	Describe the working principle along with graphic symbol of the following : ➢ a)Sequence valve and b)Counter balance valve **Sketch** ➢ **Explanation**	**5M** **5M**	
6	Design a hydraulic sequencing circuit used in a drilling machine for clamping work piece and drilling a hole ➢ **Sketch** ➢ **Explanation**	**5M** **5M**	10M

Scheme of Evaluation

Internal Assessment Test2 – Jan 22

Sub:	Industrial Safety					Sub Code:	18ME72	Branch:	ME
Date:	25/1/2022	Duration:	90 min's	Max Marks:	50	Sem / Sec:	7B		

USN

Internal Assessment Test III

Sub:	Fluid Power systems					Sub Code:	17ME72	Branch:	ME
Date:	25/01/2022	Duration:	90 min's	Max Marks:	50	Sem / Sec:	7B		OBE

	Answer any Five Questions	MARKS	CO	RBT
1	Explain briefly the principle involved in regenerative circuit and obtain an expression for the speed of actuator.	10	CO1	L2
2	Explain with suitable circuits how single acting and double acting cylinders are controlled.	10	CO1	L3
3	Sketch and explain structure of pneumatic control system. Name three reasons for considering the use of pneumatics instead of hydraulics.	10	CO1	L2
4	Sketch and explain construction and principle of working of i) Quick exhaust valve ii) Time delay valve.	10	CO2	L2
5	Describe the working principle along with graphic symbol of the following : a)Sequence valve and b)Counter balance valve	10	CO2	L2
6	Design a hydraulic sequencing circuit used in a drilling machine for clamping work piece and drilling a hole.	10	CO2	L3

CI CCI

HOD

USN

Internal Assessment Test III

Sub:	Fluid Power systems					Sub Code:	17ME72	Branch:	ME
Date:	25/01/2022	Duration:	90 min's	Max Marks:	50	Sem / Sec:	7B		OBE

	Answer any Five Questions	MARKS	CO	RBT
1	Explain briefly the principle involved in regenerative circuit and obtain an expression for the speed of actuator.	10	CO1	L2
2	Explain with suitable circuits how single acting and double acting cylinders are controlled.	10	CO1	L3