

POSTAL **Book Package**

2021

Mechanical Engineering

Conventional Practice Sets

Robotics and Mechatronics

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Actuators and Stepper Motor

Q1 List out any six inherent characteristics of a hydraulic actuator.

Solution:

Six characteristics of a hydraulic actuators are:

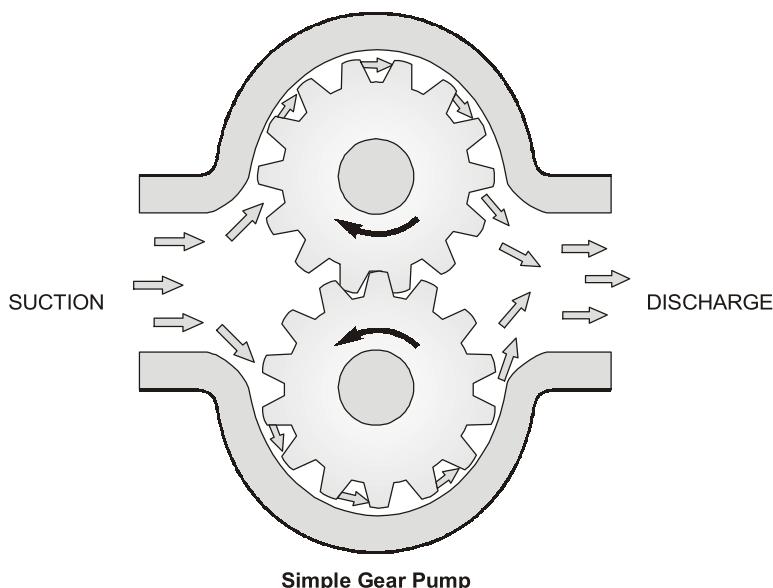
- (i) It has higher load carrying capacity.
- (ii) Its power to weight ratio is high.
- (iii) It can produce large forces to drive loads.
- (iv) Its manufacturing cost and maintenance cost is high.
- (v) It has high accuracy and fast response.
- (vi) It posses certain safety concern as leakage of oils is undesirable and should be avoided.

Q2 Explain the working of a gear pump with the help of a schematic diagram. Also detail its other properties.

Solution:

Working principle of Gear pump: A gear pump uses the meshing of gears to pump fluid by displacement. They are one of the most widely used types of pumps for hydraulic fluid power operators. As the gears rotate they separate on the intake side of the pump, creating a void and suction which is filled by fluid. The fluid is carried by the gears to the discharge side of the pump, where the meshing of the gears displaces the fluid. The mechanical clearances are small-in the order of 10 mm. The tight clearances, along with the speed of rotation, effectively prevent the fluid from leaking backwards. The rigid design of the gears and houses allow for very high pressure and the ability to pump highly viscous fluids.

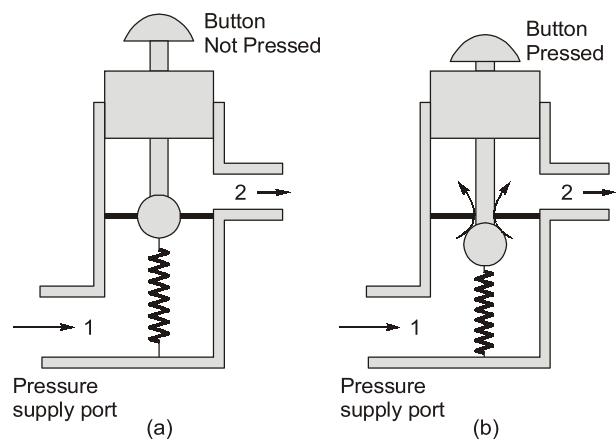
There are two main variations; external gears pump which use two external spur gears and internal gear pump which use an external and an internal spur gears. Gear pumps are positive displacement, meaning they pump a constant amount of fluid for each revolution.



Q3 Describe the basic details of a poppet valve.

Solution:

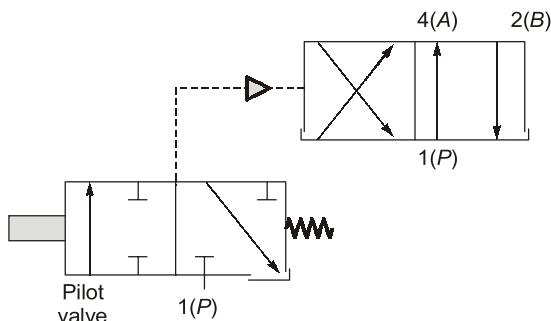
- Poppet valve is a common form of directional control valve as shown in figure.
- This valve is normally in the closed condition there being no connecting between port 1 and port 2 to which the system is connected.
- When the push button is depressed, the ball is pushed out of its seat and flow occurs as a result of port 1 being connected to port 2. When button is released, the spring forces the ball back up against its seat and so closes off the flow.



Q4 Explain the principle of a pilot-operated valve?

Solution:

- The force required to move ball or shuttle in a valve can often be too large for manual or solenoid operation.
- To overcome this problem a pilot operated valve system is used where one valve is used to control a second valve.
- Figure shows



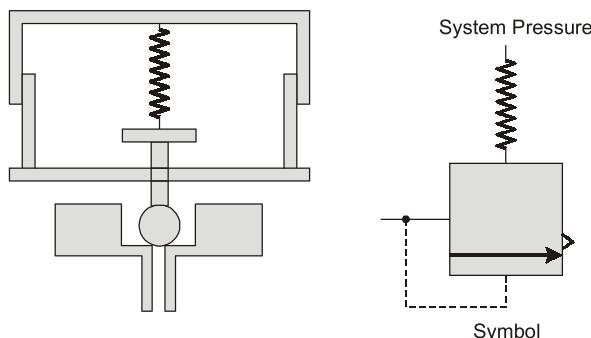
- The pilot valve is small capacity and can be operated manually or by a solenoid.
- It is used to allow main valve to be operated by the system pressure.
- The pilot pressure line is indicated by dashes.
- The pilot and main valve can operate by two separate valves but they often combine in a single housing.

Q5 Draw the symbol for

- a pressure relief valve
- a 2/2 valve which has actuators of a push-button and a spring
- a 4/2 valve
- a directional valve

Solution:

- Pressure relief valve



- (b) a 2/2 valve which has actuators of a push button and a spring.

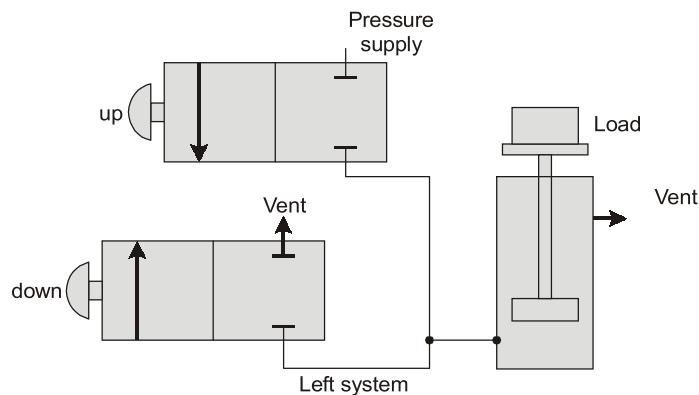
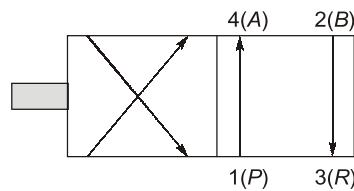


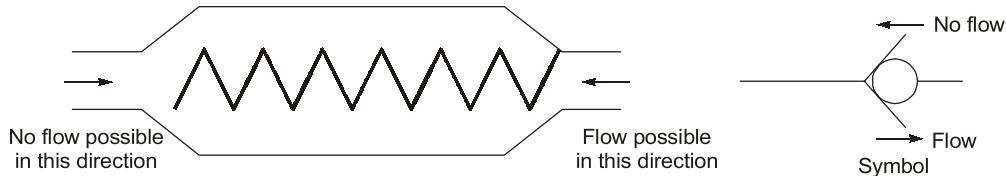
Figure shows simple application of valve in a pneumatic lift system. Two push-button 2/2 valve is used.

- (c) a 4/2 valve



The figure shows symbol for a 4/2 valve. The connection are shown for initial state. i.e. 1(P) is connected to 2(A) and 3(R) closed.

- (d) Directional Valve



Q.6 What is the difference between Hydraulic actuators and pneumatic actuator?

Solution:

Hydraulic actuators:

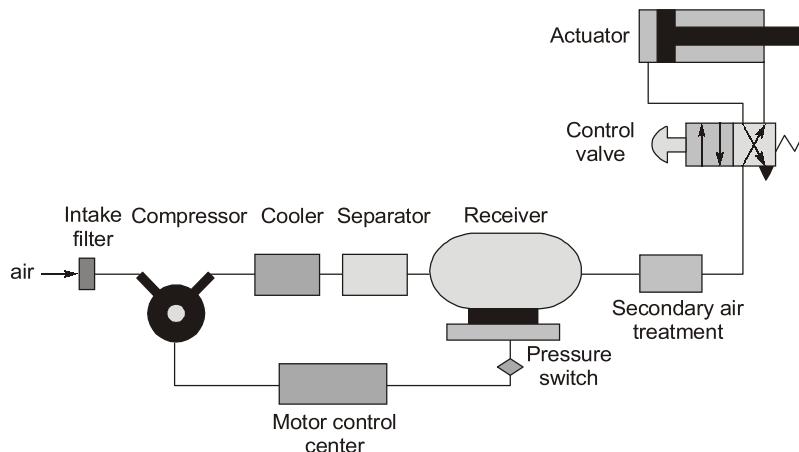
- Hydraulic actuators uses pressurized oil as a fluid. These are normally either rotary or linear piston/cylinder or control valves.
- They are ideally suited for generating very large forces coupled with large motion.
- The disadvantage with the hydraulic actuators is that they are more complex and need more maintenance.
- Rotary motors are usually used in applications where low speed and high torque are required.
- Cylinder/piston actuators are suited for application of linear motion as aircraft flap control.

Pneumatic Actuators:

- The working medium in a pneumatic device is a compressible fluid generally air.
- These are most suitable for low medium forces, short stroke and high speed application.
- The response time of pneumatic actuators is adequate for the systems that have long time constant.
- They are widely used in process systems used to control temperature, flow rate, liquid level etc.

Q.7 Explain basic components of pneumatic system with the help of block diagram.

Solution:



- (a) **Air filters:** These are used to filter out the contaminants from the air.
- (b) **Compressor:** Compressed air is generated by using air compressors. Air compressors are either diesel or electrically operated. Based on the requirement of compressed air, suitable capacity compressors may be used.
- (c) **Air cooler:** During compression operation, air temperature increases. Therefore coolers are used to reduce the temperature of the compressed air.
- (d) **Dryer:** The water vapor or moisture in the air is separated from the air by using a dryer.
- (e) **Control Valves:** Control valves are used to regulate, control and monitor for control of direction flow, pressure etc.
- (f) **Air Actuator:** Air cylinders and motors are used to obtain the required movements of mechanical elements of pneumatic system.
- (g) **Electric Motor:** Transforms electrical energy into mechanical energy. It is used to drive the compressor.
- (h) **Receiver tank:** The compressed air coming from the compressor is stored in the air receiver.

Q.8 What is stepper motor and what are its main types?

State application and advantage of stepper motor?

Solution:

- A stepper motor is a rotating machine which converts a DC voltage pulse into a series of discrete rotational steps.
- Each step is an equilibrium position without further excitation, this makes it ideally suitable for use with a digital control.
- The torque produced by a stepper motor is very small and it can be used to give an accurate positioning as in the case of computer printers, robots, machine tools etc.

There are number of forms of stepping motors but they are mainly of three types

1. Variable reluctance type stepper motor.
2. Permanent magnetic stepper motor.
3. Hybrid stepper motor.

Application:

- It is one of the motors that is essentially digital in nature and compatible for designing. Computers and computer peripheral equipments.
- Use where precise positioning is required, in combination with a microprocessor controller.