



Pneumatics and Hydraulics

Input, Control and Processing elements part 2

Dr. Ahmad Al-Mahasneh

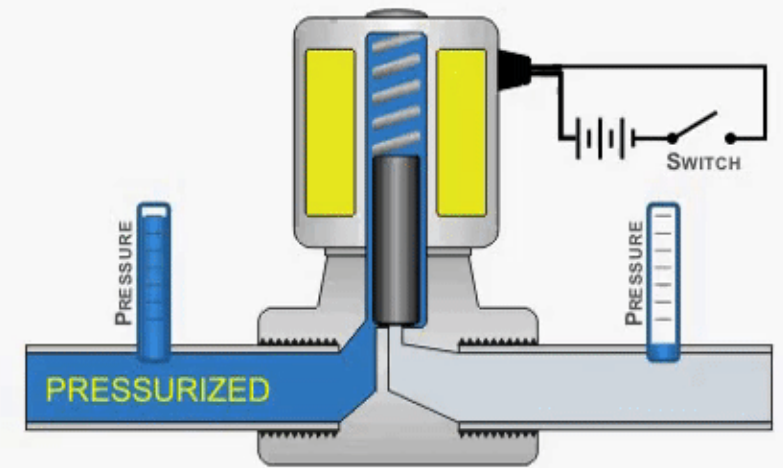
Outline

- Valves

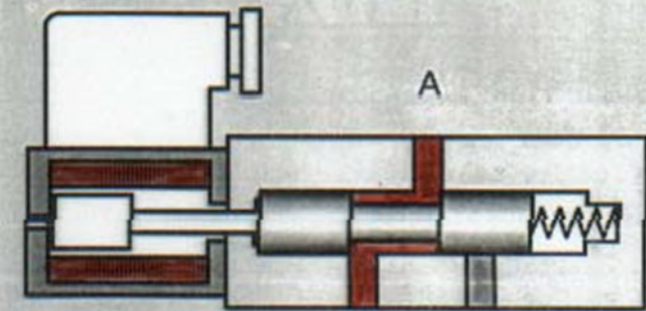
Solenoid valve

- A very common way to actuate a spool valve is by using a solenoid, illustrated in the following figure.
- As shown, when the electric coil (solenoid) is energized, it creates a magnetic force that pulls the armature in to the coil. This causes the armature to push the spool of the valve.
- Solenoid switching behavior depends on excitation type.

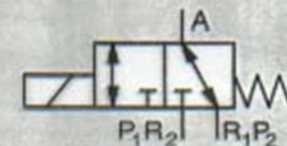
DIRECT-ACTING SOLENOID VALVE



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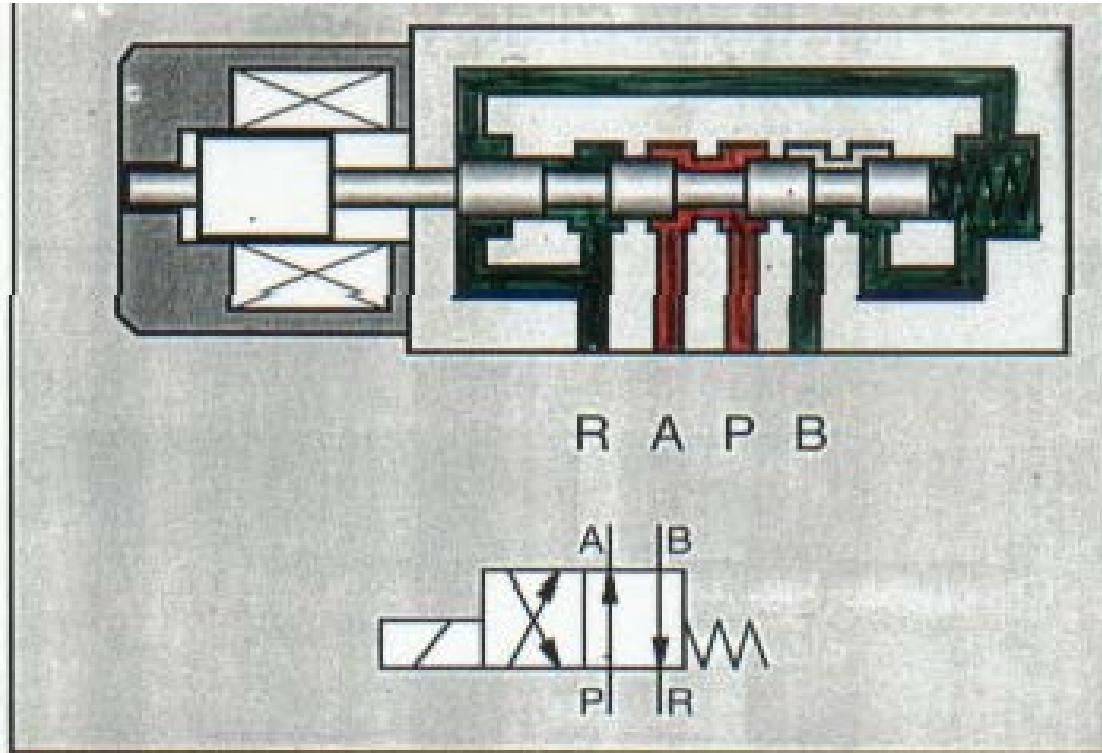


P₂,R₁ P₁,R₂

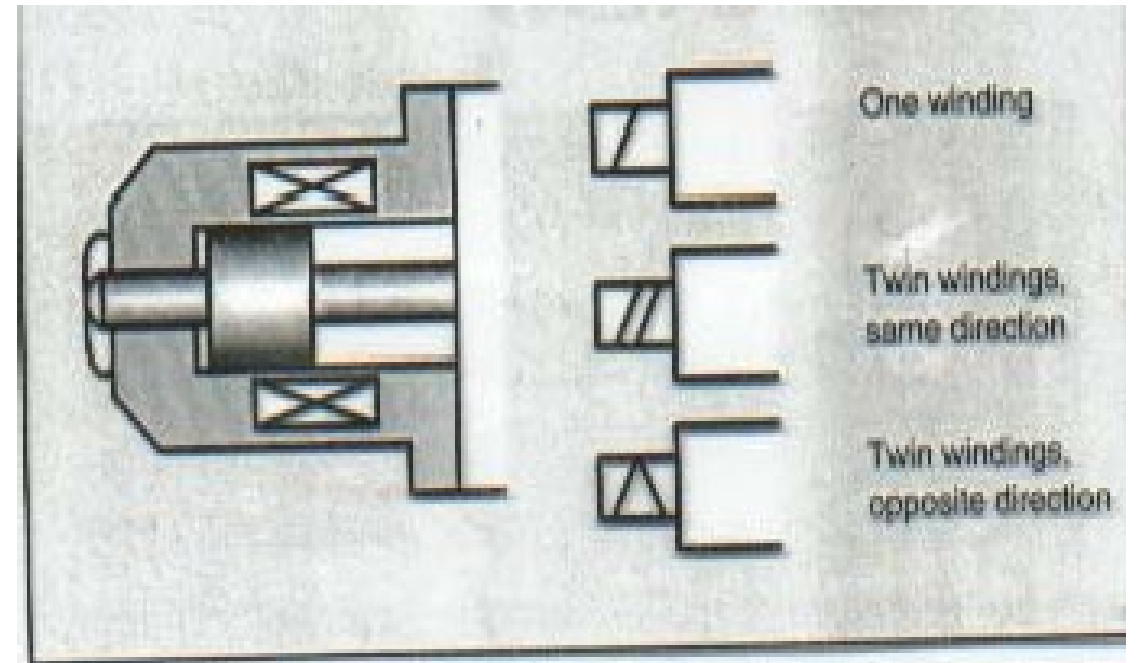


3/2 directional control valve, normally open, solenoid actuated, spring return

Solenoid valve



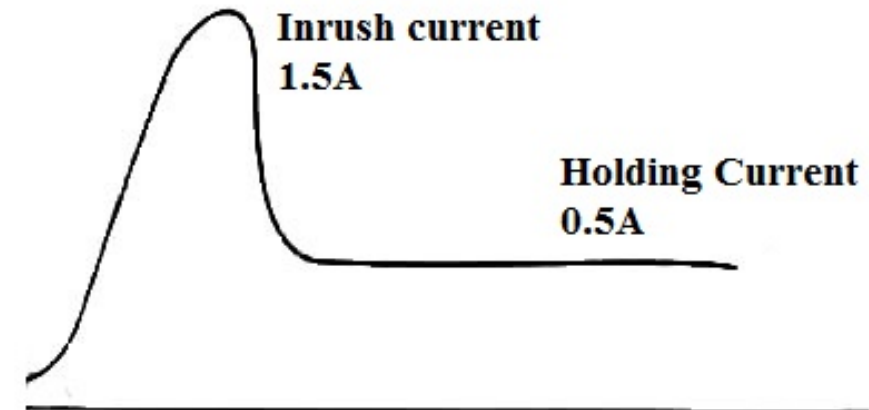
4/2 directional control valve, solenoid actuated, spring return



Solenoid actuated

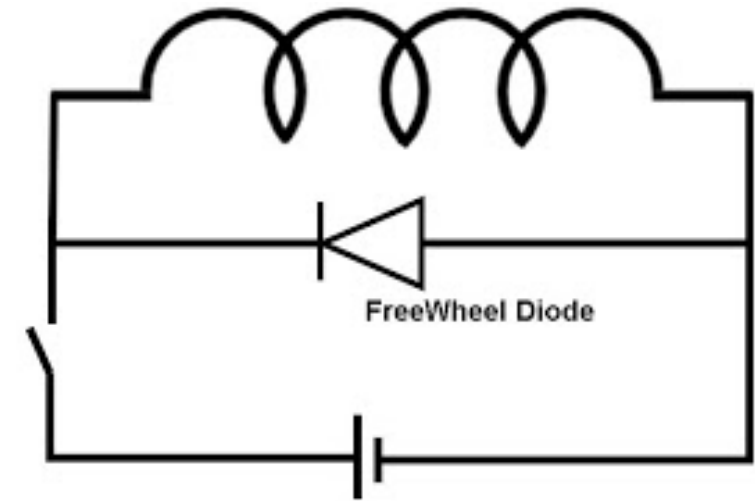
Solenoid Valve Electrical Characteristics

- Operating time for attraction and release.
- Supply: DC or AC.
- Power consumption: hold on power (The power required to hold the armature in the energized position) and inrush power (the power at maximum level of current flow).
- Protection methods: against accidental contact, water proof, pressure proof.
- Duty cycle (%).



DC Solenoid Characteristics

- Slower switching on and off (Self Inductance).
- Cut-out spikes.
- Smooth attraction.
- Safe against overload even with blocked armature.
- Bulkier than AC solenoid.
- Longer life.
- Resistance is equal to the ohmic resistance of the coil.
- Need freewheeling protection circuit.

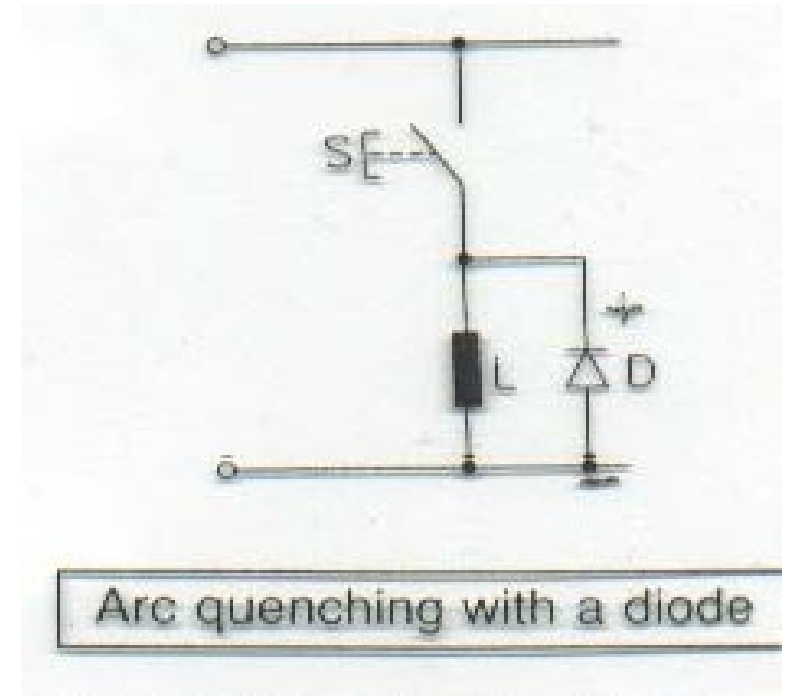
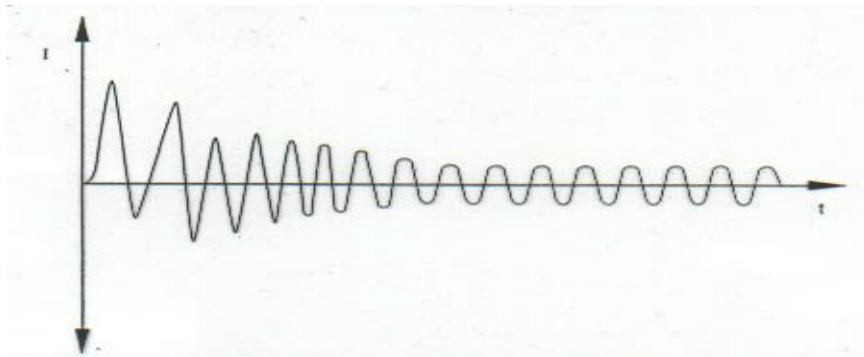
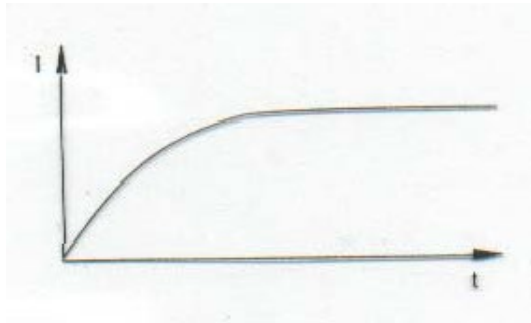




AC Solenoid Characteristics

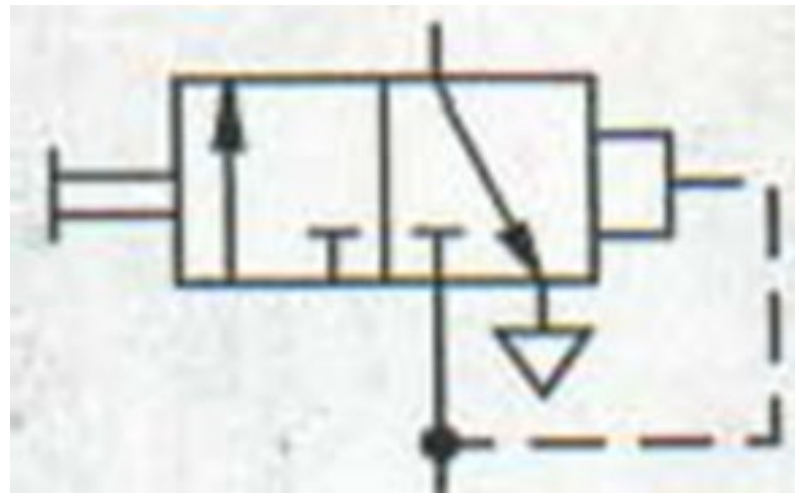
- Switching Fast and hard (due to reduced resistance at the moment of switching on, the reactance not yet having developed).
- High current drain when the armature is blocked.
- Smaller than DC solenoid.
- Eddy current and hysteresis losses.
- Total resistance consists of the ohmic resistance and reactance.
- Cannot be operated by direct current.
- Shorter life time.
- Noisy.

AC Solenoid Characteristics



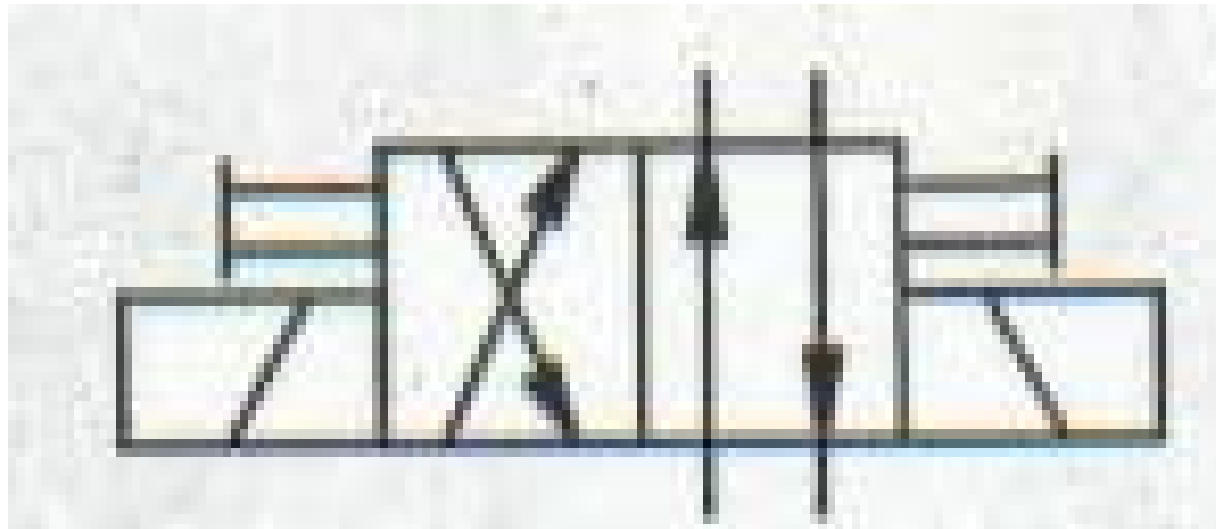
Air return

- The return of valve can be operated by a spring as well as by pneumatic pressure.
- When the return by pressure is integrated into the valve as a pneumatic feature it is known as air return.

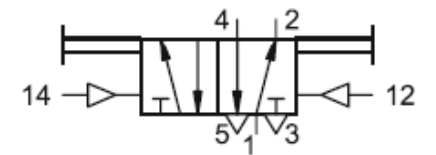
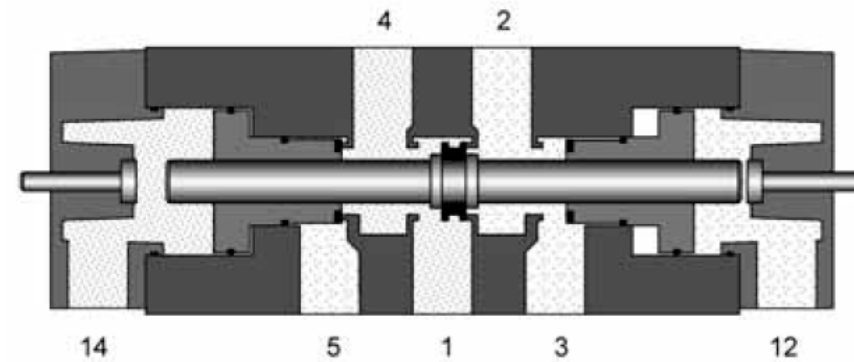
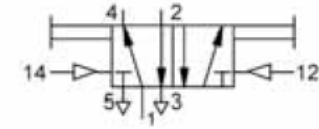
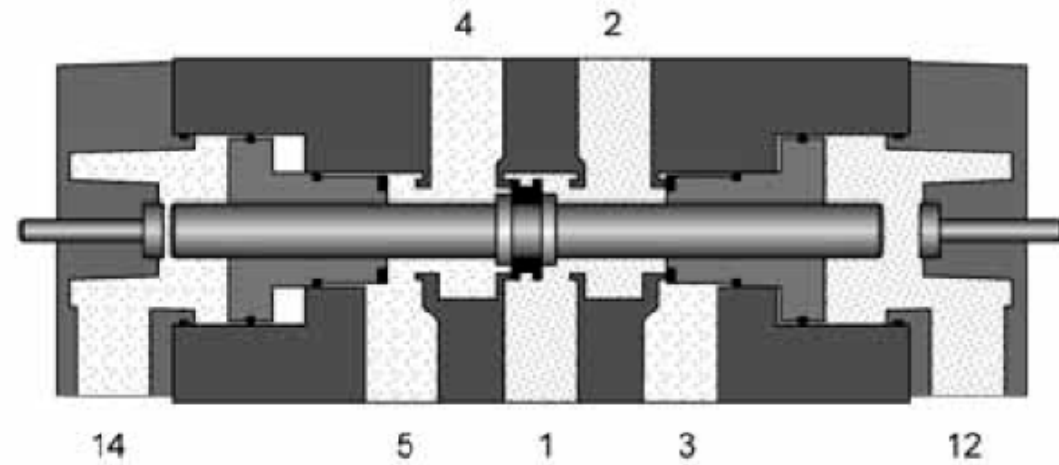
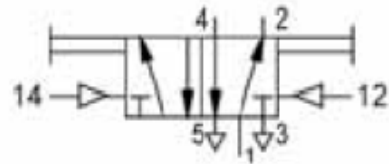


Manual Override

- Pneumatically or electrically operated valves are often equipped with a manual override.
- Thus operation is also possible in cases where the control energy is not available.

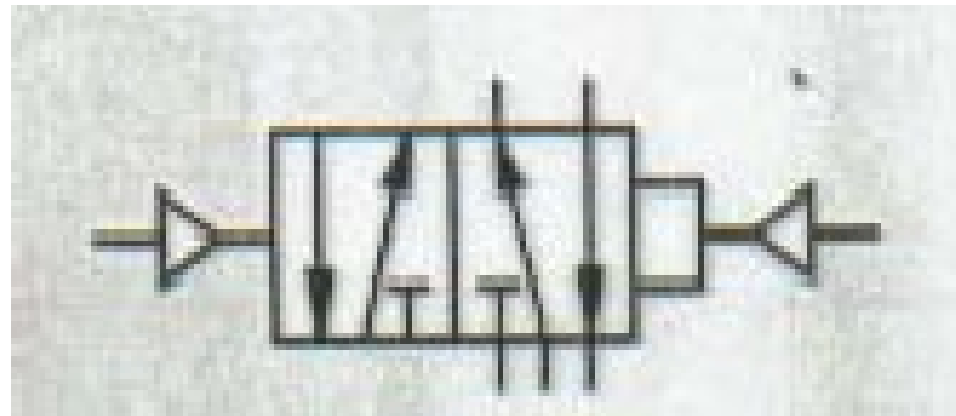


Manual Override



Valves With Differential Piston Actuation

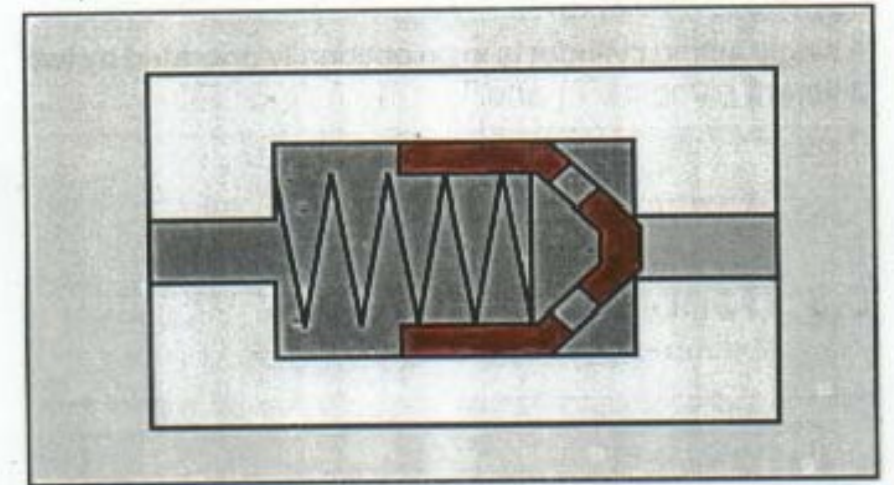
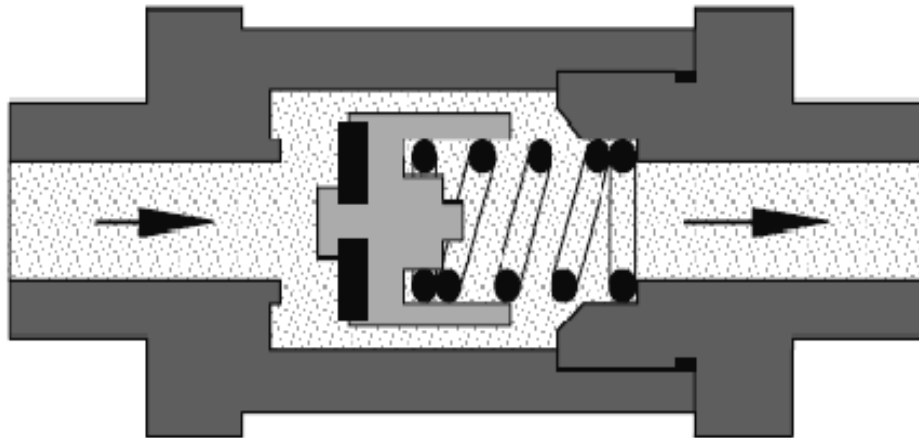
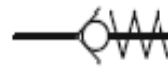
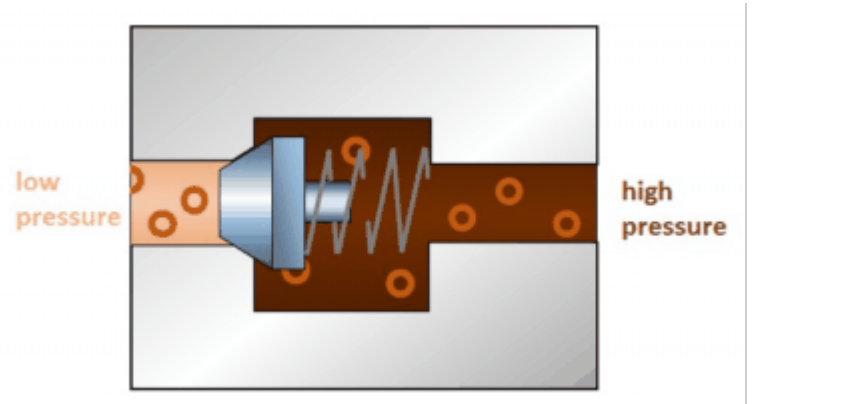
- For valves pressurized from both sides, the control can be by pistons of equal or different sizes.



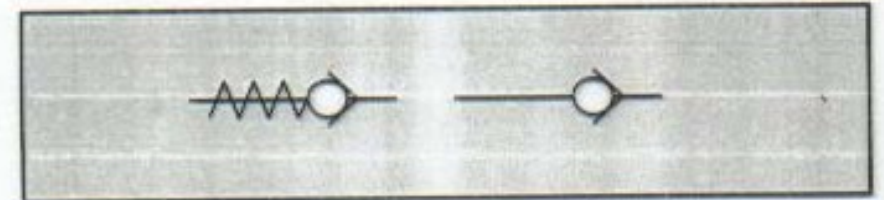
Non-Return Valves(Isolating Valves)

- Non-return valves are devices which preferentially stop the flow in one direction and permit flow in the opposite direction.
- Non-Return valves Include:
 - One Way Valves (Check Valves).
 - Shuttle Valve (Logic OR Valve).
 - Dual Pressure Valve (Logic AND Valve).
 - Quick Exhaust Valves.
 - Shutoff Valves

One Way Valve (Check Valve)



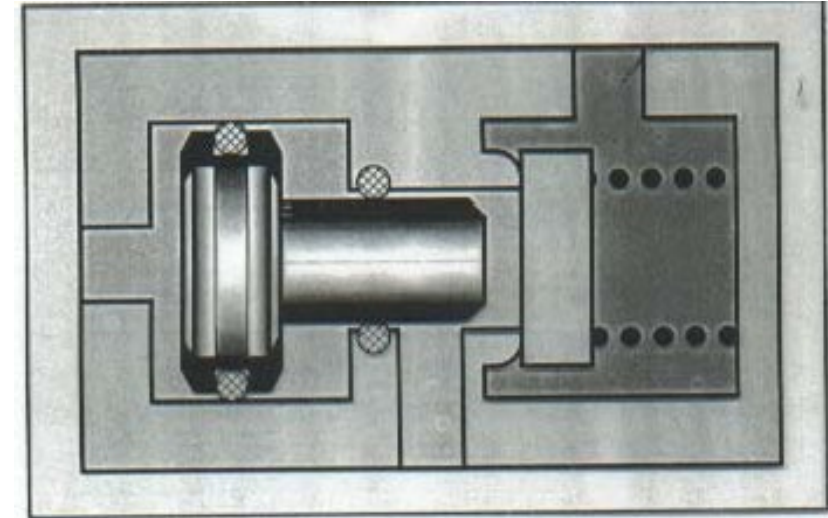
Check valve



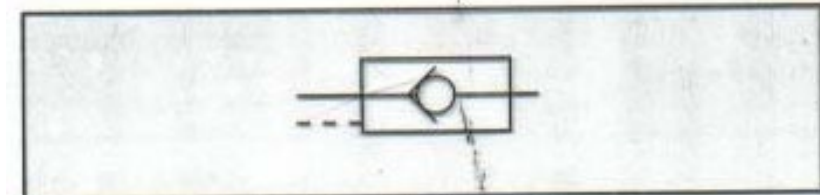
Graphic symbol acc. to DIN ISO 1219
(Symbol with and without spring)

Unlatchable Check Valve

- This valve offers the possibility of canceling the check action in the blocking direction by means of a control signal applied to the additional pilot port.
- In this way, flow through the valve is possible in either one direction or the other.

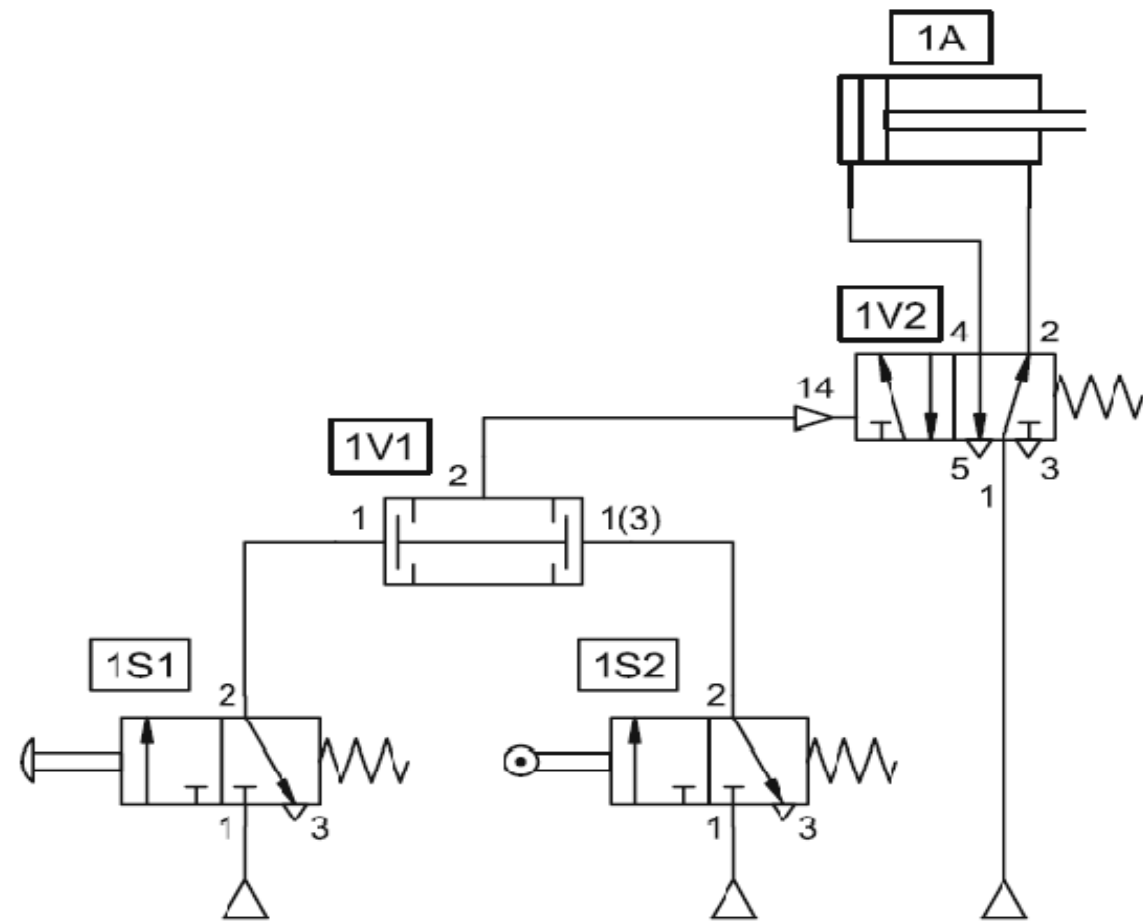
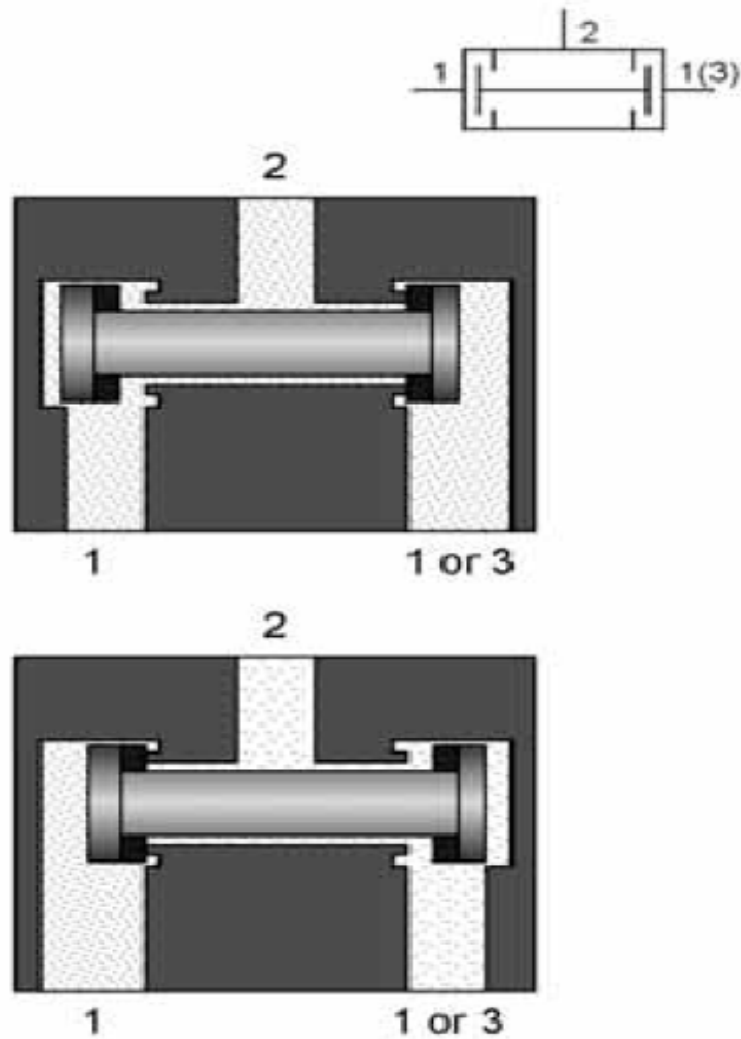


Check valve with override

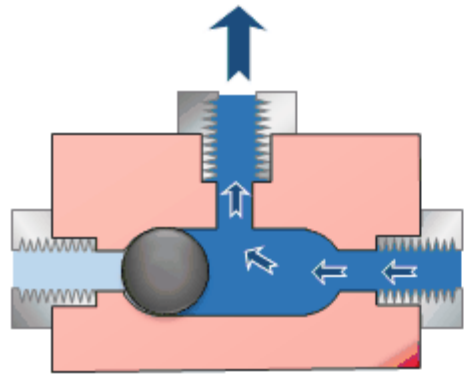


Graphic symbol acc. to DIN ISO 1219

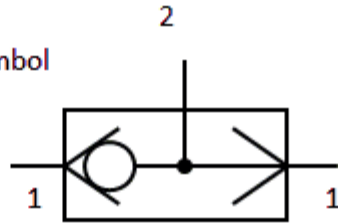
Dual Pressure Valve (AND Valve) (Double Cutoff Valve)



Shuttle Valve (OR Valve)

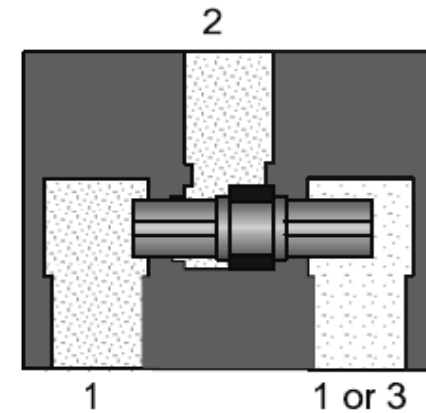
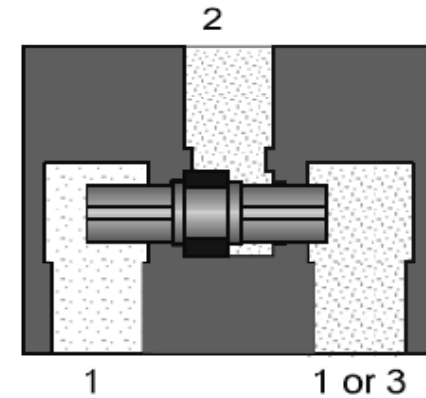
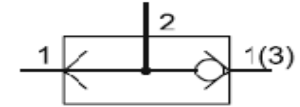
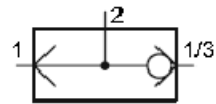


Symbol

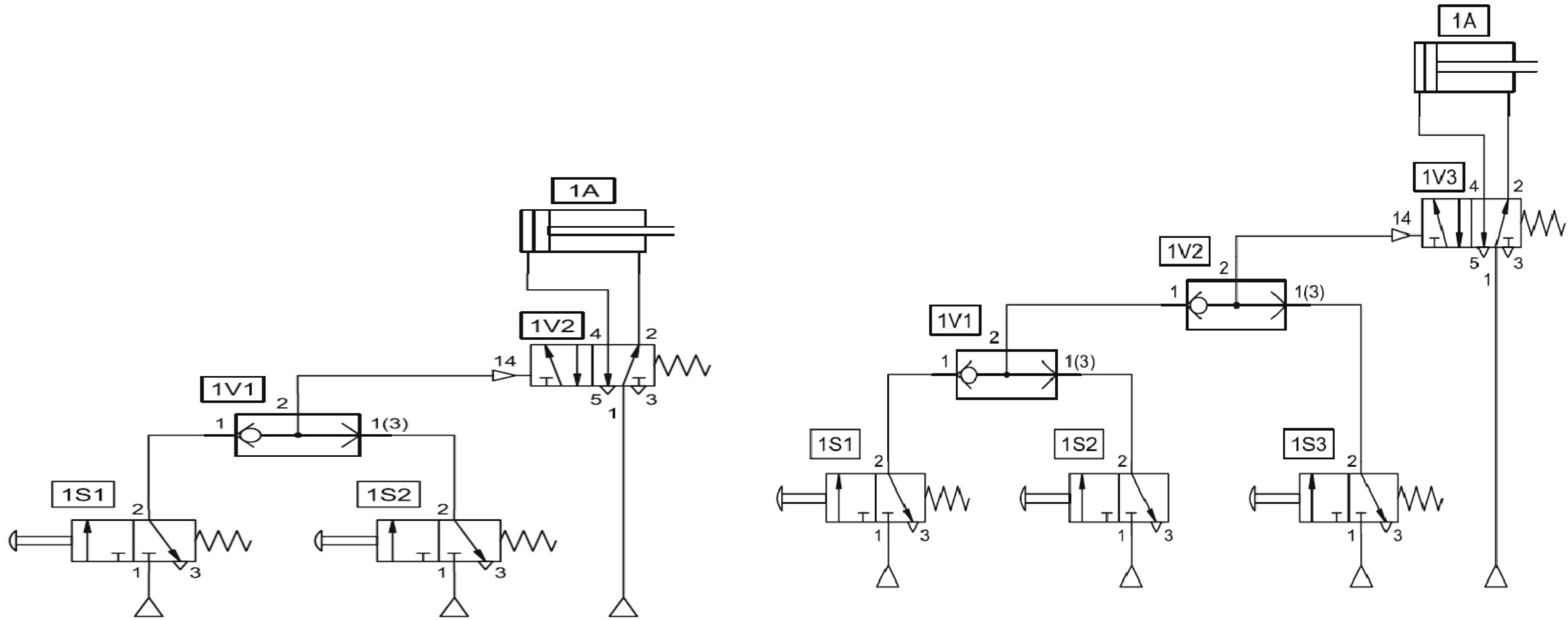


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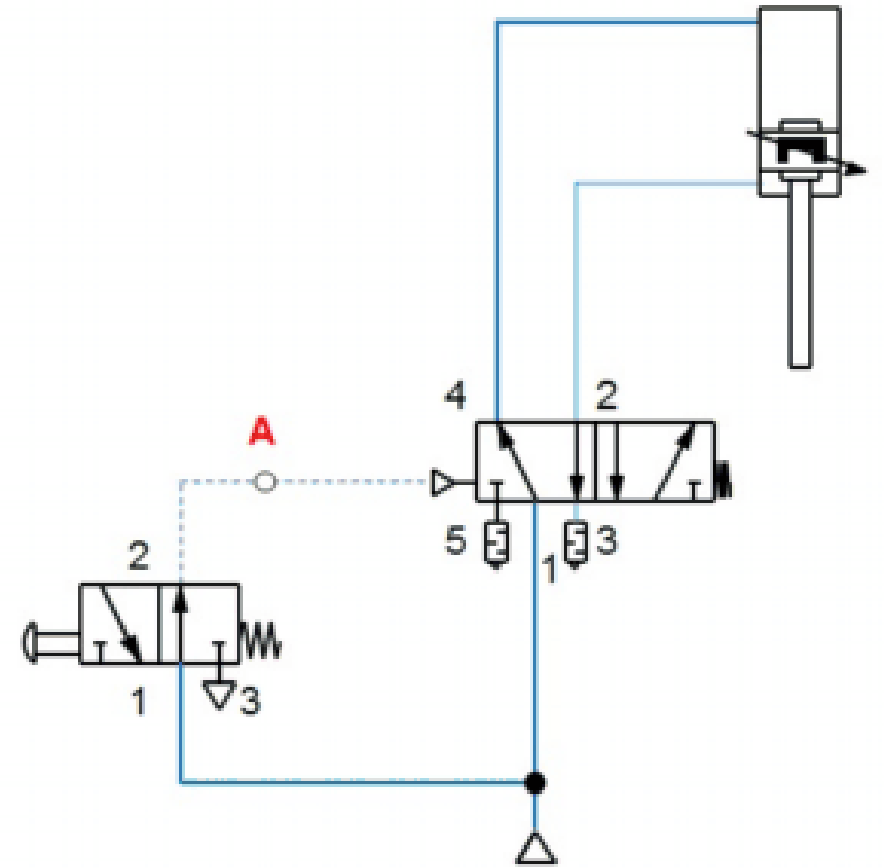
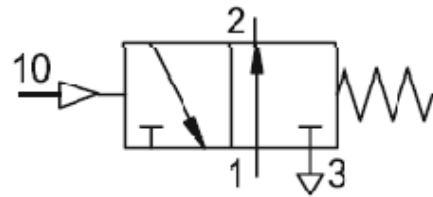
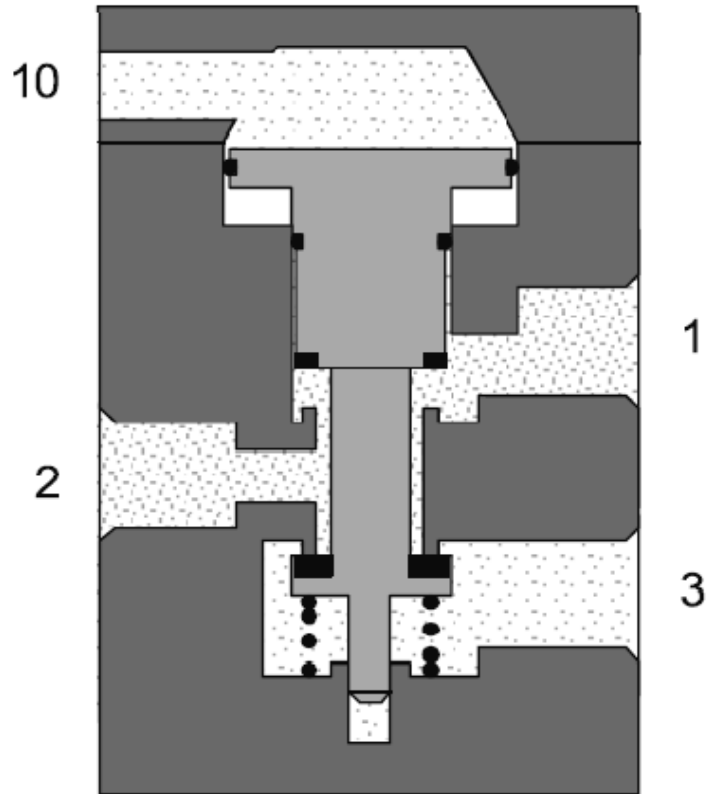
■ high pressure
■ low pressure



Shuttle Valve (OR Valve)



Logic not valve

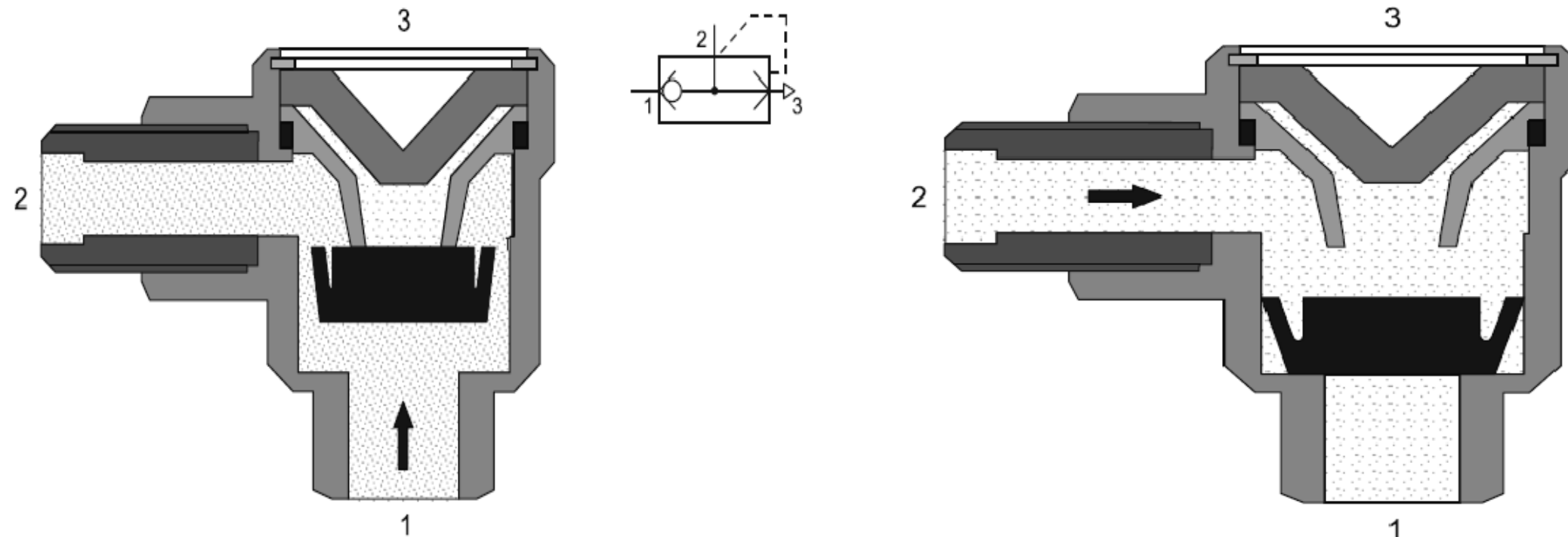


Quick exhaust valve

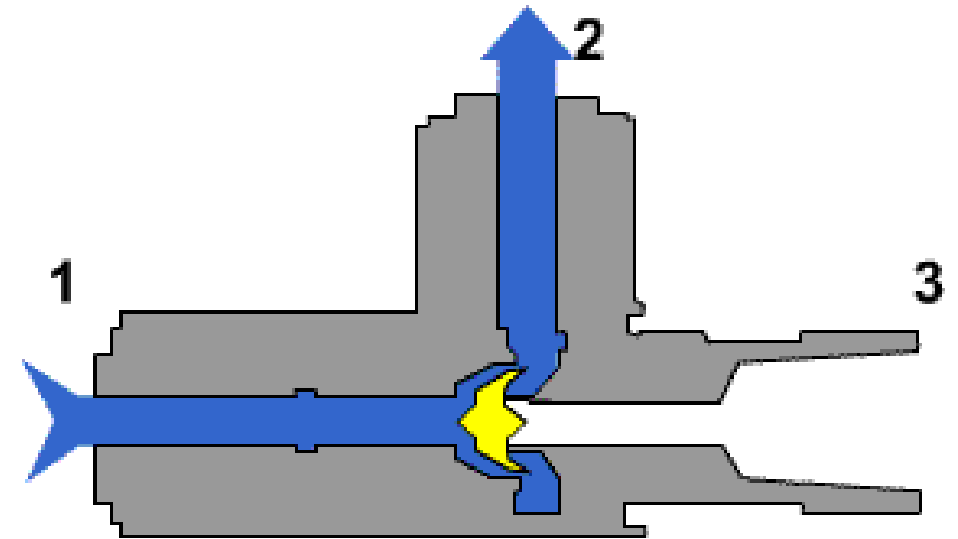
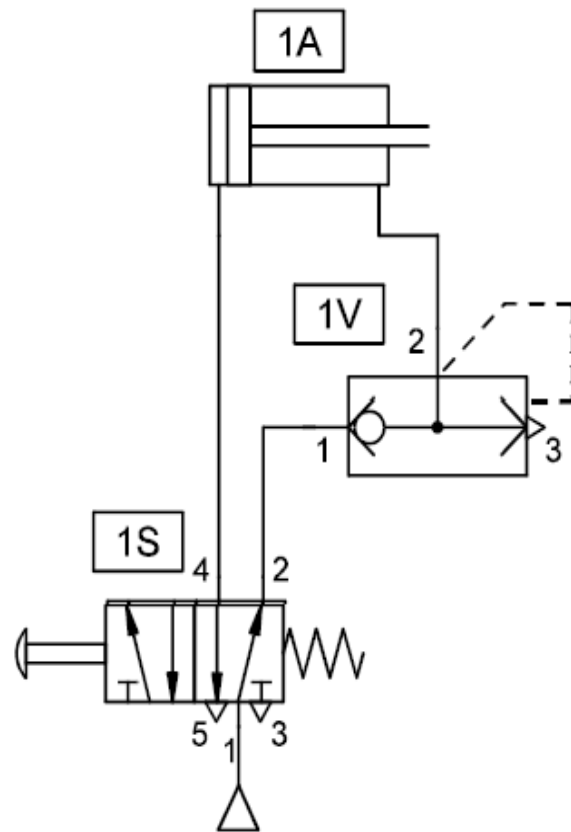
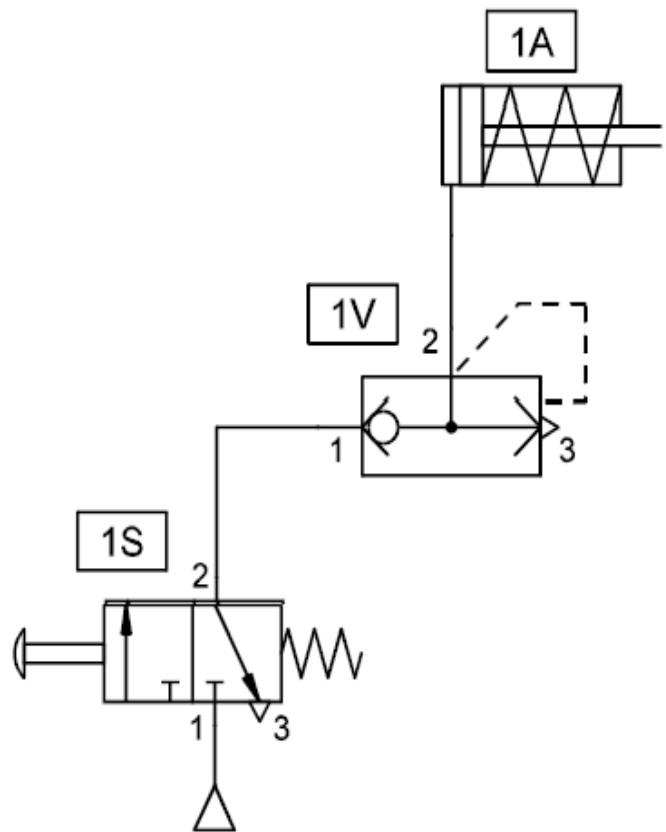
Quick exhaust valves work by providing a rapid exhaust of controlled air when placed directly onto an air cylinder after the control valve.

The seal inside Clippard's quick exhaust valve is shaped like a bat wing. When air pressure is sent to the cylinder, it hits the back side of the seal and pushes the front side against the exhaust port.

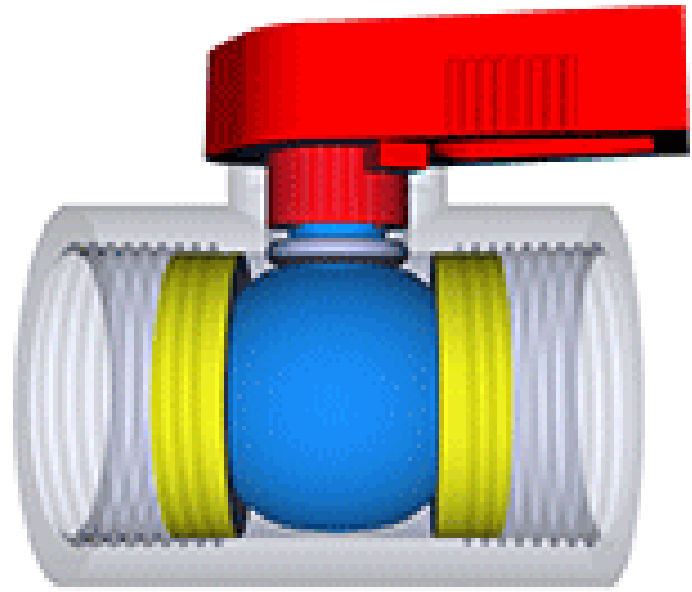
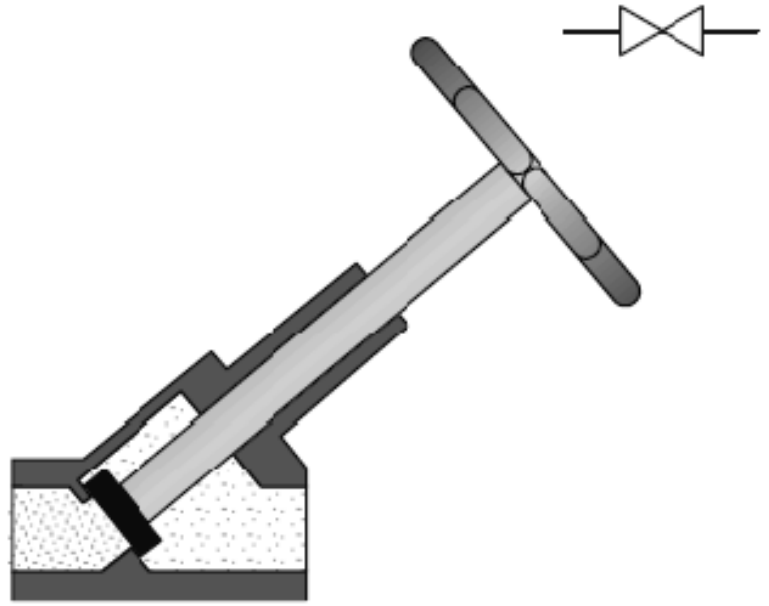
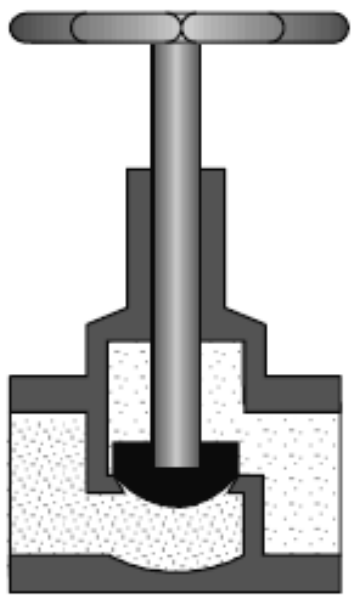
This seals it off and allows air to enter the cylinder.



Quick exhaust valve



Shout off valve



Flow control valves

$$Q = A \Delta P$$

Flow control valves influence the volumetric flow of the compressed air in both directions.

Flow Control valves Include:

- **Throttle Valves.**
 - Chock Throttle Valves.
 - Disc Throttle Valves.
- **One Way flow control valves (Check Chock Valves).**
 - Manually Adjustable.
 - Mechanically Adjustable.

Flow control valves

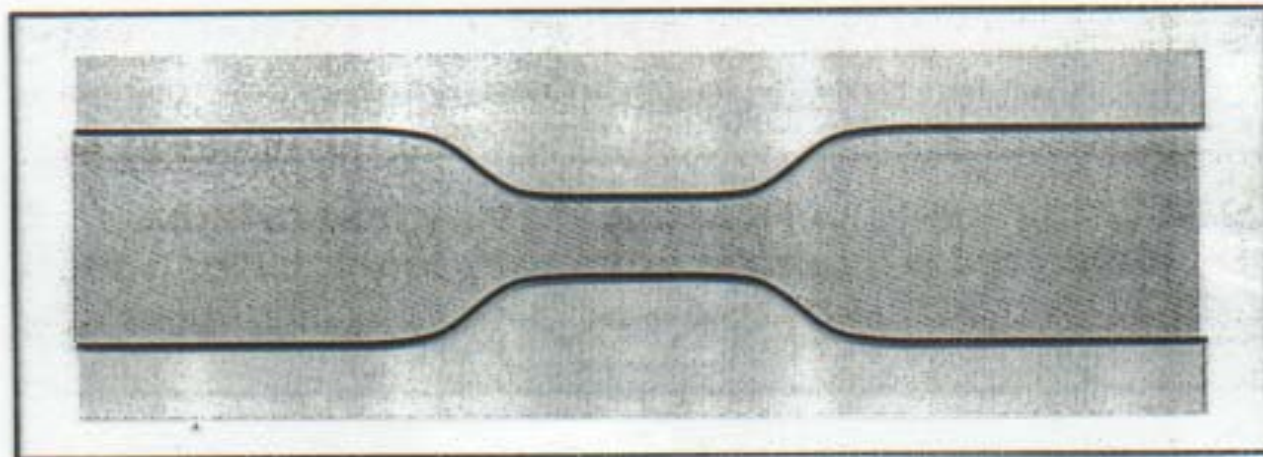
Choke: fixed or adjustable restriction

Characteristics: long restriction in comparison to cross section (diameter) • flow depends on the pressure differential • flow not dependent on the viscosity

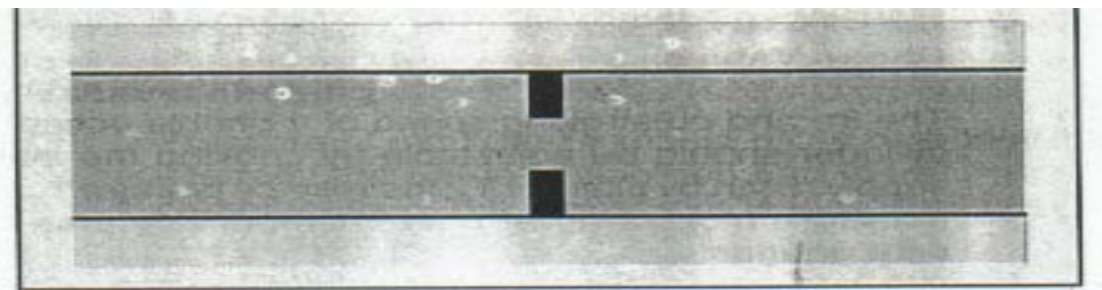
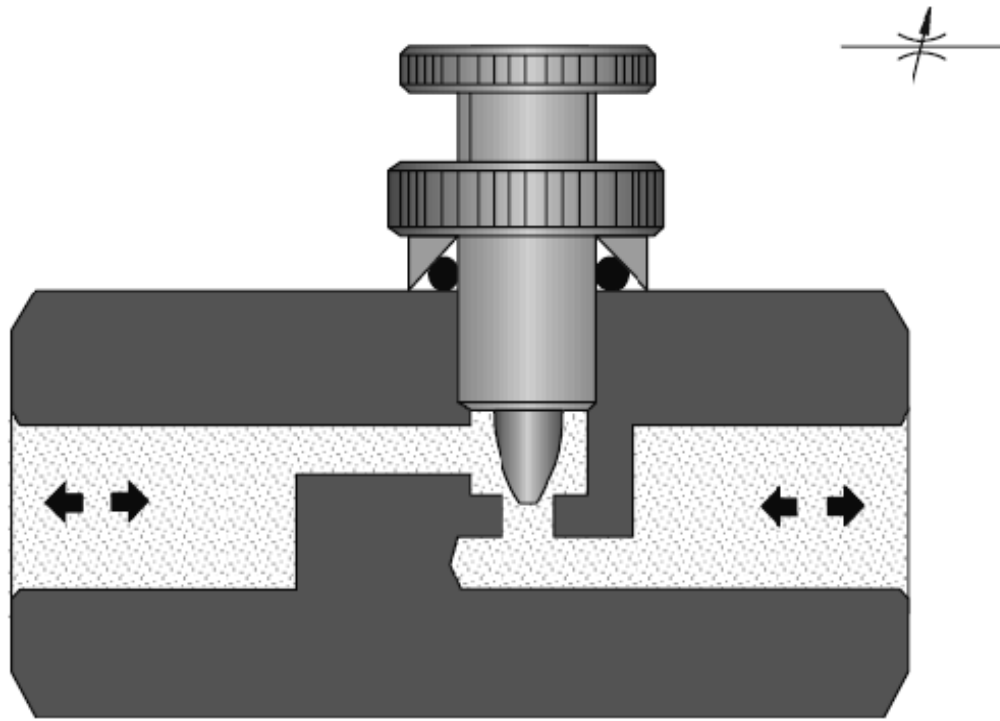
$$Q =$$

Disc throttle: fixed or adjustable

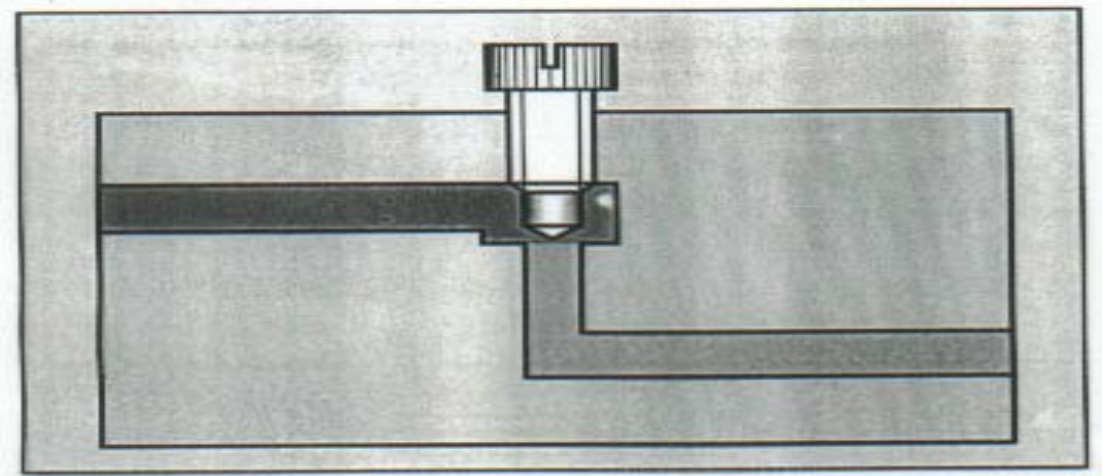
Characteristics: short restriction in comparison to cross section (diameter) • flow depends on the pressure differential • flow not dependent on the viscosity • turbulent flow



Bi-Directional Chock Valves

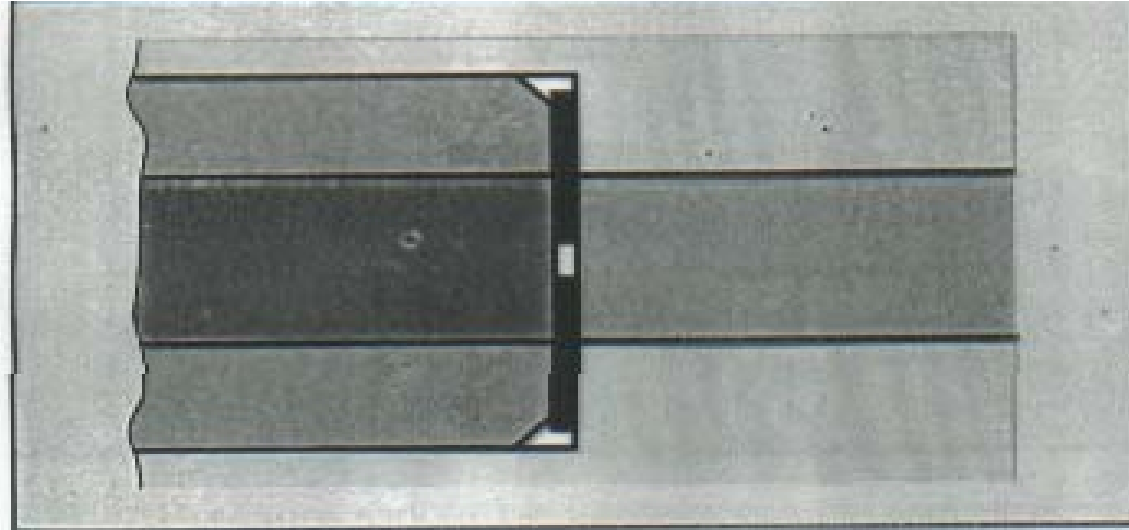


Disc throttle



Throttle, adjustable

Bi-Directional Chock Valves

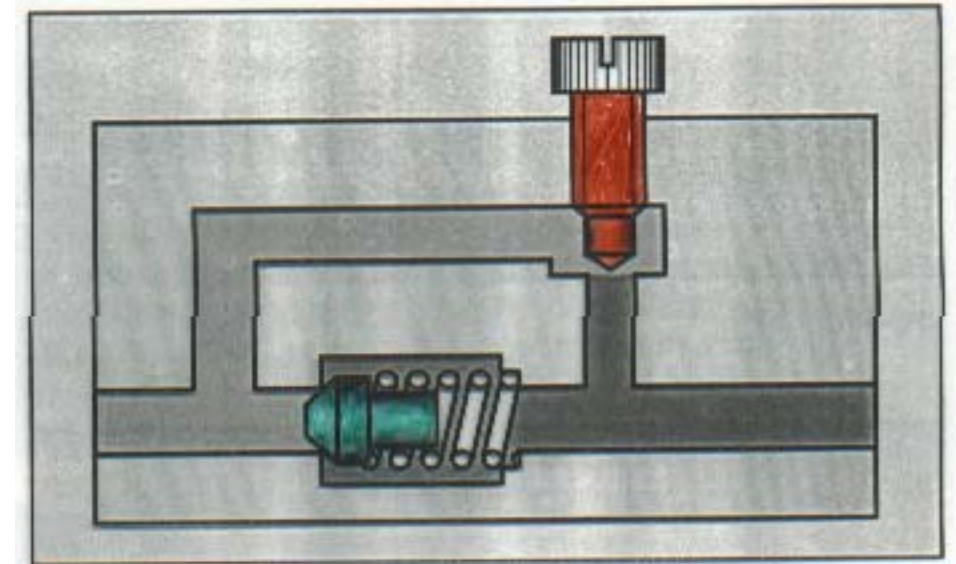
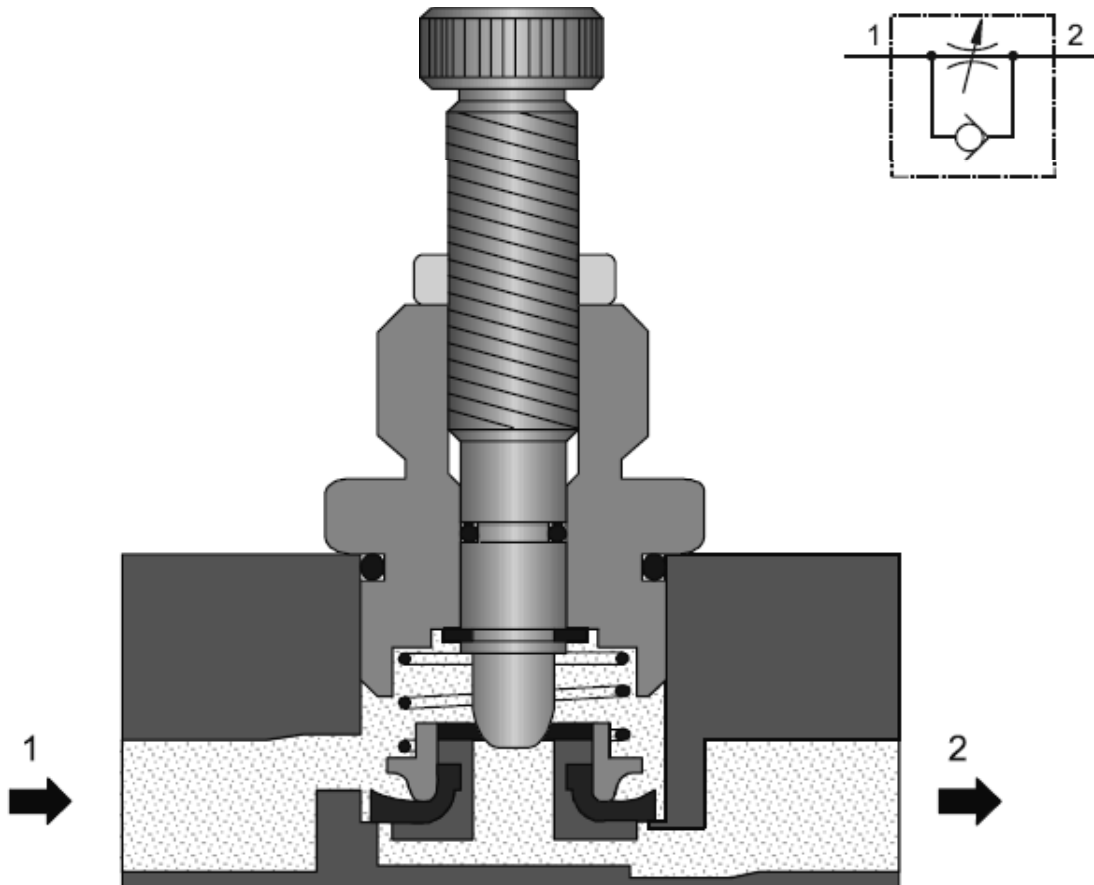


Disc throttle, fixed



*Graphic symbol acc. to DIN ISO 1219
a) Throttle, fixed, b) Throttle adjustable,
c) Disc throttle, fixed, d) Disc throttle, adjustable*

One Way, Manually Adjustable Flow Control Valve (Check Chock Valve)

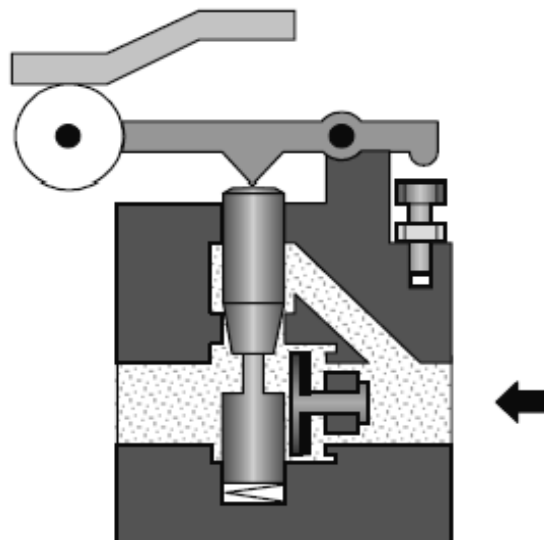
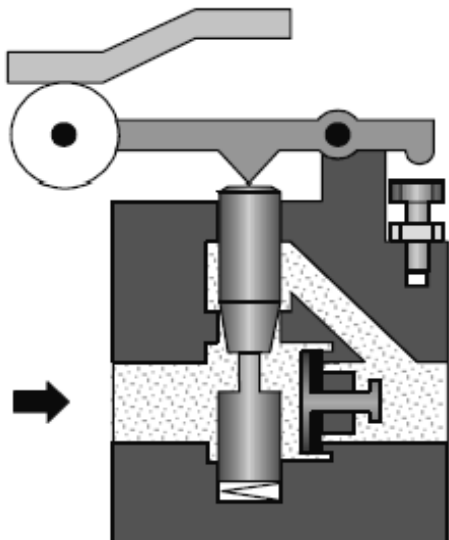
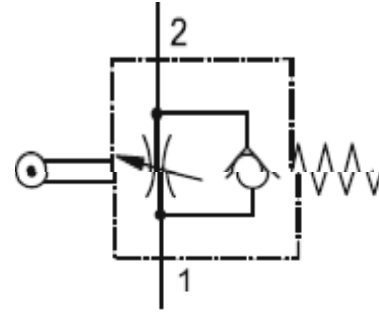


Check-choke valve



Graphic symbol acc. to DIN ISO 1219

One Way Mechanically Adjustable Flow Control Valve



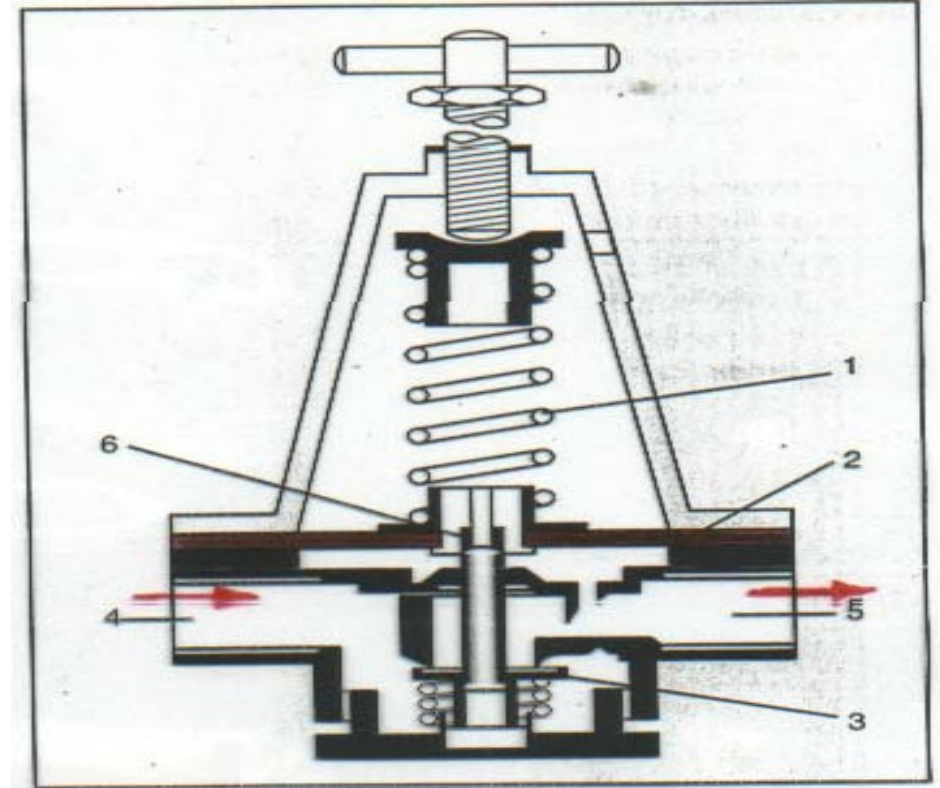
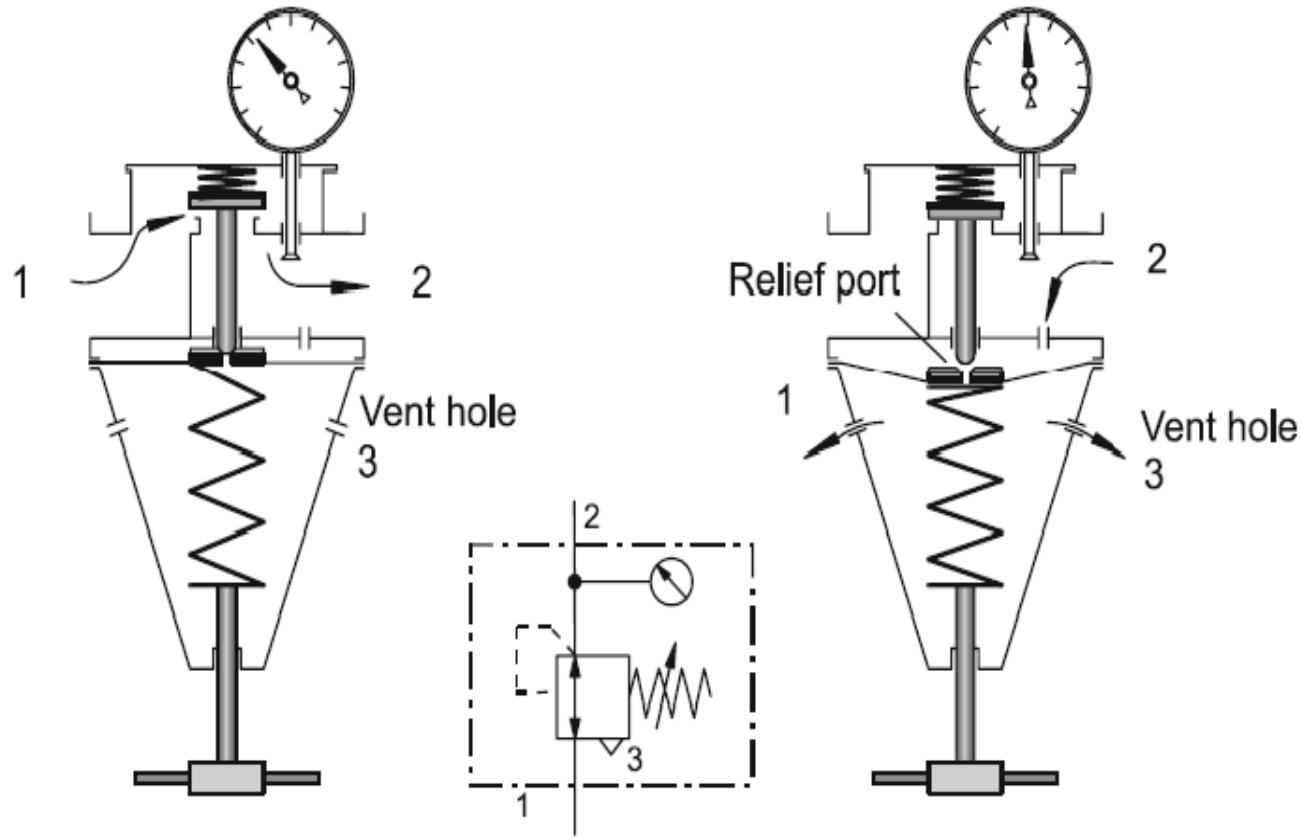
Pressure Control Valves

Pressure control valves are elements which predominantly influence the pressure or are controlled by the magnitude of the pressure.

They are divided into the three groups:

- Pressure regulating valve (Pressure Reduce Valve)
- Pressure limiting valve (Pressure Relief Valve)
- Pressure sequence valve (Pressure Switch).

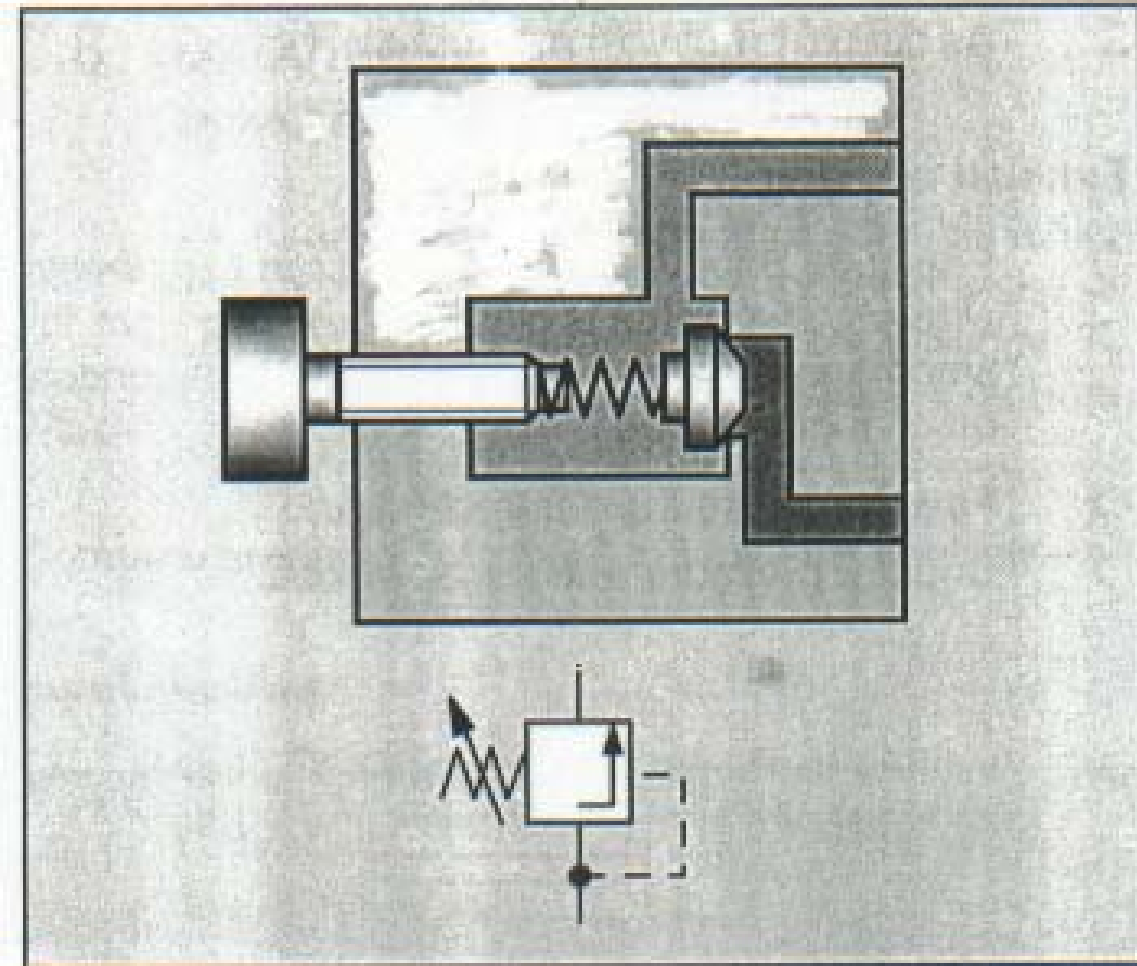
Pressure Regulator



Main components are: 1 Spring, 2 Diaphragm, 3 Valve seat for flow control, 4 Supply port, 5 Delivery port, 6 Exhaust valve seat (for regulator with exhaust)

Pressure relief valve

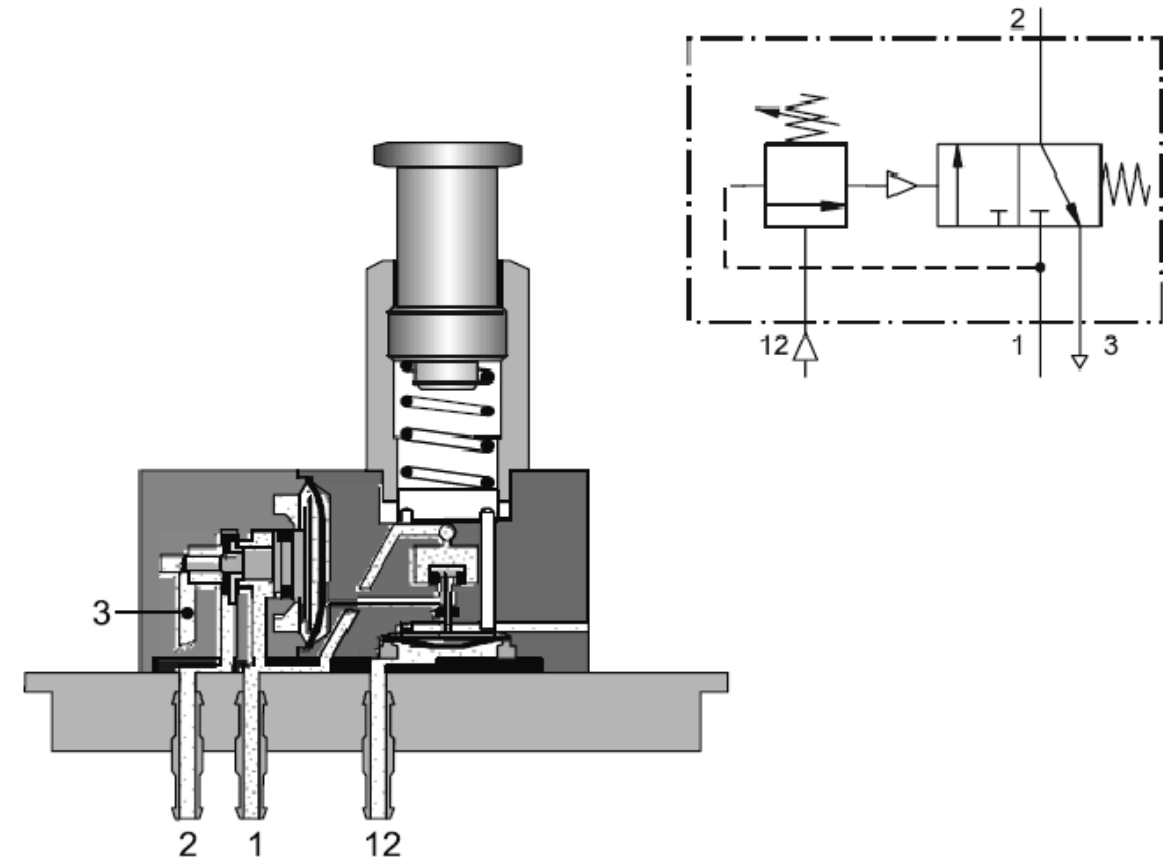
- The pressure limiting valves are used mainly as safety valves (pressure relief valves).
- They prevent the maximum permissible pressure in a system from being exceeded.
- If the maximum pressure has been reached at the valve inlet, the valve outlet is opened and the excess air pressure exhausts to atmosphere.
- The valve remains open until it is closed by the built-in spring after reaching the preset system pressure.



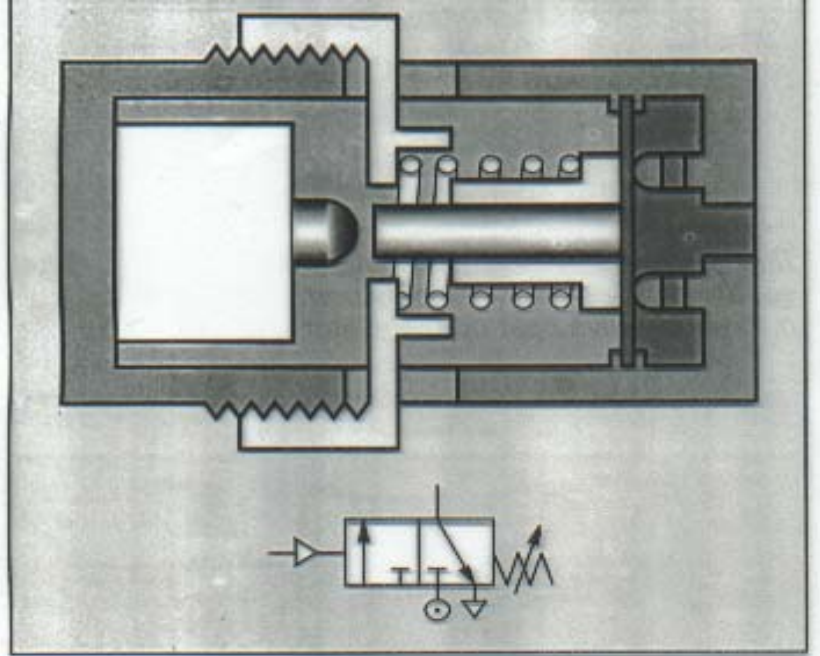
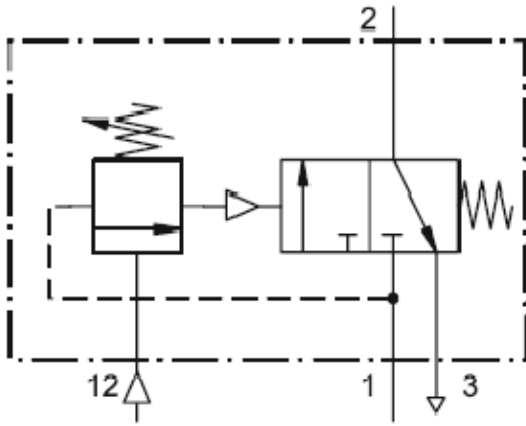
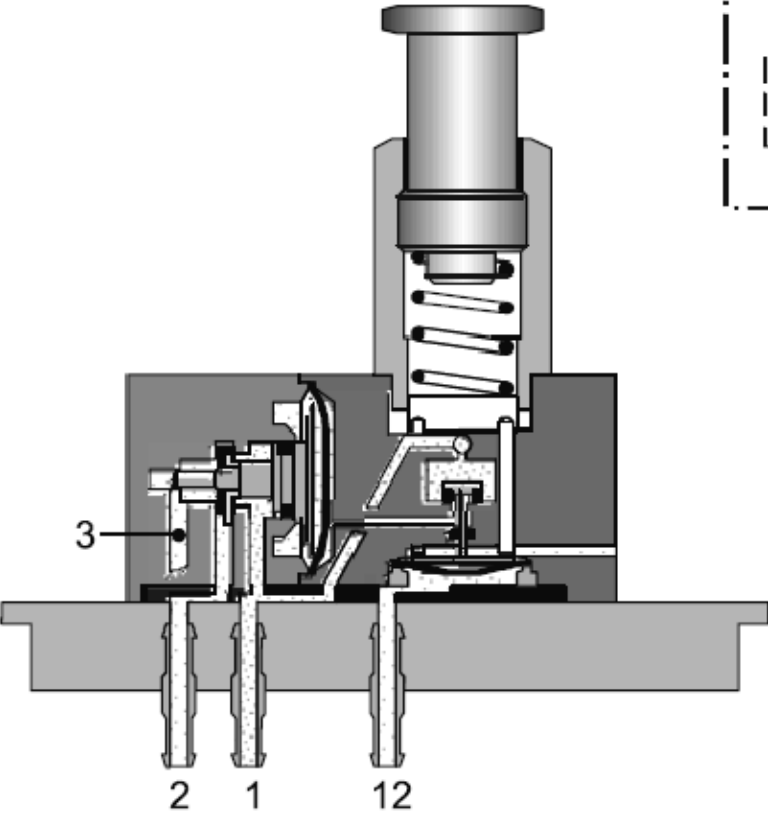
Section view and graphic symbol acc. to DIN ISO 1219 of a pressure relief valve

Pressure sequence valve

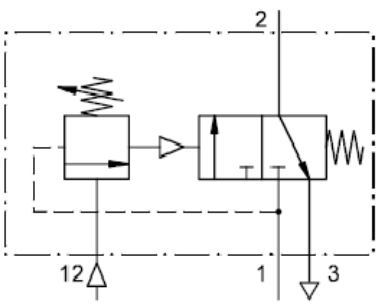
- Pneumatic sequence valves typically are five-way directional control valves with adjustable springs to set their shifting pressure.
- They are used to start a second operation after the preceding one finishes.



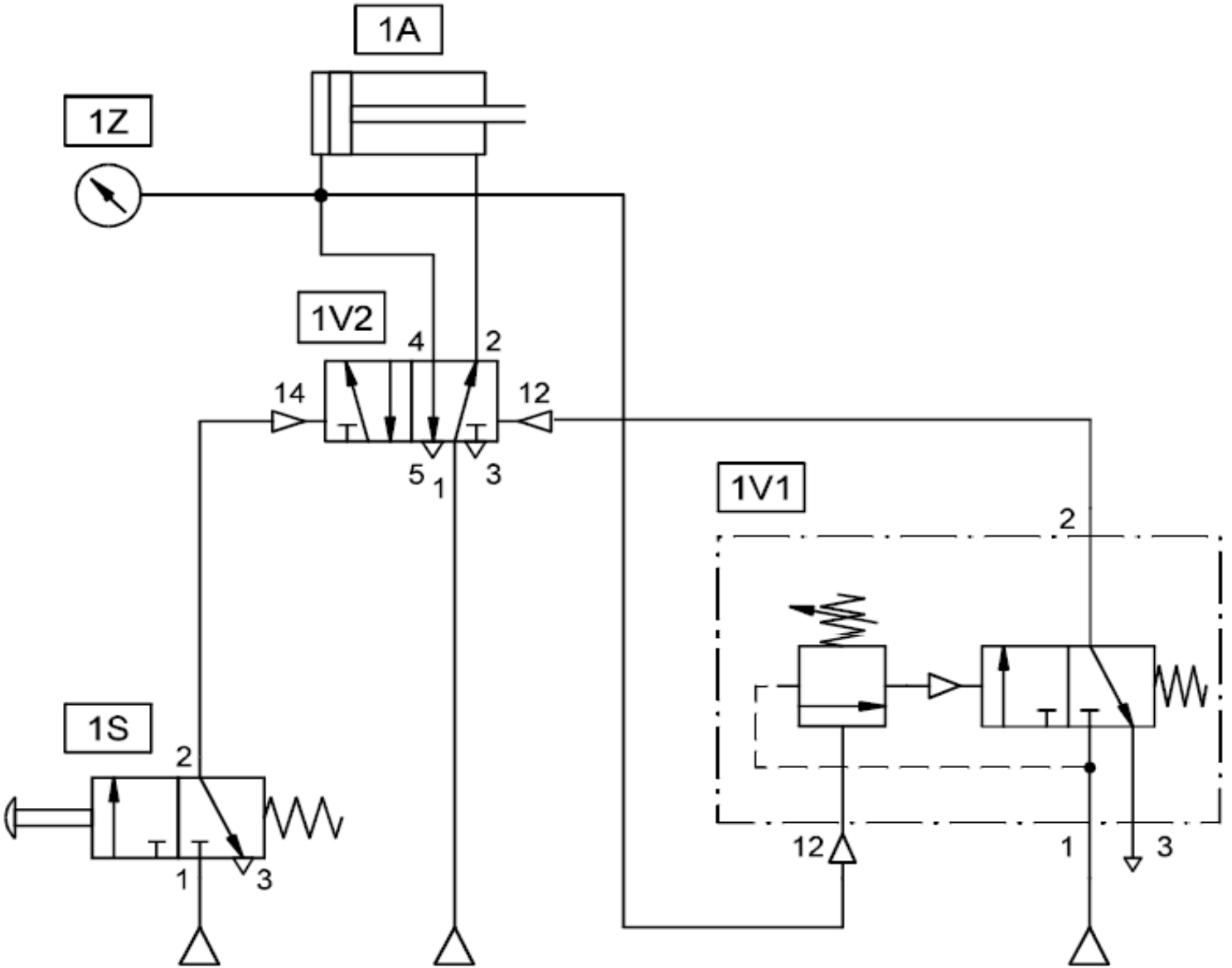
Pressure sequence valve



Section view and graphic symbol acc. to DIN ISO 1219 of a pressure switching valve with variable switching point



Pressure sequence valve



Combinational valves

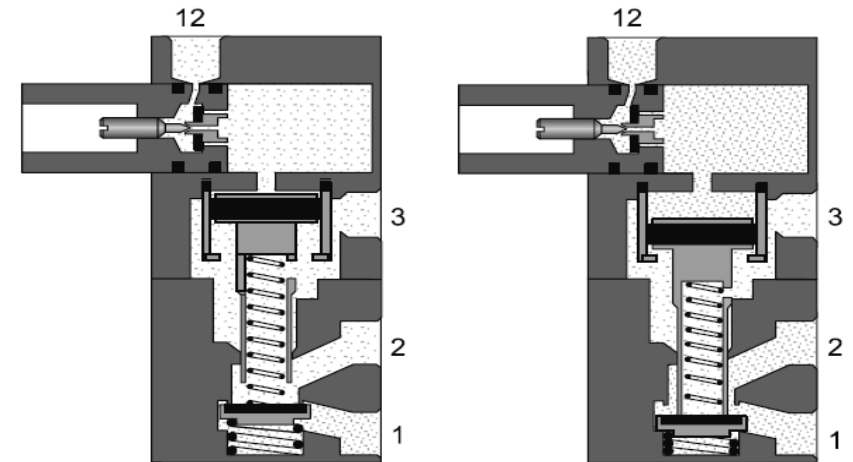
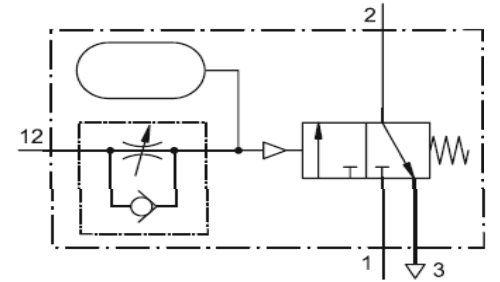
- Components of different control groups can be combined into the body of one unit with the features, characteristics and construction of a combination of valves.
- Time delay valves: for the delay of signals.
- 5/4-way valve: for the stopping of double-acting cylinders in any position.
- Vacuum generator with ejector: for pick and place applications

Time Delay valves

- The time delay valve is a combined **3/2-way valve**, **one way flow control valve** and **air reservoir**. The 3/2-way valve can be a valve with *normal position open or closed*. The delay time is generally **0-30** seconds for both types of valves.
- By using additional reservoirs, the time can be extended. An accurate switch-over time is assured, if the air is clean and the pressure relatively constant.

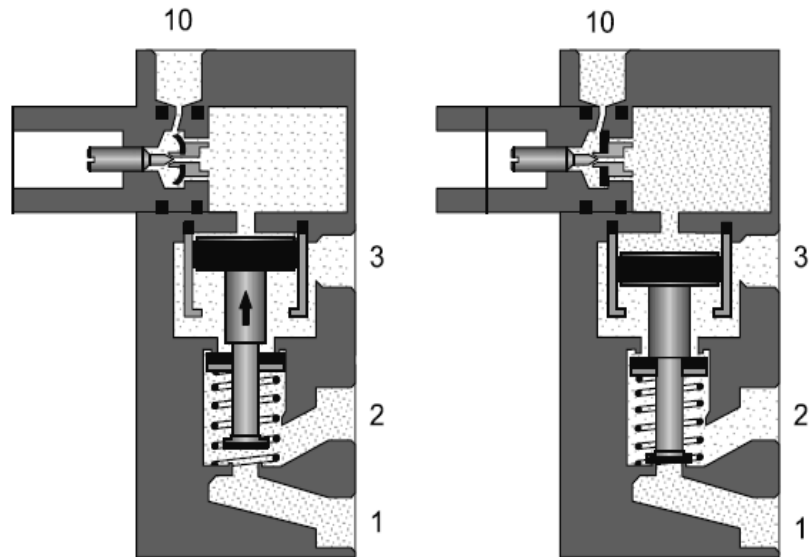
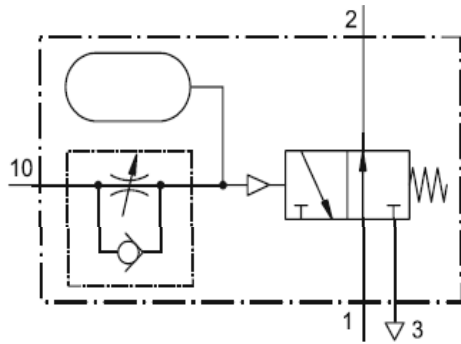
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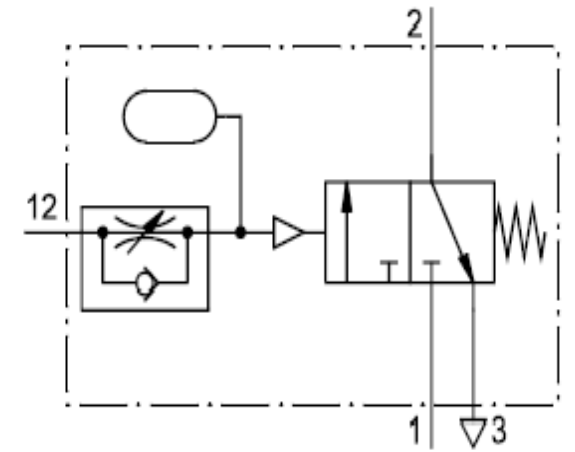


Normally closed

Time Delay valve

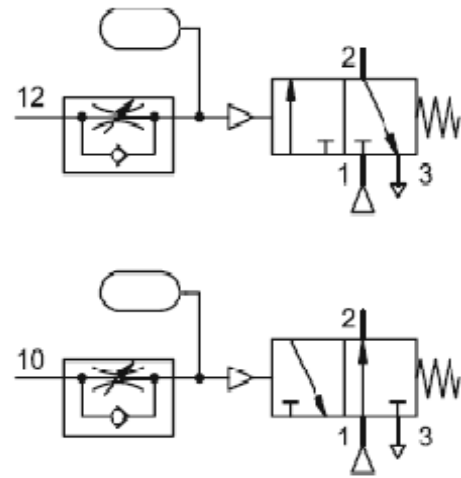
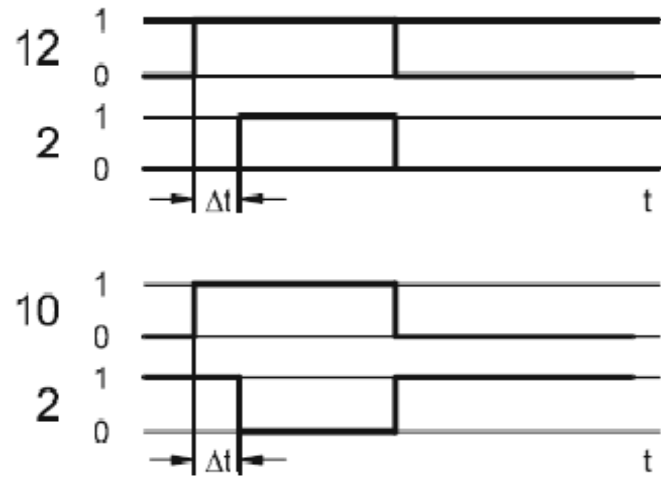


Normally open

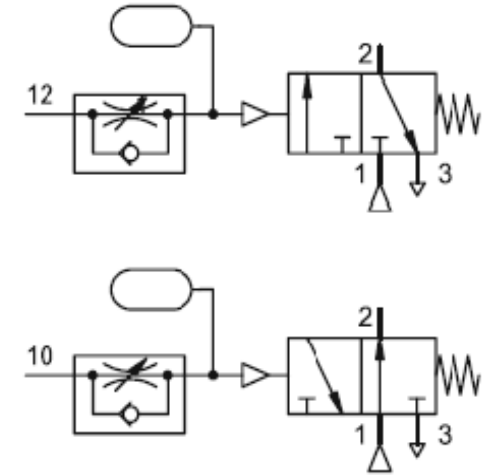
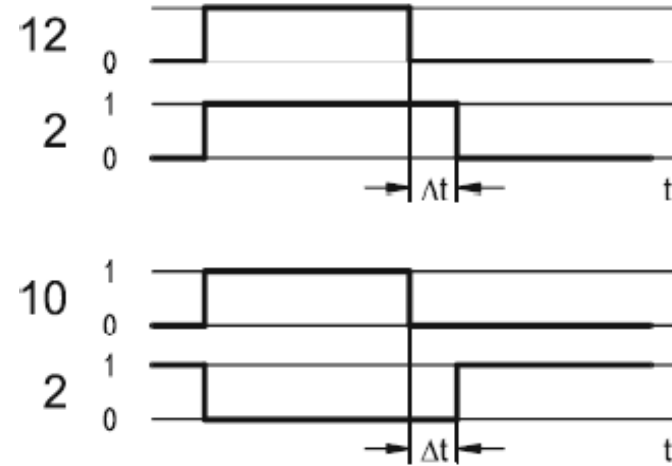


Time Delay valve

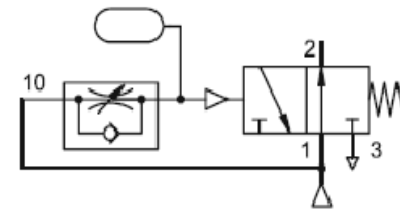
Time response with delay-on



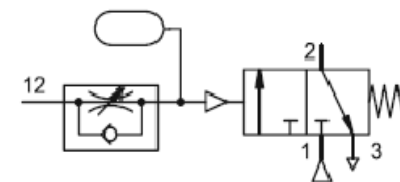
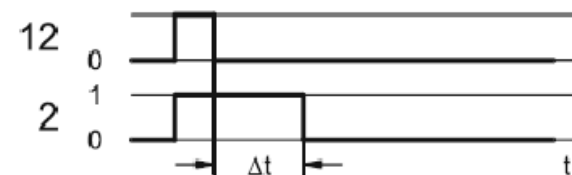
Time response with delay-off



Signal shortening / signal switch-off



Signal lengthening



Time Delay valve

