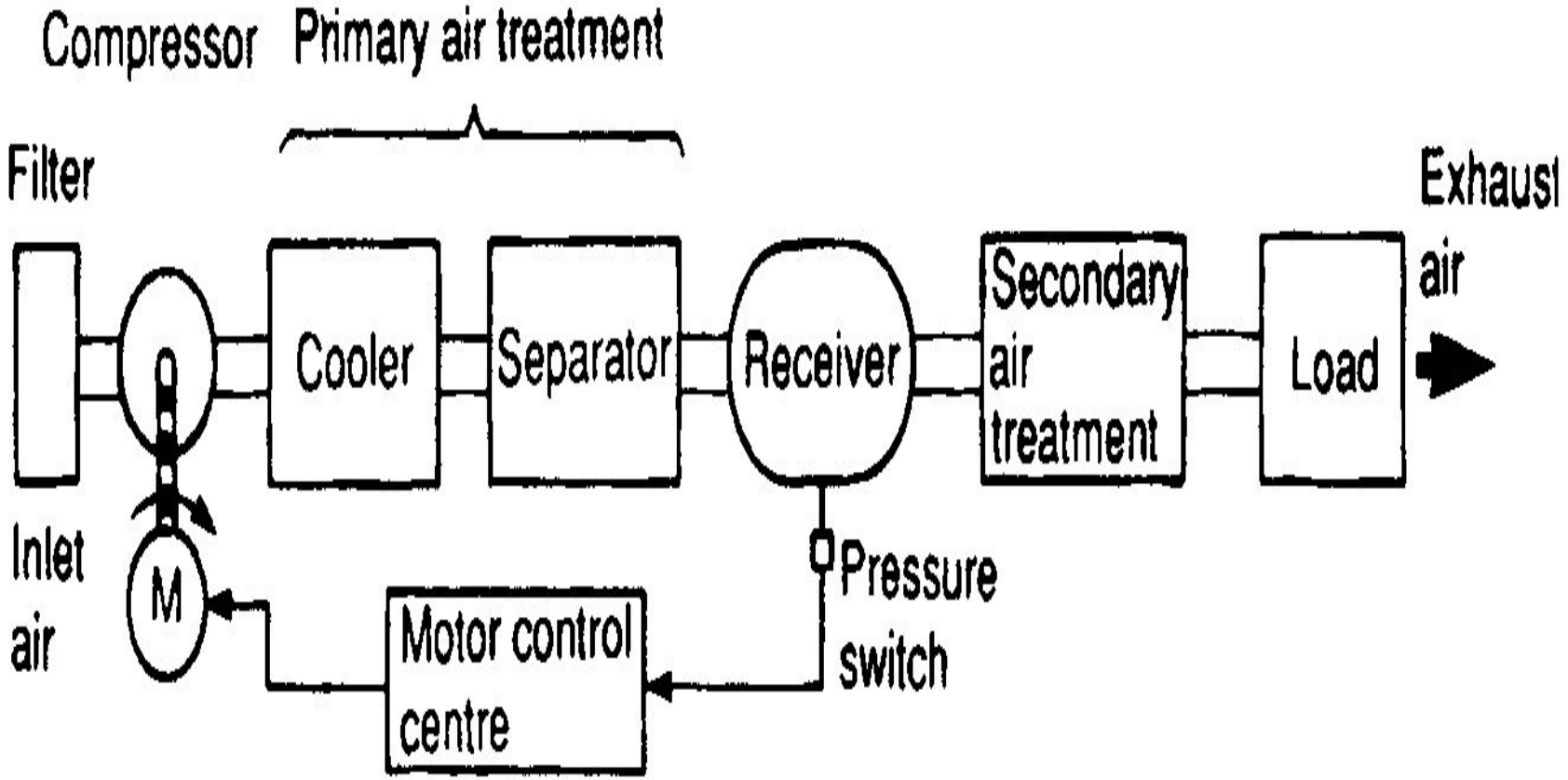
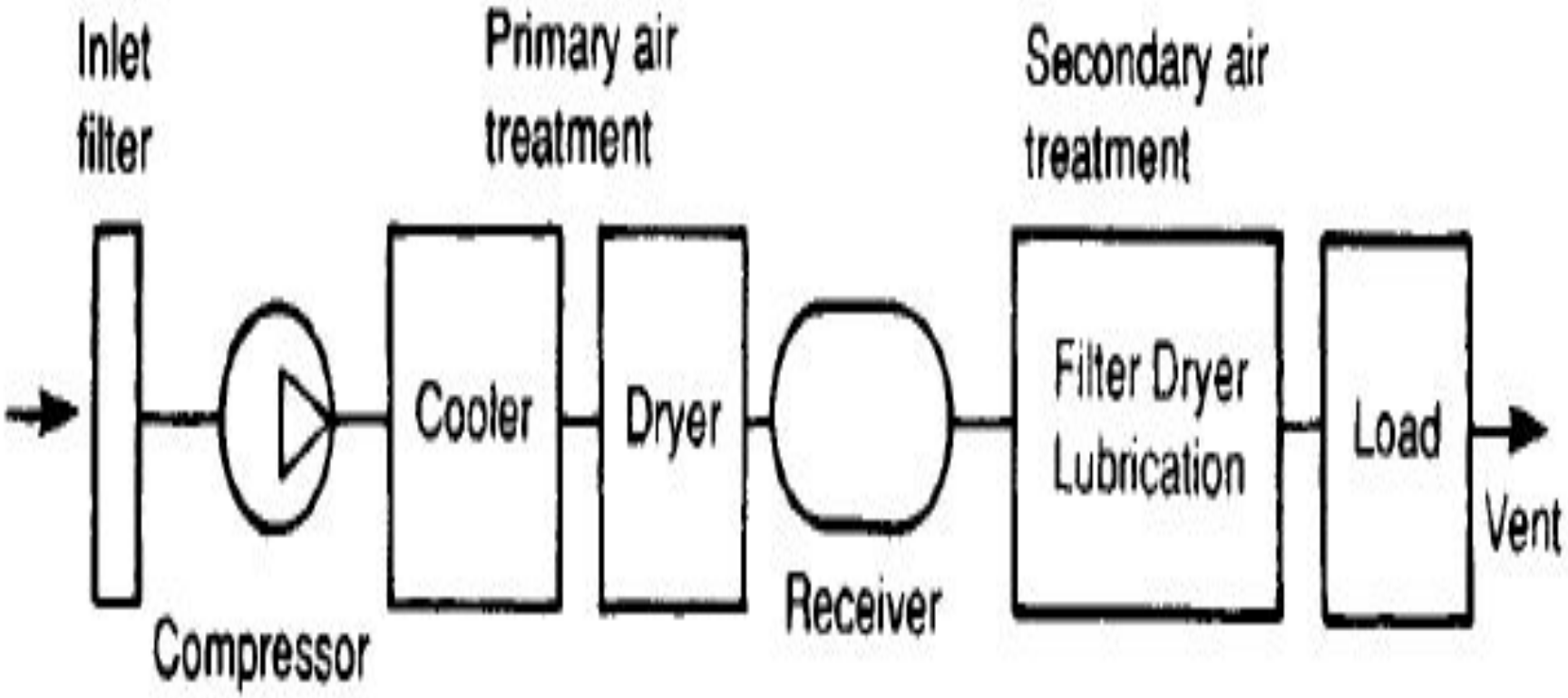
Pneumatics

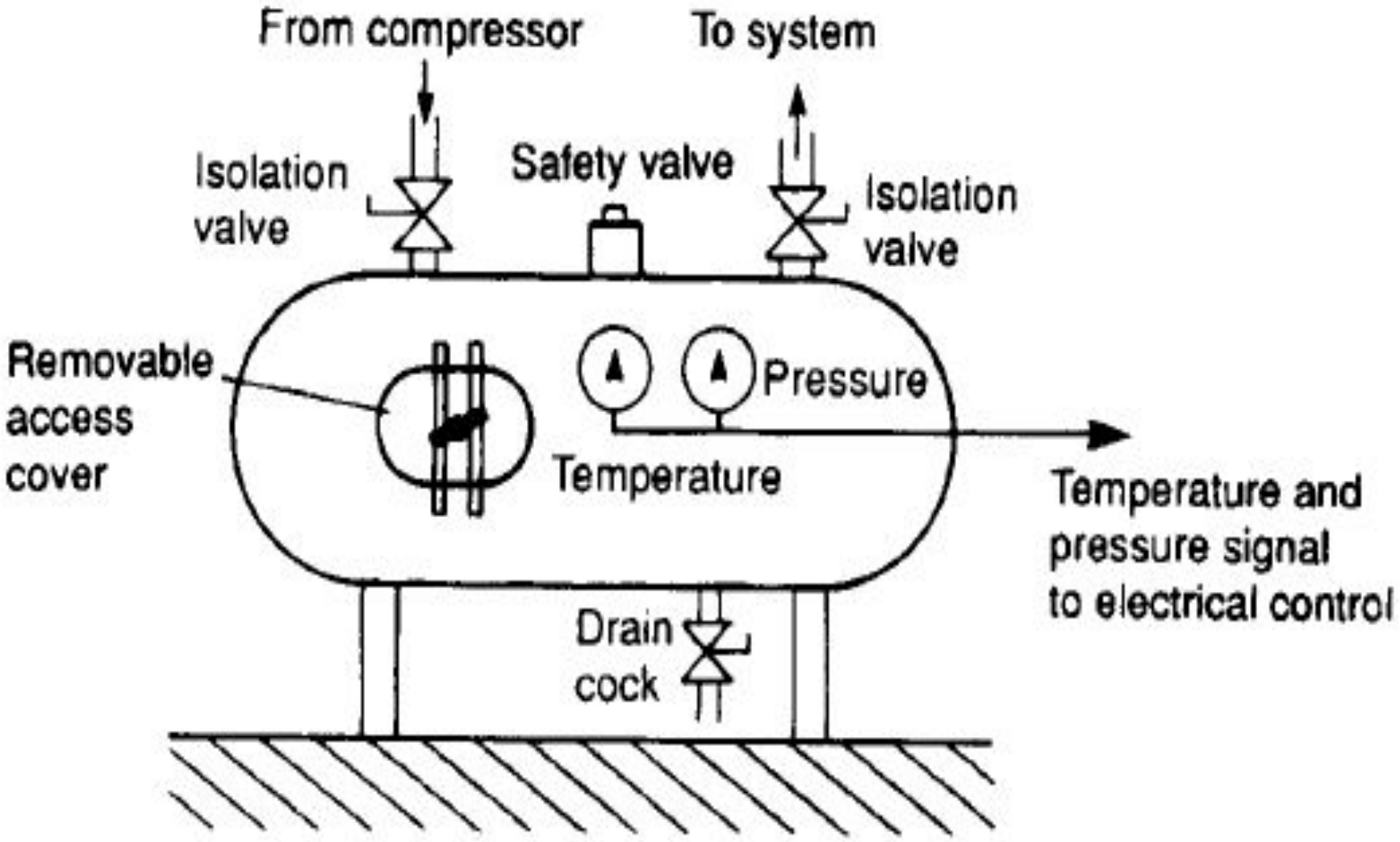
Component parts of a pneumatic system



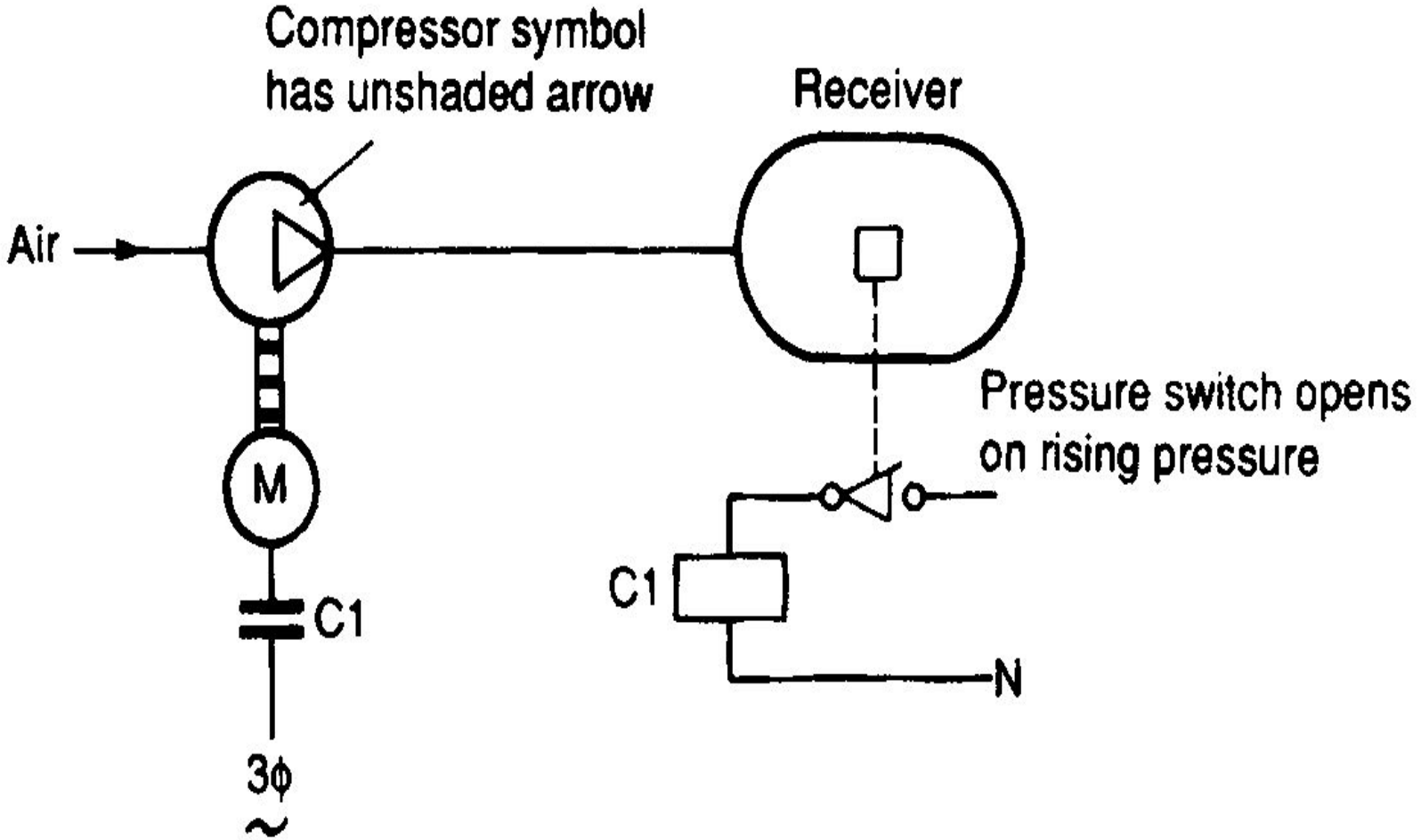
Three stages of air treatment



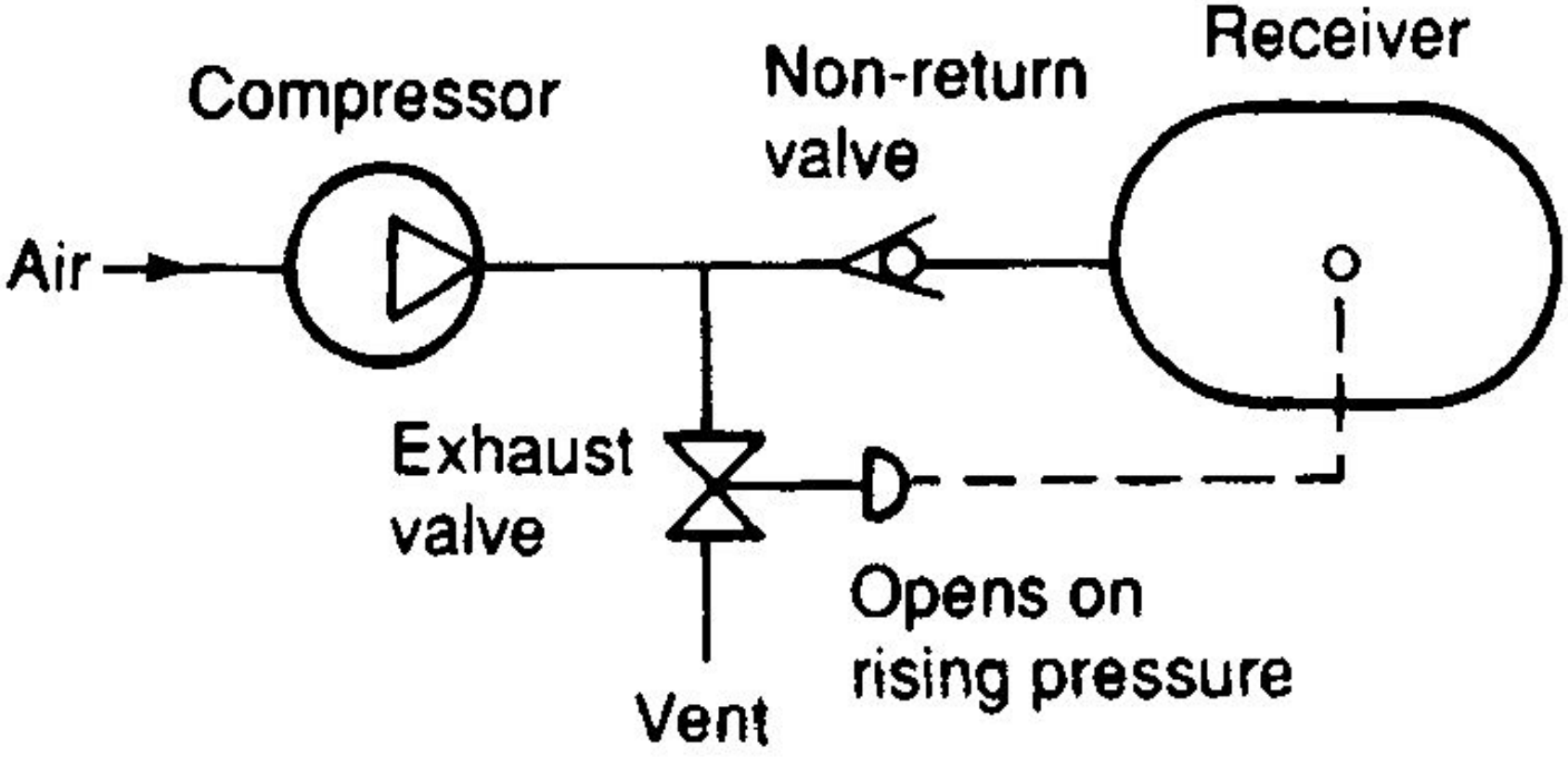
Compressed air receiver



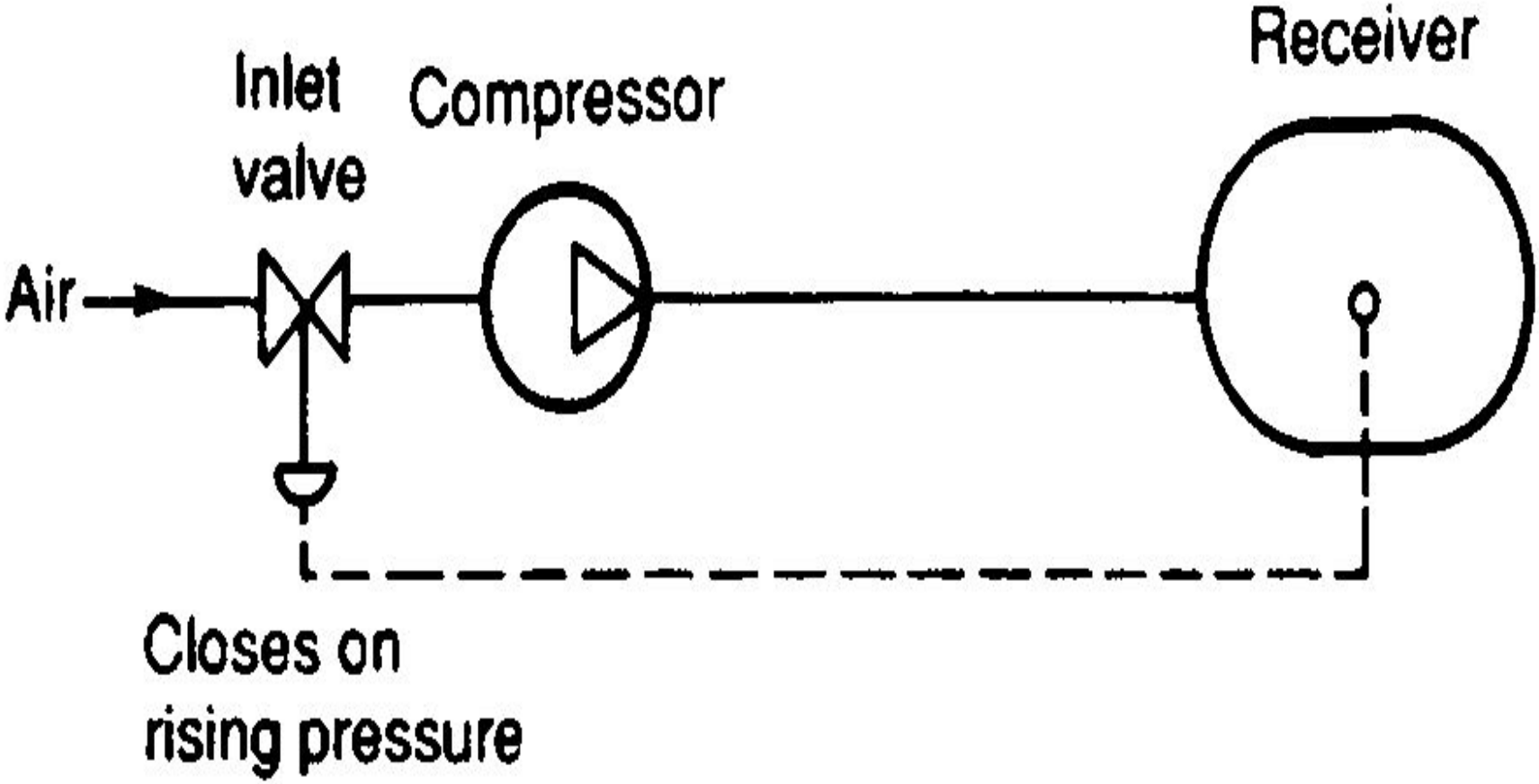
Receiver pressure control via motor start/stop



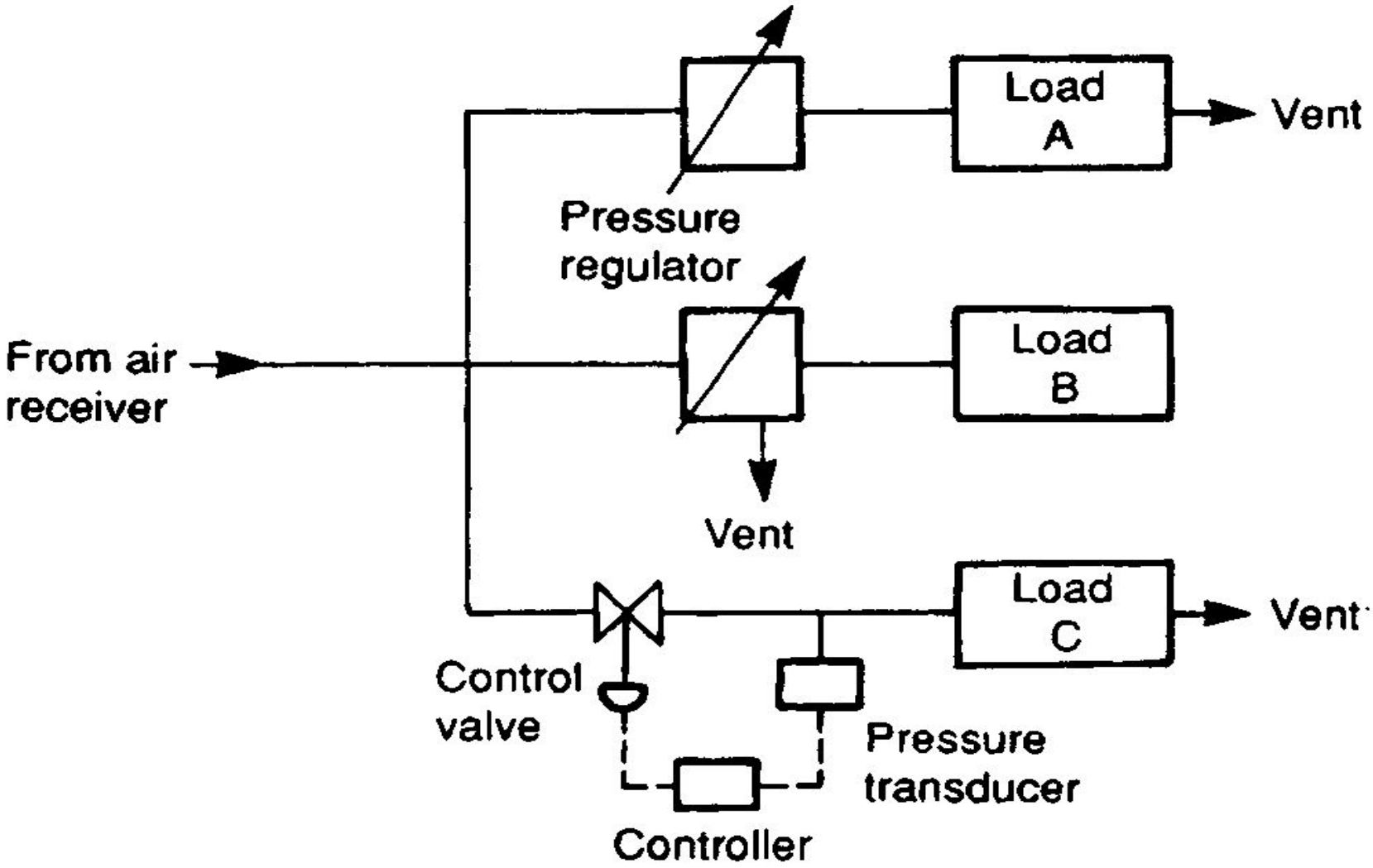
Receiver pressure control using compressor outlet valve

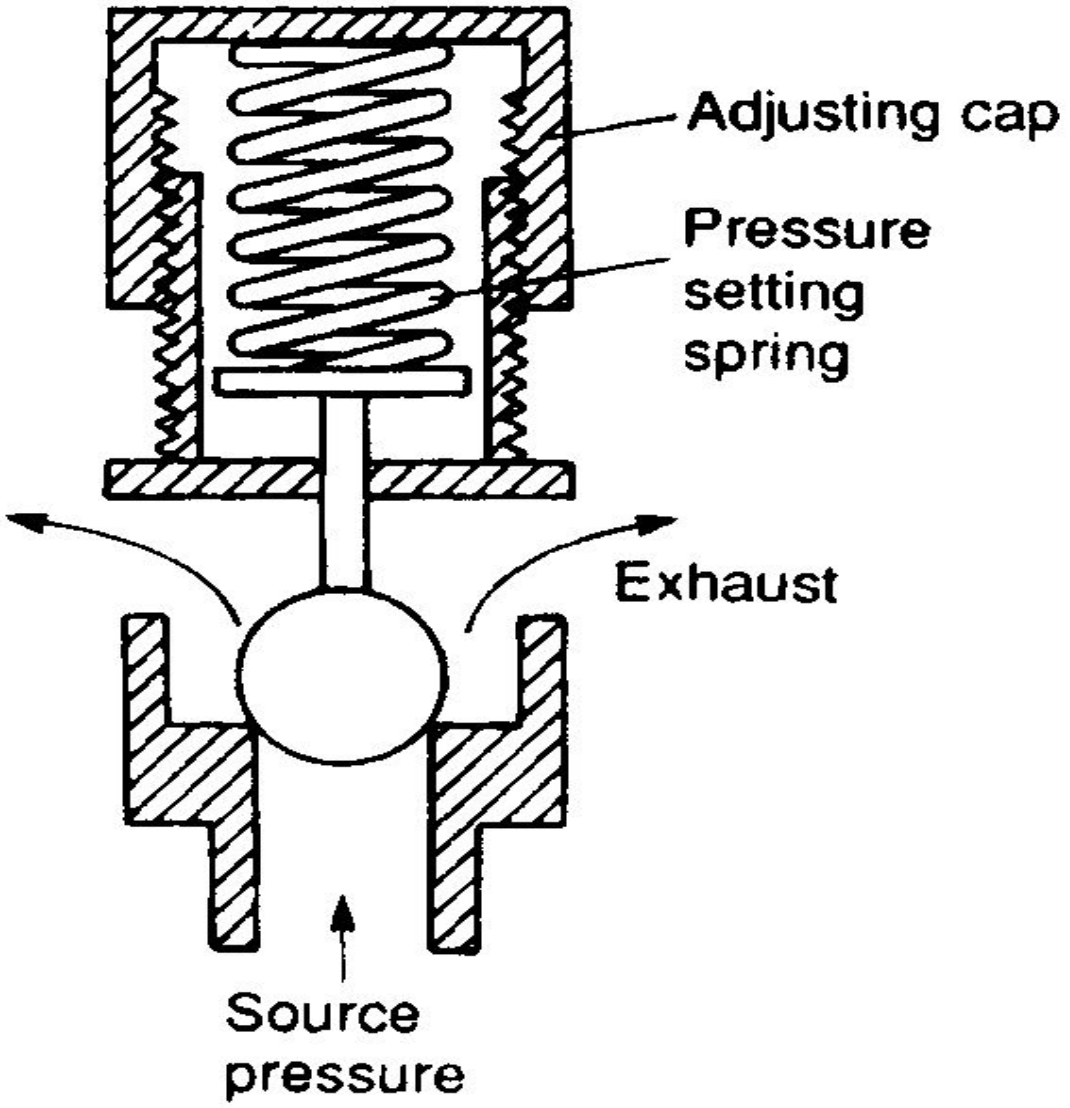


Receiver pressure control using compressor inlet valve

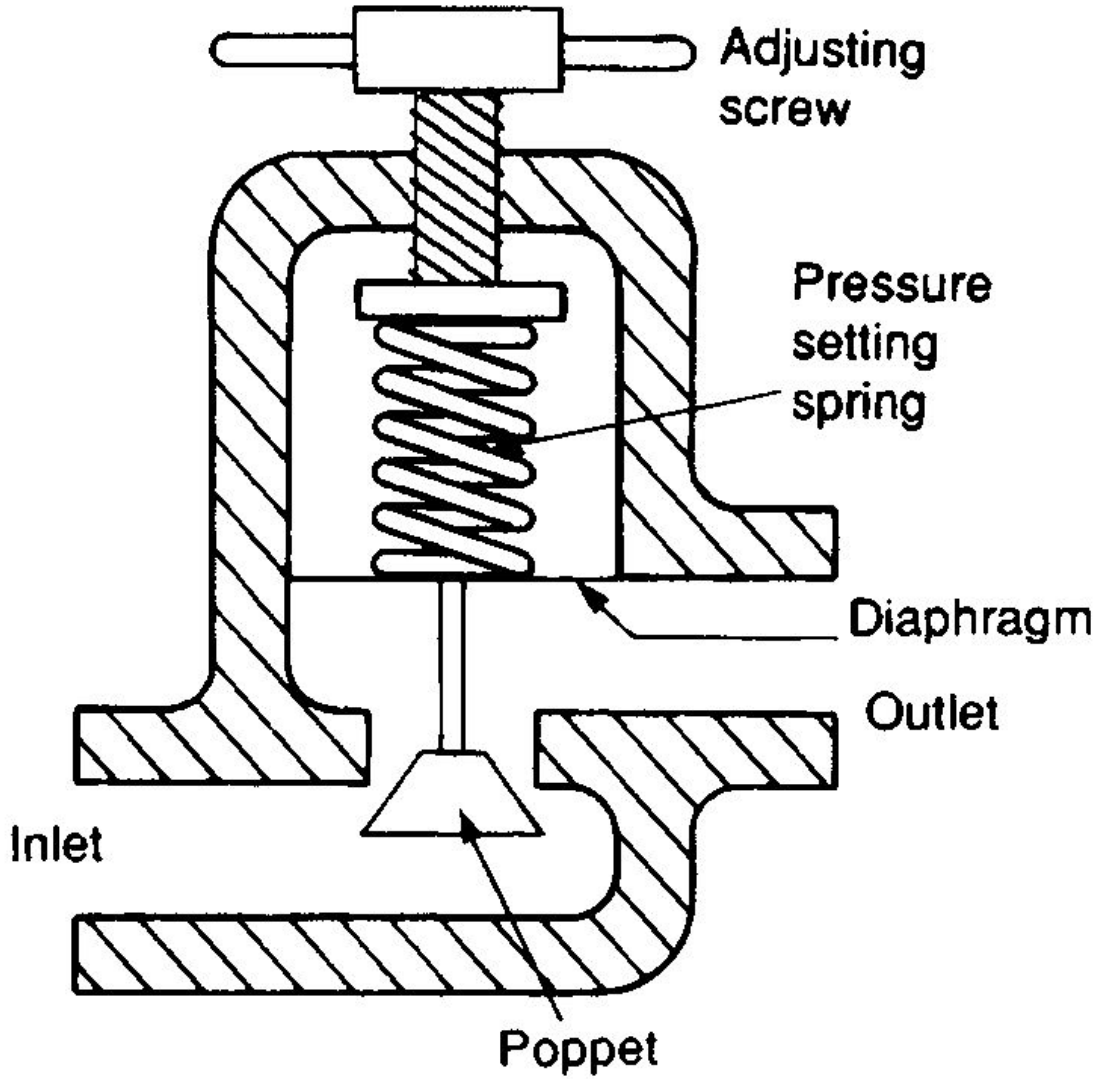


Three types of pressure regulator



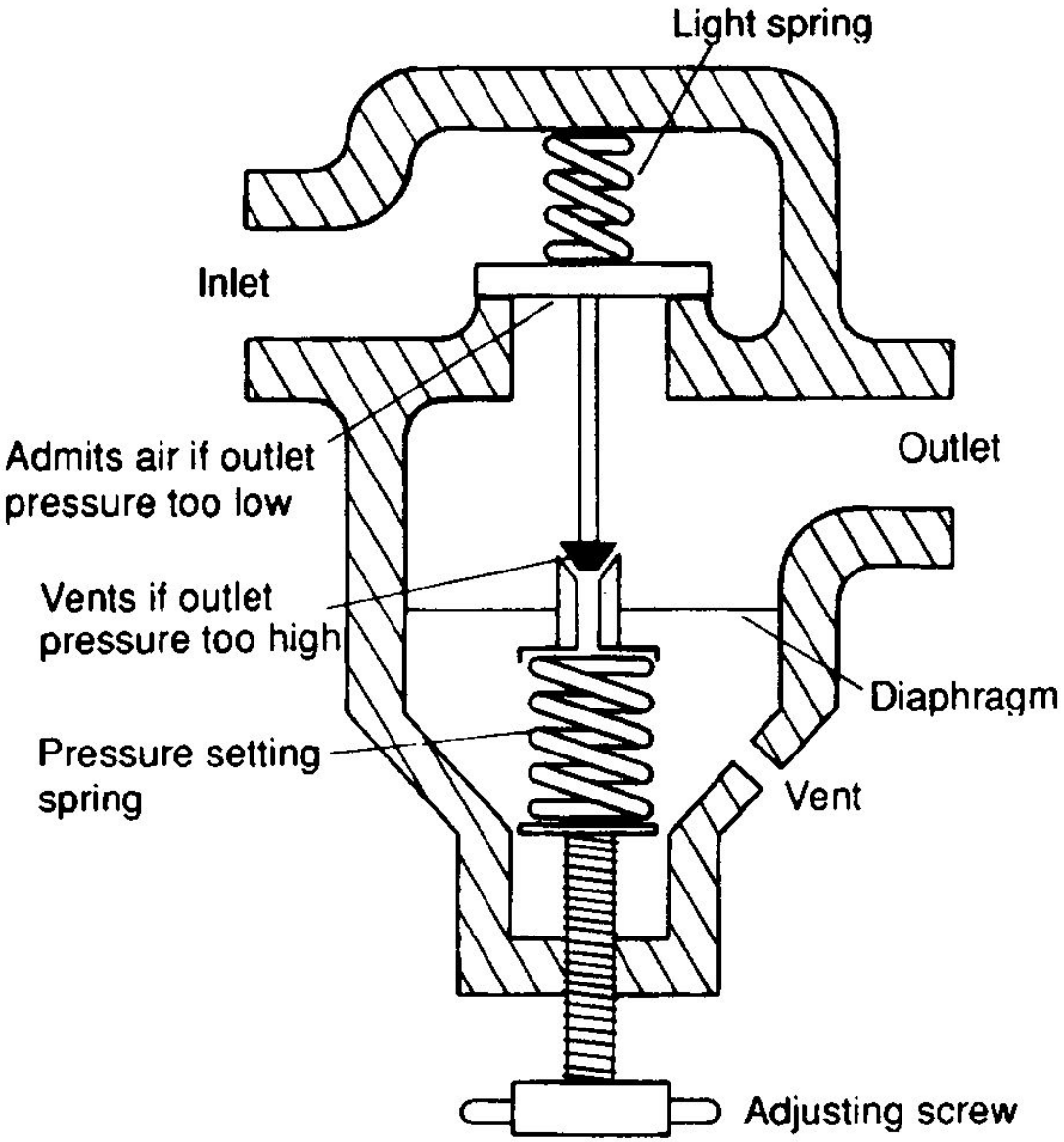


Relief valve

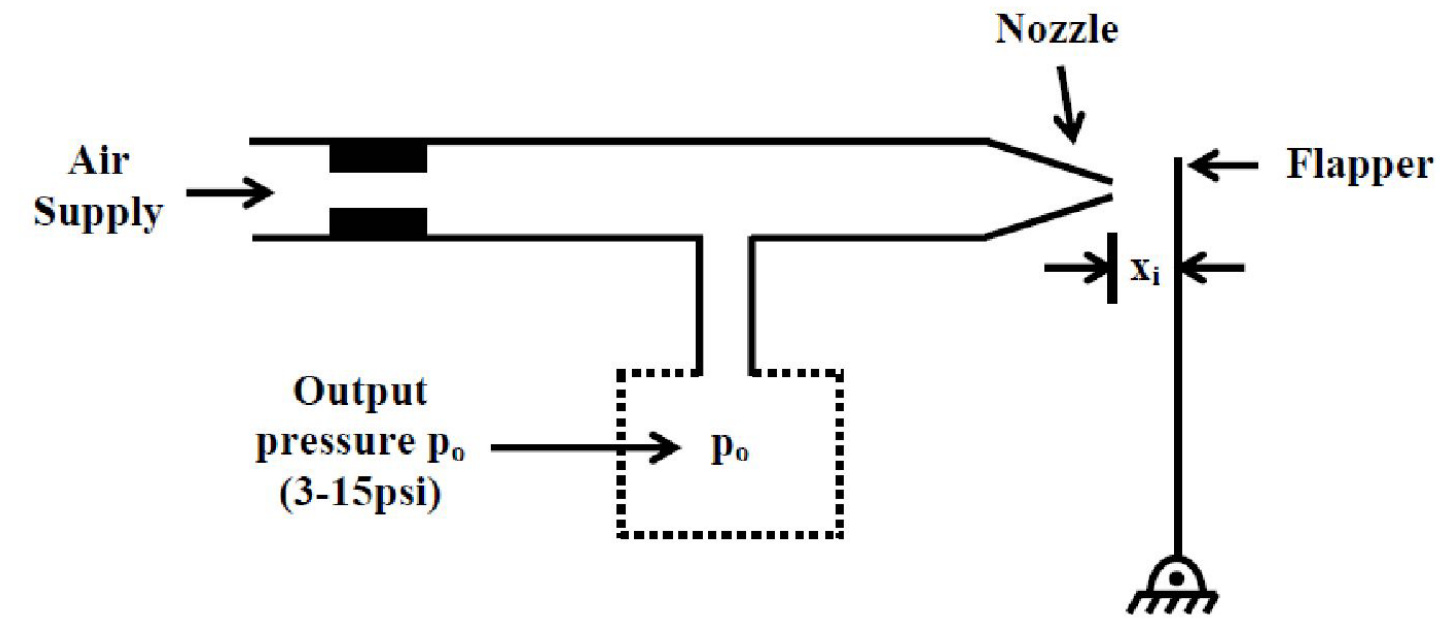


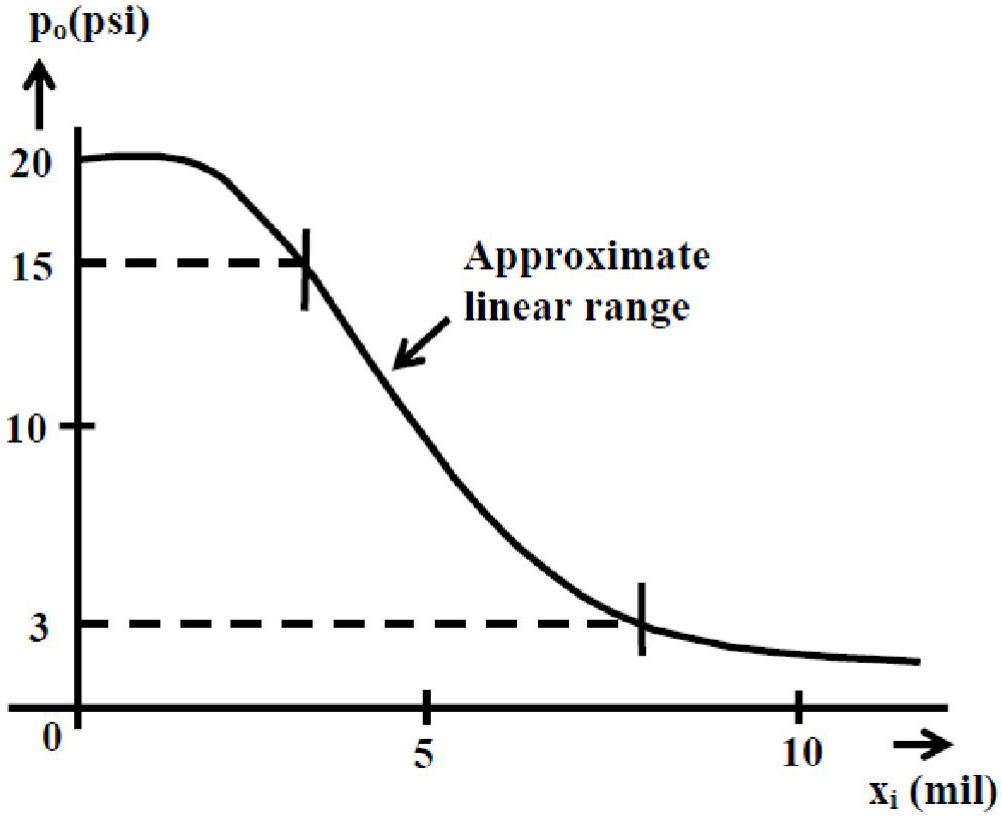
Non-relieving pressure regulator

Relieving pressure regulator

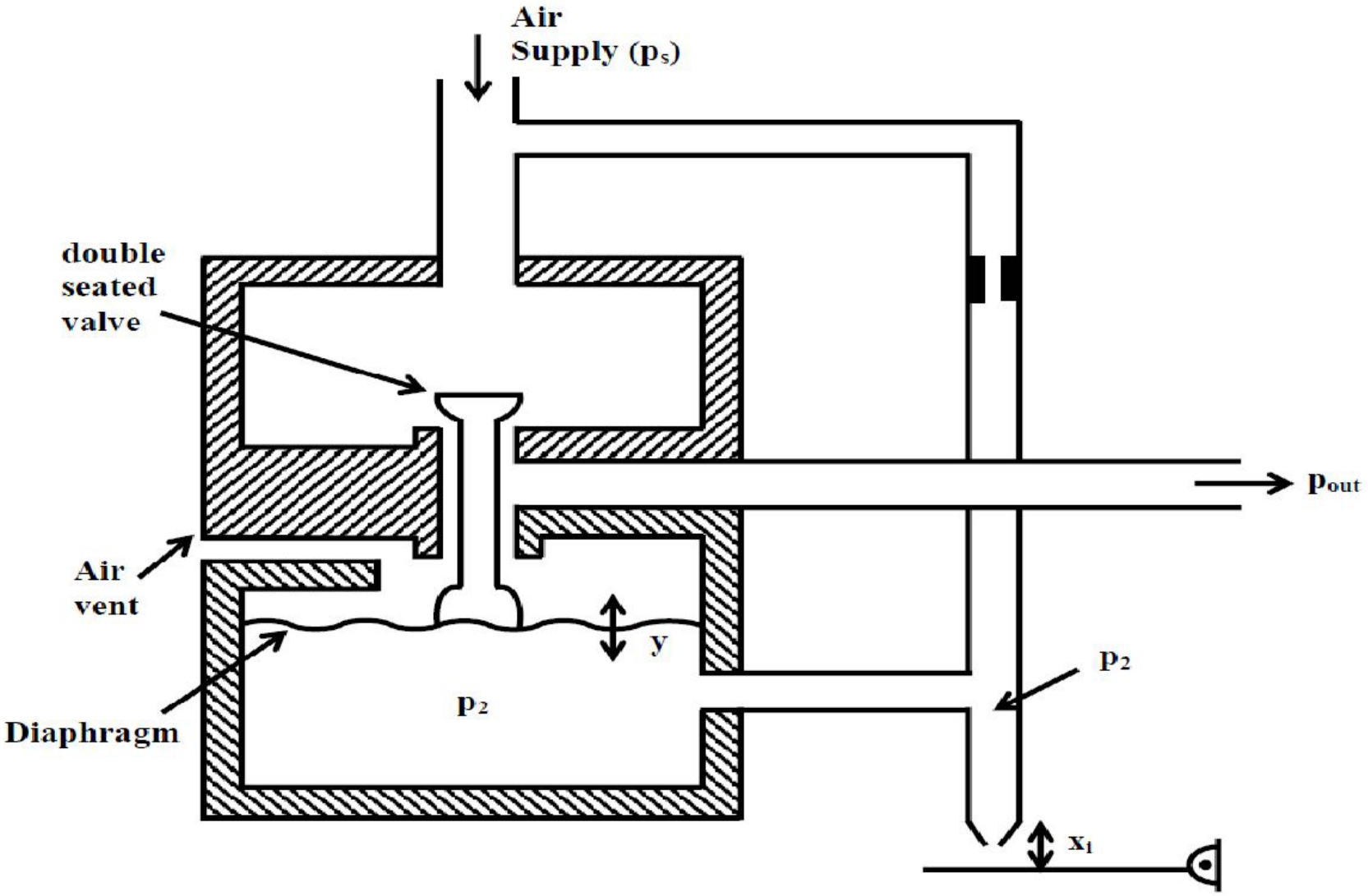


Flapper Nozzle Amplifier




p_o(psi)
20
15
10
3
0
5
10
x_i (mil)
Approximate
linear range

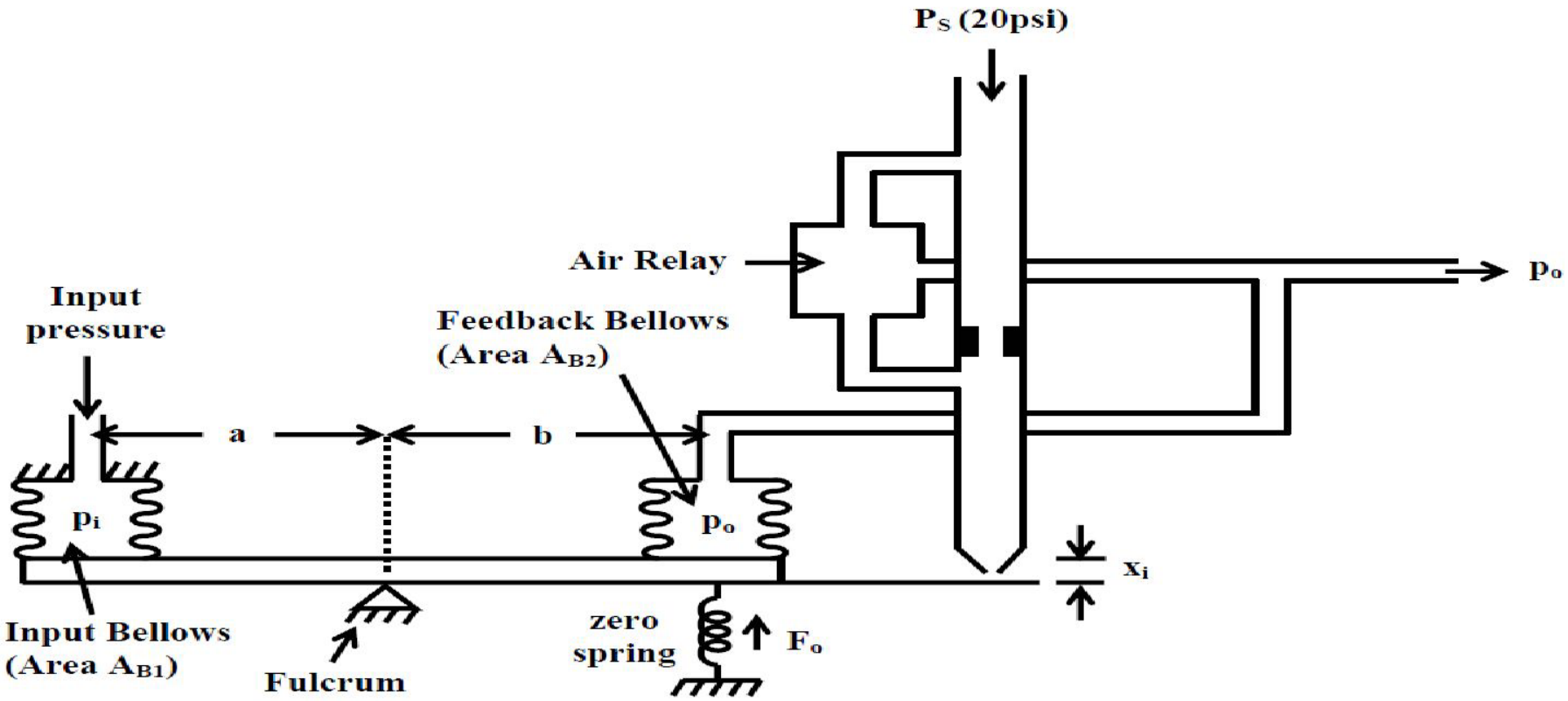
Air relay


Air
Supply (p_s)
double
seated
valve
p_{out}
Air
vent
y
p_2
p_2
Diaphragm
x_1

Pneumatic relays are commonly used to switch air signals from one source to another, supply pressure to or exhaust pressure from a particular line or control device, or to initiate a control function.

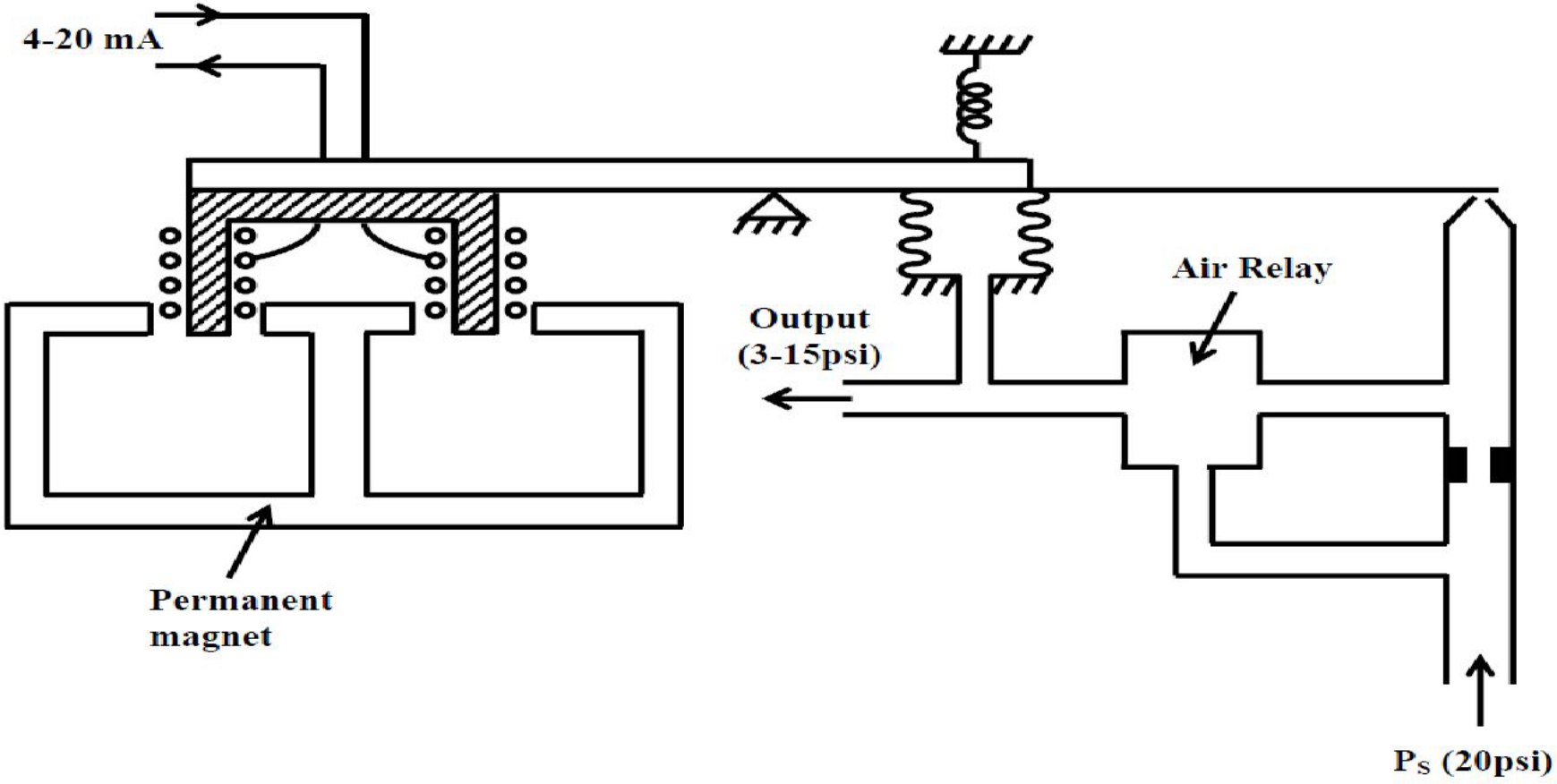
It can be seen from Fig.3 that the air relay is directly connected to the supply line (no orifice in between). The output pressure of the flapper nozzle amplifier (p_2) is connected to the lower chamber of the air relay with a diaphragm on its top. The variation of the pressure p_2 causes the movement (y) of the diaphragm. There is a double-seated valve fixed on the top of the diaphragm. When the nozzle pressure p_2 increases due to decrees in x_i, the diaphragm moves up, blocking the air vent line and forming a nozzle between the output pressure line and the supply air pressure line. So more air goes to the output line and the air pressure increases. When p_2 decreases, the diaphragm moves downward, thus blocking the air supply line and connecting the output port to the vent. The air pressure will decrease.

Flapper nozzle amplifier with feedback



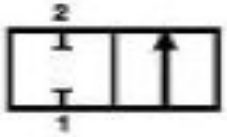
When the input pressure increases, the left side of the link moves down, thus moving the flapper on the right hand side closer to the nozzle. This will increase the nozzle pressure and subsequently the pressure p_0 at the outlet of the air relay. The bellows in the right hand side is connected to this output pressure line. Increase in this pressure will result in more downward force by the output bellows, thus moving the nozzle back to almost its original position. From the expression given in (6), it is apparent that the output pressure here is independent of the diameters of the orifice and nozzle, thus is not affected by the accumulation of dirt or sensitivity variation due to variation of the supply pressure. Moreover the sensitivity can be adjusted by varying the lengths a and b.

I-P Converter

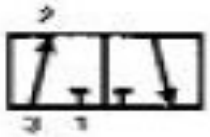


It has been mentioned earlier, that the controller used in process control is normally electronic and for actuation pneumatic actuator is the preferred. Thus there is a need for converting the electrical signal (often 4-20 mA) from the controller to pneumatic 3-15 psi signal. Such a scheme is shown in Fig.5. It is similar to that one shown in Fig.4, except there is an electromagnet and a permanent magnet on the left of the link. The current flowing through the electromagnet causes a force of repulsion between the electromagnet and the permanent magnet. An increase in current through the coil increases the repulsive force, thereby moving the link upward on the left hand side and decreasing the gap between the flapper and the nozzle. The feedback action causes the increase in the output pressure and brings back the link in its equilibrium position.

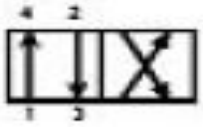
Valve Symbols, Flow Paths and Ports



2-Position, 2-Way, 2-Ported

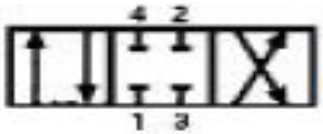


2-Position, 3-Way, 3-Ported

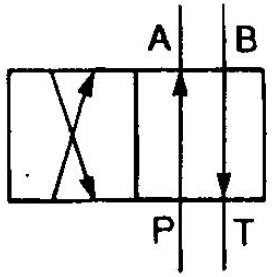


2-Position, 4-Way, 4-Ported

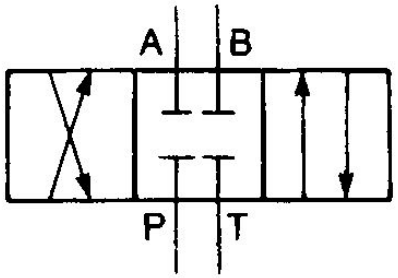
2-Position, 4-Way, 5-Ported



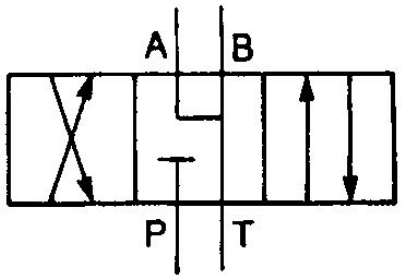
3-Position, 4-Way, 4-Ported
Closed Center



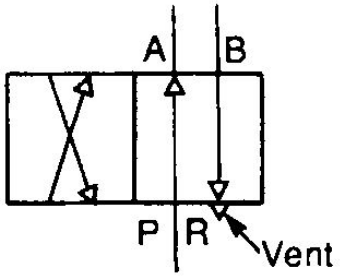
(a) 4/2 valve



(b) 4/3 valve centre off (load isolated)



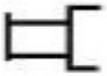
(c) 4/3 valve, load free in centre

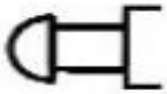


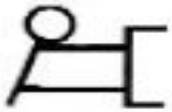
(d) Pneumatic valve with vent (pneumatic valves often represented with unshaded arrowheads)

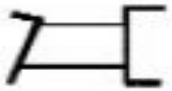
Port	Designation
Working lines	A, B, C and so on
Pressure (power) supply	P
Exhaust/Return	R, S, T and so on (T normally used for hydraulic systems, R and S for pneumatic systems)
Control (Pilot) Lines	Z, Y, X and so on

Actuator Symbols


Manual

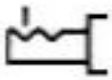

Push Button

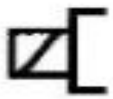

Lever

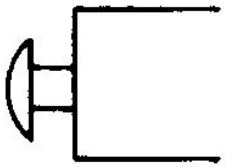

Foot Operated

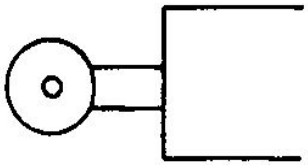

Mechanical

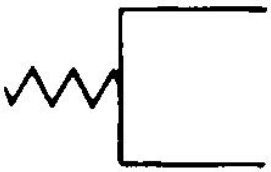

Spring

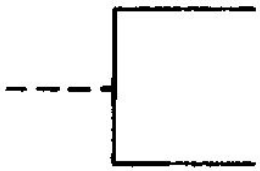

Detent

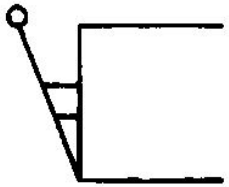

Solenoid

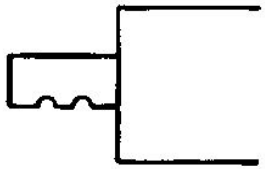

Push button

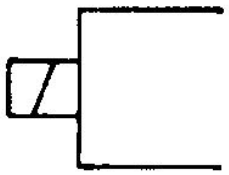

Roller limit SW


Spring


Pressure line (pilot)

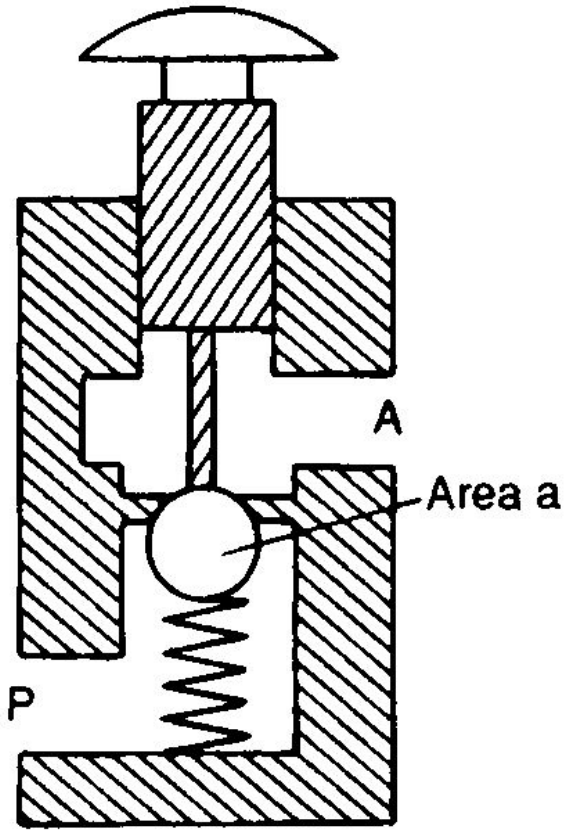

Lever


Detent (holds position)

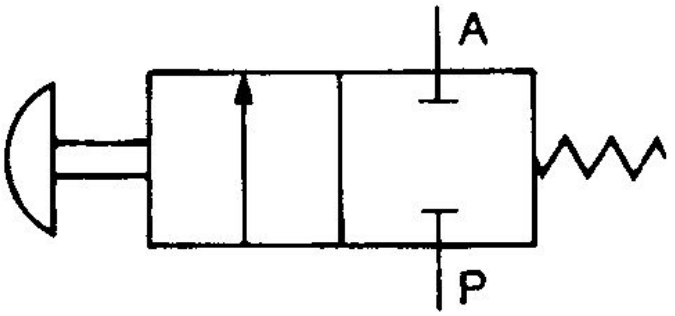

Solenoid

(a) Actuation symbols

Simple 2/2 poppet valve

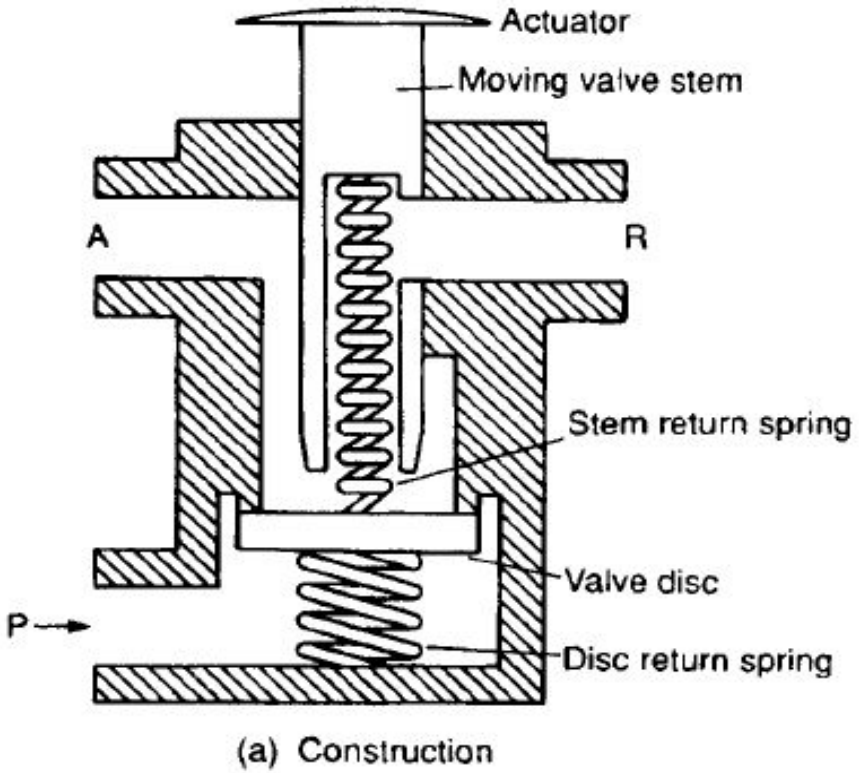


(a) Construction

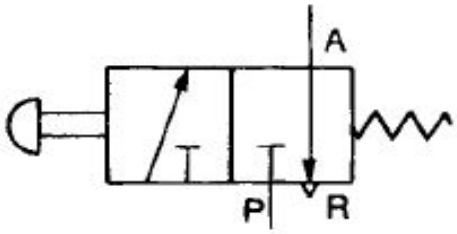


(b) Symbol

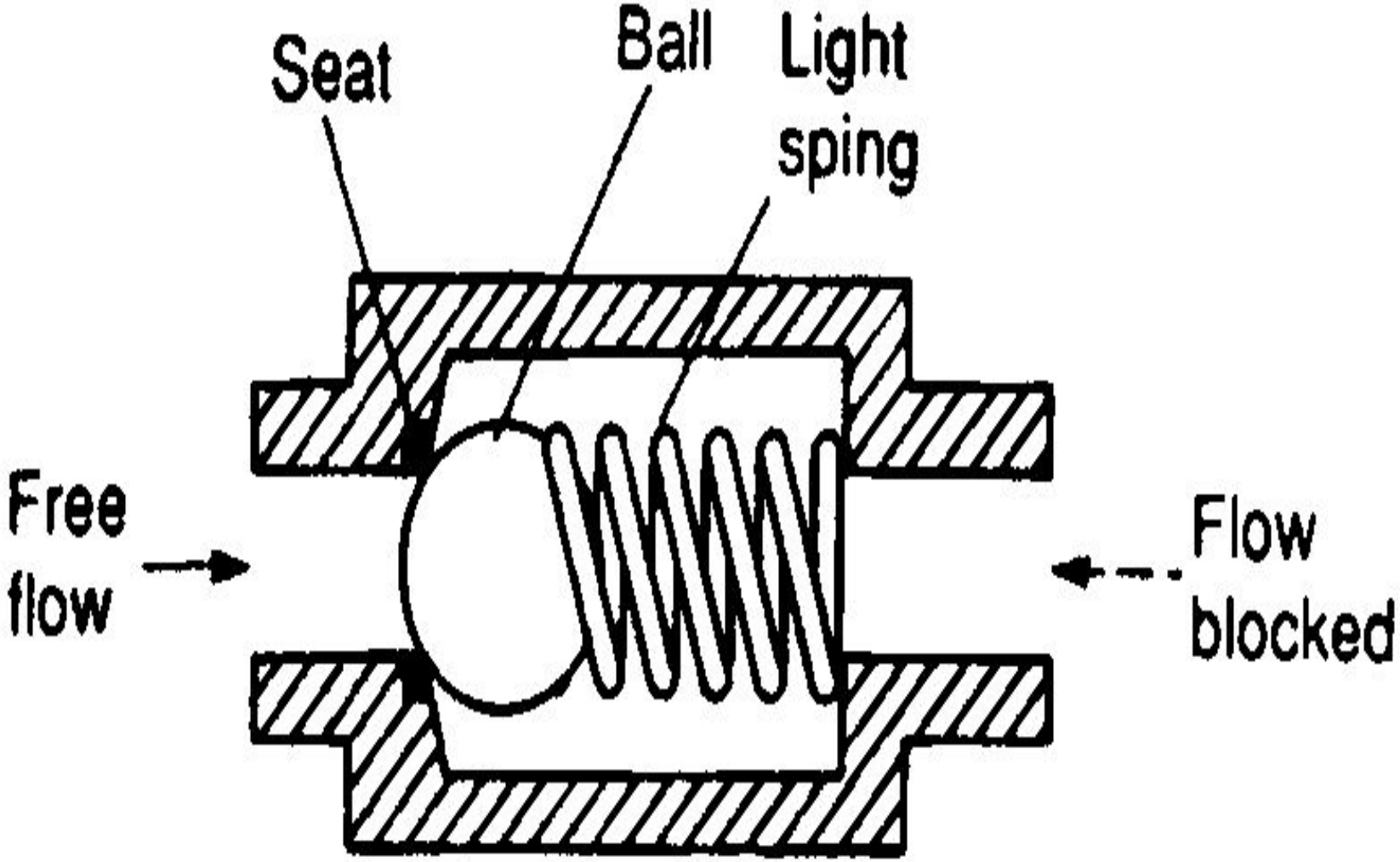
A 3/2 poppet valve



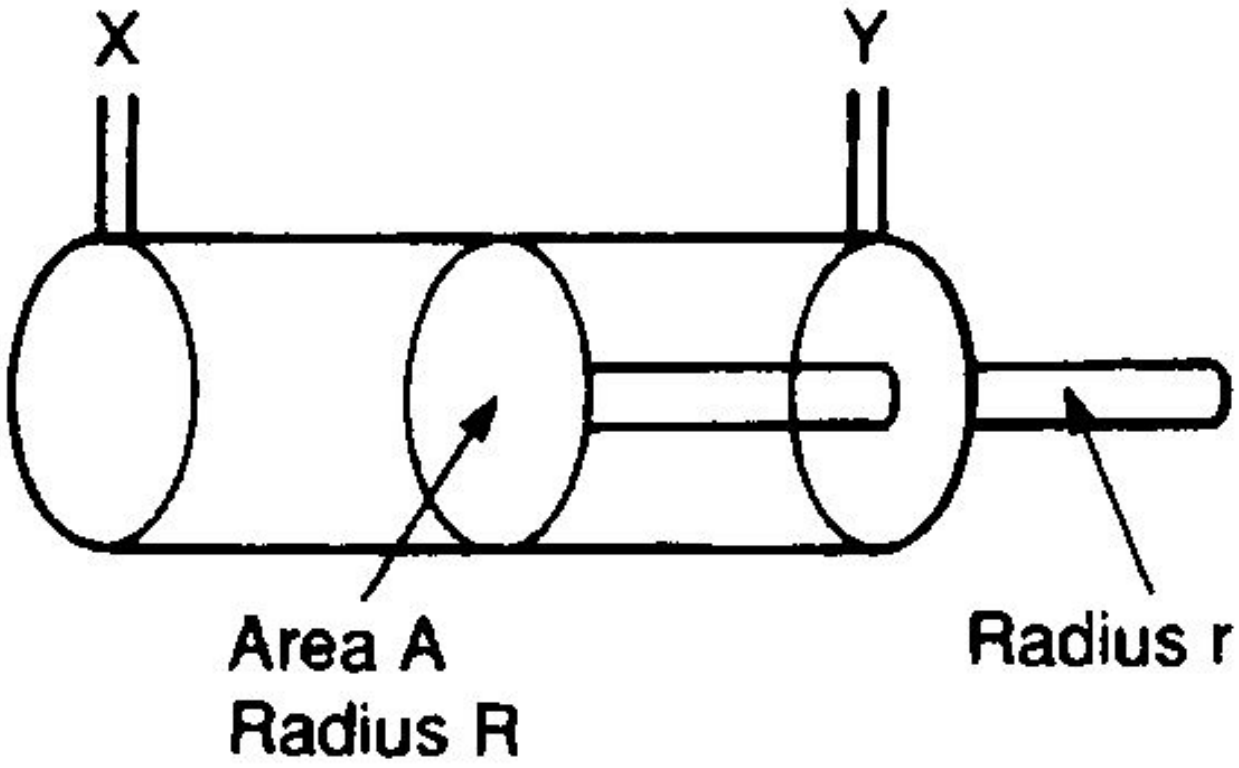
(a) Construction



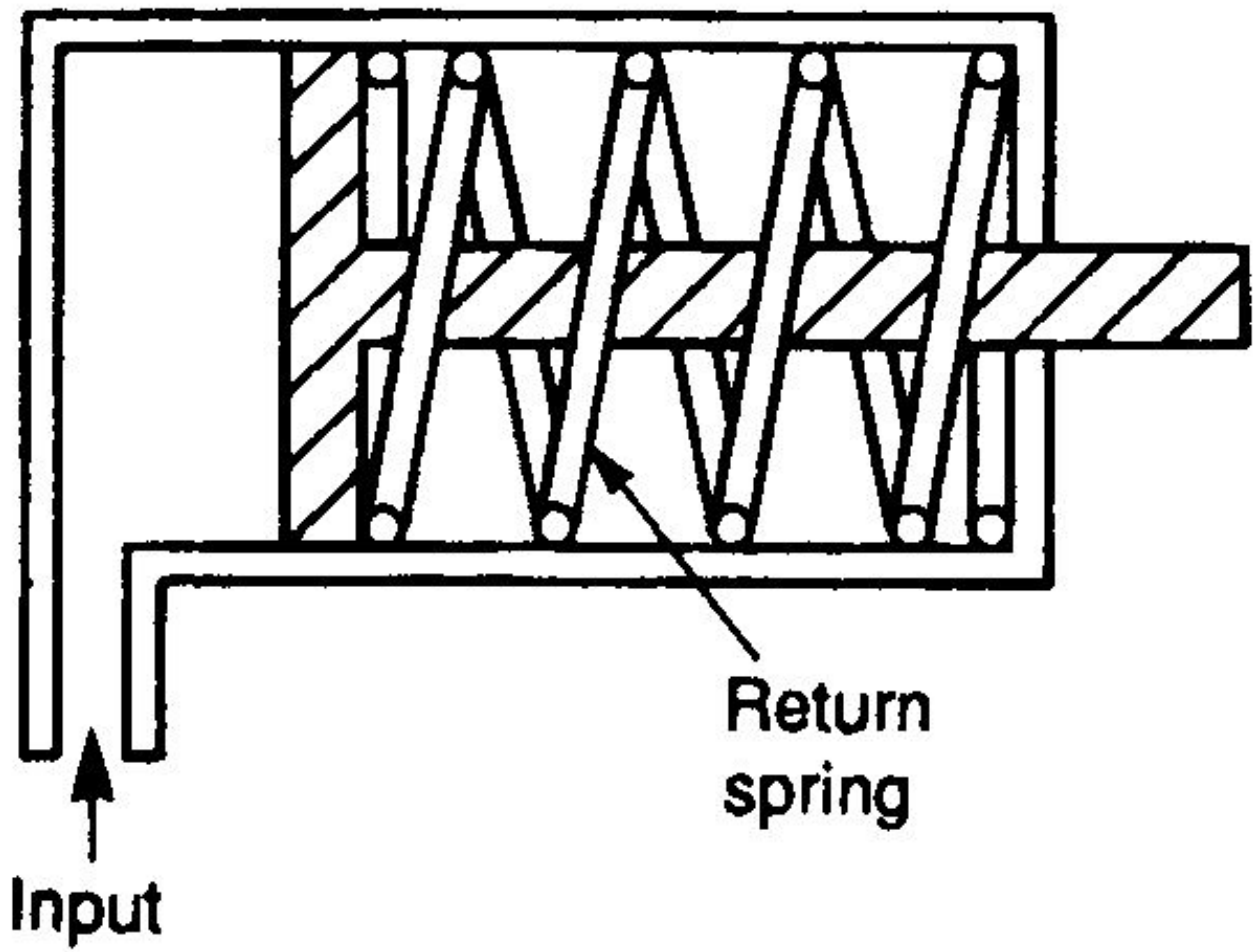
(b) Symbol



(a) Simple check valve



A simple cylinder



Single-acting cylinder

Pilot-operated valve