

HYDRAULIC ACTUATORS

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- Linear actuator: For linear actuation (hydraulic cylinders).
- Rotary actuator: For rotary actuation (hydraulic motor).
- Semi-rotary actuator: For limited angle of actuation (semi-rotary actuator).

Types of Hydraulic Cylinders

- Single-acting cylinders.
- Double-acting cylinders.
- Telescopic cylinders.
- Tandem cylinders.

Single-Acting Cylinders

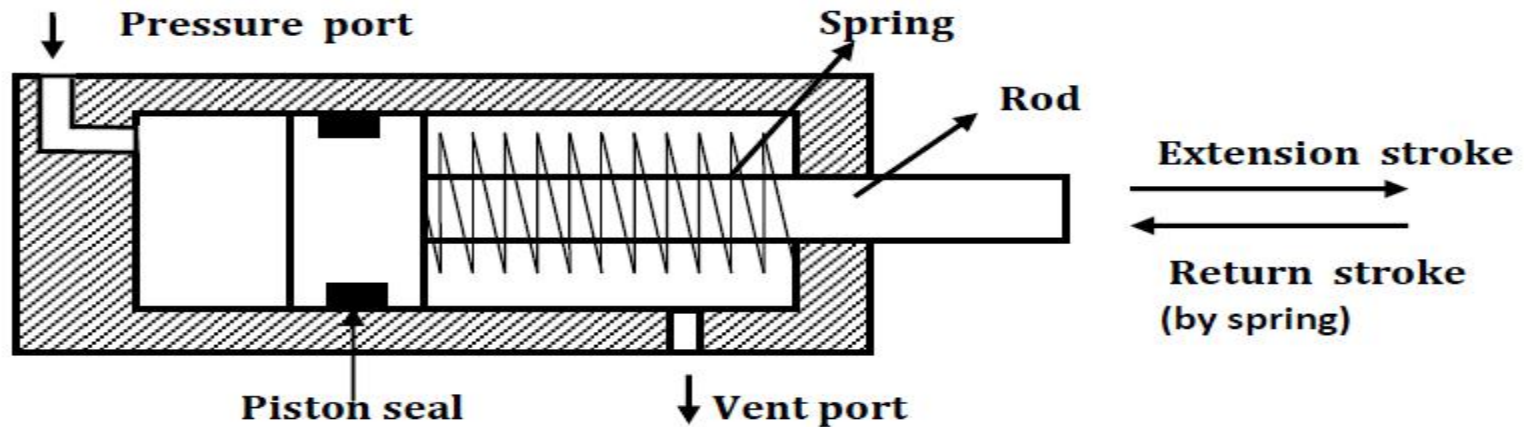


Figure 1.1 Single-acting cylinders

According to the type of return, single-acting cylinders are classified as follows:

- Gravity-return single-acting cylinder.
- Spring-return single-acting cylinder.

Gravity-Return Single-Acting Cylinder

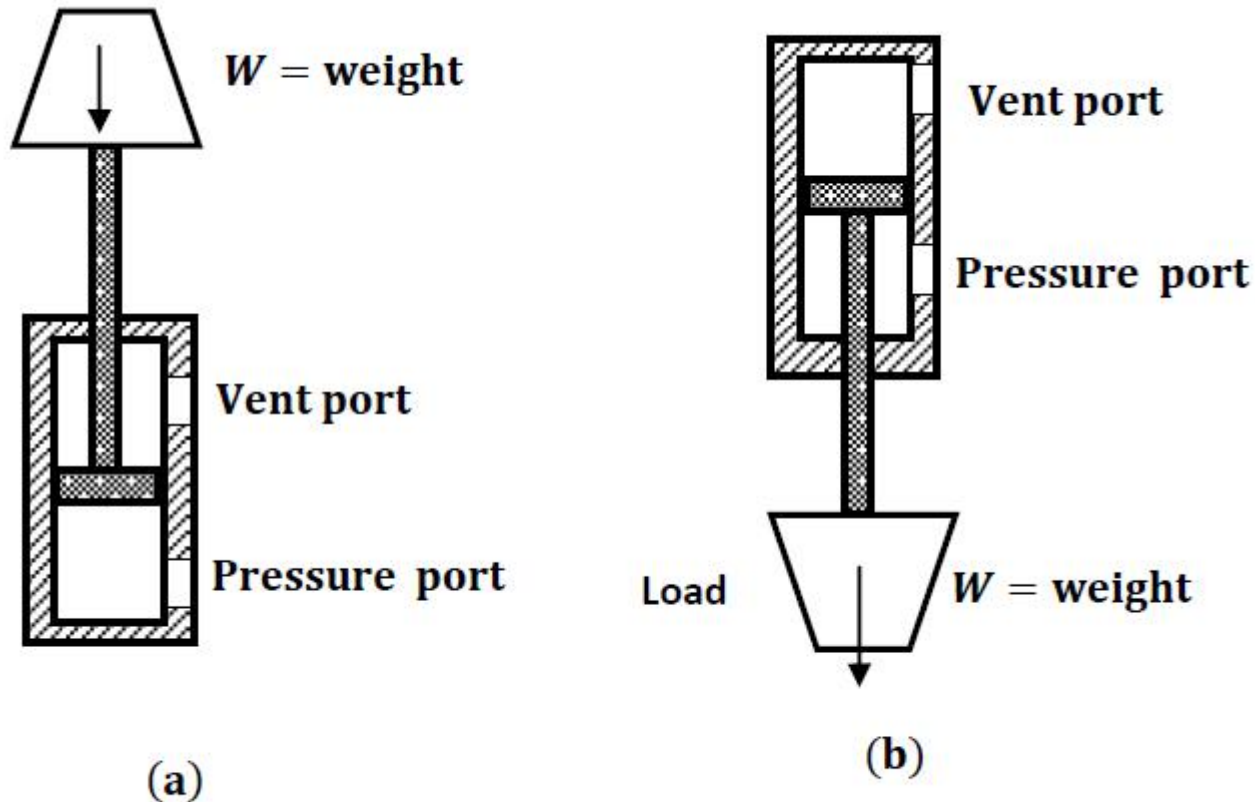


Figure 1.2 Gravity-return single-acting cylinder: (a) Push type; (b) pull type

Double-Acting Cylinder

- Double-acting cylinder with a piston rod on one side.
- Double-acting cylinder with a piston rod on both sides.

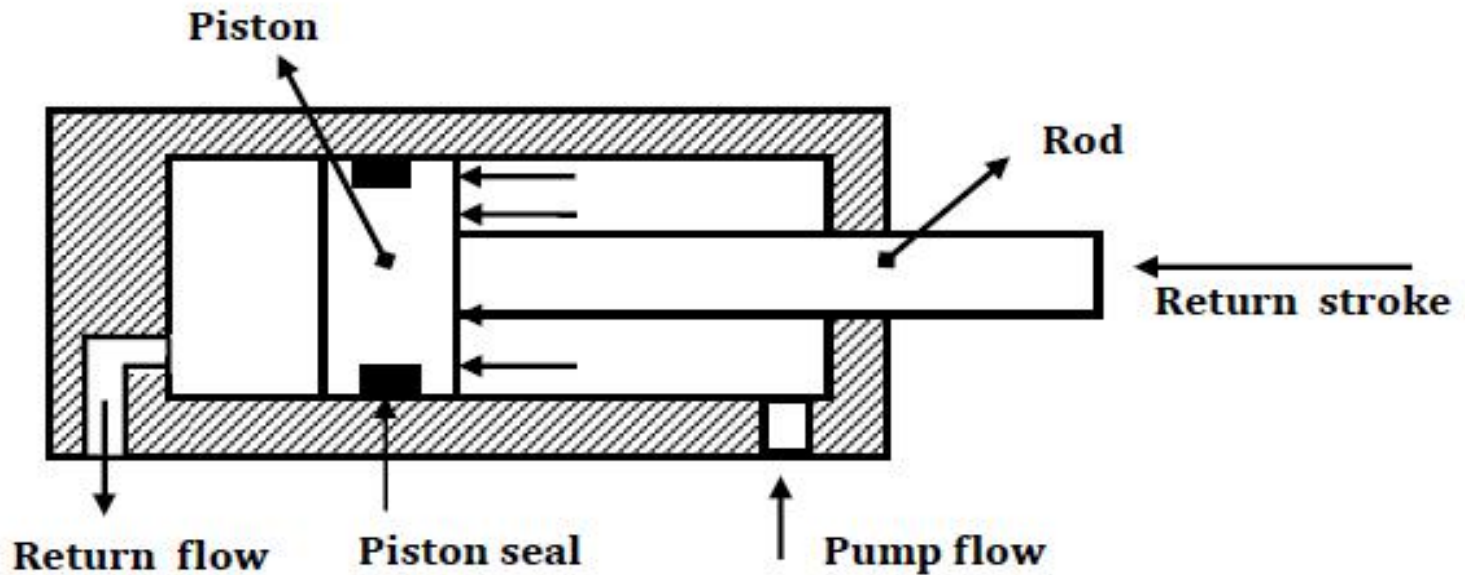
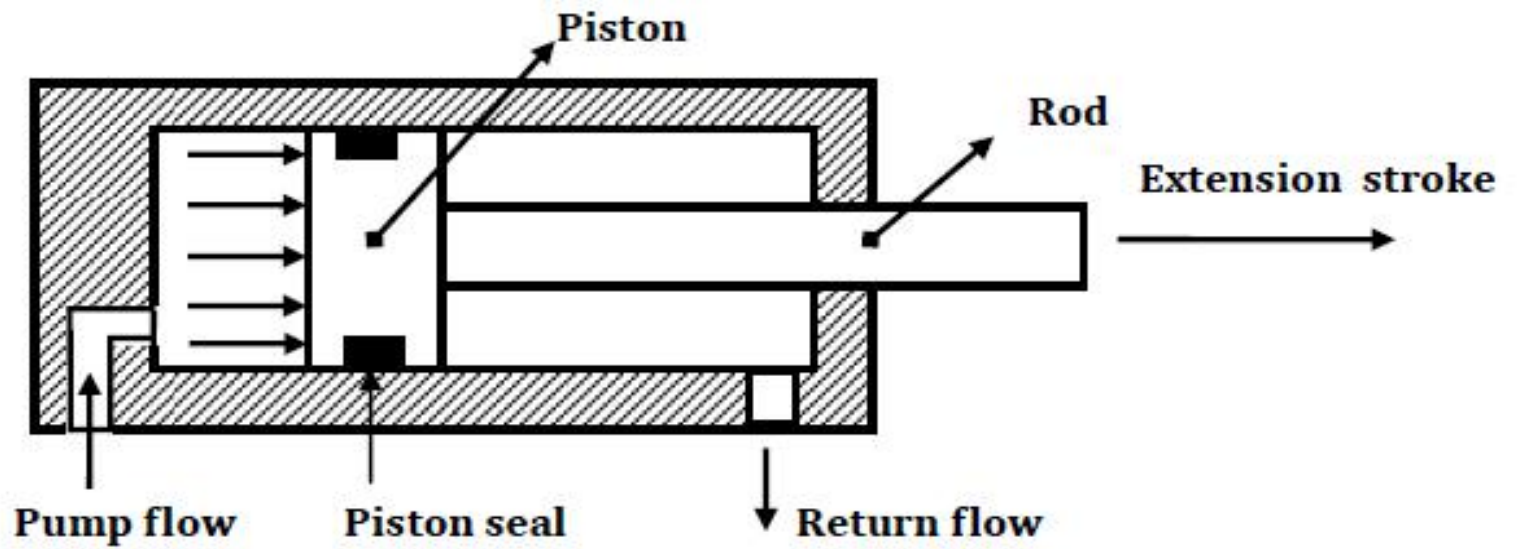


Figure 1.4 Double-acting cylinder with a piston rod on one side

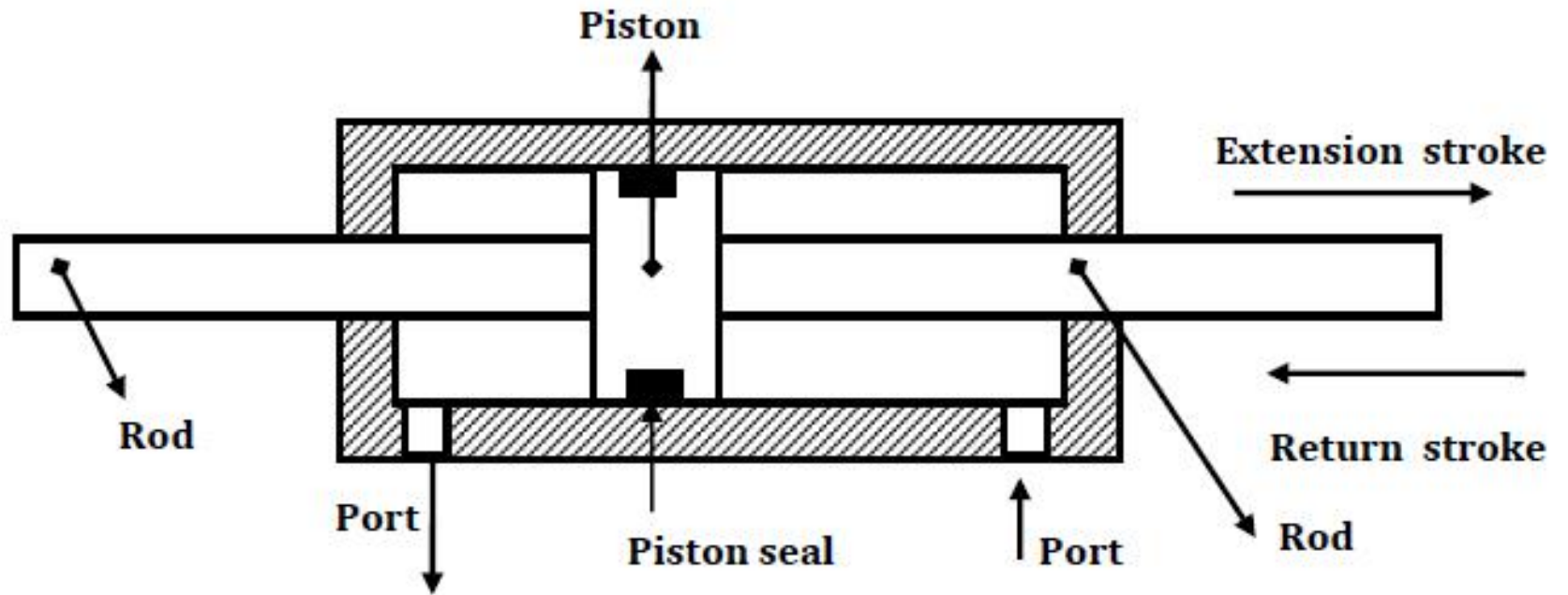
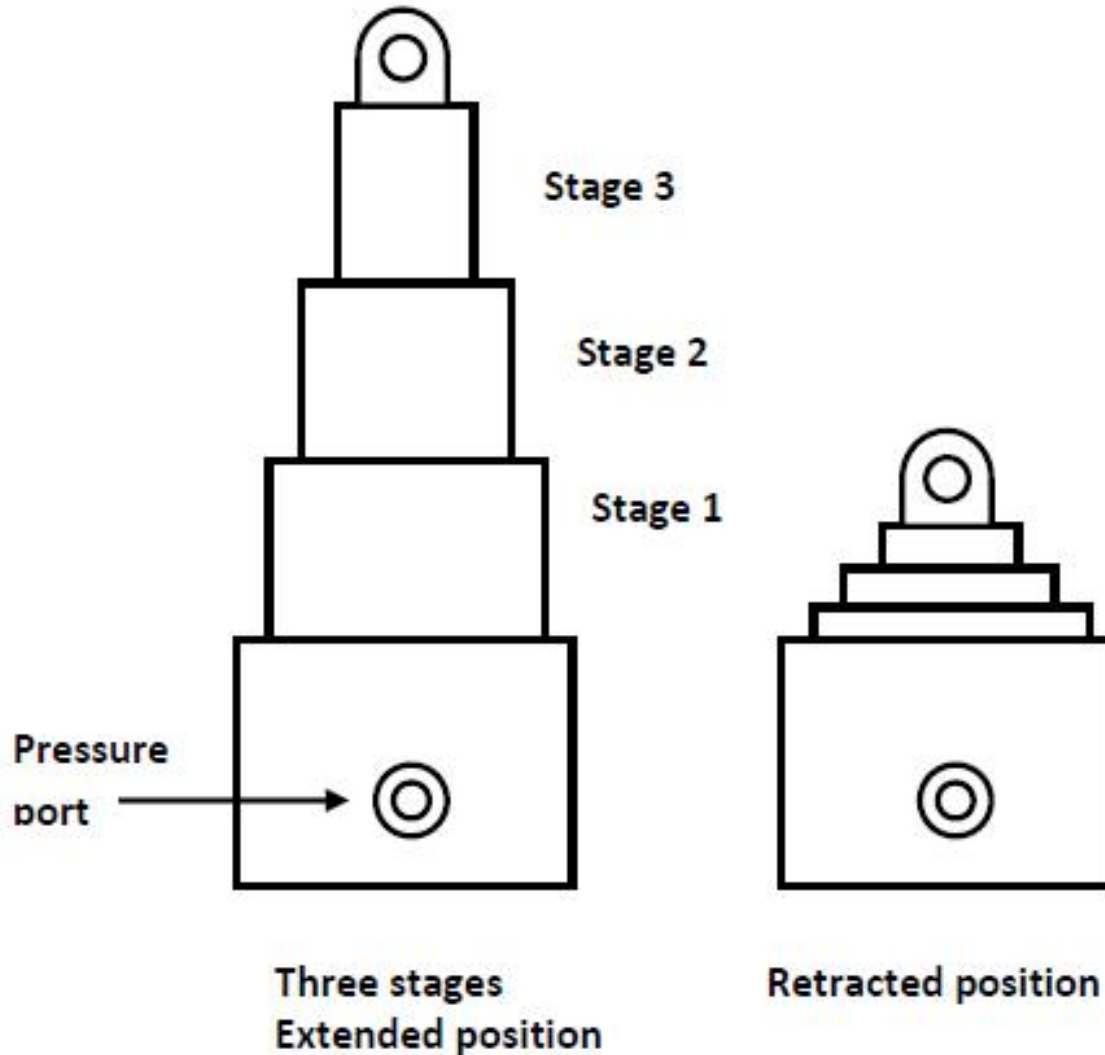


Figure 1.5 Double-acting cylinder with a piston rod on one side

Telescopic Cylinder



Tandem Cylinder

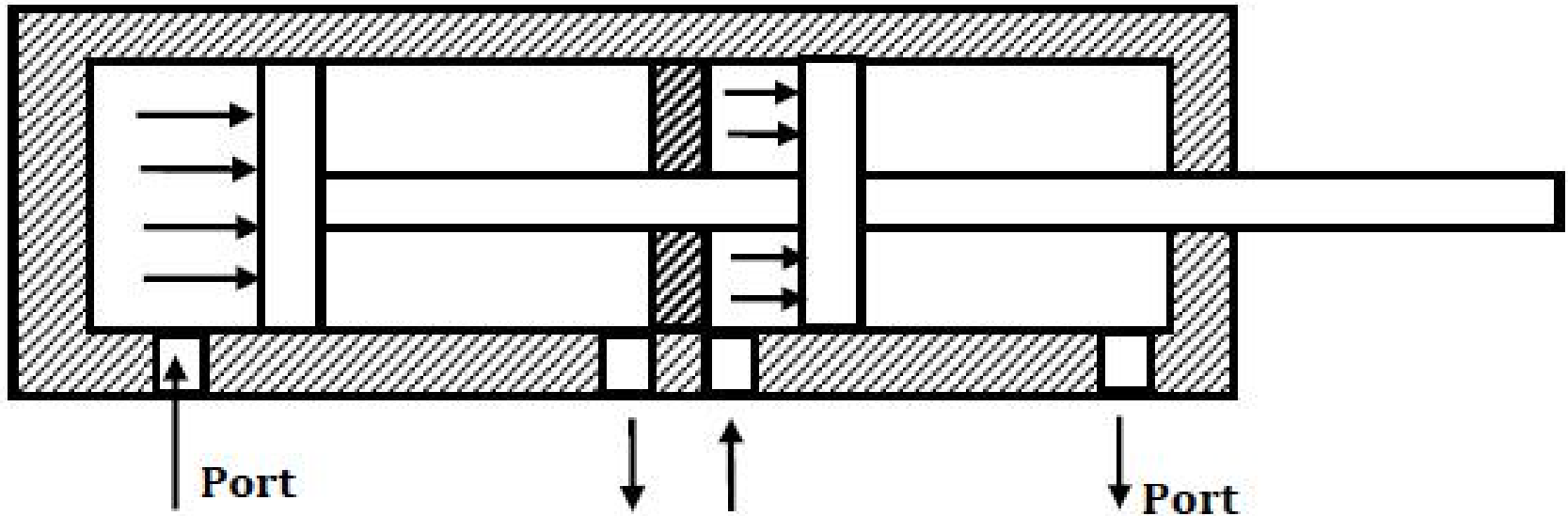
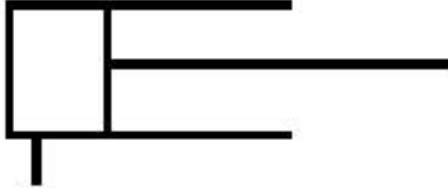
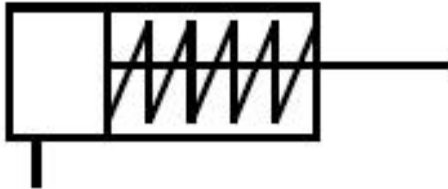
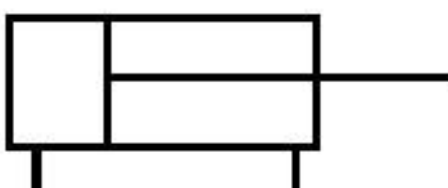

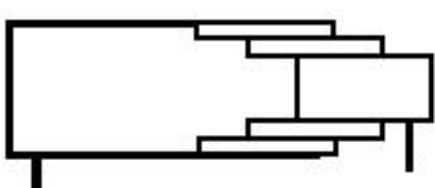
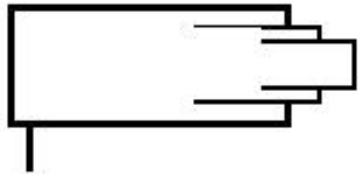
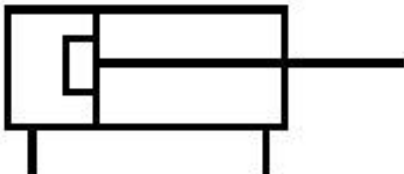

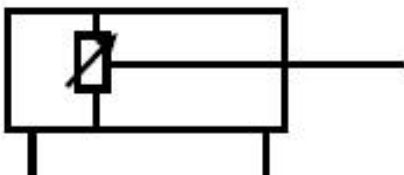
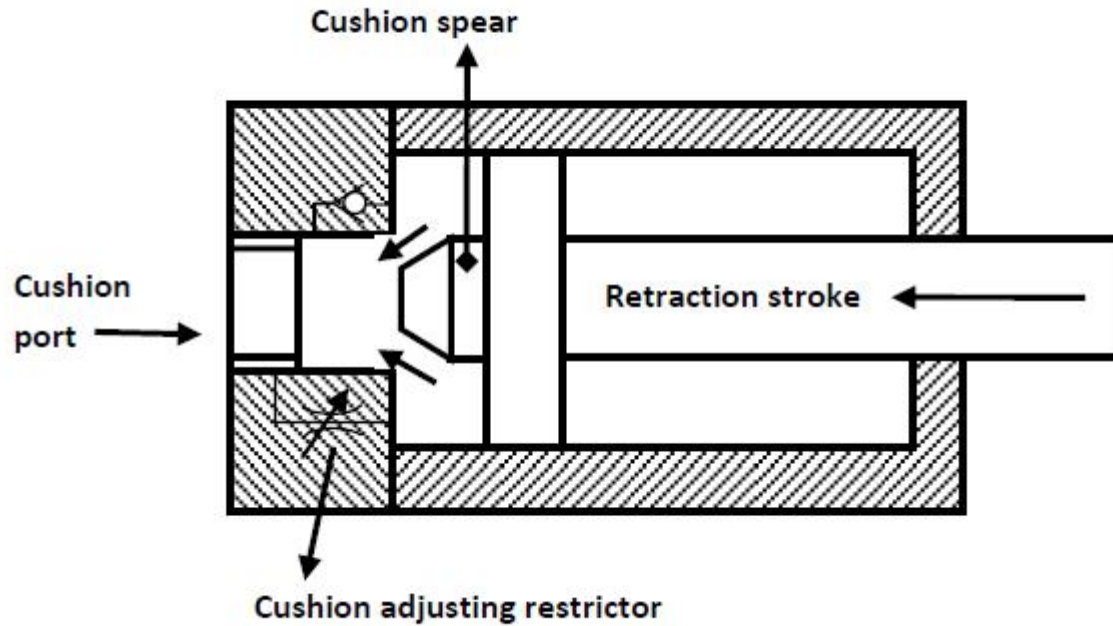


Figure 1.7 Tandem cylinder

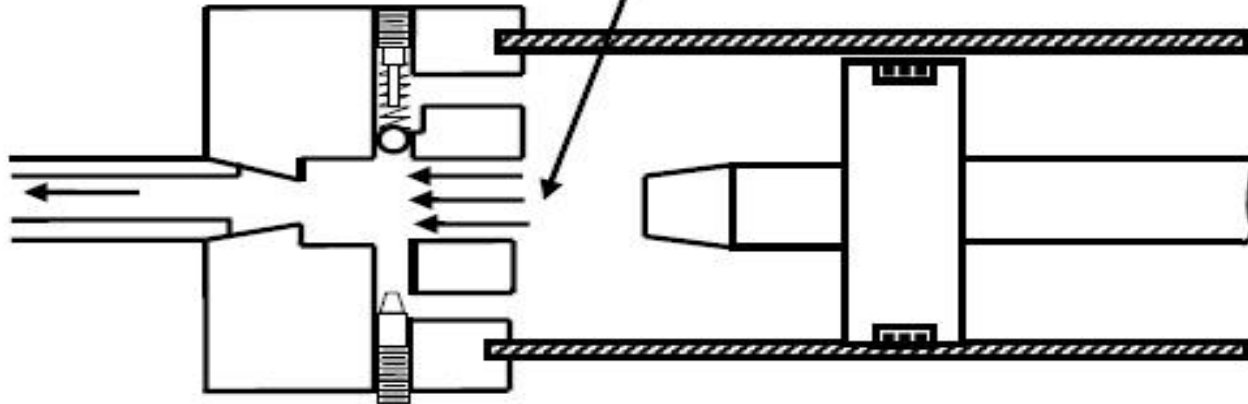
S. No.	Graphical Symbols	Explanation
1.		Single-acting cylinder with unspecified return
2.		Single-acting cylinder with spring return
3.		Double-acting cylinder –single piston rod
4.		Double-acting cylinder –double piston rod
5.		Telescopic cylinder–double acting

6.		Telescopic cylinder–single acting
7.		Double-acting cylinder– fixed cushion on one side
1.		Double-acting cylinder–variable cushion on one side
9.		Double-acting cylinder–variable cushion on both sides

Cylinder Cushions

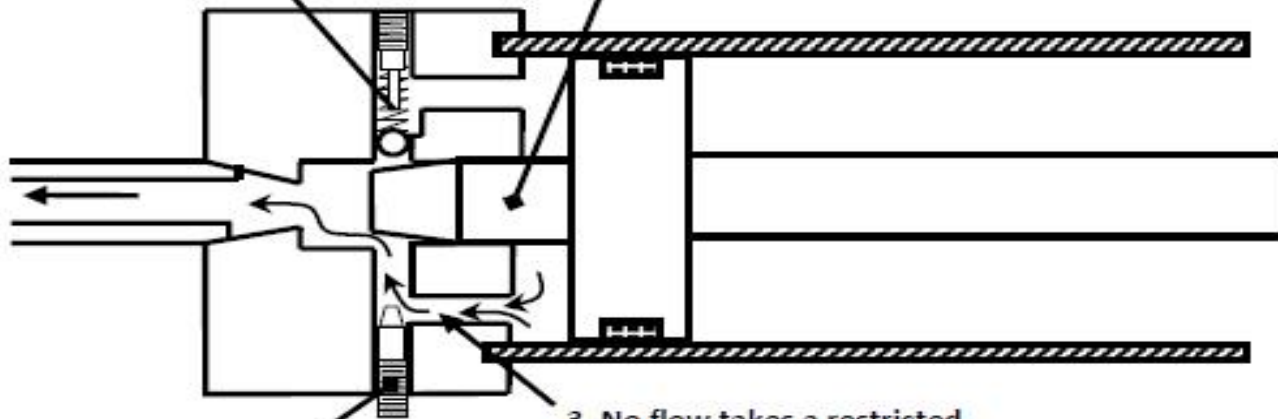


1. Exhaust flow passes freely out of the cylinder



5. Check valve allows free flow to the piston to extend

2. Plunger enters the cap



3. No flow takes a restricted path causing the piston to decelerate

4. Rate of deceleration can be adjusted here

DCVs

Classification of DCVs based Fluid Path

- Check valves.
- Shuttle valves.
- Two-way valves.
- Three-way valves.
- Four-way valves.

Classification of DCVs based on Design Characteristics

- An internal valve mechanism that directs the flow of fluid. Such a mechanism can either be a poppet, a ball, a sliding spool, a rotary plug or a rotary disk.
- Number of switching positions (usually 2 or 3).
- Number of connecting ports or ways.
- Method of valve actuation that causes the valve mechanism to move into an alternate position.

Classification of DCVs based on the Control Method

- **Direct controlled DCV**
- **Indirect controlled DCV**

Classification of DCVs based on the Construction of Internal Moving Parts

- **Rotary spool type**
- **Sliding spool type**



Each individual switching portion is shown in a square



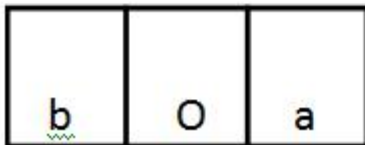
Flow path is indicated by means of arrow within a square



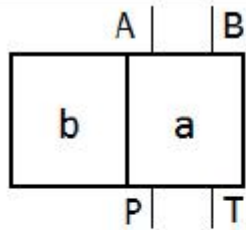
Closed position



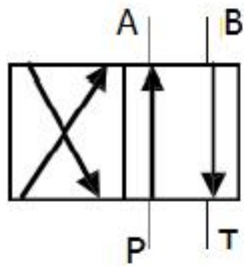
Two-position valve



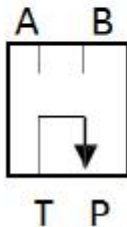
Three-position valve



Ports added to the two-position valve



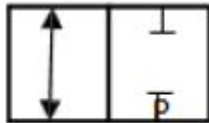
Two flow paths



Two ports are connected, two ports are closed

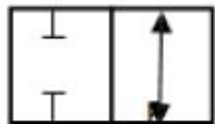
2/2-way valve: 2-ports and 2-position DCV

A



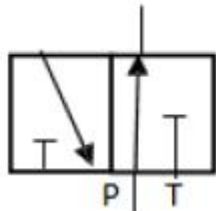
Normally closed position: P is not connected to A.
When the valve is not actuated, the way is closed.

A

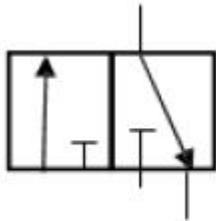


Normally open position: P is connected to A. When
the valve is not actuated, the way is open.

3/2 way valve : 3ports and 2 position DCV

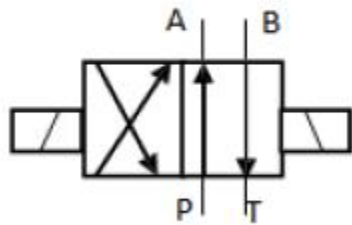


Normally open position: P is connected to A. When the valve is not actuated, the way is open.

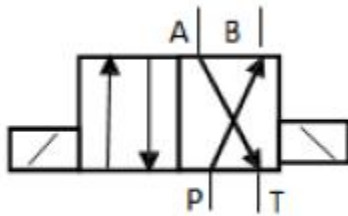


Normally open position: P is connected to A. When the valve is actuated, the way is closed

4/2-way valve – 4-port and 2-position DCV

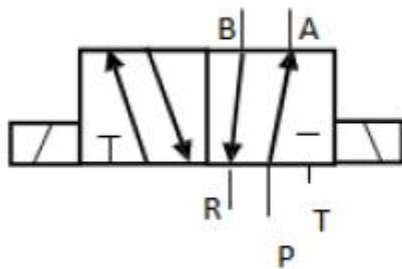


P is connected to A
B is connected to T



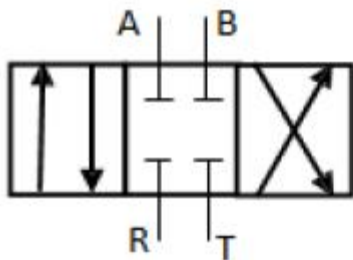
Position 2:
P is connected to B
A is connected to T

5/2-way valve – 5-port and 2-position DCV

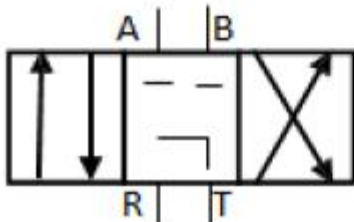


Normal position:
P is connected to B
A is connected to R

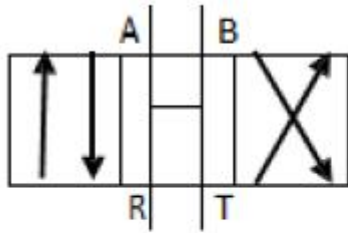
4/3-way valve – 4-port and 3-position DCV



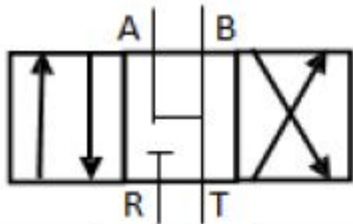
P, T, A, B



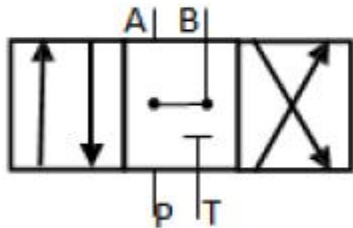
Mid-position pump reticulating:
P to T, A and B closed



H-Mid-position closed:
P to A, B to T



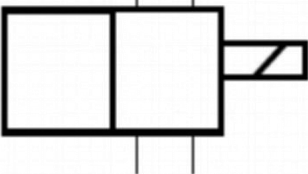
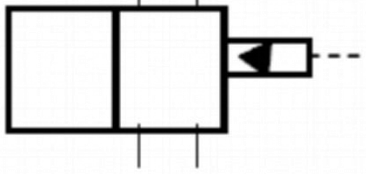
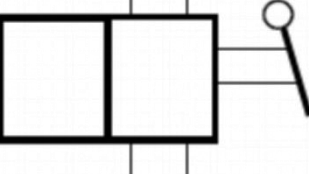
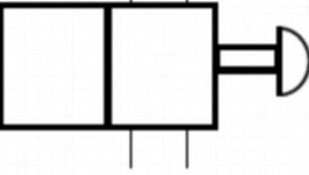
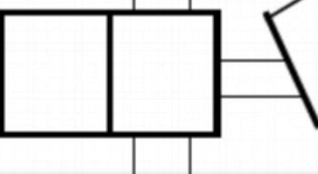
Mid-position working lines depressurized:
P, A to B to T

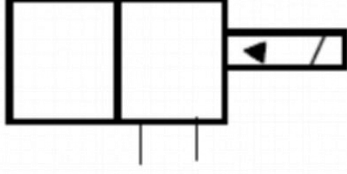
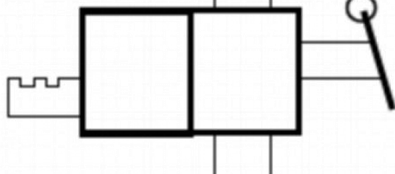
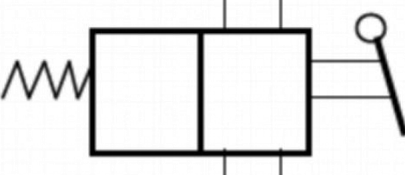


P to A to B, T

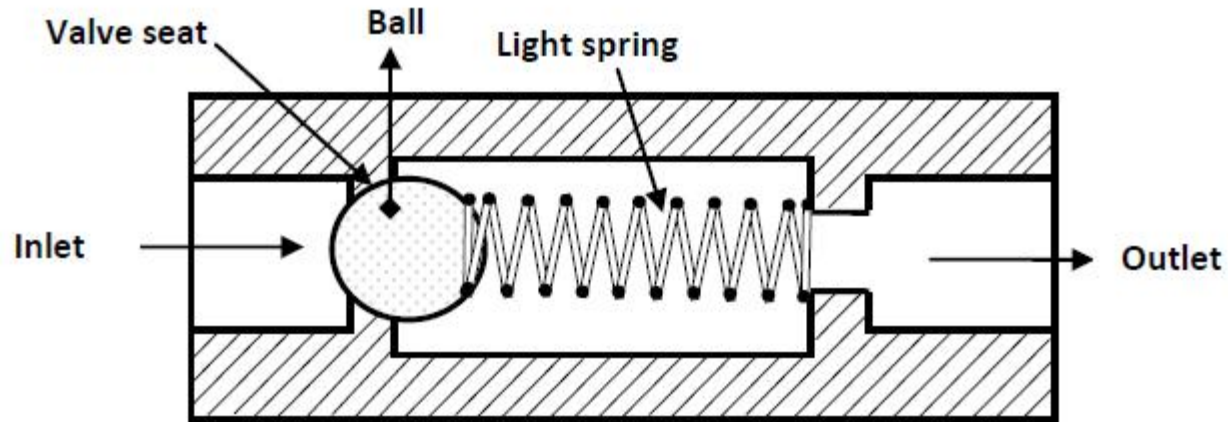
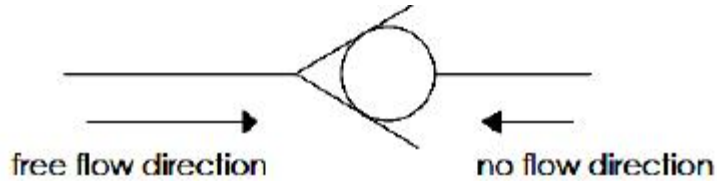
Actuating Devices

- **Manually operated**
- **Mechanically operated**
- **Solenoid operated**
- **Pilot operated**

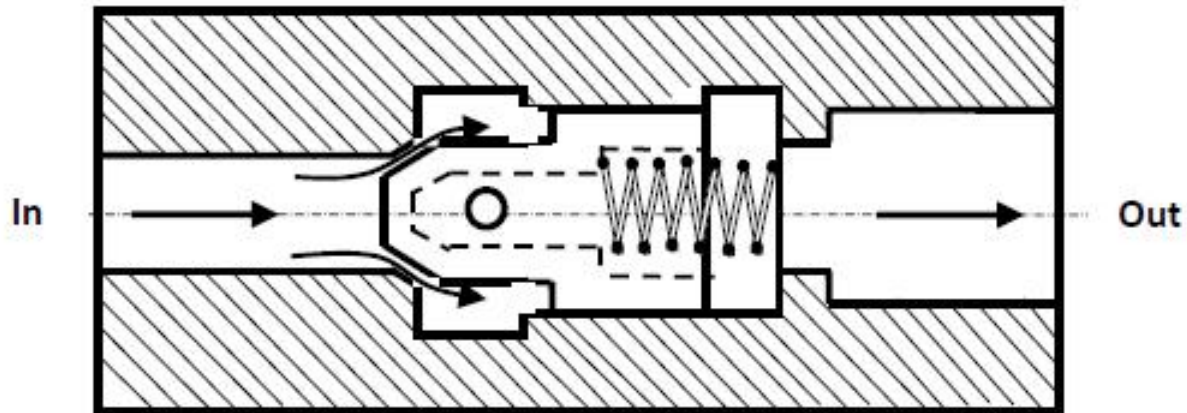
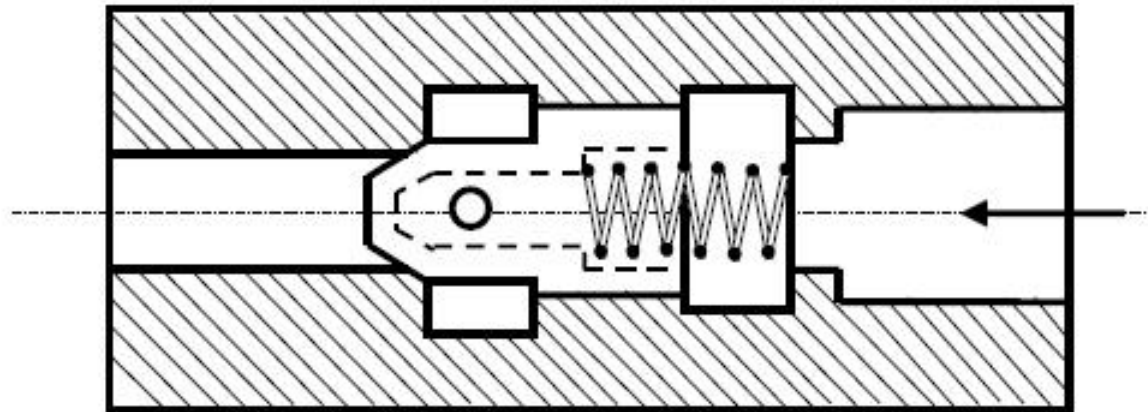
	Solenoid operated
	Pilot operated
	Manual operated
	Push button
	Foot operated

	Pilot-operated solenoid
	Two-position detent
	Spring return

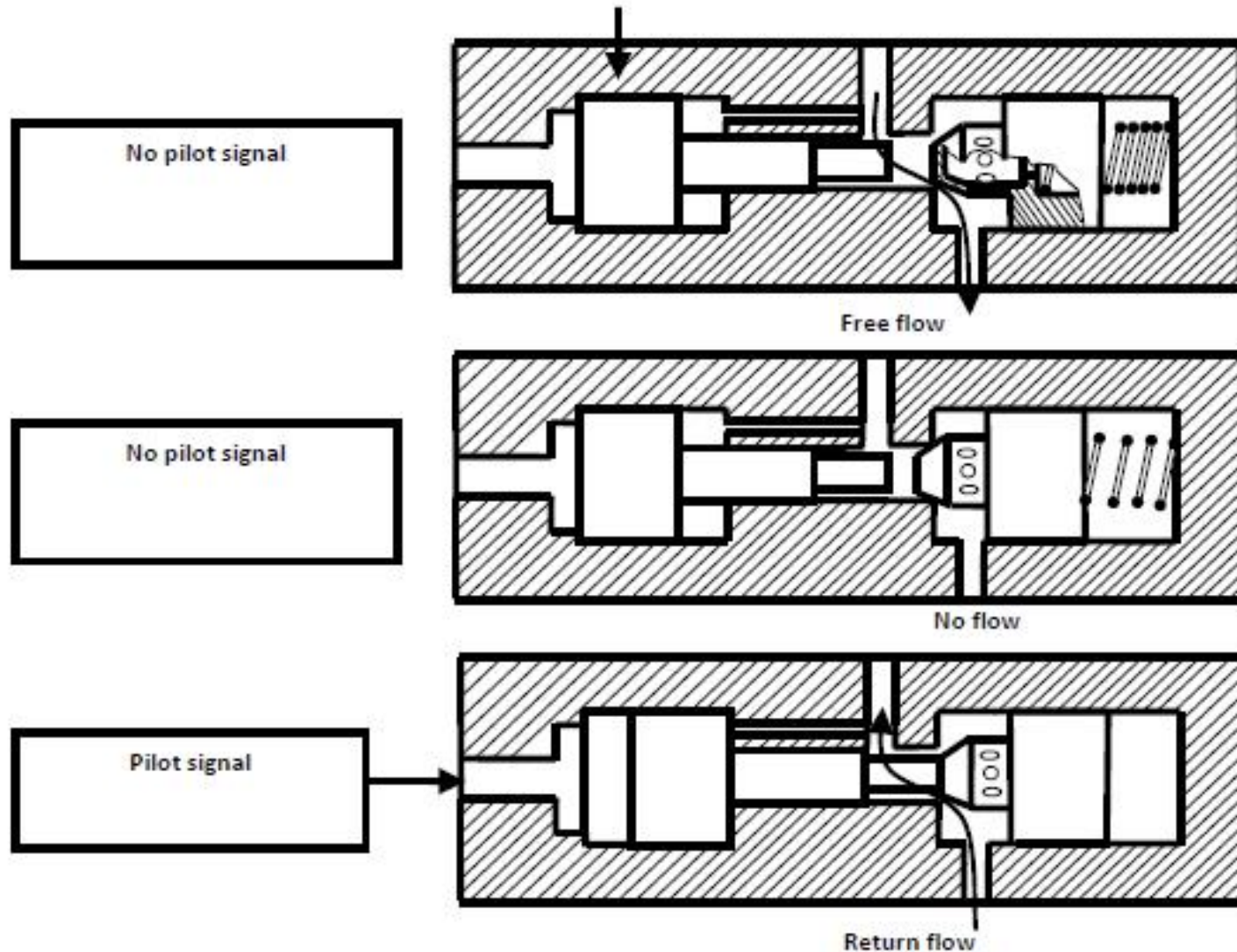
Check Valve



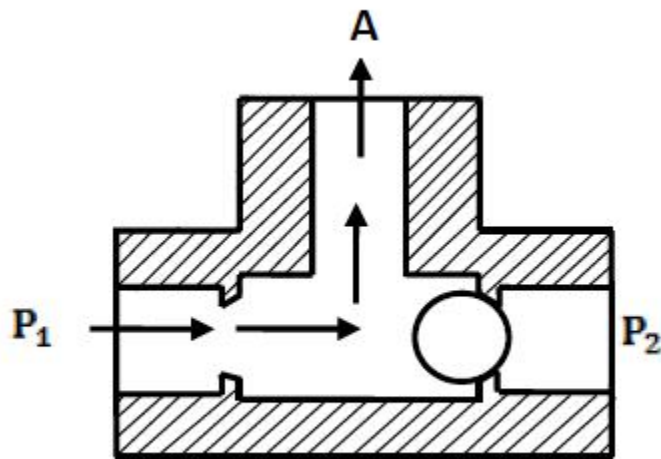
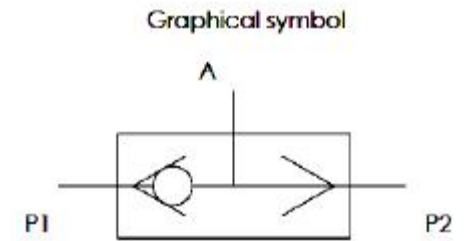
Check Valve



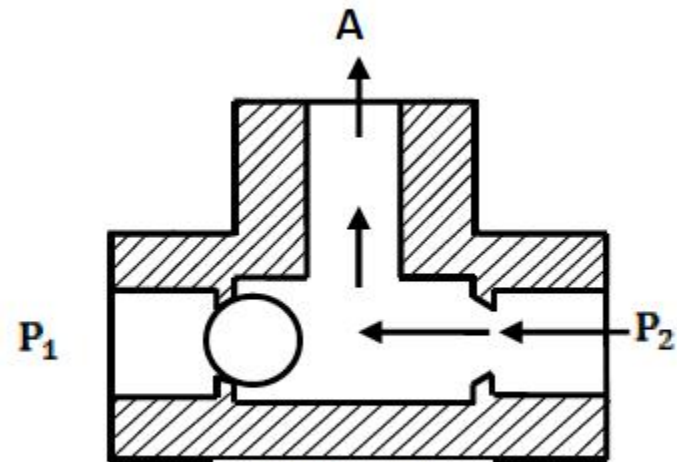
Pilot Operated Check Valve



Shuttle Valve

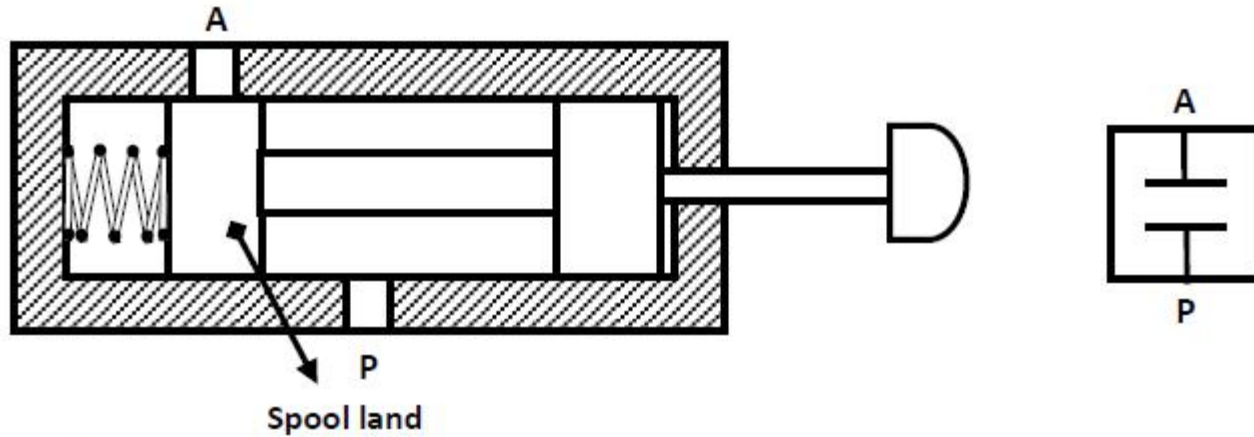


(a) $P_1 > P_2$

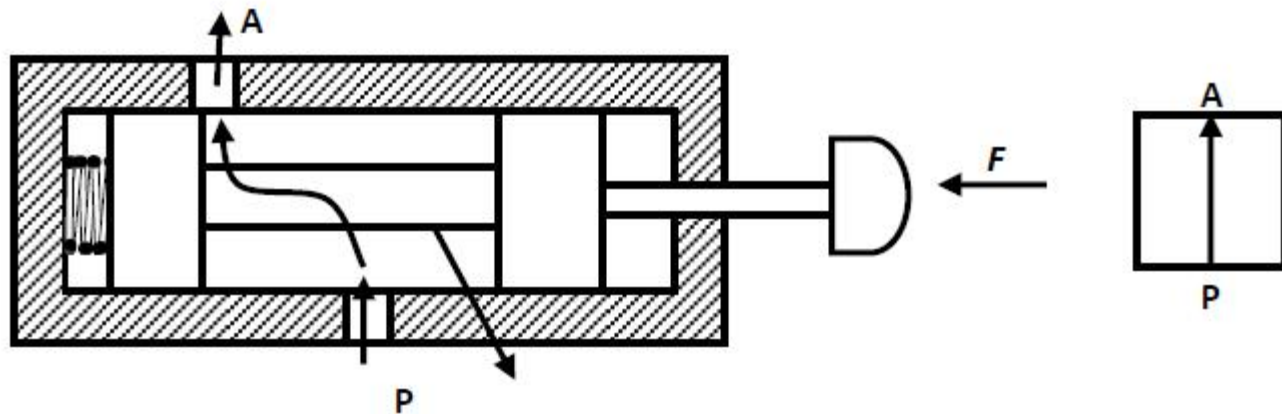


(b) $P_2 > P_1$

2/2-Way DCV (Normally Closed)

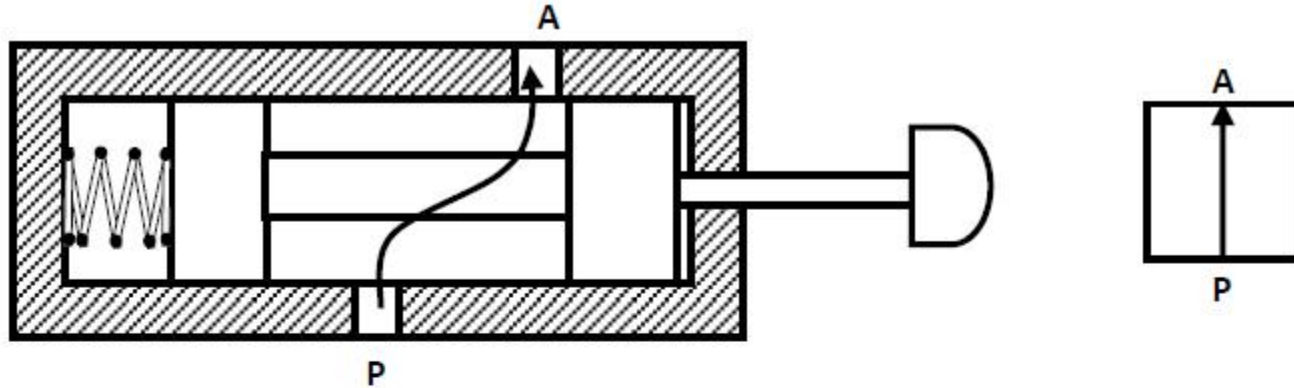


(a)

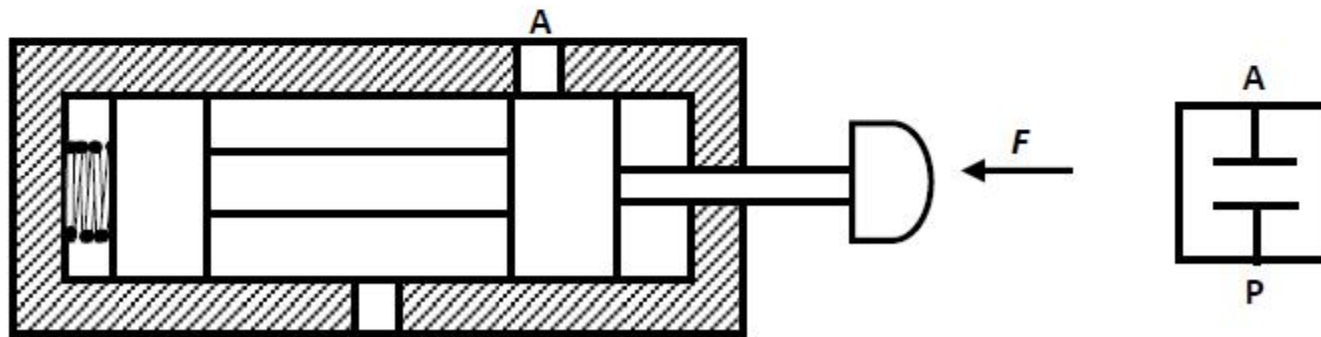


(b)

2/2-Way DCV (Normally Opened)

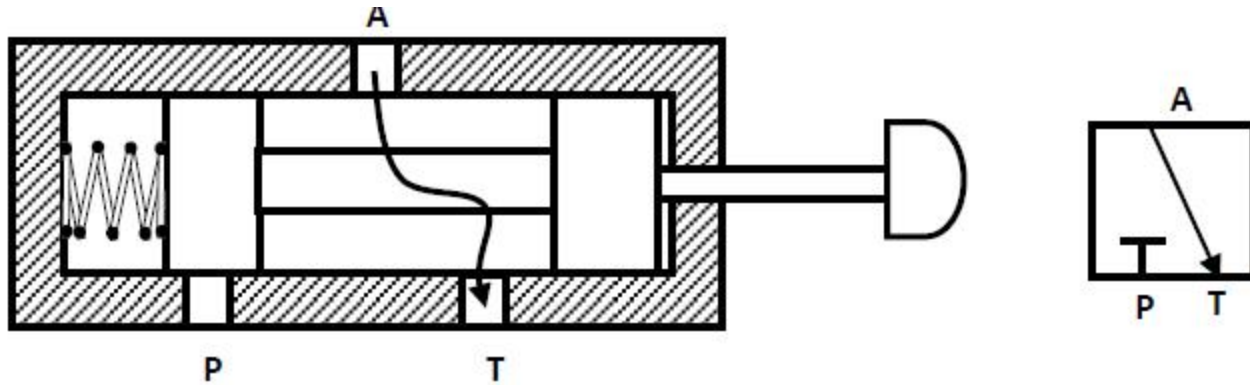


(a)

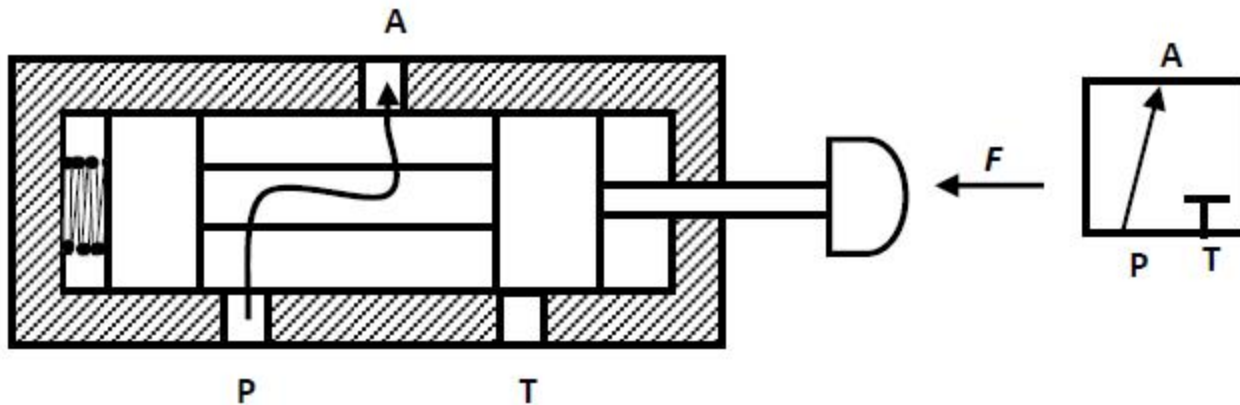


(b)

3/2-Way DCV (Normally Closed)

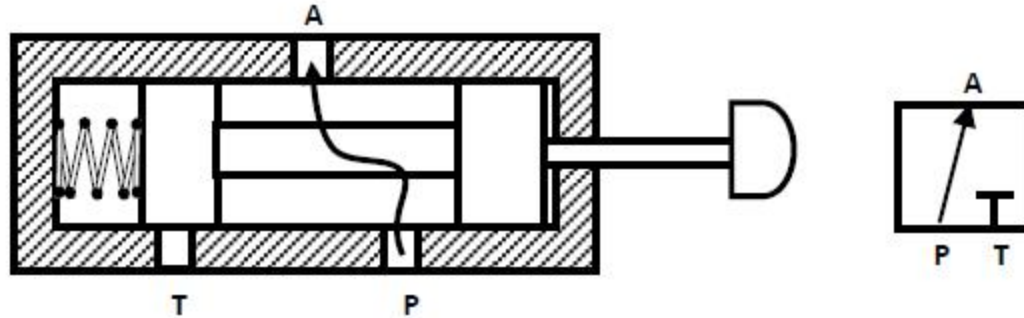


(a)

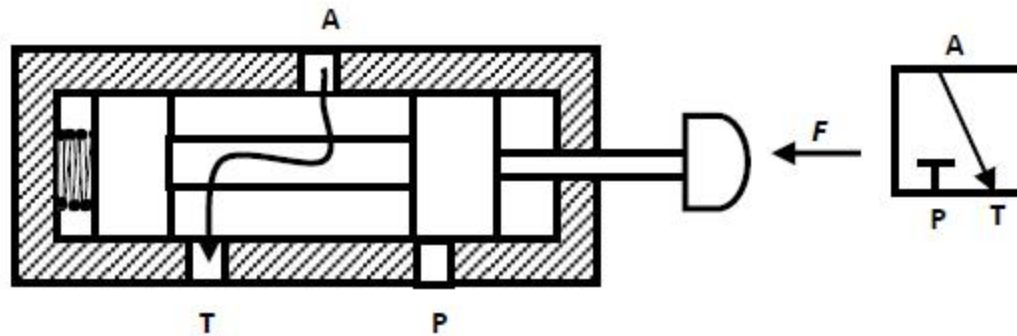


(b)

3/2-Way DCV (Normally Opened)

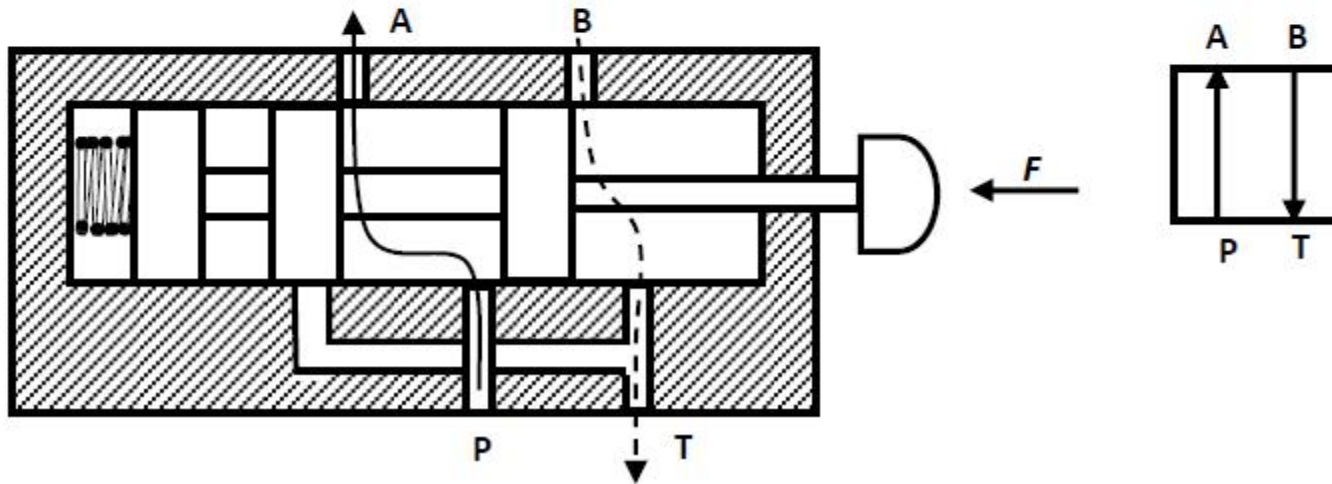
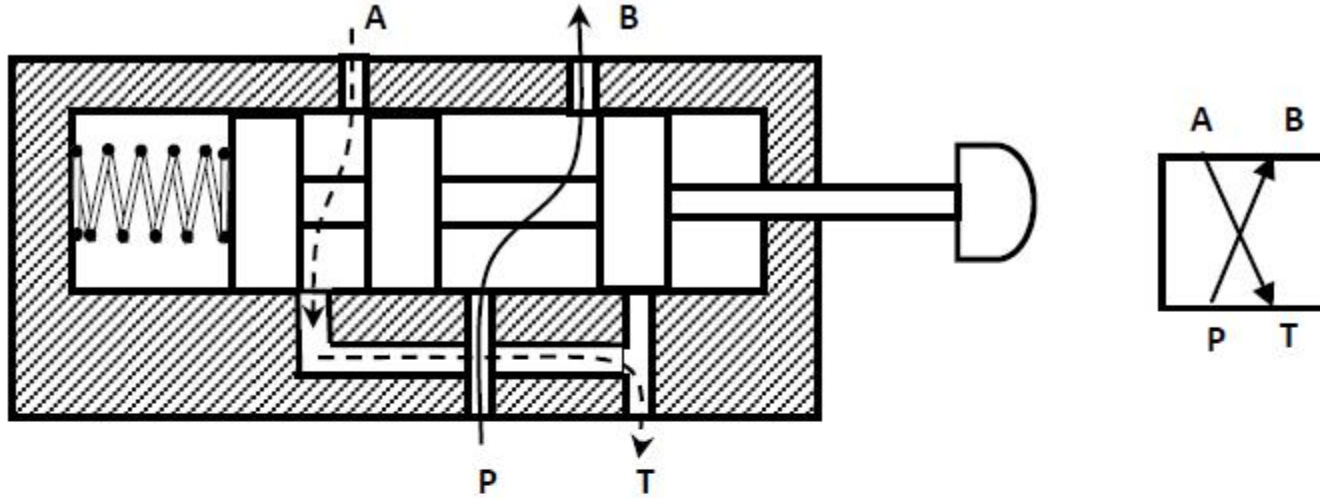


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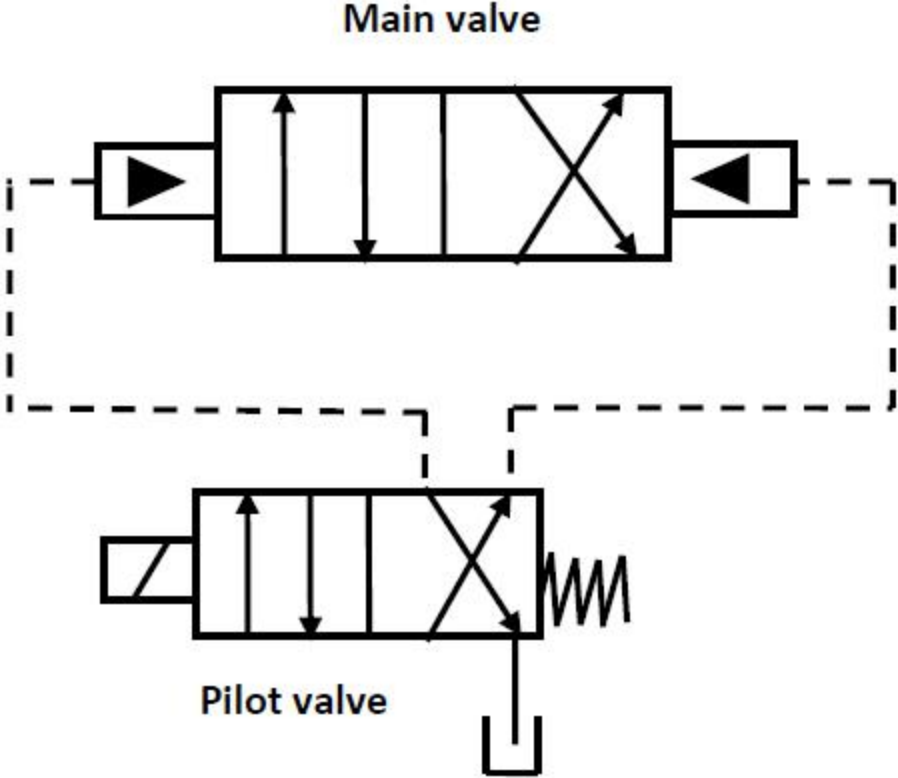


(b)

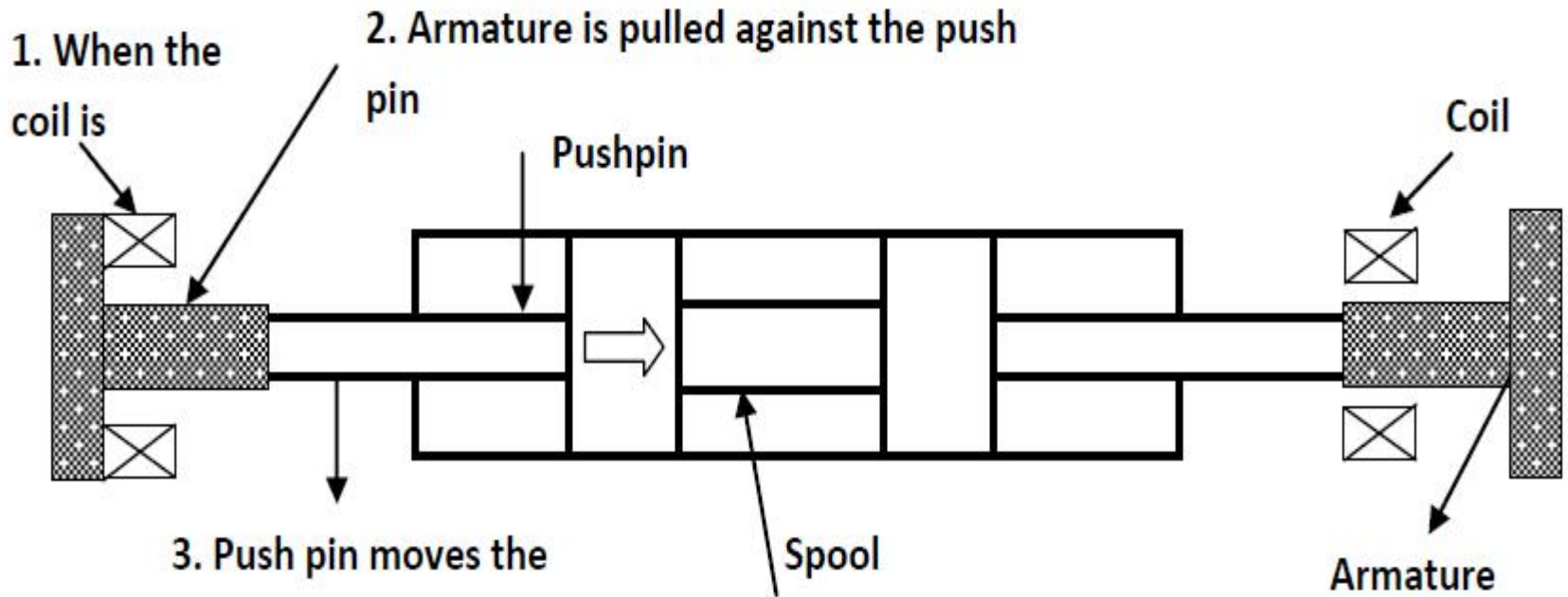
Four-Way Direction Control Valves



Pilot-Operated Direction Control Valves

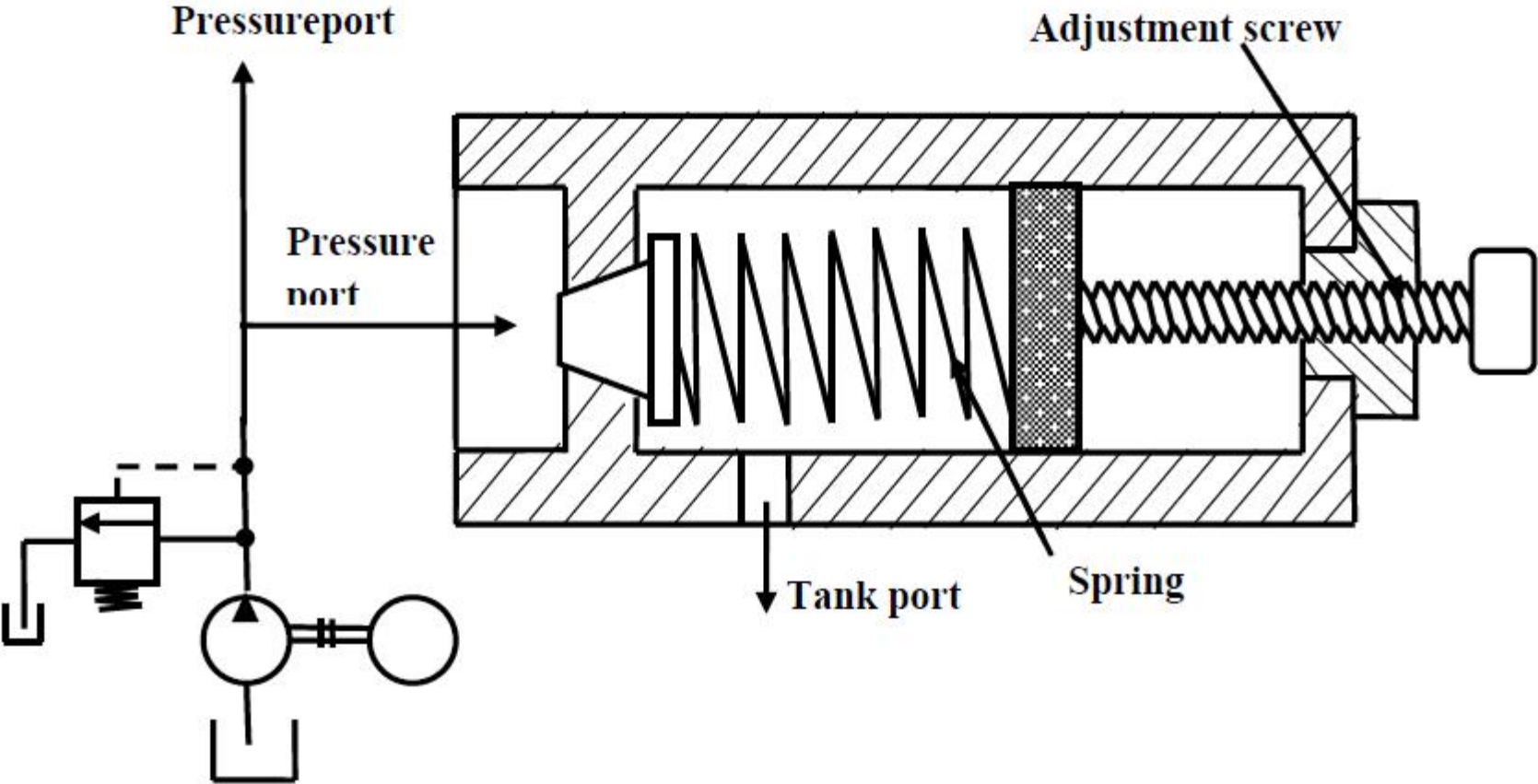


Solenoid-Actuated Valve



PRESSURE CONTROL VALVES

Simple Pressure-Relief Valve



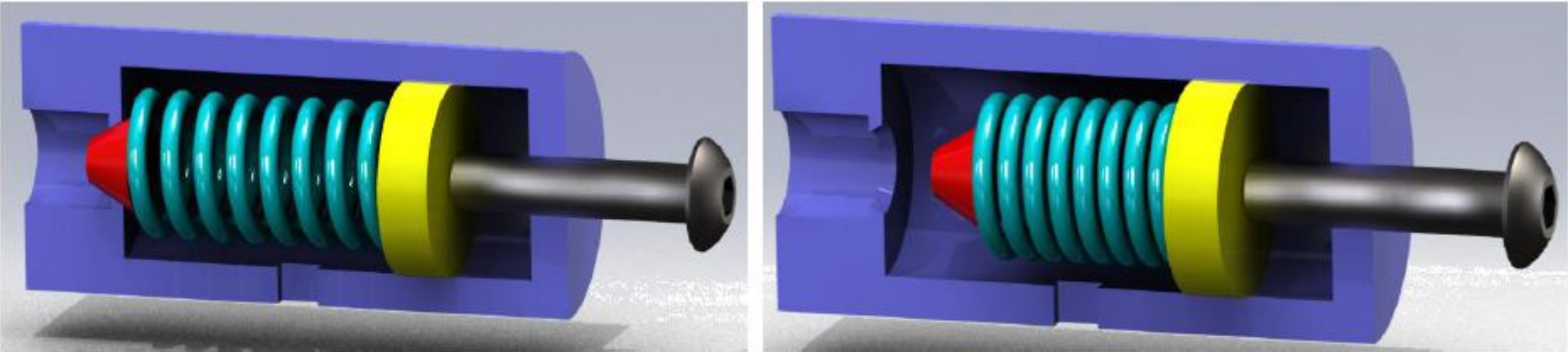
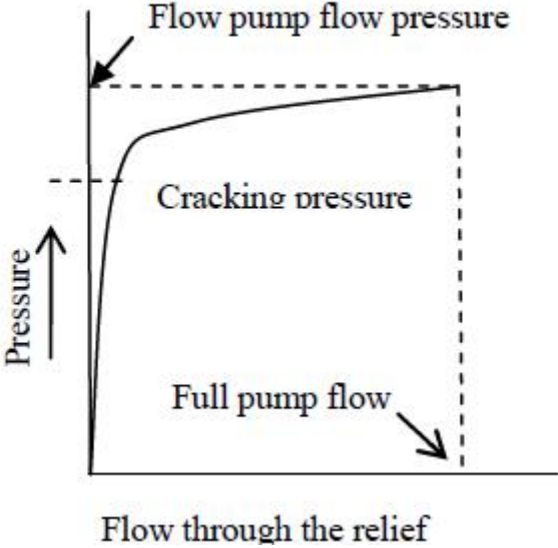
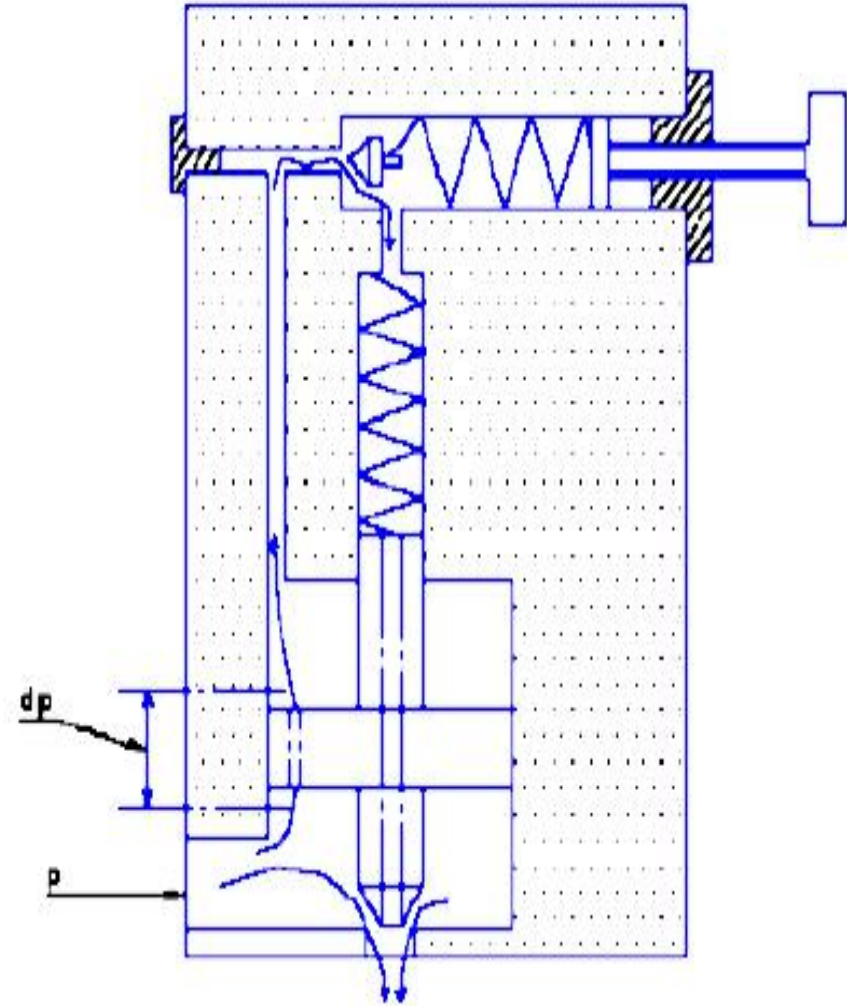
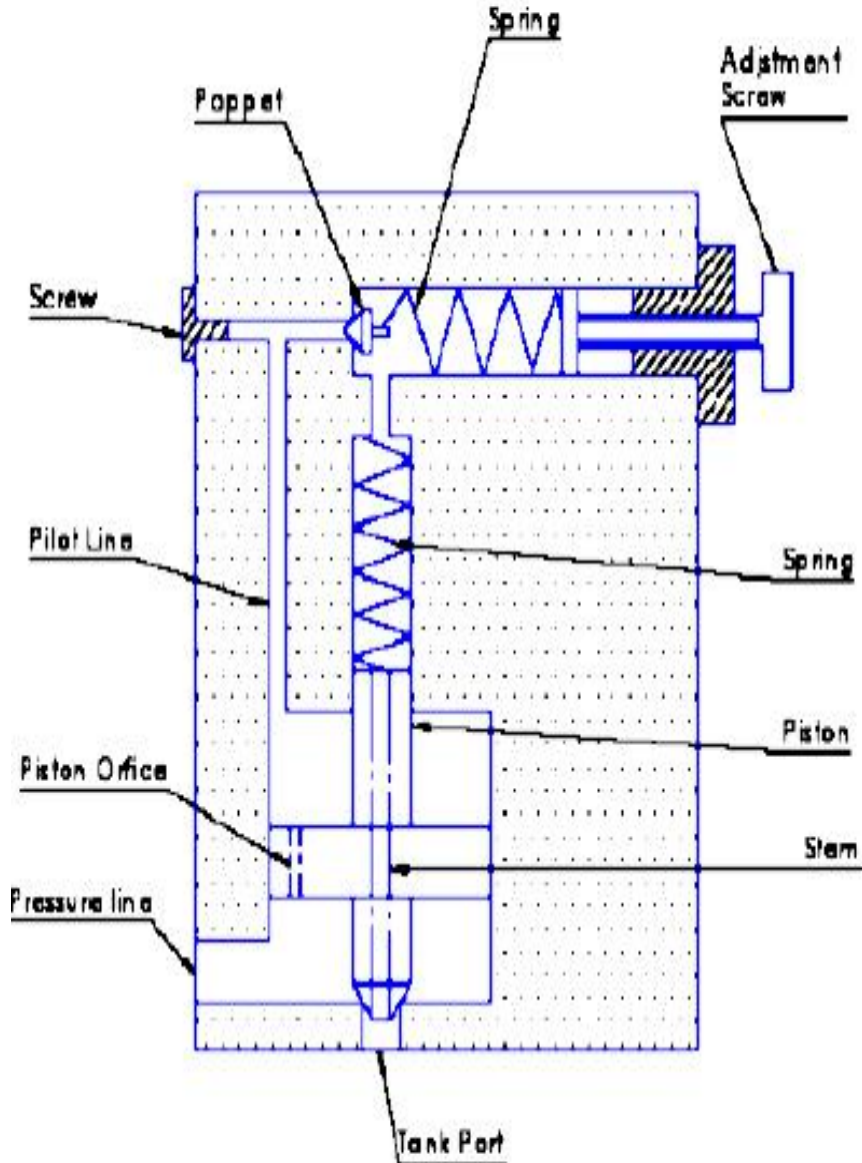


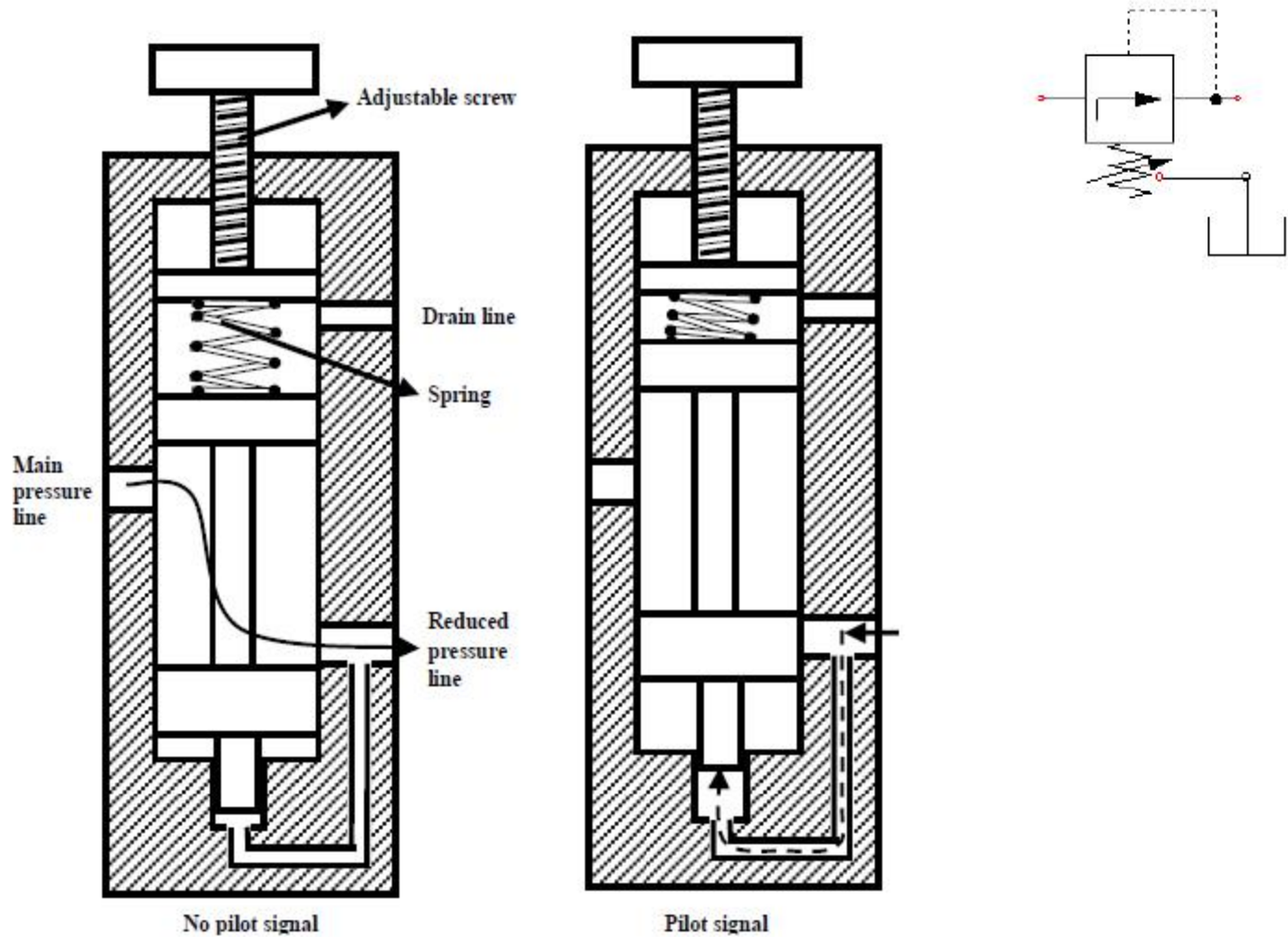
Figure 1.2 Three-dimensional view of simple pressure-relief valve.



Valve (Pilot-Operated Pressure Relief Valve)



Pressure-Reducing Valve



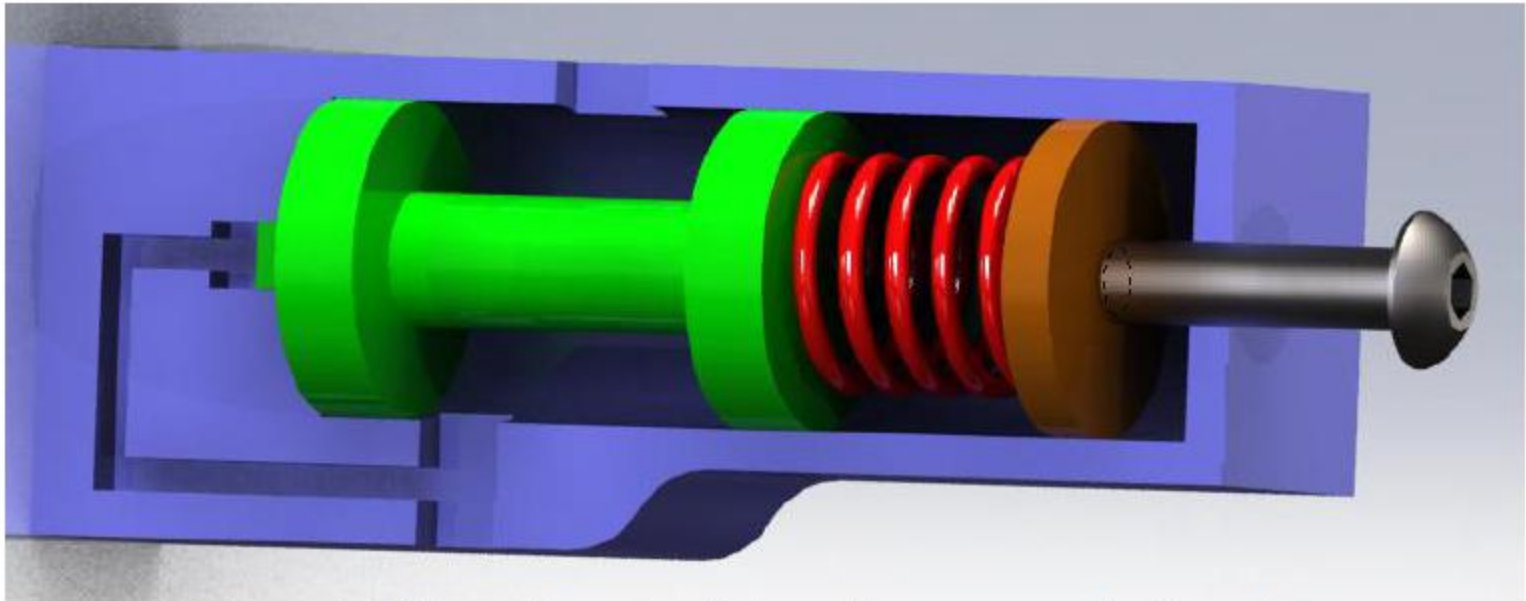
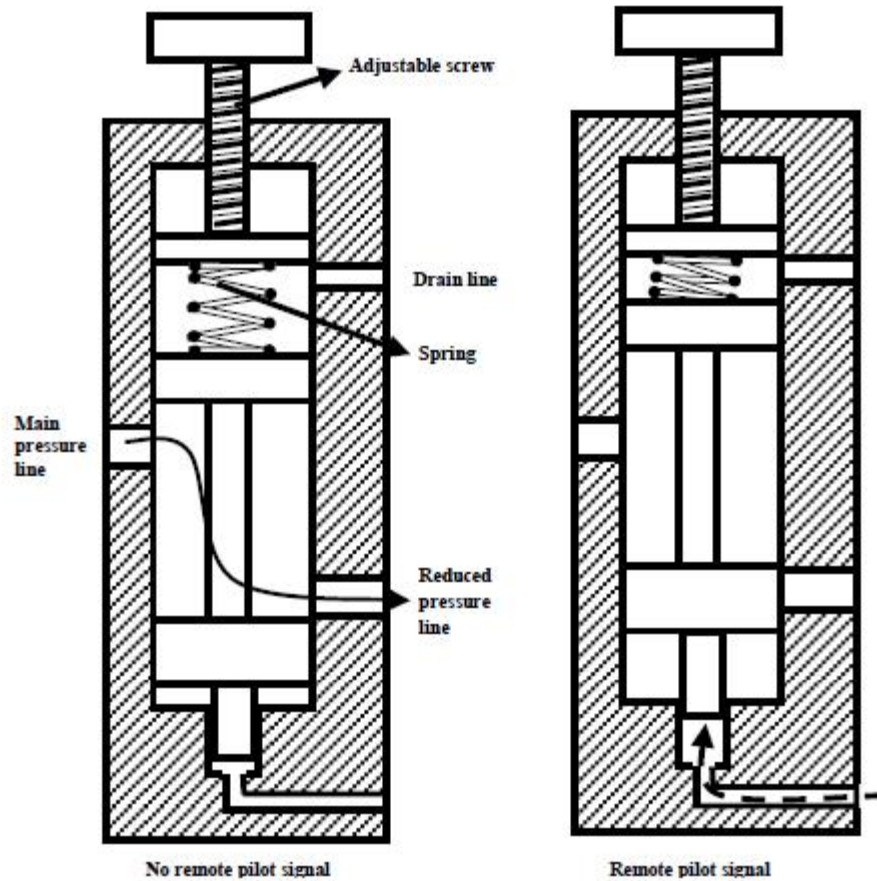
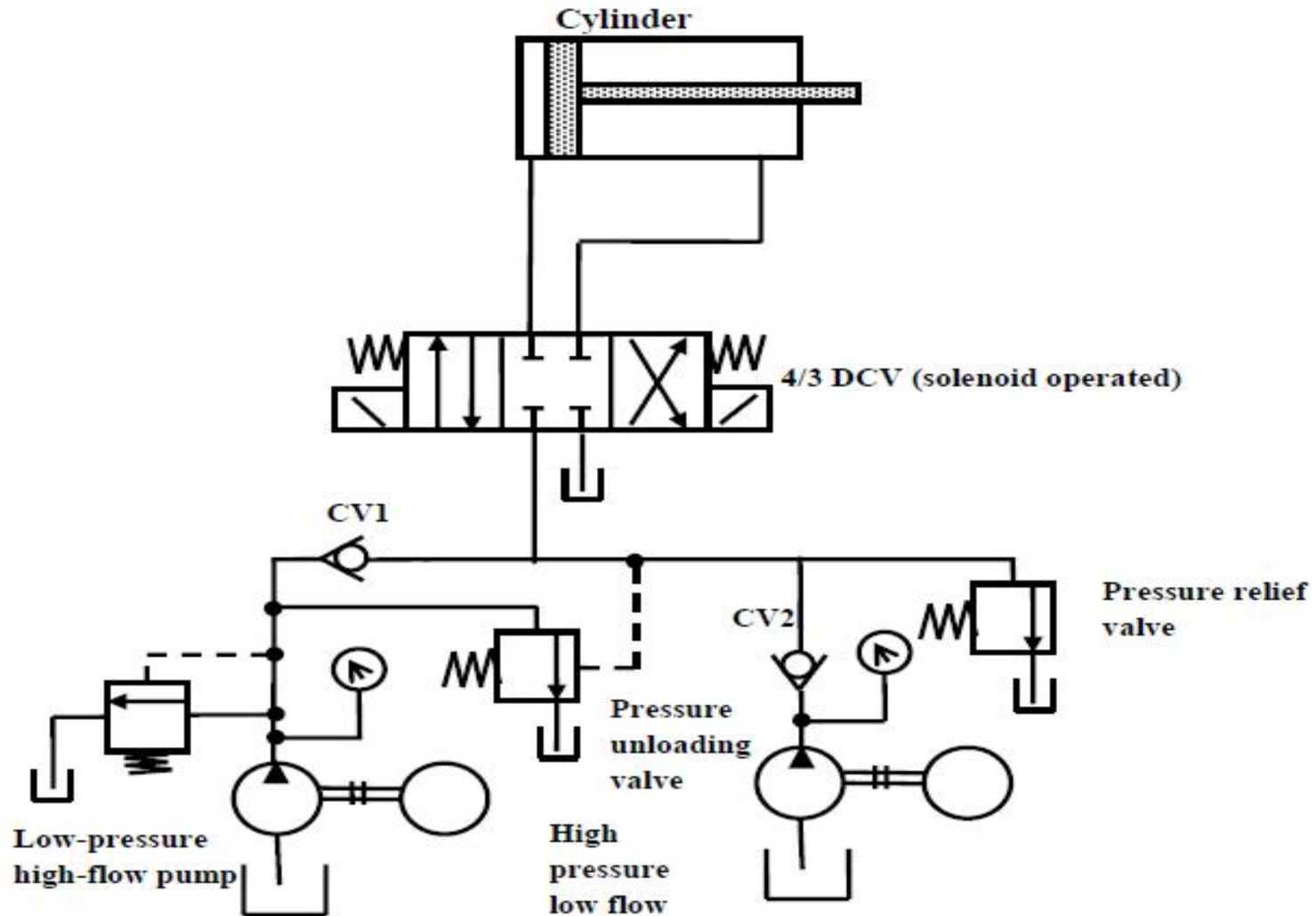


Figure 1.8 Three-dimensional view of a pressure-reducing valve.

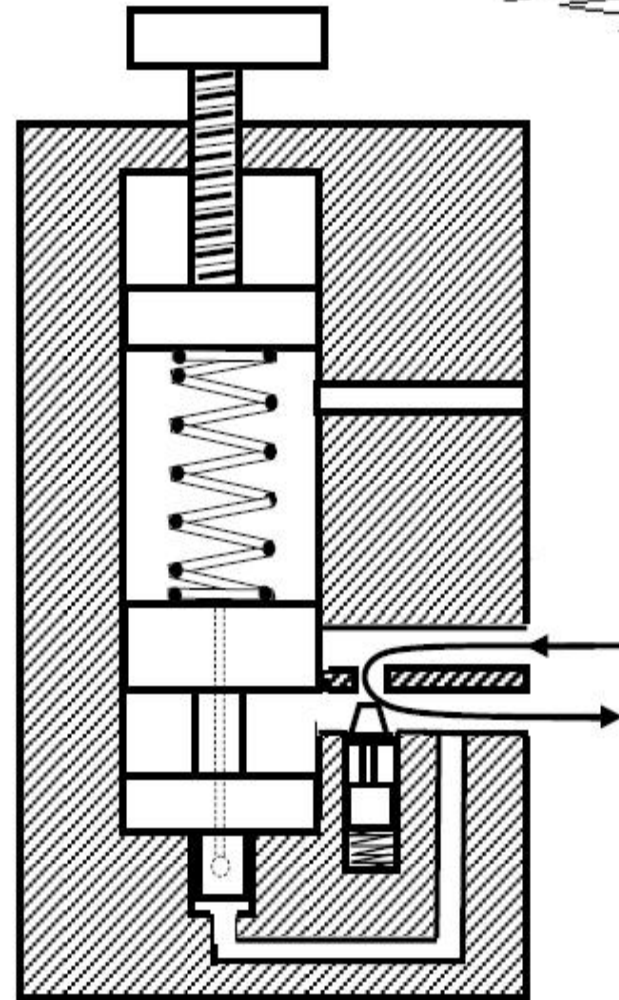
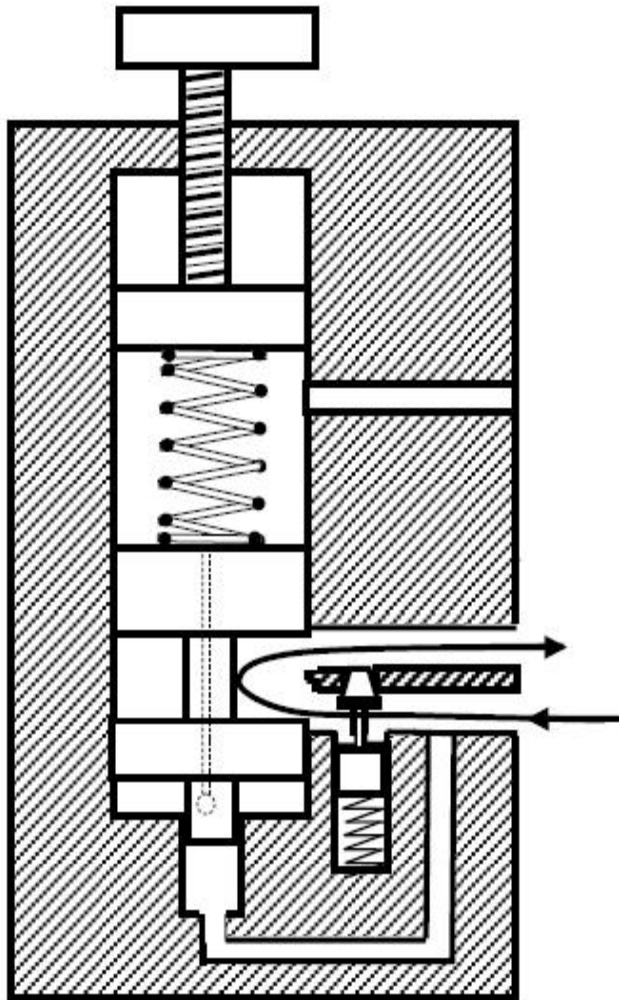
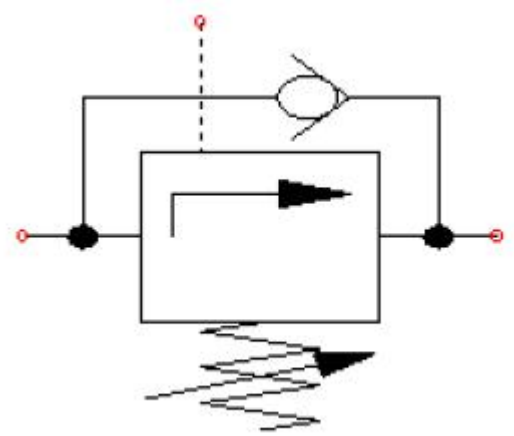
Unloading Valves



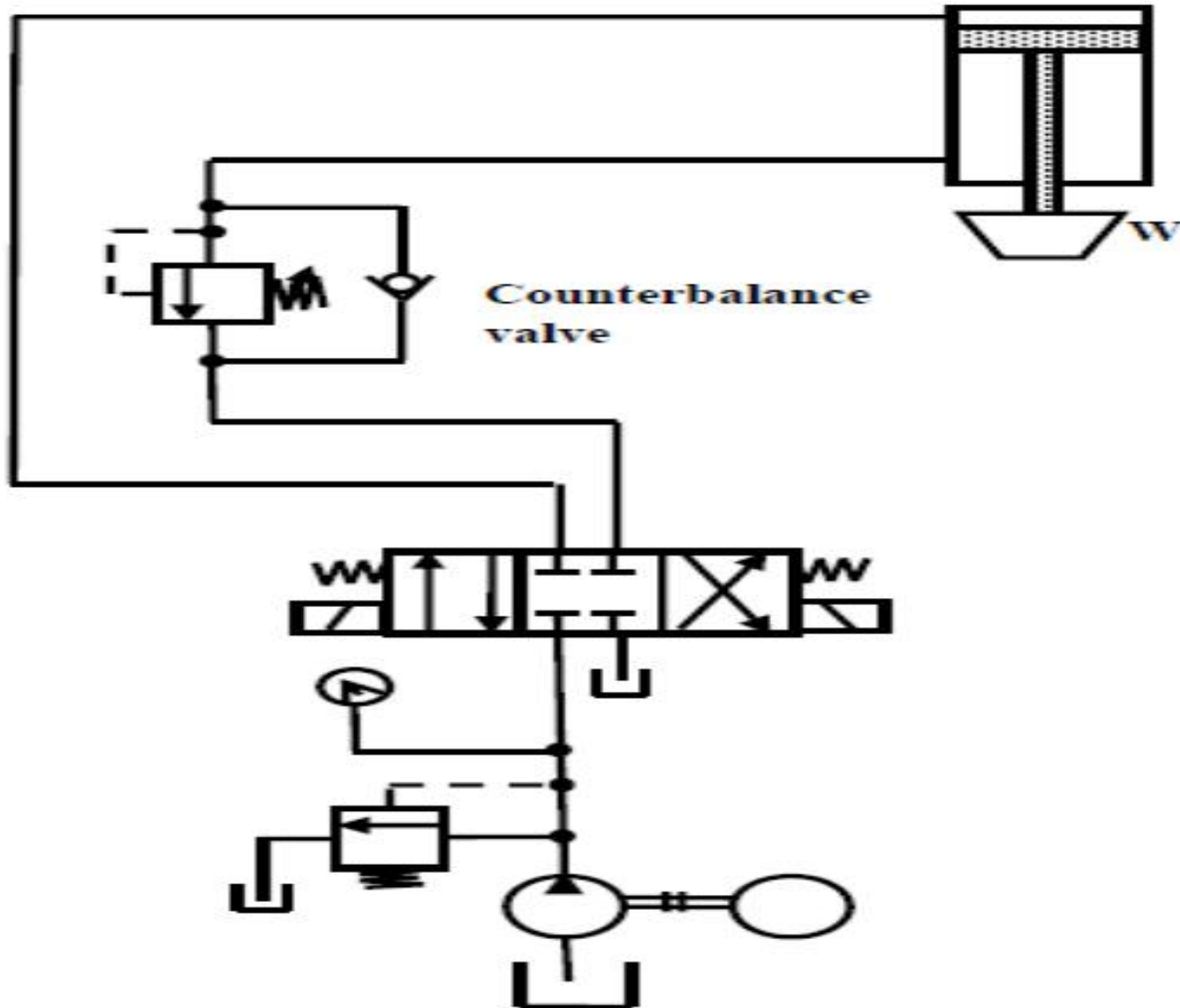
Application of unloading valve in a punching press (high-low circuit)



Counterbalance Valve



Application of a Counterbalance Valve



Pressure Sequence Valve

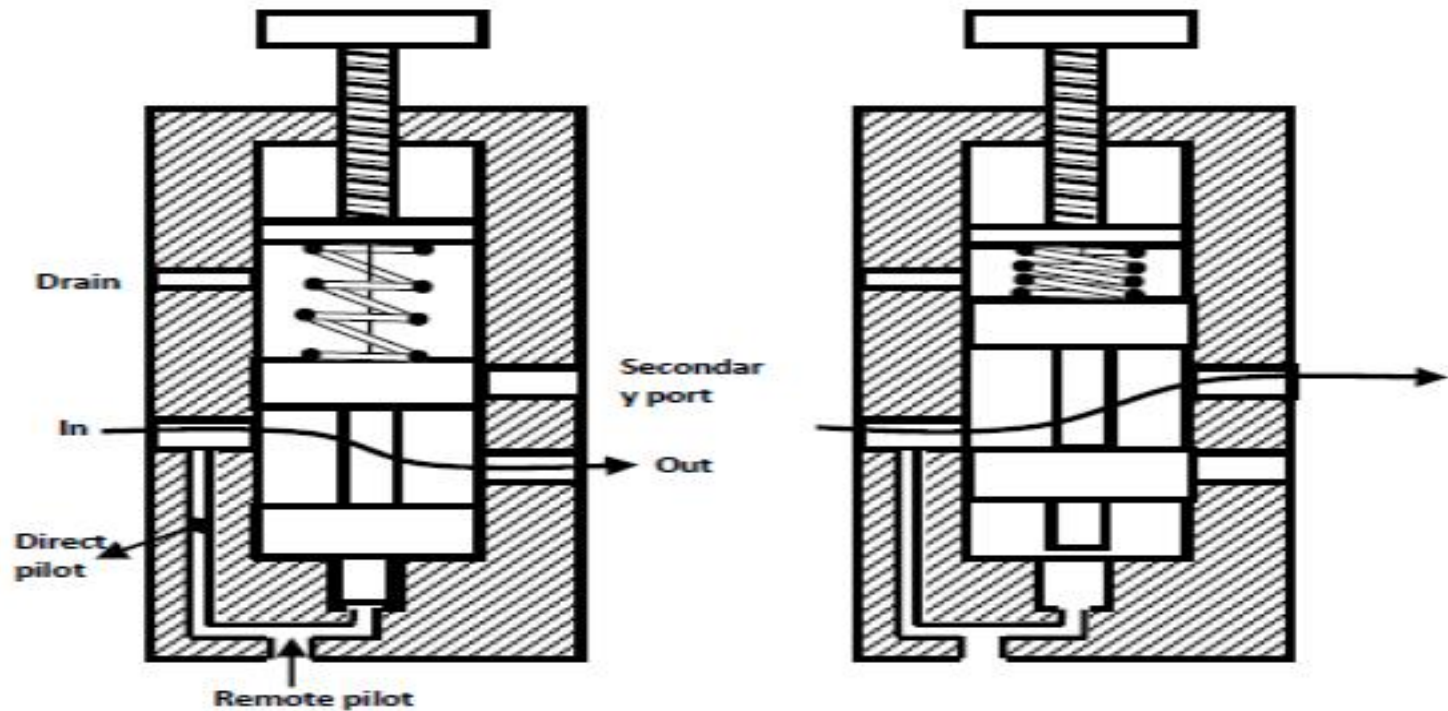
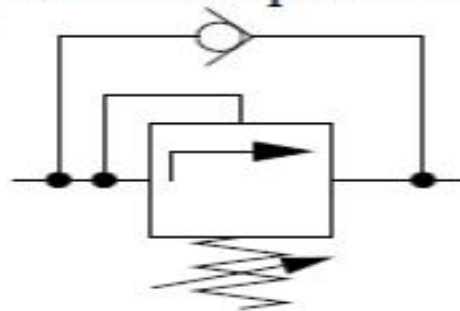


Figure 1.18 Sequence valve.

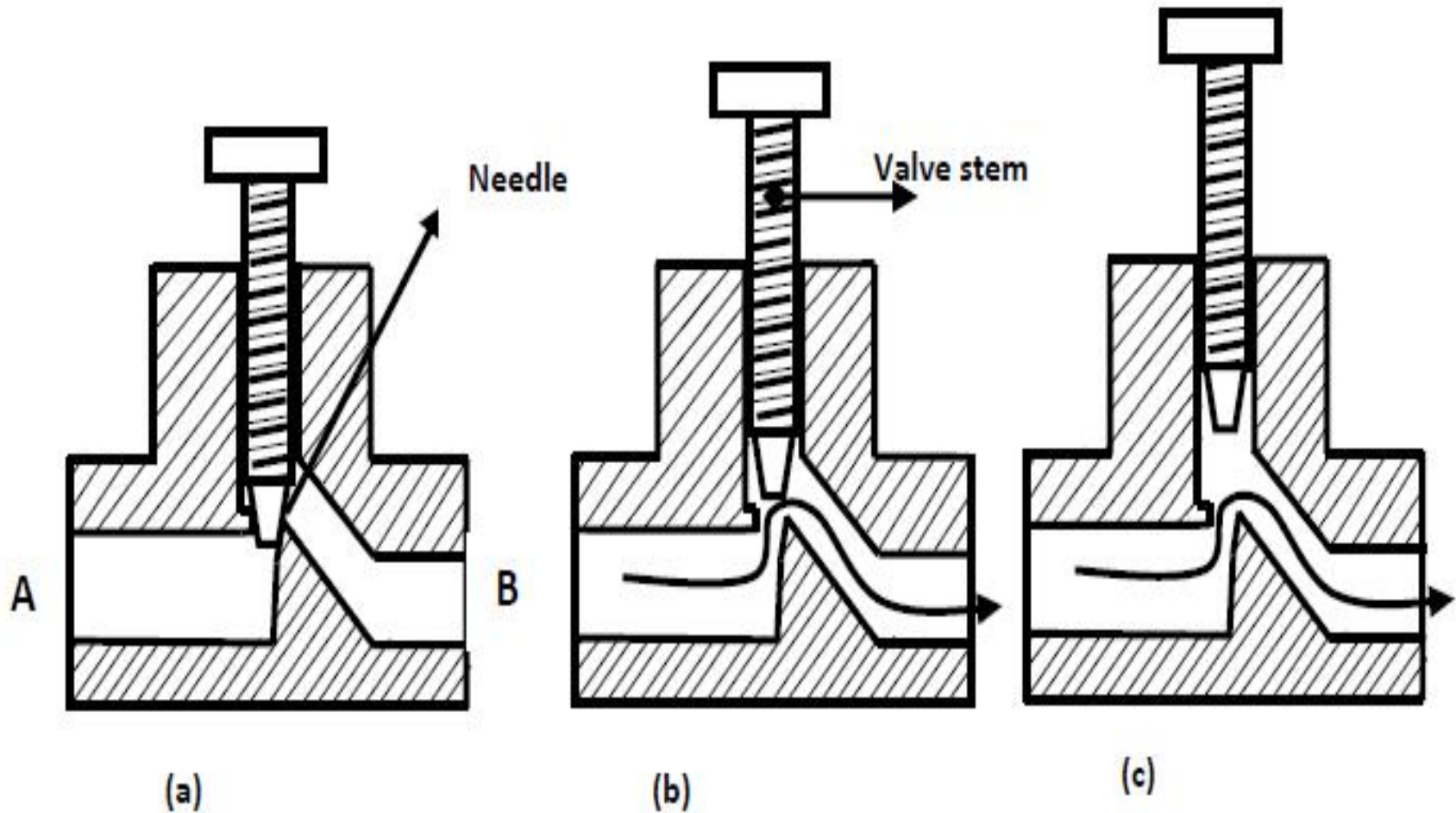


FLOW CONTROL VALVE

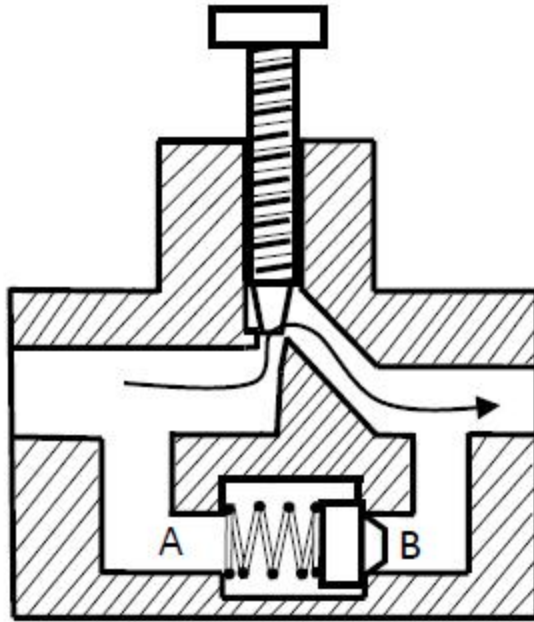
Classification of Flow-Control Valves

- Non-pressure compensated.
- Pressure compensated.

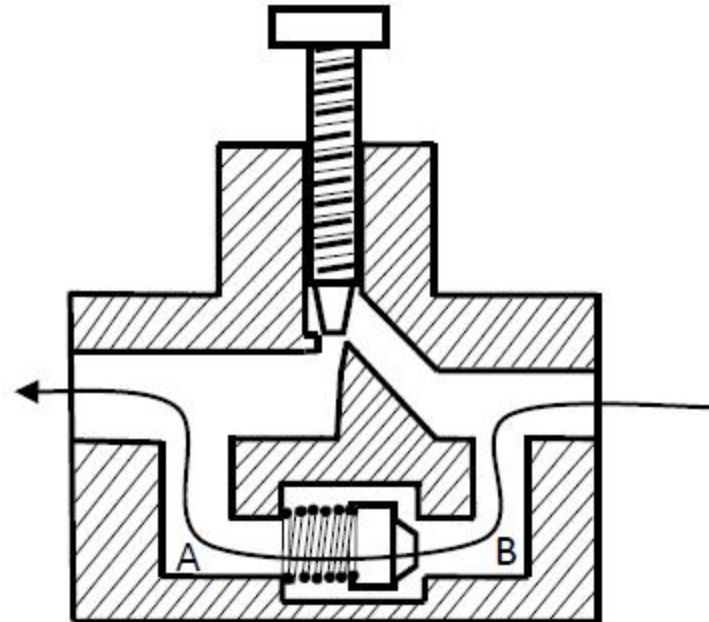
Non-Pressure-Compensated Valves



Flow-control valve with an integrated check valve

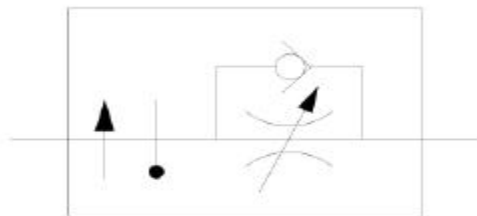
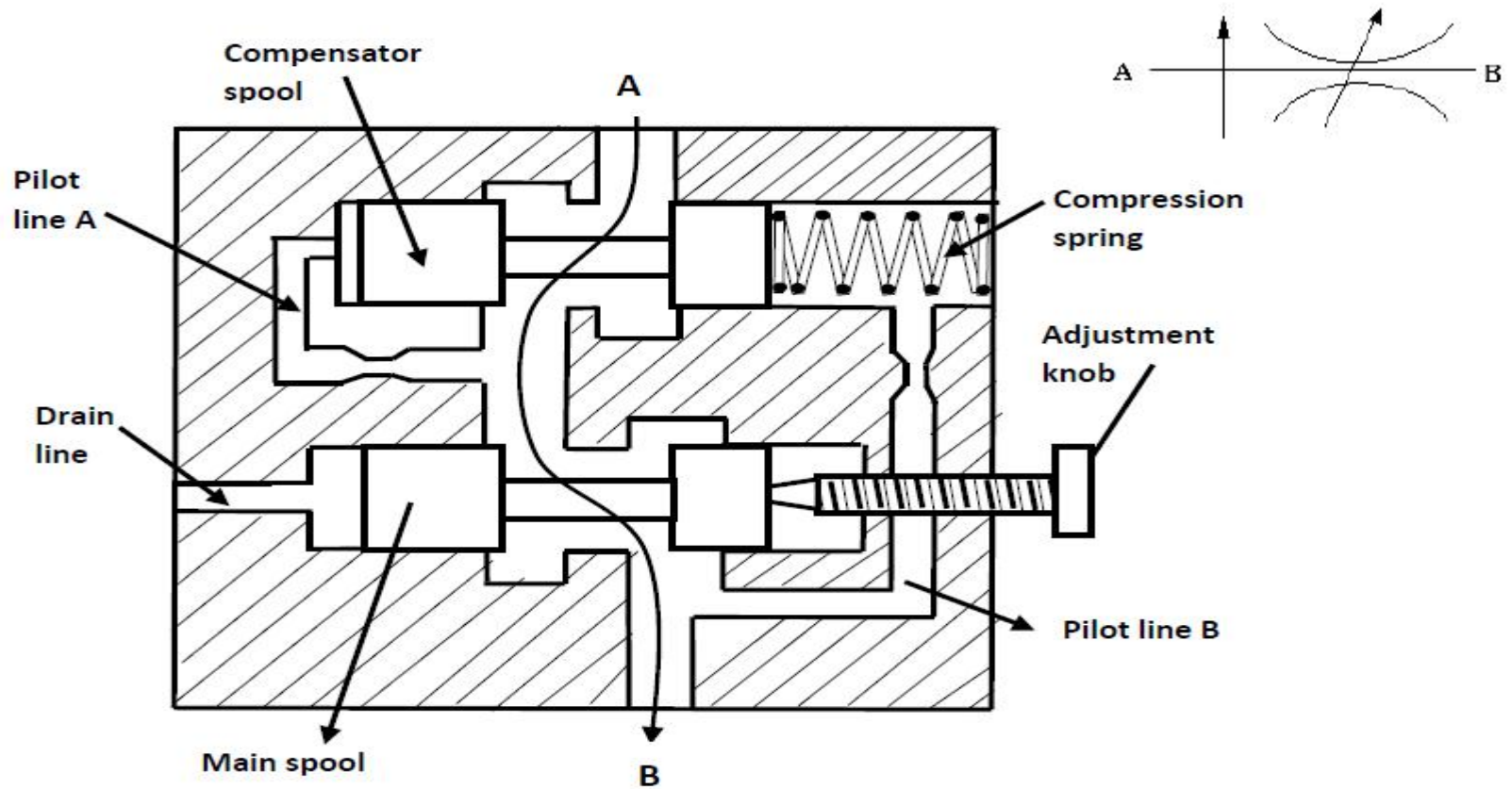


Restricted flow



Free flow

Pressure-Compensated Valves

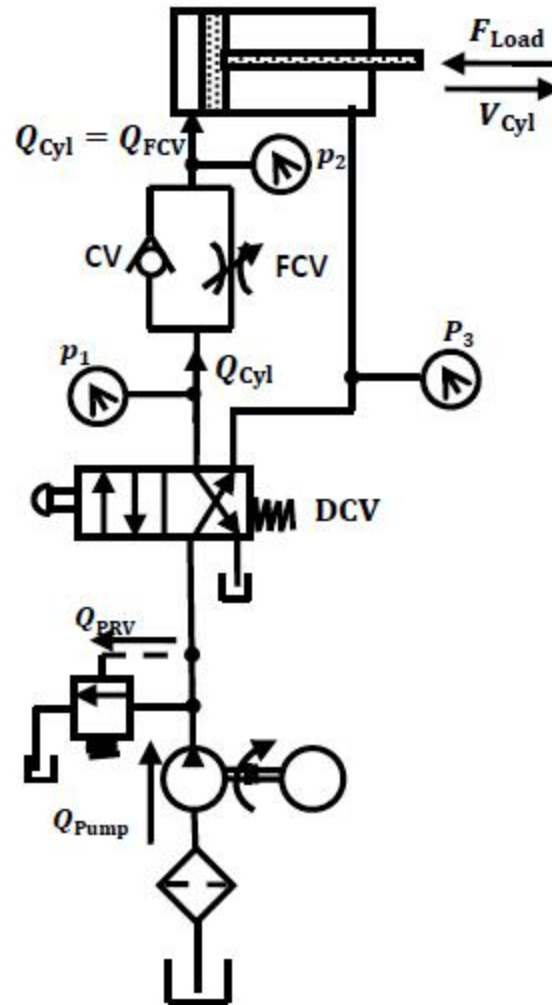


'Pressure- and temperature-compensated flow-control valve.

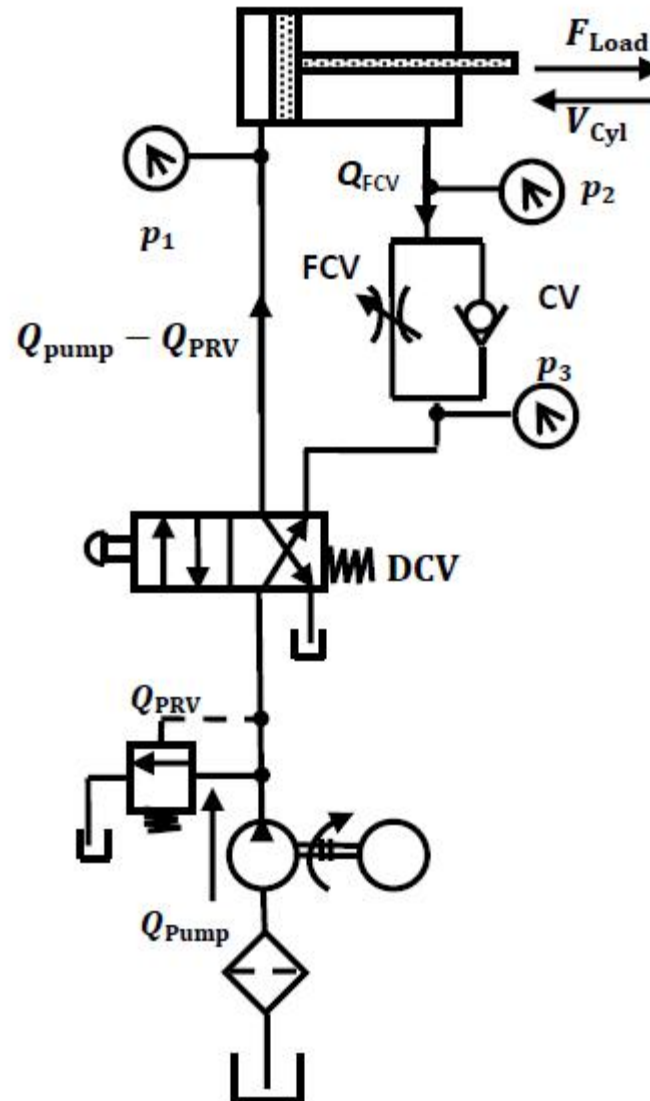
Speed-Controlling Circuits

- ***Meter-In Circuit***
- ***Meter-Out Circuit***
- ***Bleed-Off Circuit***

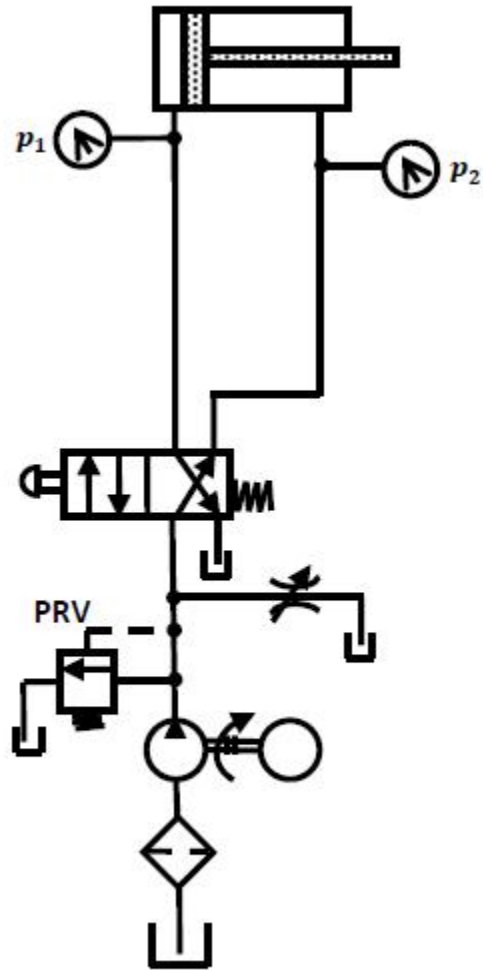
Meter-In Circuit



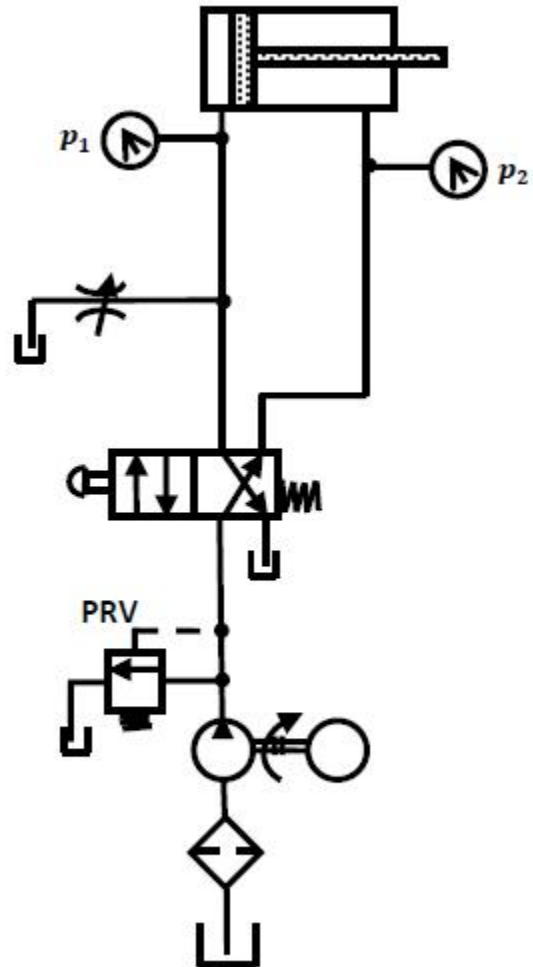
Meter-Out Circuit



Bleed-Off Circuit



(a)



(b)