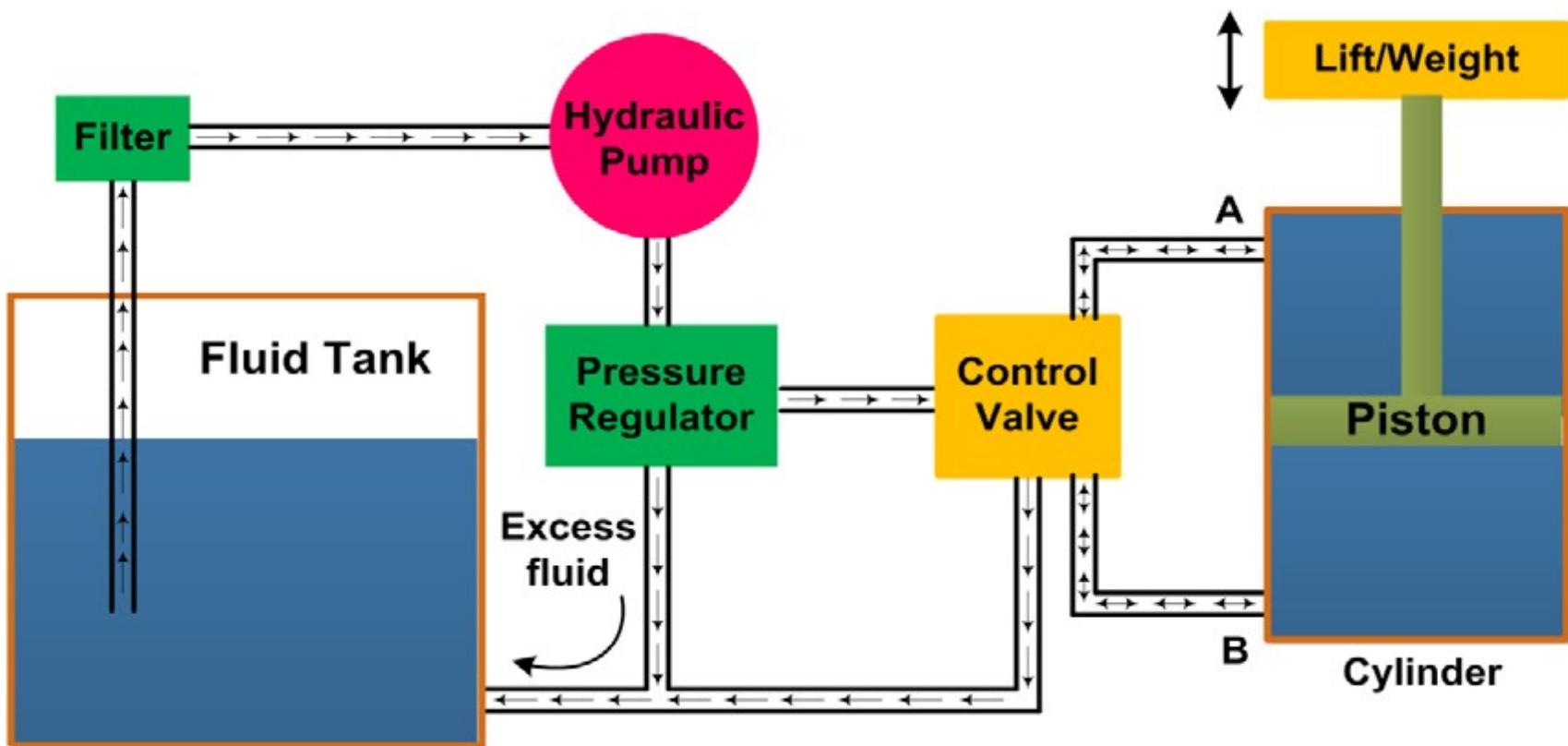


Basic components of Hydraulic & Pneumatic Systems

Basic layout of Hydraulic System



Applications of hydraulic systems

The hydraulic systems are mainly used for precise control of larger forces. The main applications of hydraulic system can be classified in five categories:

- ***Industrial:*** Plastic processing machineries, steel making and primary metal extraction applications, automated production lines, machine tool industries, paper industries, loaders, crushes, textile machineries, R & D equipment and robotic systems etc.
- ***Mobile hydraulics:*** Tractors, irrigation system, earthmoving equipment, material handling equipment, commercial vehicles, tunnel boring equipment, rail equipment, building and construction machineries and drilling rigs etc.
- ***Automobiles:*** It is used in the systems like breaks, shock absorbers, steering system, wind shield, lift and cleaning etc.
- ***Marine applications:*** It mostly covers ocean going vessels, fishing boats and navel equipment.
- ***Aerospace equipment:*** There are equipment and systems used for rudder control, landing gear, breaks, flight control and transmission etc. which are used in airplanes, rockets and spaceships.

4.1 Hydraulic & pneumatic actuators

A) Hydraulic Actuators:- Hydraulic actuators classified in to two groups.

1) Linear Actuators (Hydraulic Cylinder)-

- a) Single (SA) acting cylinder
- b) Double (DA) acting cylinder
- c) Telescopic Cylinder

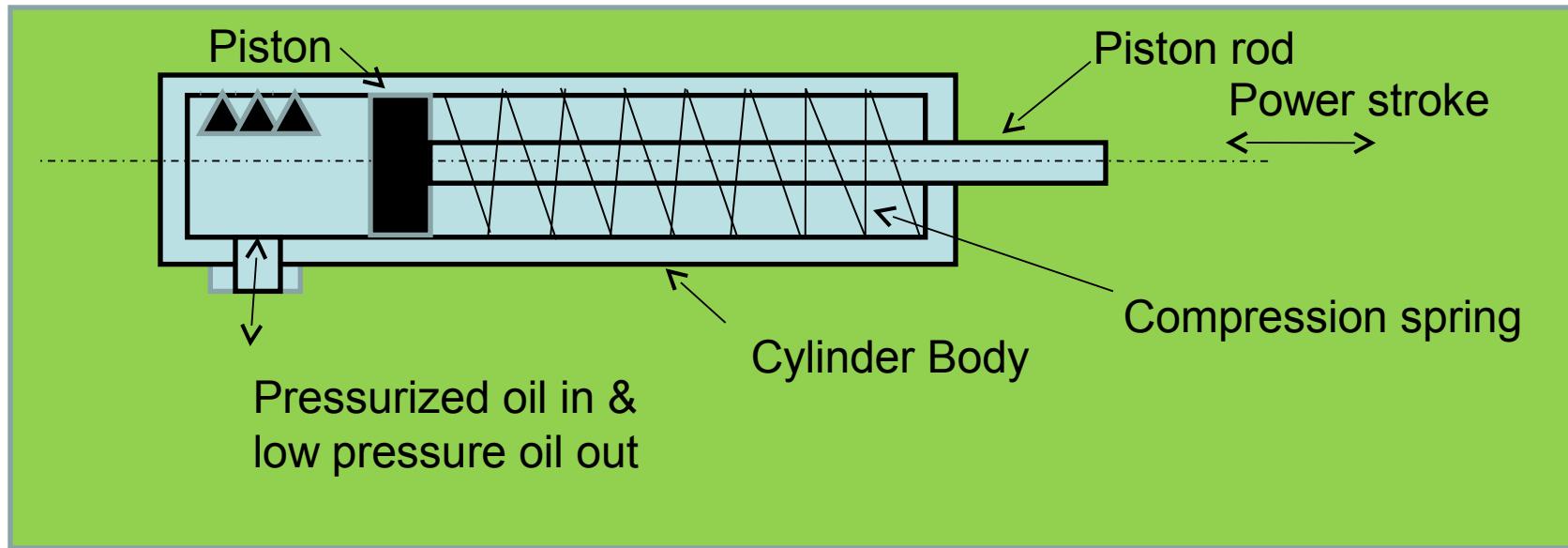
2) Rotary Actuators (Hydraulic Motors)-

- a) Gear motor
- b) Vane motor
- c) Axial Piston motor- i) Swash plate axial piston motor
ii) Bent axis piston motor.

1. Linear Actuators (Hydraulic cylinder)

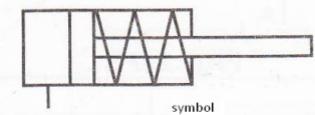
It provides Linear i.e. forward & backward motion.

a) Single acting cylinder (SA) with single piston rod-

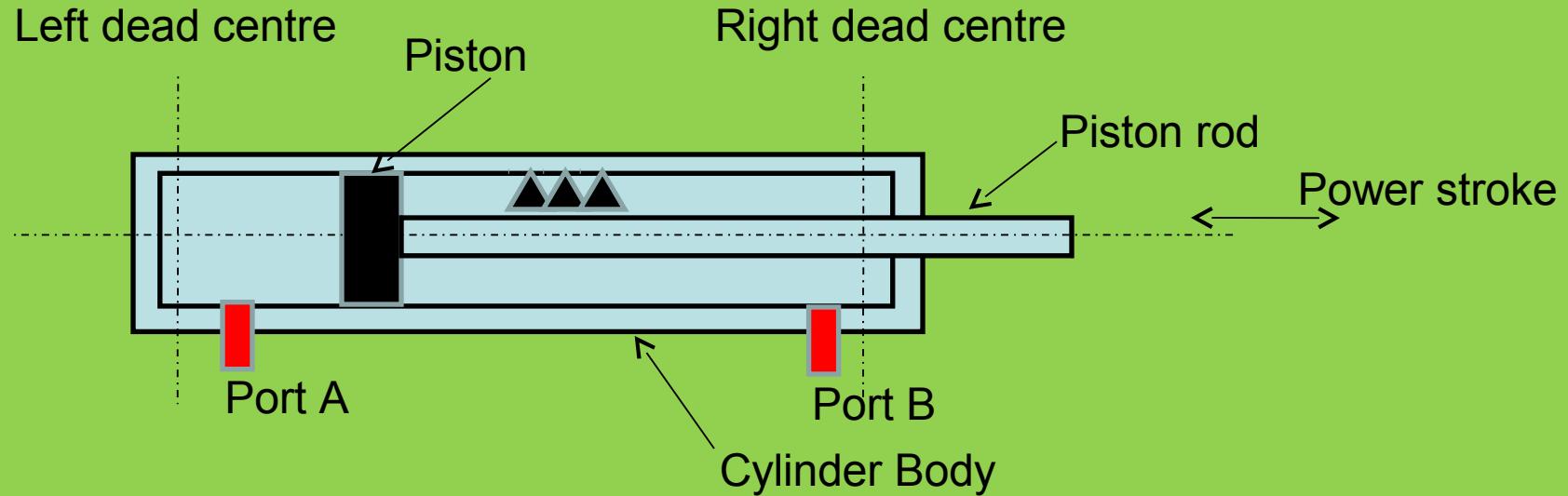


Application:- This cylinder is having applications in sequencing circuit or in clamping the work piece

The symbol is similar to its construction.



b) Double acting cylinder (DA) with single piston rod-

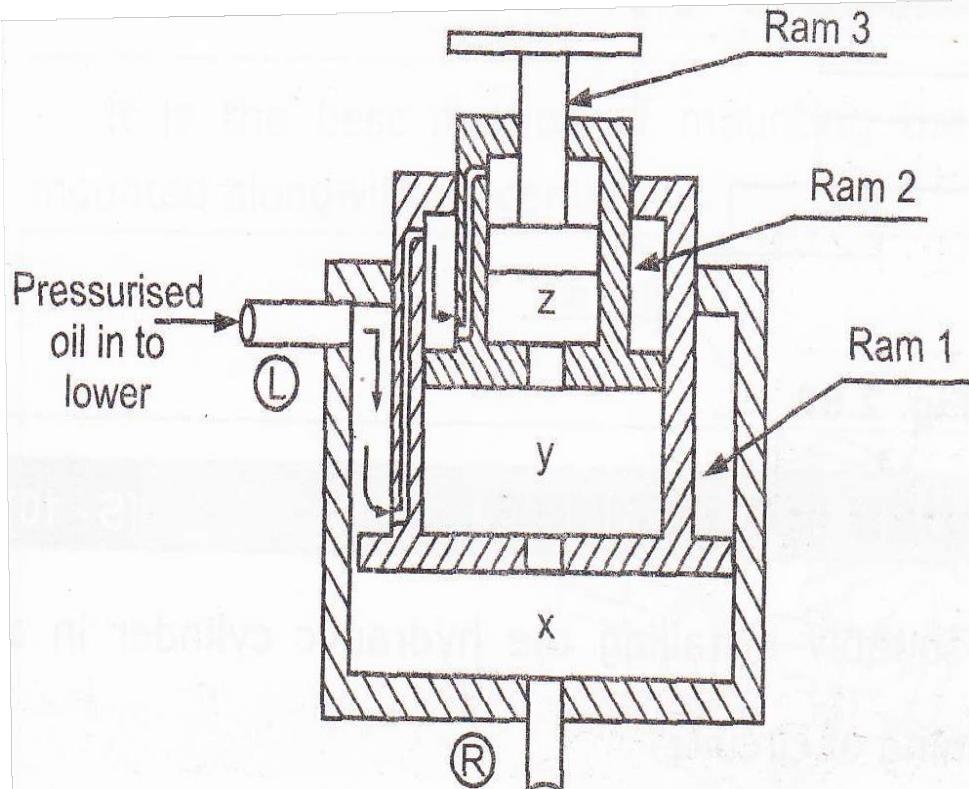


The symbol is similar to its construction.

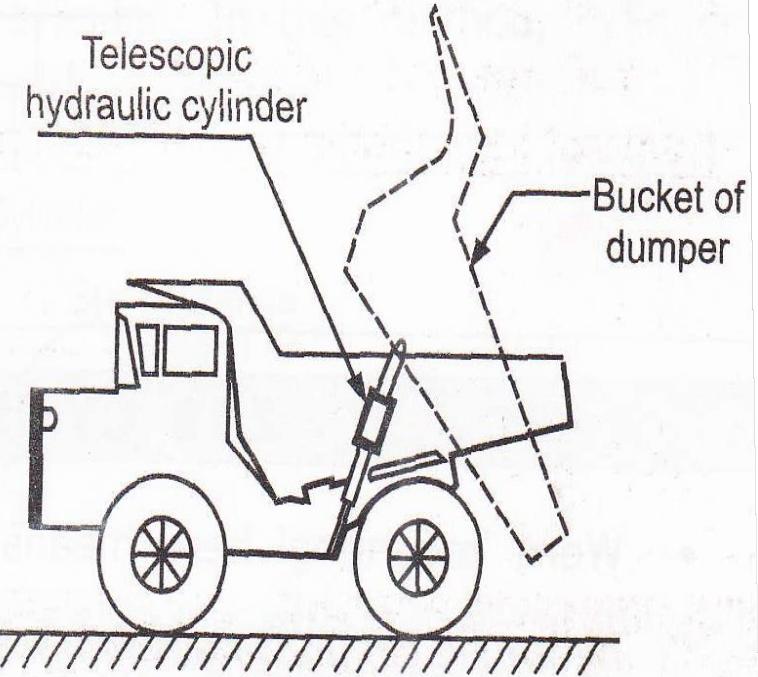


Symbol of
DA cylinder

c) Telescopic Cylinder-

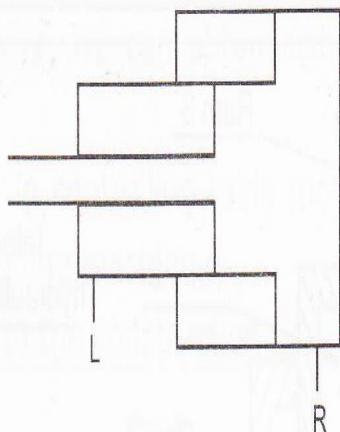


(a)



(b)

Symbol

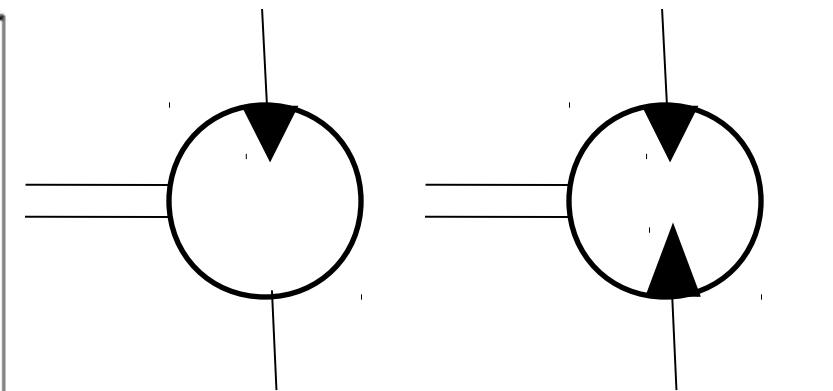
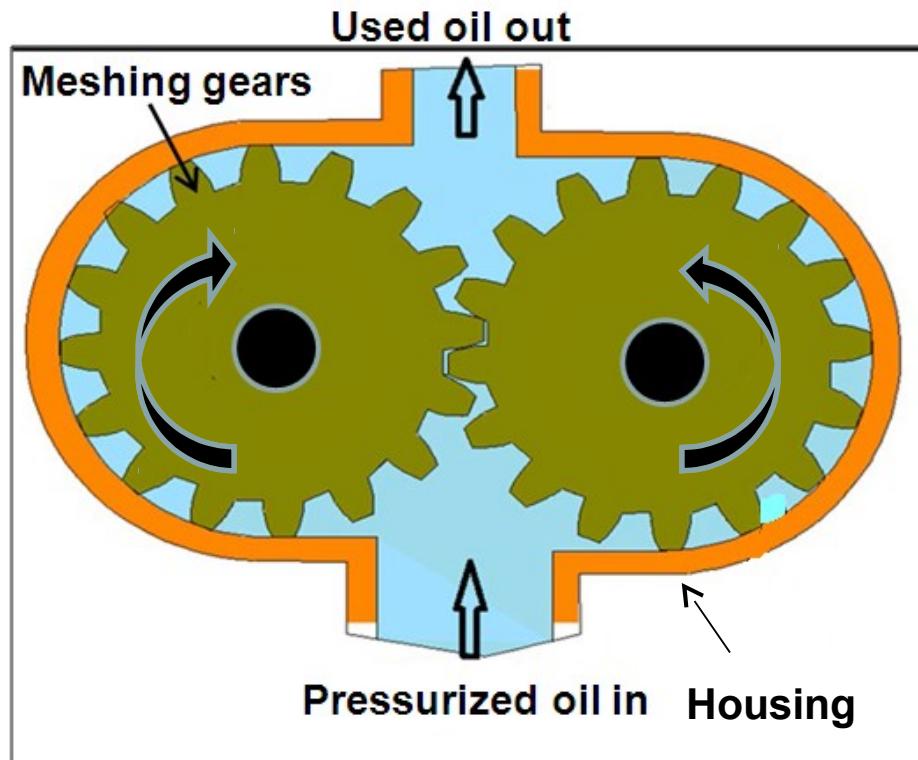


2)Rotary Actuators (Hydraulic Motors)-

-It provides rotational motion

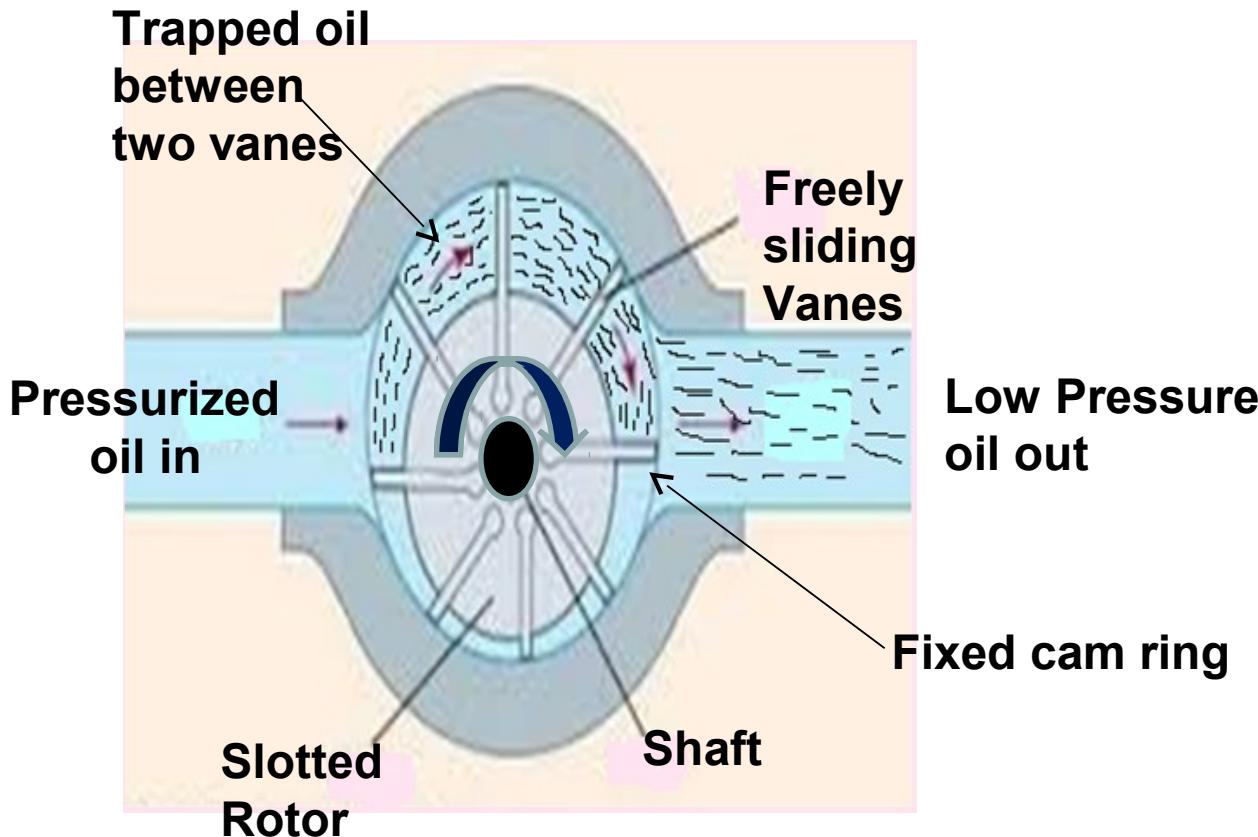
a) Gear motor:- construction similar to gear pump.

It converts hydraulic energy (pressure energy) in to rotary mechanical energy used in many industrial application .



Unidirectional Hydraulic motor Bi-directional Hydraulic motor

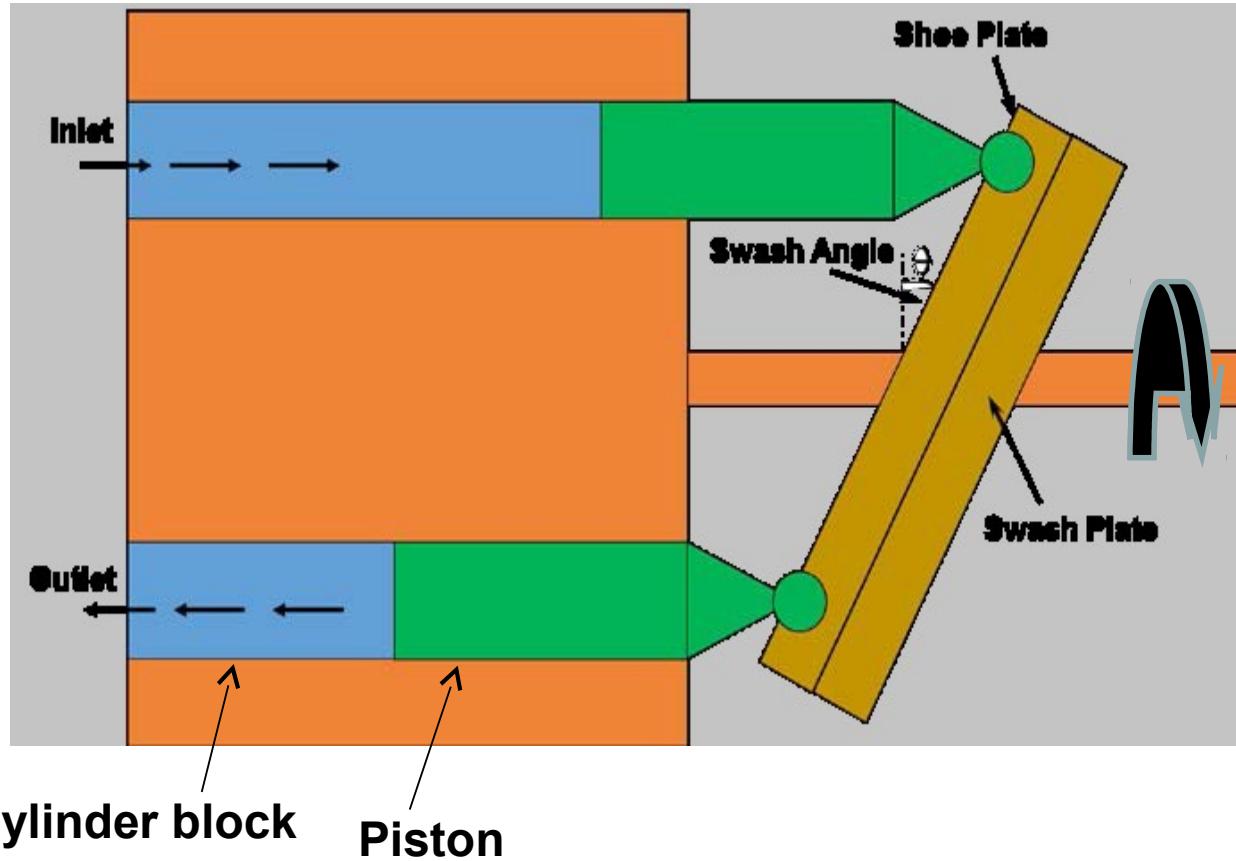
b) Vane motor:- The construction is similar to unbalanced vane type pump. The rotor is eccentric to housing. It is having two types i) unbalanced type ii) Balanced type (**NOT FOR SYLLABUS**)



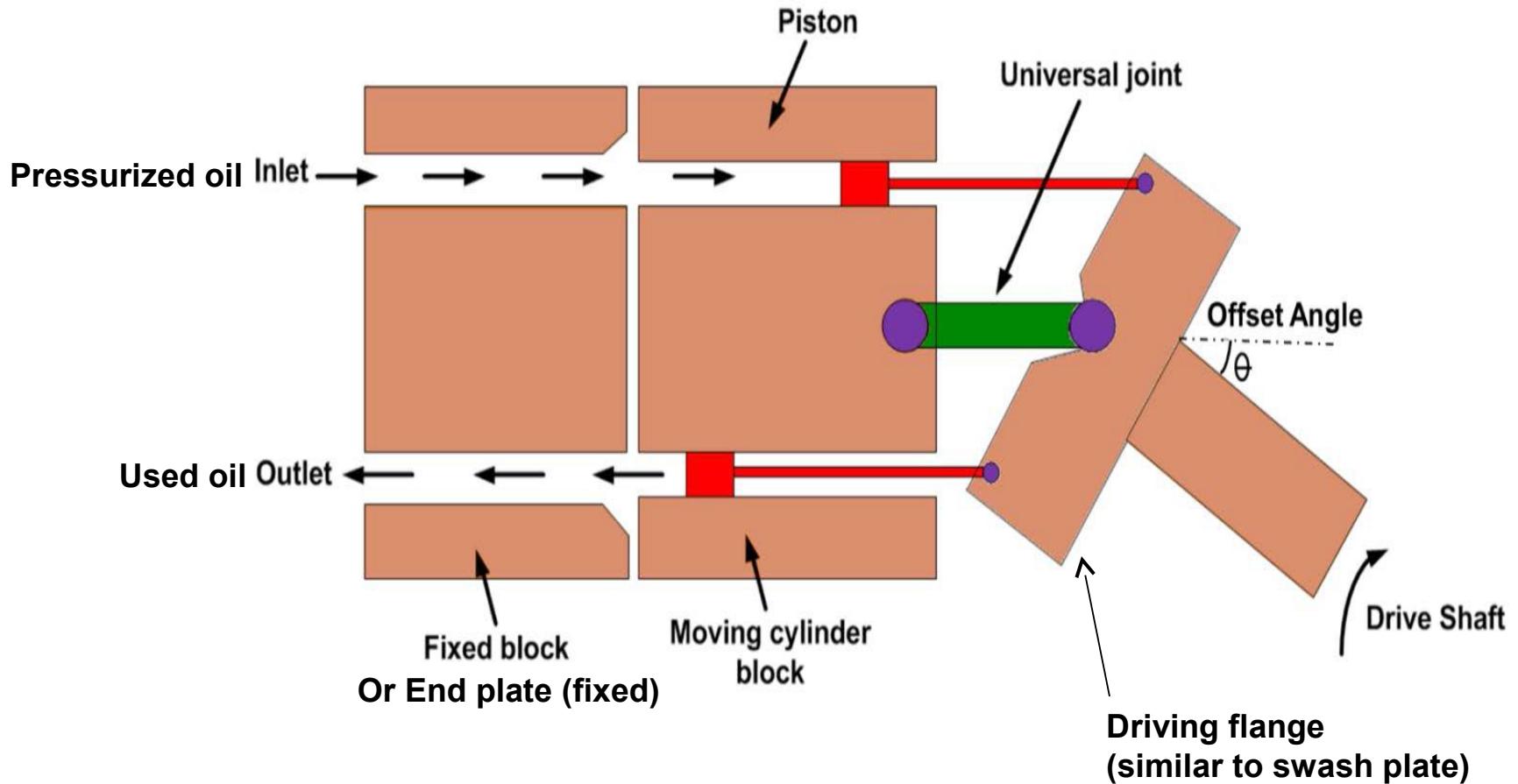
Unbalanced type vane motor

c) Axial Piston motor- Similar to axial piston pumps there are two types:-

i) Swash plate axial piston motor:- It is similar to swash plate axial piston pump. In general it requires minimum 3 nos. piston but for uniform motion no. of piston must be above 7 Nos.



Bent axis piston motor:- Similar to bent axis pump. This motor consists of i) Cylinder block having circumferentially arranged cylinder bores. ii) Pistons iii) Driving flange similar to swash plate iv) Cylinder block end plate (fixed)



Pneumatic Actuators

A) Pneumatic Actuators:- Pneumatic actuators classified in to two groups.

1) Linear Actuators (Pneumatic (Air)Cylinder)-

- a) Single (SA) acting cylinder

- b) Double (DA) acting cylinder

2) Rotary Actuators (Pneumatic (Air) Motors)-

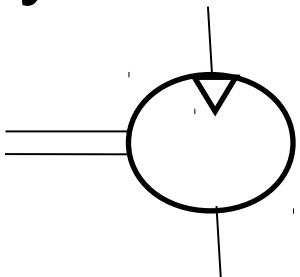
- a) Gear motor b) Gerotor motor

- c) Vane motor d) Turbine motor

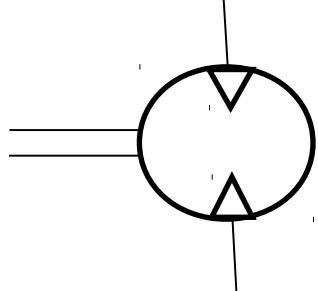
- e) Axial Piston motor-

- i) Swash plate axial piston motor

Symbol of Air motors



**Unidirectional
Air motor**



**Bi-directional
Air motor**

These are rotary actuators & are used to generate “ROTORY MOTION” by using force of compressed air. We can achieve the speed of 10,000 rpm with help of air motors.

Applications:- i) In all pneumatic power tools like screw drivers, angle grinders, straight grinders. ii) To rotate conveyor belts in food industry. iii) Power device in printing press machine. iv) Vibrators.

4.2 Valves for Hydraulic & Pneumatic system

- **Classification of valves:-**

There are basically three types of valves employed in hydraulic systems:

1. **Directional control valves** - route the fluid to the desired actuator or direction.
2. **Flow control valves (Volume control)** - control the amount of flow in order control the speed of actuators.
3. **Pressure control valves** – adjust or regulate the pressure (psi) for system component or end users. It can perform-
 - Limit system pressure
 - Reduce pressures
 - Set pressure at which oil enters a circuit
 - Unload a pump

1. Classification of directional control valves

Directional control valves can be classified in the following manner:

1. Type of construction:

- Poppet valves or seat valve
- Spool valves – i) Sliding spool ii) Rotary spool

2. Number of ports:

- Two- way valves
- Three – way valves
- Four- way valves.

3. Number of switching position:

- Two – position
- Three - position

4. Actuating mechanism:

- **Manual actuation** (Manual actuators are hand lever, push button and pedals etc.)
- **Mechanical actuation** (The DCV spool can be operated by using mechanical elements such as roller and cam, roller and plunger and rack and pinion etc.)
- **Solenoid actuation** The solenoid actuation is also known as electrical actuation.)
- **Hydraulic actuation**(This type actuation is usually known as pilot-actuated valve)
- **Pneumatic actuation** (DCV can also be operated by applying compressed air against a piston at either end of the valve spool.)
- **Indirect actuation** (The direction control valve can be operated by manual, mechanical, solenoid (electrical), hydraulic (pilot) and pneumatic actuations.)

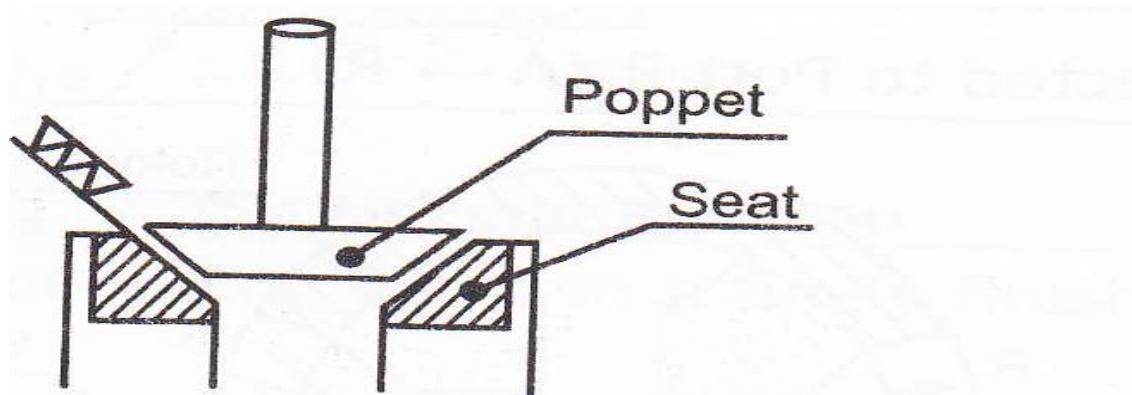
1. Seat or poppet valve:- In this valve a poppet or ball or similar item like plate or cone is made to seat over a specially constructed finely machined & polished seat.

ADVANTAGES :- i) Suited for very high pressure applications.

ii) Very minor leakage.

Disadvantages:- i) Not suitable for large valve size.

ii) Complicated construction & cost is high.



: Seat or Poppet Type DC Valve

2. Spool Valve

A) Sliding spool:- In this valve there is small piston inside a valve casing which slides inside the casing thereby opening ports (drilled or closing the holes) in the valve body,

- Advantages:-

- (a) Simple in construction.

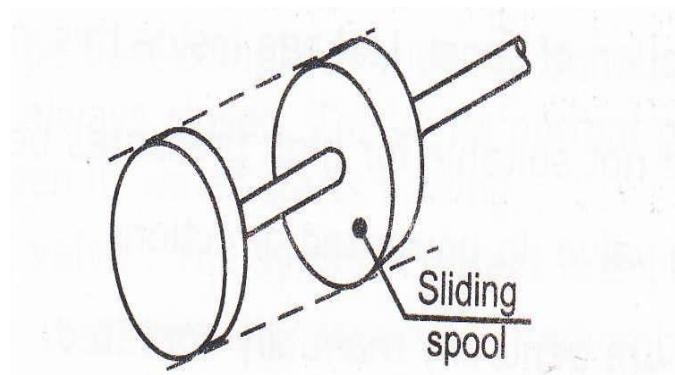
- (b) Cost is low.

- (c) These valves are permanently balanced.

- Disadvantages :

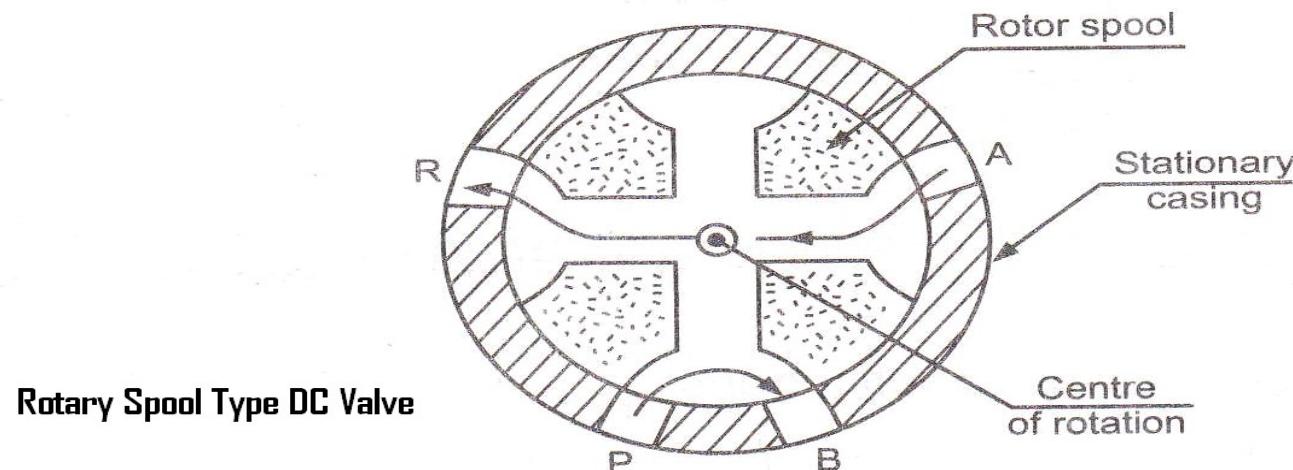
- (a) Leakage inside the valve is possible.

-sliding spool type DC valve is most widely used valve.



B) Rotary Spool Type DC Valve:- Rotary spool valve consists of a rotating spool which aligns with ports in the stationary valve casing, so that fluid is directed to the required port. A/B/P/R are the ports in casing. Port 'P' is pressure port through which pressurized oil is coming in the valve. 'R' port is the port through which used oil is returning to the oil tank. From fig it is clear that:-

Port P is connected to Port B ($P \rightarrow B$) and
Port A is connected to Port R ($A \rightarrow R$).



Advantages of rotary DC valves:-

- i) These are compact & simple in design.
- ii) Are having low operating forces.

Disadvantages:-

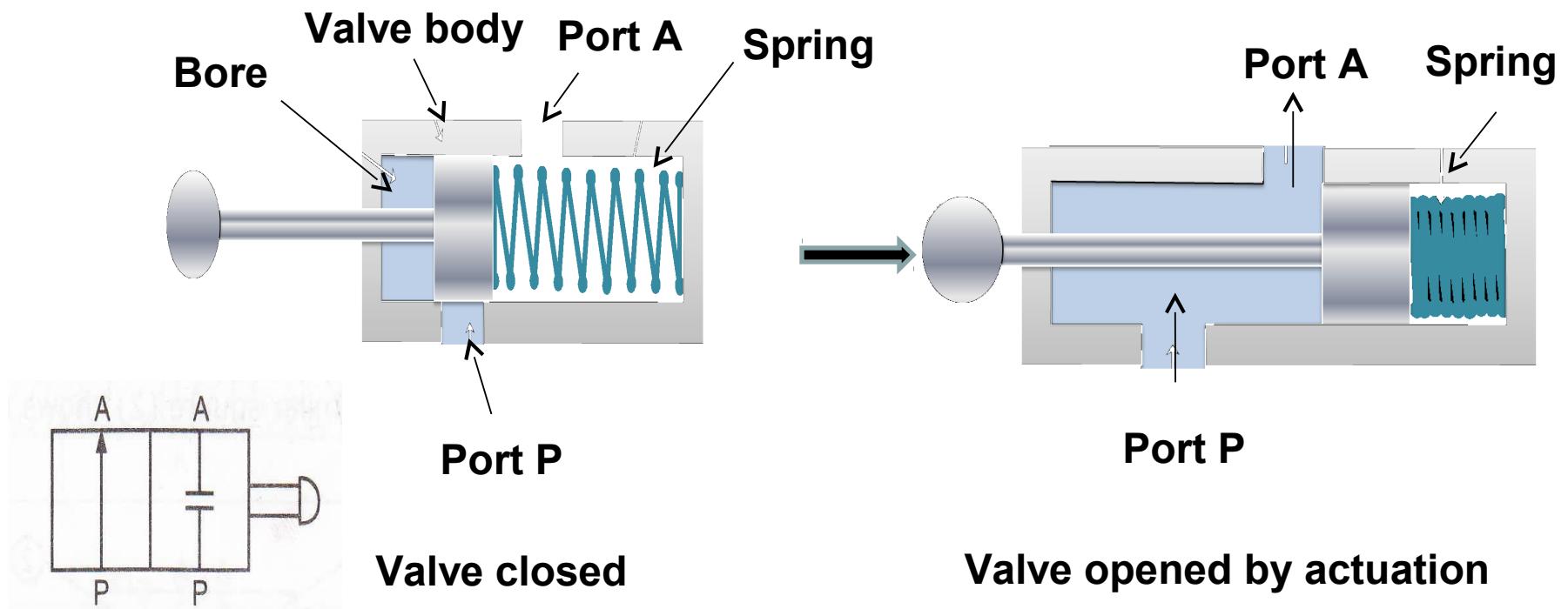
- i) Due to rotary motion of spool, leakage inside this valve is possible.
- ii) These valves are not suitable for high pressures because sometime pressure of oil rotates the valve in unwanted directions.

These are generally manually operated.

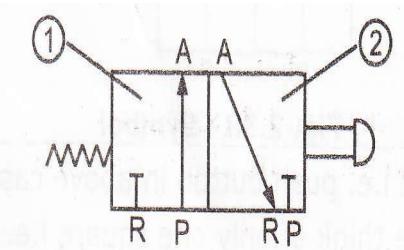
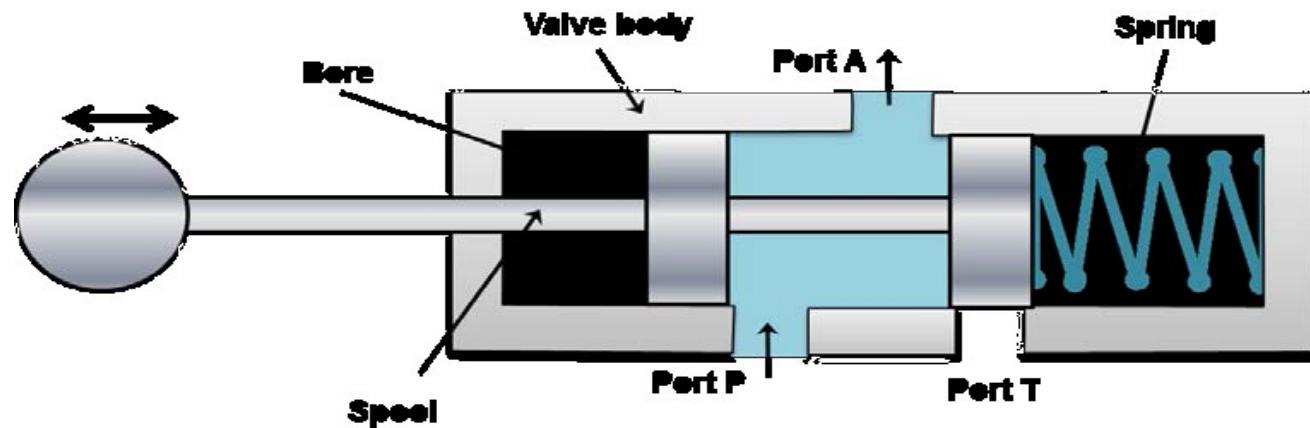
Types of DC valves based on Number of ports (Spool Type) :-

- i) 2x2 DC valve (compared with ON-OFF water tap in house)
- ii) 3x2 DC valve
- iii) 4x2 DC valve
- iv) 4x3 DC valve
- v) 5x2 DC valve

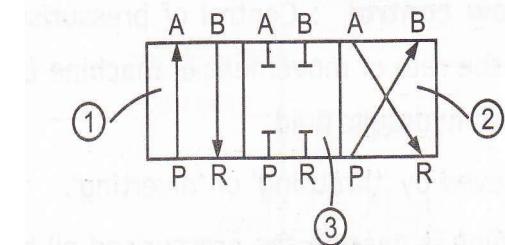
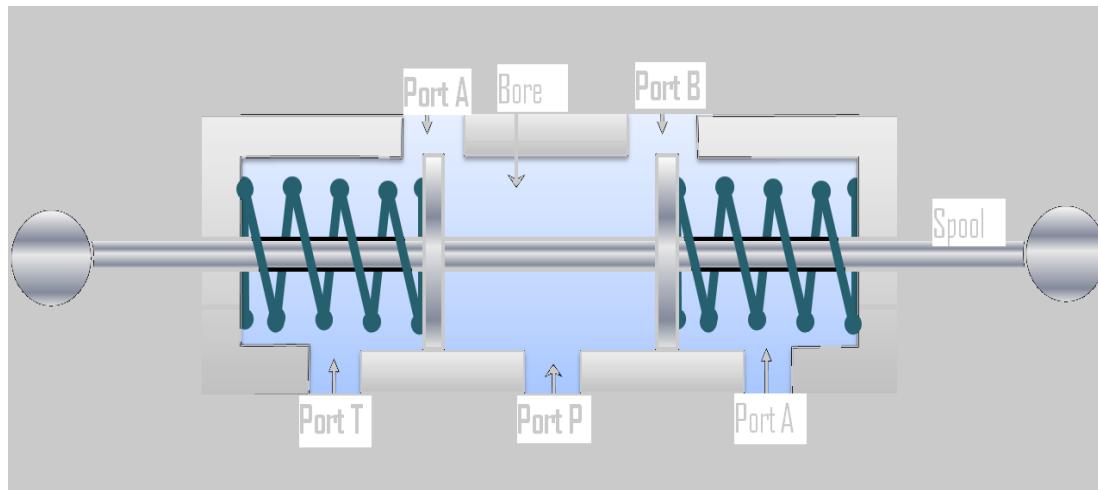
i) 2x2 (Read as 'two –by- two) DC valve:-



ii) Three way valve:- 3x2



iii) Four Way valve:-4x3



2. Classification of Flow or Volume control valves

1. Flow control -Control amount of flow & it is achieved by “Throttling or Diverting”.

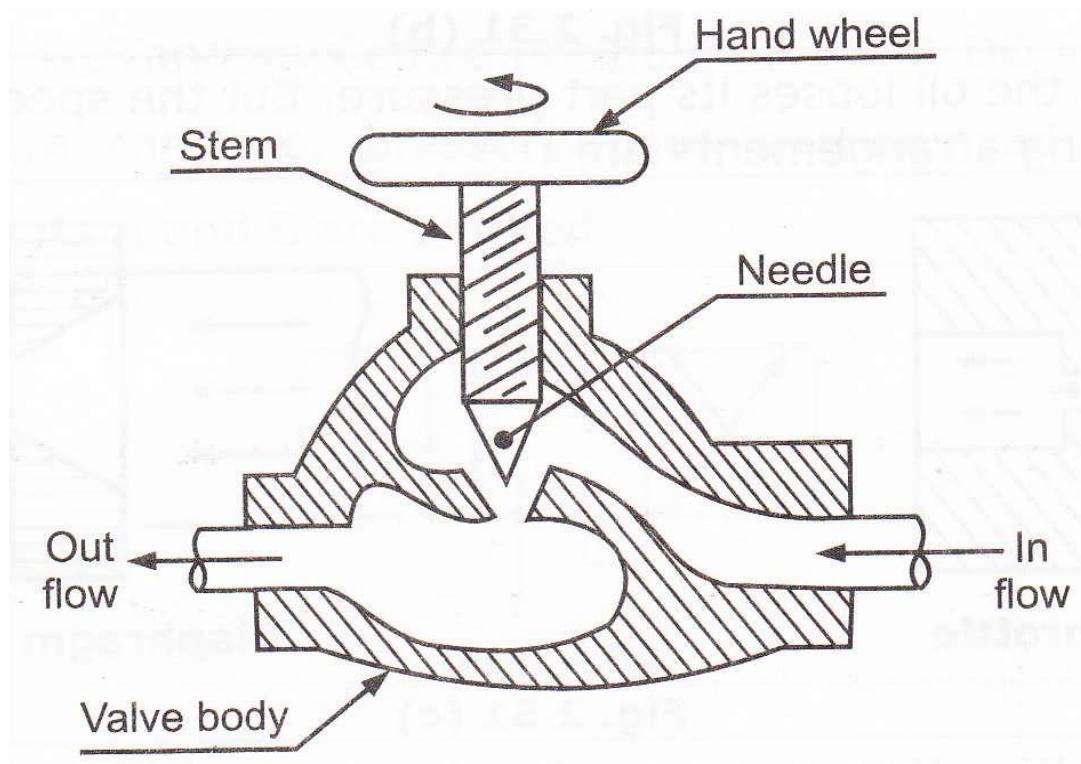
1. Fixed type flow control valve (Pressure Compensated flow control valve).
2. Variable flow control valve (Non-compensated flow control valve)

Types:-

- I) Needle valve (two way flow control valve)
- II) Pressure compensated flow control valve.
- III) Non-compensated flow control valve.
- IV) Check valve.

A) Needle Valve:-It has a pointed stem or needle that can be adjusted upward or downward by rotating the hand wheel. Since stem is threaded we can accurately control the needle which in turn controls the out flow. This is the most commonly used flow control valve in many hydraulic system.

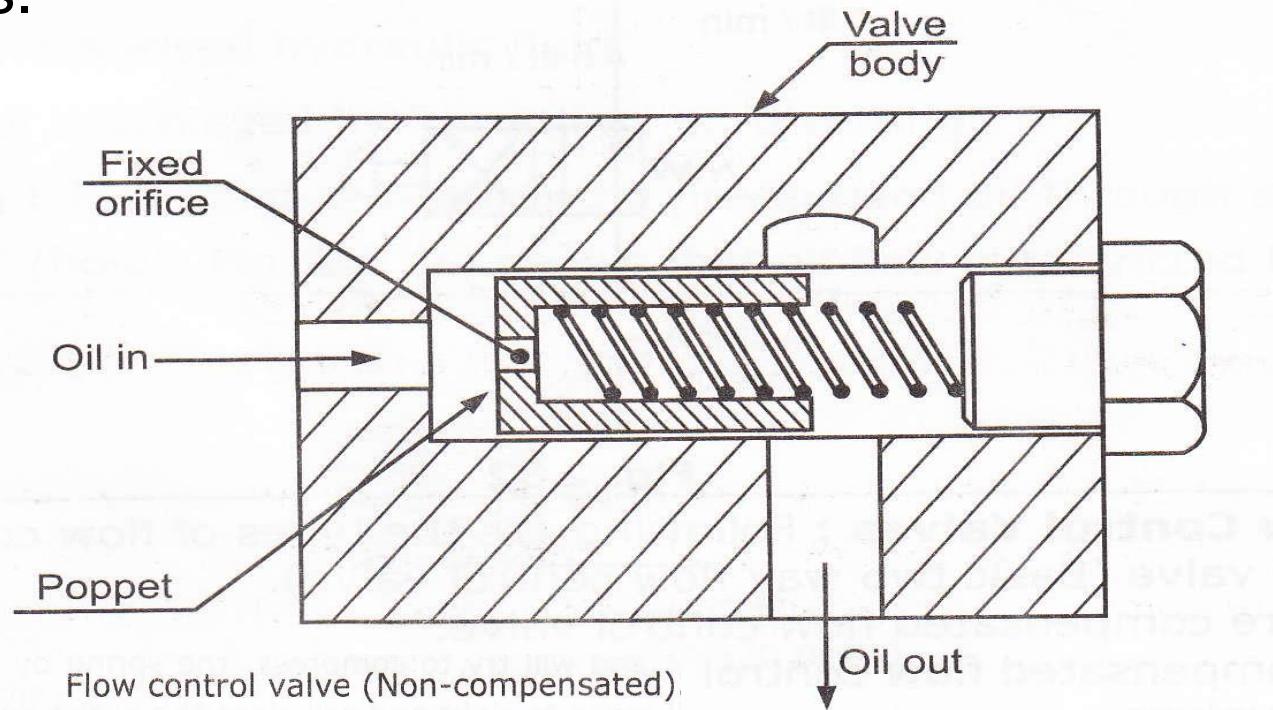
This valve is used as 'stop valve' or shut-off the flow.



B) Pressure compensated flow control valve:-

In any hydraulic circuit there are slight variations in pressure of oil. When pressure changes, the rate of flow changes. But many circuits require constant flow regardless of input or output pressure variations in circuit. Then we must use pressure compensated flow control valve.

Applications:- These valves are used in material handling systems.

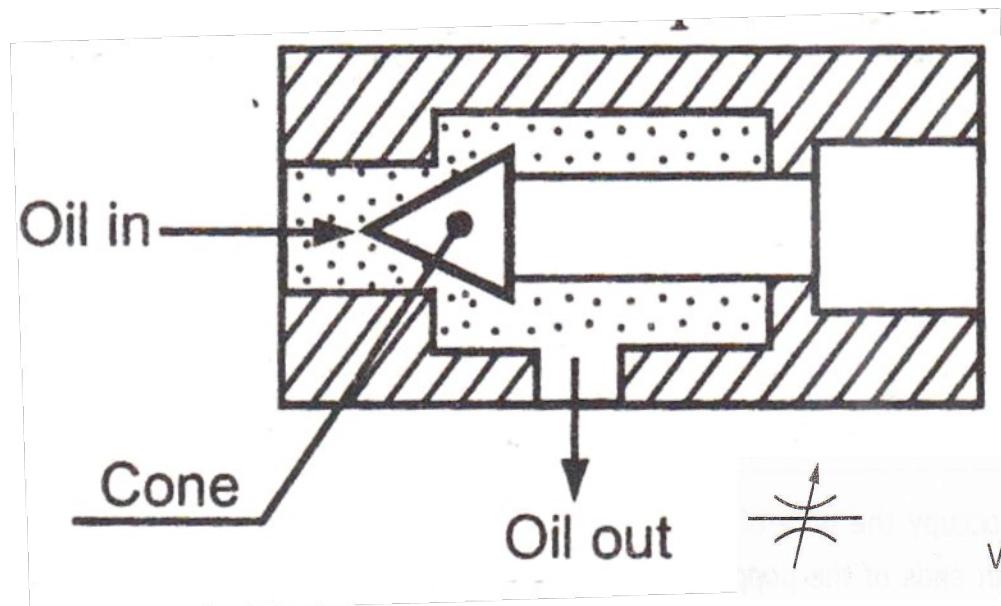


C) Non- compensated flow control valve:-

Non -compensated flow control valve that controls the flow by throttling or restricting. Needle vale we have seen is non –compensated valve.

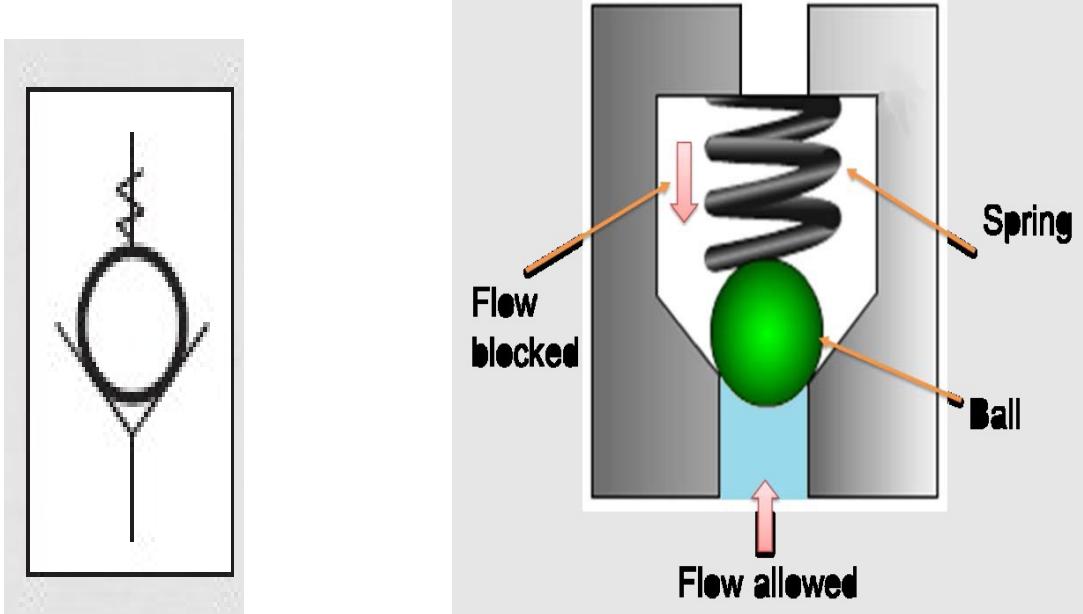
Applications:-

These valves are used where accuracy in actuator movement & speed of actuator is not important.



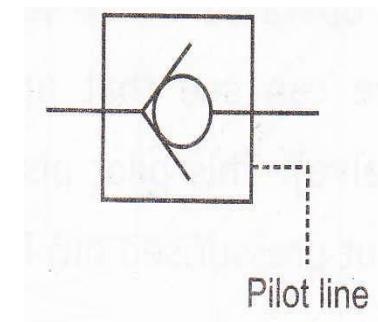
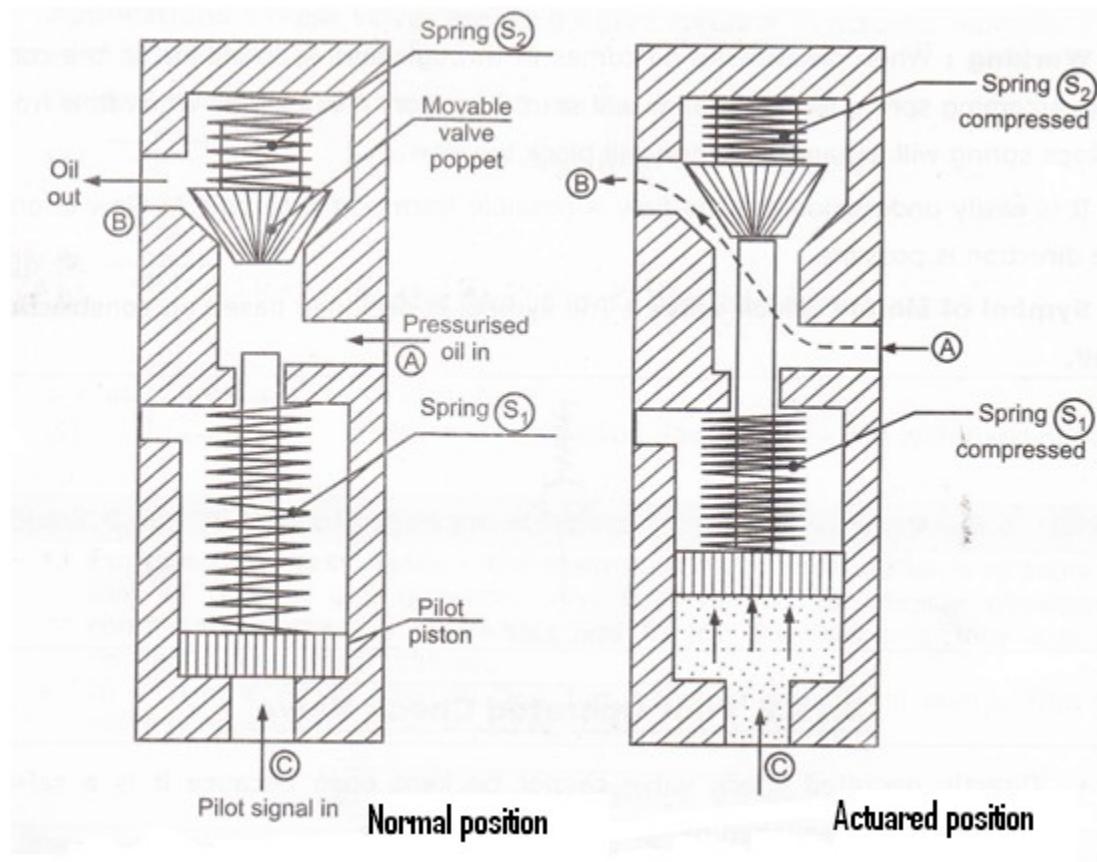
Variable flow control valve (Non-compensated)

D) i) Check valves (Non-return Valve NRV):-



These are ~~unidirectional valves~~ and permit the free flow in one direction only. These valves have two ports: one for the entry of fluid and the other for the discharge. They are ~~consists~~ of a housing bore in which ball or poppet is held by a small spring force.

ii) Pilot operated check valve:- it is the modification of directly operated check valve. if we want continuous flow from port a to b for specific period.



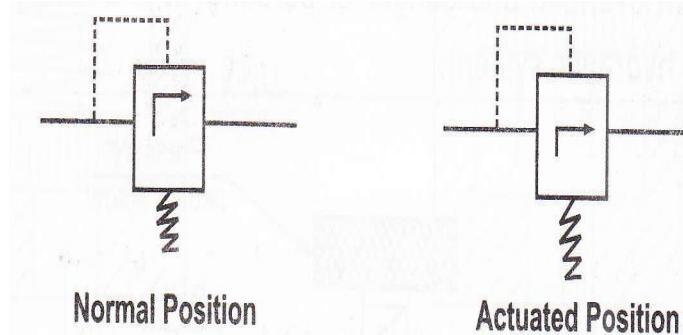
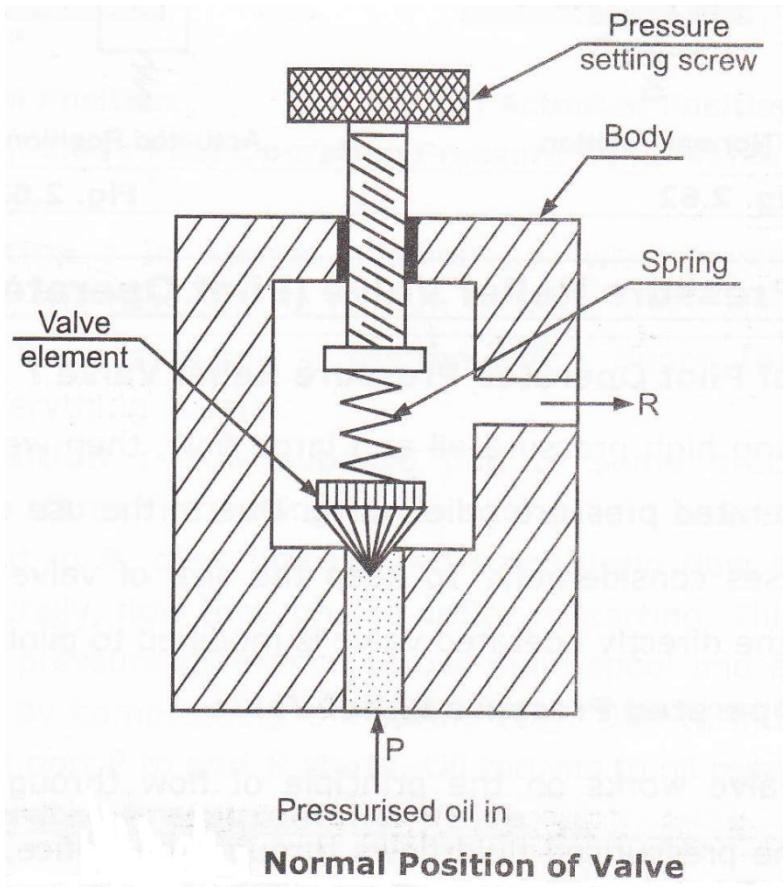
symbol

3. Pressure Control & regulating valves.

Pressure control valves maintain the desired pressure level the various parts of the hydraulic circuit.

- Types:-
 - (a) Pressure Relief Valve (Directly Operated)
 - (b) Pressure Relief Valve (Pilot Operated).
 - (c) Pressure Reducing Valve.
- Its main function is to limit the pressure in the system and thus to protect the individual component and hydraulic oil carrying lines from overload and danger of bursting. It is a safety valve. It takes care of safety of the hydraulic system.

a) Directly Operated pressure relief valve:-



END OF PRESENTATION

*Wish u all Happy & Prosperous
Dipawali.*