



Important Instructions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. 1 a) Attempt any THREE of the following:

(4x3=12)

(i) List any four desirable properties of hydraulic oil used in hydraulic system. (Any Four) (1 Mark for each point)

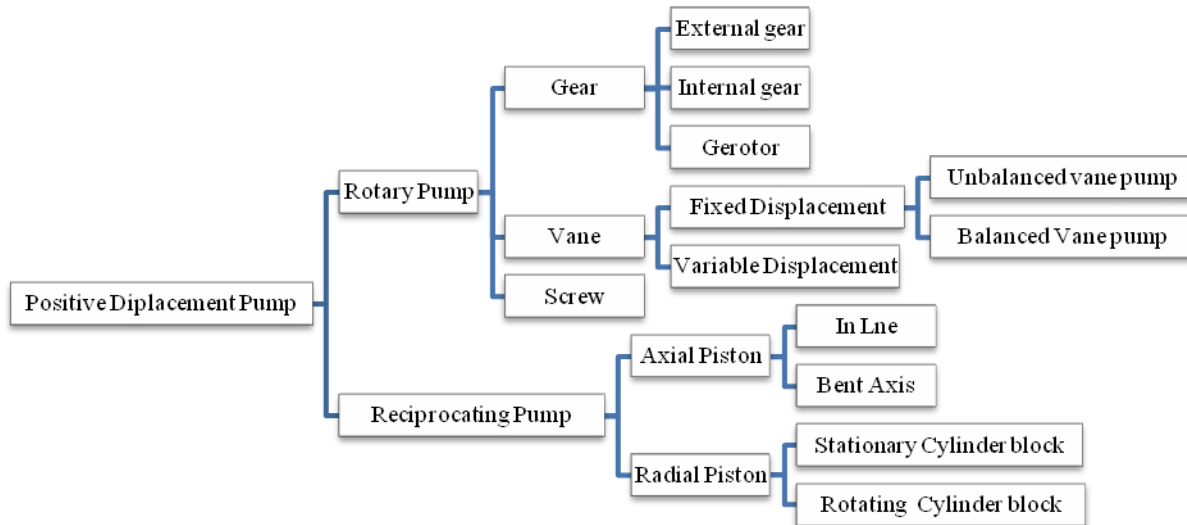
1. **Demulsibility:** The ability of a fluid that is insoluble in water to separate from water with which it may be mixed in the form of emulsion. Or it is the oil ability to release water.
2. **Lubricity:** it is the measure of the reduction in friction of a lubricant.
3. **High flash point:** Flash point is a temperature at which liquid catches fire automatically. The flash point of good hydraulic oil must be as high as possible so that fire possibility nullified.
4. **Minimum Toxicity:** Good hydraulic oil must be minimum toxic to human being working with them. Some fire resistance hydraulic oils are highly toxic which can cause occupational diseases.
5. **Low Foaming Tendency:** When oil returns to receiver, it comes in contact with air above the liquid surface. The oil has tendency to absorb air or gas which results in foam formation. Good hydraulic oil must release the air/gas very quickly so that it does not form foam.
6. **Fire resistance:** Good hydraulic oil must be fire resistant to avoid accidents.

(ii) State the importance of pump used in hydraulic system, Give its classification.

Importance of pump: (2 Marks)

1. They convert mechanical energy into hydraulic energy.
2. The Volumetric efficiency of pump is relatively high
3. They have high performance characteristics under varying speed and pressure requirements
4. Pumps used to generate high pressure in hydraulic system

Classification of Pump. (2 Marks)



iii) Give merits and demerits of hydraulic system.

Merits: (2 Marks)

- 1) We can generate very high pressures in hydraulic system. Due to this nature of hydraulic system we can use this power to lift, hold, press very heavy loads
- 2) Weight to power ratio of a hydraulic system is comparatively less than that of an Electro-Mechanical System. Electric motor weigh appropriately 8.5 Kg/kW whereas, same power hydraulic motor weighs 0.85 kg/kW only.
- 3) The speed control of linear as well as rotary actuators can be achieved with ease. By merely adjusting small flow control valve, wide range of speed and feed can be obtained.
- 4) Limiting and balancing of hydraulic forces can be easily performed.

Demerits: (2 Marks)

- 1) Elements of hydraulic system have to be machined to high degree of precision which increases manufacturing cost of system.
- 2) The hydraulic system, due to oil leakages is 'dirty' and we cannot use this system in food and pharmaceutical industry.
- 3) Petroleum based hydraulic oils can create fire hazards if the temperature of the system goes beyond its 'flash point'
- 4) Leakage of hydraulic oil during its flow in system causes heavy pressure drops.

iv) Differentiate between gear pump and piston pump on the basis of function, construction, pressure range and delivery of oil. (1 Mark for each point)

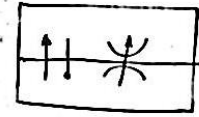
| Parameters | | Gear pump | | Piston pump |
|-----------------|----|-----------------------------------|----|----------------------------|
| Function | 1. | Low Pressure Range | 1. | High Pressure Range |
| Construction | 2. | Simple Compact Low Space required | 2. | Complex require more space |
| Pressure Range | 3. | 300-350 bar | 3. | 700 bar |
| Delivery of Oil | 4. | Continuous | 4. | Intermittent (Pulsating) |



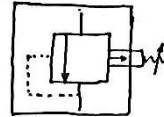
b) Attempt any ONE of the following (01 x 06 = 06)

(i) Draw symbols of (Each symbol 2 mark)

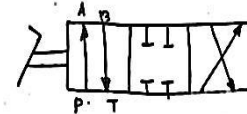
1) Temperature and pressure compensated flow control valve



2) Pilot operated pressure relief valve

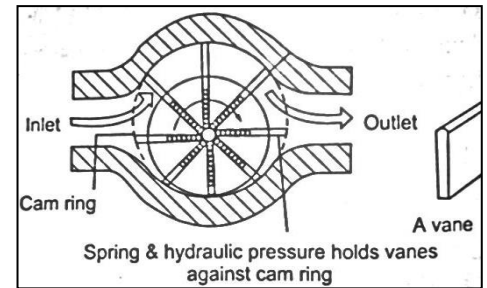


3) Pedal operated 4/3 DC valve



(ii) Explain vane type pump with neat sketch. (Sketch 2 Marks, Explanation: 4 Marks)

It consists of a cylindrical rotor, which is mounted with an offset inside a circular casing. The vanes are sealed in the radial slots of rotor and held against the casing by spring or hydraulic force. Hence there will not be any leakage of oil between the vane tip and the casing. But still, there is some leakage of oil between the rotor face and the body sides. Hence its volumetric efficiency will be around 95%. As the rotor rotates, the size of pockets goes on increasing on the left side and reducing on the right side.

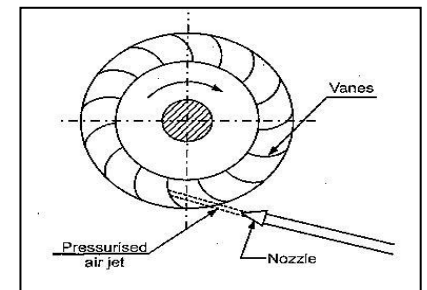


This causes suction of oil at left side and delivery of oil at right side. Difference in pressure between inlet and outlet ports create a side thrust on the rotor shaft, which consequently load bearings. Due to this bearing life reduces. This problem of side thrust on bearings is nullified in the design of balanced vane pump.

2. Explain any FOUR of the following.

a) Explain with sketch any one type of air motor. (Sketch: 2 Marks, Explanation 2 Marks)

Figure shows turbine type air Motor. In this air motor, light weight impeller having curved vanes is used. This pressurized air is passed through nozzle. The impact of jet will rotate the impeller. These motors are high speed low torque motors; and being simple in construction and are used in many applications. **Any type of motor with sketch can be considered**



b) State the various losses in pipes pneumatic system. (Correct listing- 4 marks)

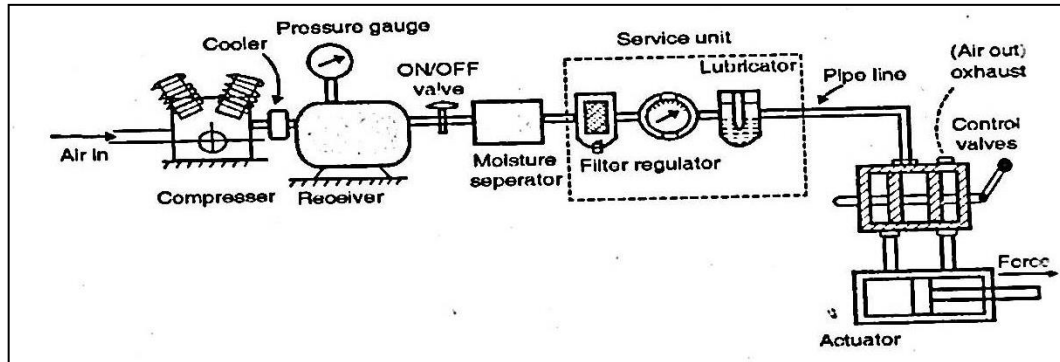
Losses in pipe of pneumatic system

1. Pipe friction – Major losses
2. Losses due to change in flow are and friction:

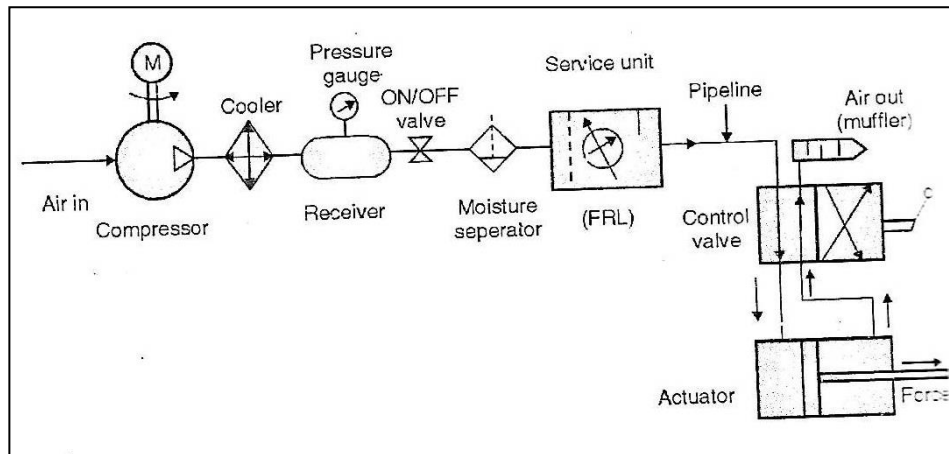
Minor Losses:

- a) Losses due to sudden contraction
- b) Losses due to sudden enlargement
- c) Losses due to pipe fitting
- d) Losses at entrance and exit

c) Draw a general layout and symbolic representation of pneumatic system



General layout of Pneumatic System (2 Marks)



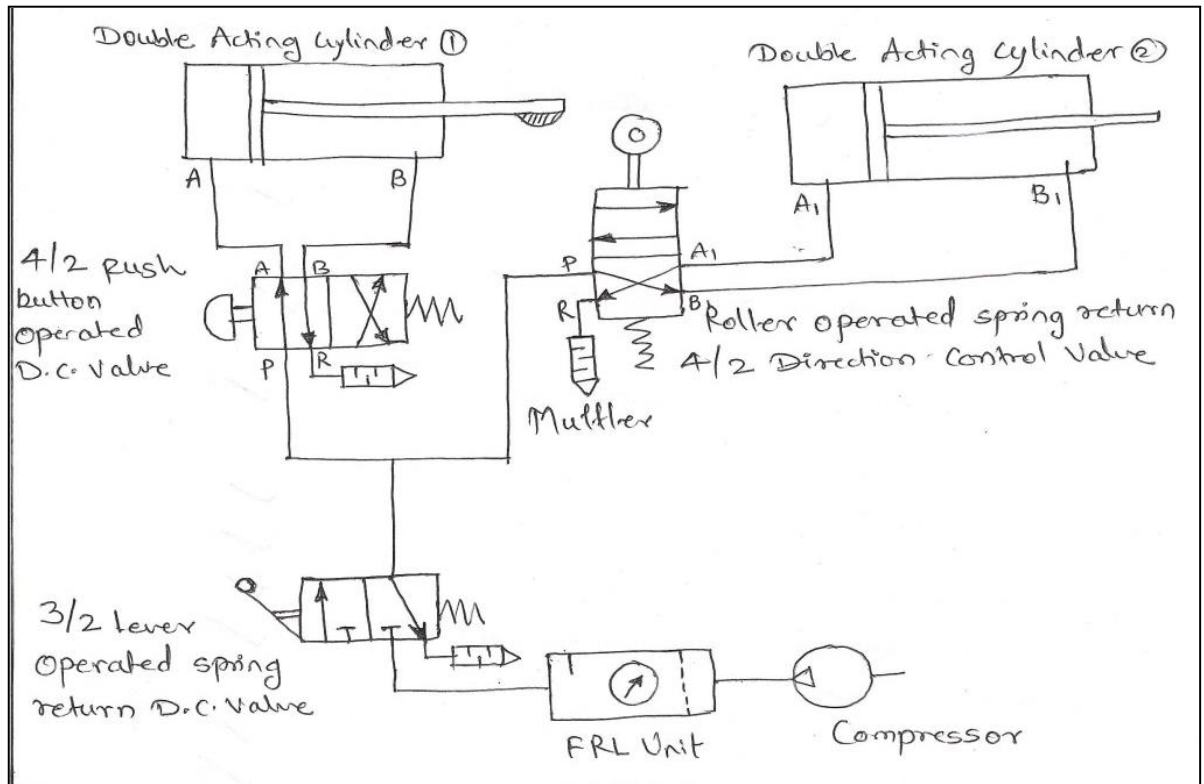
Symbolic layout of Pneumatic System (2 Marks)

d) Write any four limitations of pneumatic system

Limitations of Pneumatic system (Correct limitations – 4 Marks)

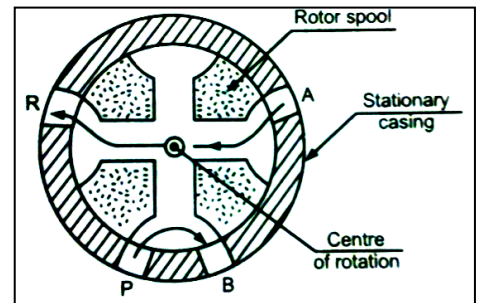
1. The pneumatic system can be used only up to 10 bar and hence not suitable for heavy duty applications
2. Due to compressible nature of air, pneumatic system is not highly accurate and precise hence cannot be used in precision machines.
3. It makes lot of noise which makes it irritating for the workers.
4. Precise control of speed is not possible. This is because of low viscosity and fast motion of air into the cylinder.

e) Draw and label the circuit for working of two double acting air cylinder. (Correct circuit – 4 Marks)



f) Explain with neat sketches working of Rotary Spool type DC valve with sketch. (Sketch 2 Marks, Working 2 Marks)

A rotary spool valve consists of a rotating spool which aligns with ports in stationary valve casing, so that fluid is directed to required port. A/B/P/R are the ports in casing. The port 'P' is a pressure port through which pressurized oil is coming in the valve. 'R' port is the port through which used oil is returning to oil tank. From fig port p is connected to port B and port A is connected to port R

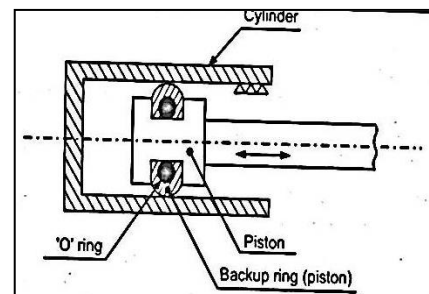
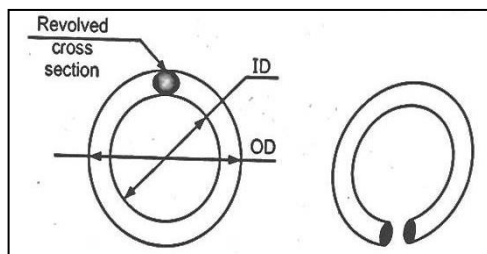


3. Attempt any FOUR of the following (04 x 04 = 16)

a) What is the purpose of hydraulic oil seal? Explain any one type of oil seal.

Purpose of oil Seal (2 Marks)

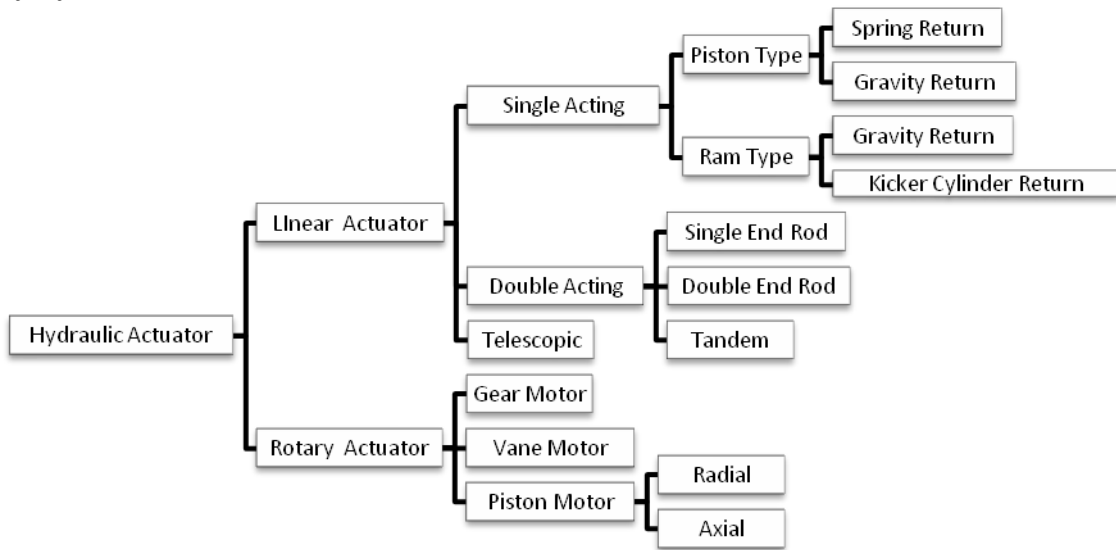
- 1) To stop leakage of oil
- 2) To maintain the pressure
- 3) To keep out contamination in the system
- 4) To enhance the working life of the system
- 5) To enhance the functional reliability of components over a longer period



‘O’ Ring Seal: (2 Marks)

Figure shows ‘O’ ring seal. These are most common and simple seal with circular cross-section like ‘O’. Hence called O-ring is used as static as well as dynamic seal. The material used for O-Ring is synthetic rubber and is specified by its ID/OD. The round cross-section are non-positive seals. O-rings are fitted with back ring the following figure depicts sealing of cylinder and piston by using ‘O’-ring with backup ring.

c) Classify hydraulic actuator (4 Marks)



c) Explain working of telescopic cylinder with neat sketch. Sketch 2 m, working 2 marks

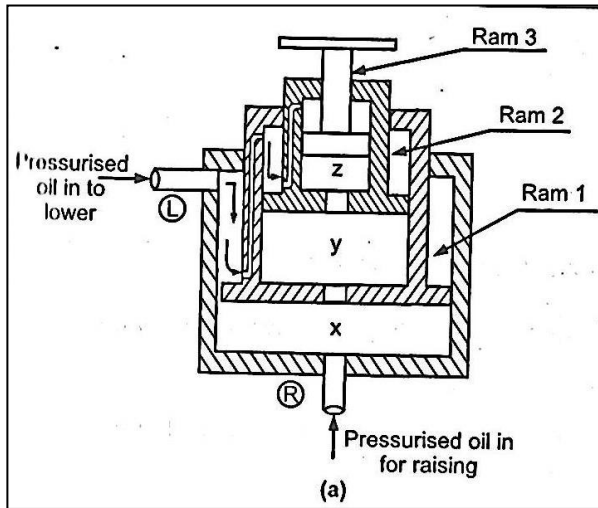
Construction:

Figure shows three Rams assembled in each other like telescope. This arrangement provides relatively long stroke with good mechanical strength. There are two inlet ports through which pressurized hydraulic oil enters. Port (R) is raising the cylinder or extending the cylinders while port (L) is for cylinder lowering.

Working:

1. Raising or extending the cylinders: hydraulic oil under pressure will enter through port (R). Space ‘X’ will be filled by oil and Ram 1 will start raising upwards. When its raising stops, the oil now will start entering through and will occupy space ‘Y’. Due to this Ram 2 will raise. When raising of Ram 2 stops, the oil will start entering through and will occupy space ‘Z’. This will raise final Ram 3 upwards.

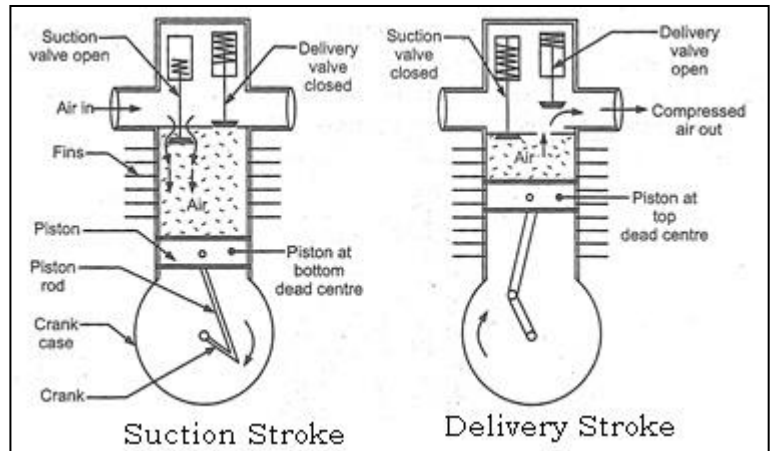
2. Lowering the rams: When pressurized oil will enter through port (L), then Ram 1 will come down. After it’s lowering Ram 2 will lower and then Ram 3 will lower.



d) Explain reciprocating compressor used in pneumatic system

Construction: (2 Marks)

In its simplest form single acting reciprocating air compressors used 4 bar mechanism i.e. cylinder-piston-piston rod-crank. There are valves which are spring operated. The cylinder is having fins from outside to increase the surface area so that it will dissipate the heat and will be cooled earlier. The crank is driven by electric motor/turbine/engine.



Working:(2 Marks)

Piston reciprocates in cylinder. Figure shows suction stroke. In this stroke the piston is at bottom dead center position. Due to downward movement of piston vacuum is created in cylinder and air sucks in by operating suction valve. The cylinder is now full of atmospheric pressure air.

Now piston starts moving up. During this movement suction valve closes. Air gets compressed and delivery valve opens. The compressed air moves out of delivery port and goes to air receiver. In this compressor compression of air takes place on one side of piston only.

e) Compare pneumatic motor with electric motor (4 Marks)

| Pneumatic Motor | | Electric Motor | |
|-----------------|----------------------------------|----------------|---------------------------------------|
| 1 | Working medium is Compressed Air | 1 | Working medium is Electric current |
| 2 | Simple in Construction | 2 | Complicated in construction |
| 3 | Easy speed control by FCV | 3 | Speed control is difficult and costly |
| 4 | Weight to power ratio is High | 4 | Weight to power ratio is Low |
| 5 | Noisy Operation | 5 | Smooth Operation |
| 6 | Explosion Proof | 6 | Less chances of explosion |
| 7 | Less efficiency | 7 | High Efficiency |
| 8 | Available in limited power | 8 | High power available |

f) Give the function of FRL unit. Draw its symbol.

Function of FRL unit (3 Marks)

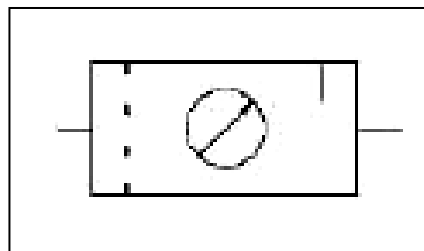
Filter (F) – 1) To remove the micron and sub-micron particles present in the entering air of compressor

2) Used to separate out contaminants like dust, dirt particles from the compressed air

Regulator (R)–In pneumatic system the pressure of compressed air may not stable due to possibility of line fluctuation. Hence there is a need to maintain and regulate the air pressure. This function is perform by regulator.

Lubricator (L) – Sliding components like spool, a pneumatic cylinder has sliding motion between parts. It may cause friction and wear and tear at mating parts. To reduce friction, lubricating oil particles are added in the compressed air with the help of lubricator.

Symbol (1 Mark)



Q 4 a) i) Pressure reducing valve. (Sketch 2 Marks, working 1 Mark and construction 1 Marks)

Fig No 4.1

Construction: It consist of spool and spring enhoused in the bore of valve body. Spring compression can be adjusted by pressure setting screw. Port P is pressure port connected to pump. Port A is consumer port requiring reduced pressure.



Working : In normal position ,Port P is supplying oil to consumer port A. If the main supply pressure is below the set pressure ,there will be continuous flow from P to A. So this valve is open. When outlet pressure rises to set valve , then oil will flow through passage X and will act on spool and spool will shift to right thereby closing the port A. Then only enough flow will pass through port A ,so that consumer connected to A will receive reduced pressure.

ii) Pressure operated flow control valve. (**sketch 2 Marks and Explanation 2 Marks**)

Construction: It consists of Hollow cylinder shaped poppet at the bottom of which there is fixed hole. There is a spring inside the poppet.

Working: Pressurized oil entering through the inlet port will apply full force on the bottom of poppet and will try to compress the spring by shifting the poppet to right. The poppet will move to right and will close the outlet port. Then movement of poppet toward the right will stop. Now oil flow passing through the orifice will start. Oil will occupy bore of cylinder. This flow of oil will equalization the pressure on both ends of the poppet. Then The poppet will balance. During this process , spring will expand and poppet will move towards left ,thereby uncovering the outlet port. A balance will reestablished by maintaining quantity of oil through oil through orifice and quantity of oil come out through the outlet port. If the pressure of incoming oil changes, then rebalancing will be existing and constant flow of oil will come out.

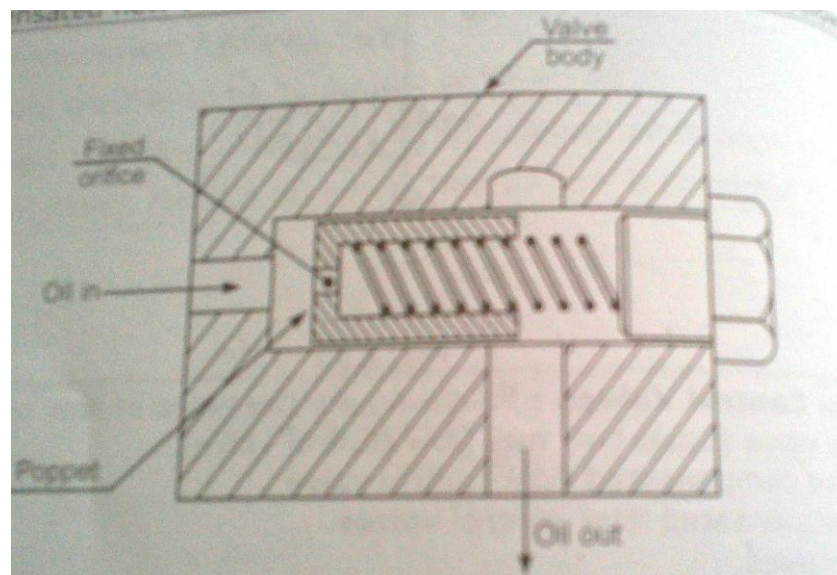


Fig no4.2

(iii) Classification of filters: (**2 Marks**)

- 1- Full flow filter
- 2- Proportional flow filter

3- Edge type filter

Explain any one of them (sketch 2 Marks and Explanation 2 Marks)

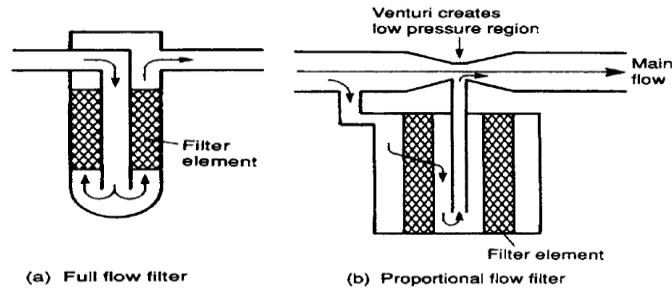


Fig No 4.3

Full flow filter:

- Incurs a large pressure drop.
- A relief valve is needed which cracks when the filter becomes blocked.

Proportional flow filter:

- Localised low pressure area is formed at the venturi.
- The fluid is drawn from the filter due to the pressure difference.
- low pressure drop

(iv) Gerotor pump.(Explanation 02 marks & Sketch 02)

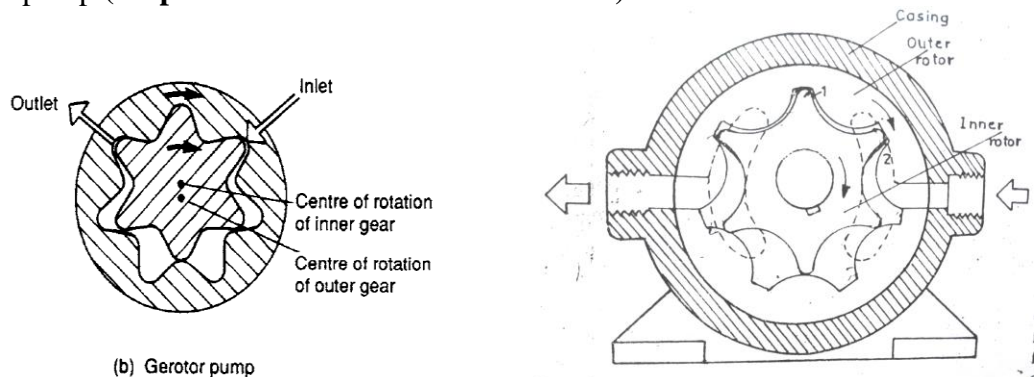


Fig No 4.4

- These pumps have a pair of gear shaped elements, meshing each other.
- The teeth on inner rotor has always one teeth less than outer. Generally inner has six and outer has seven teeth.

- The tooth form of the inner element is such that each tooth of the inner element is always in sliding contact with the surface of the outer element. Thus sealing between suction and discharge chamber.

b) (i) Working of double acting air cylinder (3 Marks for Sketch and 3 Marks for Explanation)

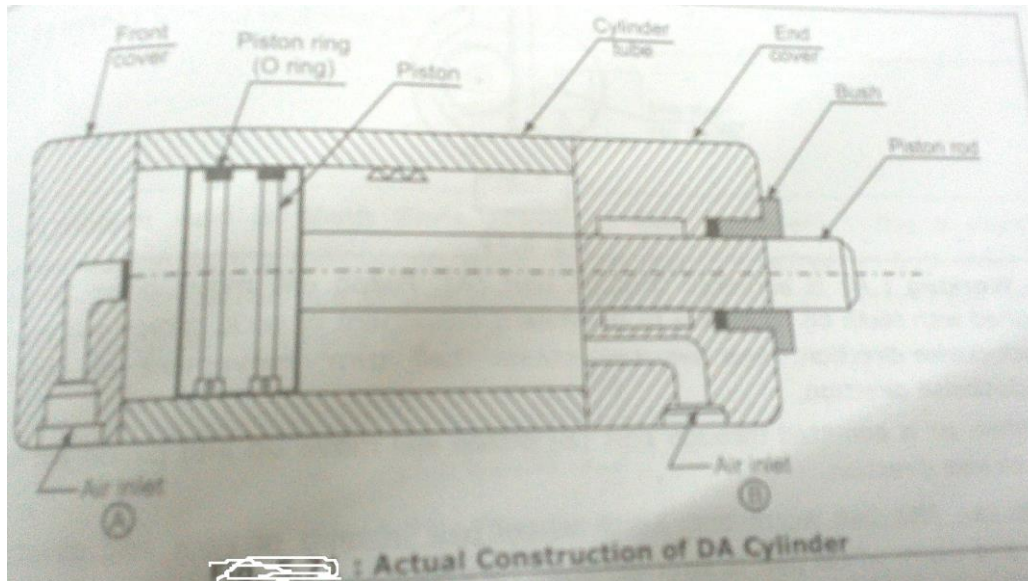


Fig No 4.b 1

Double Acting Cylinders are equipped with two working ports- one on the piston side and the other on the rod side. To achieve forward motion of the cylinder, compressed air is admitted on the piston side and the rod side is connected to exhaust. During return motion supply air admitted at the rod side while the piston side volume is connected to the exhaust. Force is exerted by the piston both during forward and return motion of cylinder. In double acting cylinder, air pressure can be applied to either side (supply and exhaust) of the piston, thereby providing a pneumatic force in both directions. The double acting cylinders are mostly commonly used in the application where larger stroke length is required. Double acting cylinders are available in diameters from few mm to around 300 mm and stroke lengths of few mm up to 2 meters

(ii)(Function 1 Mark, Classification 2 Mark, any one Sketch 1.5 Marks & Explanation 1.5 Marks)

Function : A hydraulic accumulator is a device that stores the potential energy of an incompressible fluid held under pressure by an external source against some dynamic force.



The stored potential energy in the accumulator is a quick secondary source of fluid power capable of doing useful work.

Classification

1. Weight loaded or gravity accumulator
2. Spring loaded accumulator:
3. Gas loaded accumulator: There are two types of gas-loaded accumulators:
 - Non-separator type accumulator.
 - Separator type accumulator

(a) Piston-type accumulator (b) Diaphragm accumulator(c) Bladder accumulator

1. Weight-loaded or gravity accumulator: Fig.no 4b.2

It is a vertically mounted cylinder with a large weight. When the hydraulic fluid is pumped into it, the weight is raised. The weight applies a force on the piston that generates a pressure on the fluid side of piston. The advantage of this type of accumulator over other types is that it applies a constant pressure on the fluid throughout its range of motion. The main disadvantage is its extremely large size and heavy weight. This makes it unsuitable for mobile application.

2. Spring-loaded accumulator: Fig. no4b.3

A spring-loaded accumulator stores energy in the form of a compressed spring. A hydraulic fluid is pumped into the accumulator, causing the piston to move up and compress the fluid under pressure. The compressed spring then applies a force on the piston that exerts a pressure on the hydraulic fluid. This type of accumulator delivers only a small volume of oil at relatively low pressure. As the springs are compressed, the accumulator pressure reaches its peak, and as the springs approach their free lengths, the accumulator pressure drops to a minimum.

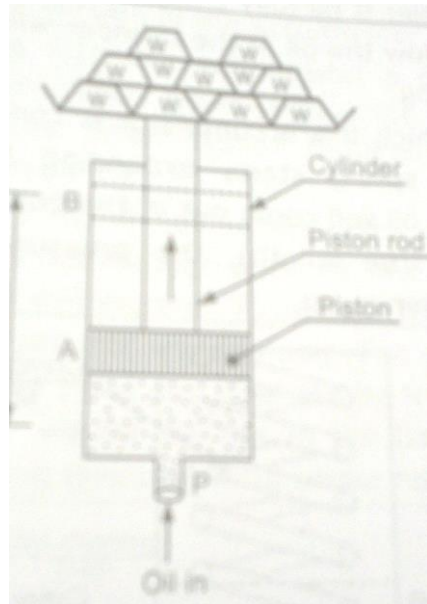


Fig 4b.2

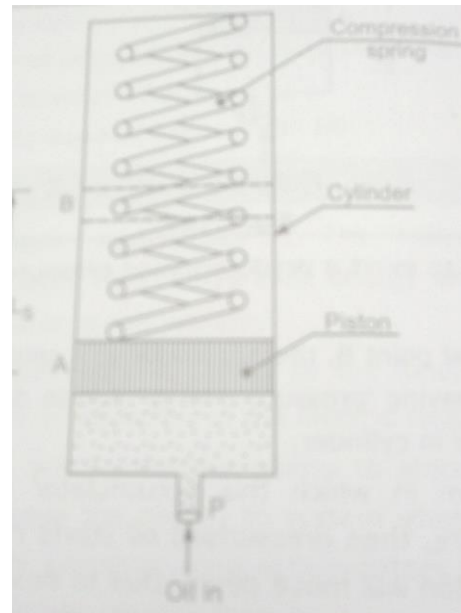


Fig 4b.3

3. Gas-loaded accumulator: Fig. no 4b.4

A gas-loaded accumulator is popularly used in industries. Here the force is applied to the oil using compressed air. Schematic diagram of a gas loaded accumulator is shown in Fig..A gas accumulator can be very large and is often used with water or high water-based fluids using air as a gas charge. Typical application is on water turbines to absorb pressure surges owing to valve closure and on ram pumps to smooth out the delivery flow.

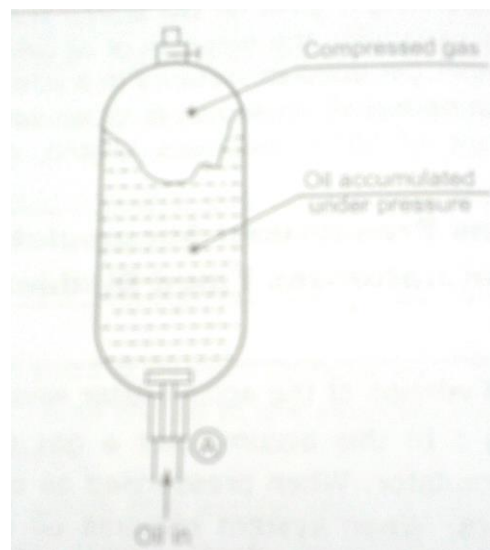


Fig 4b.4

Q 5 a) Hydraulic circuit for shaping machine.

(4 Marks for Sketch and 4 Marks for Explanation)

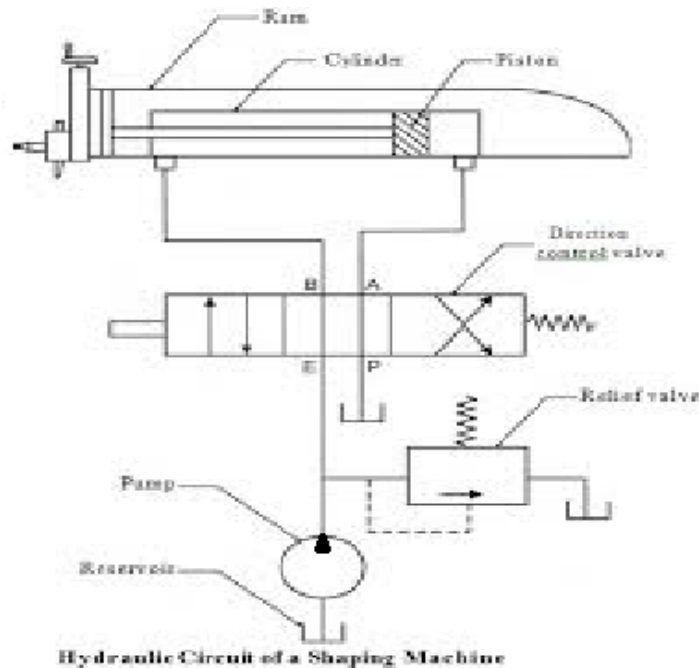


Fig No 5.1

Elements: Fixed DA cylinder ,spool type DC valve, spool shaft stroke adjusting lever, pump, pressure relief valve, return line with filter, oil reservoir.

Forward stroke : As shown in fig ,the pump is supplying oil to DA cylinder through DC valve and through port B. Hence piston will move from right to left with force and this is a cutting stroke.

Backward Stroke : When lever touches the stopper, then spool shifts to right and flow directions in DC valve change. The oil is entering through port A of DA cylinder and piston will move from left to right. During this stroke ,the tool post slightly lift with ideal stroke.

b) Develop a circuit for speed control during a return stroke. **(6 Marks and label it's parts 2 Marks)**

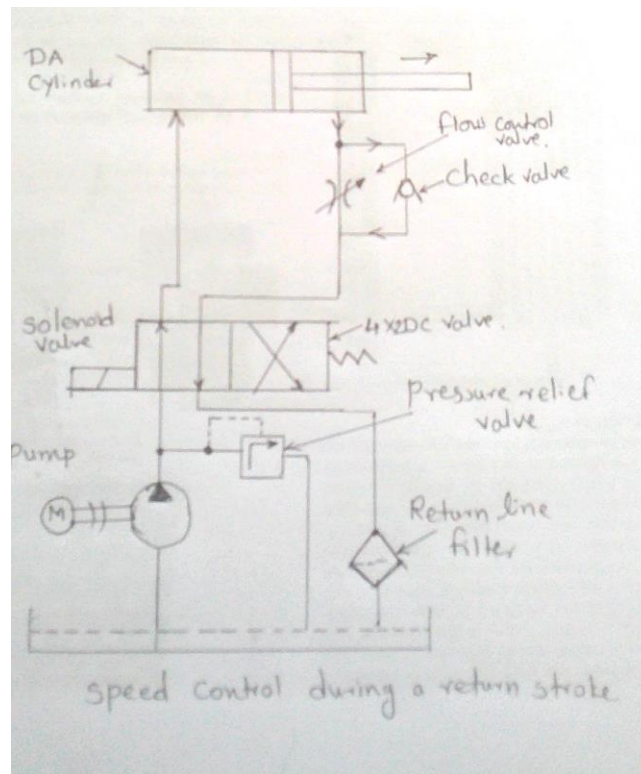


Fig No 5.b

(alternative circuit drawn with meter out type can also be considered)

c) Develop a pneumatic circuit (Sketch 06 Marks and label 02 Marks)

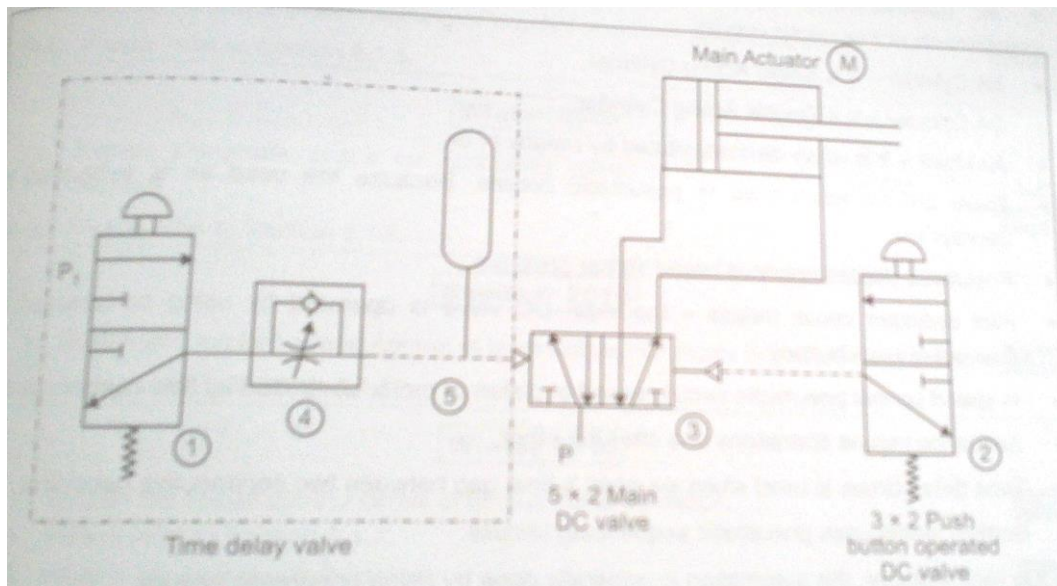


Fig No 5.c

Q 6 a) Criteria for selection of hydraulic pump (any four, 1 mark each) (1 x 4 = 4)

1. Highest operating pressure
2. Maximum delivery

3. Pump drive speed
4. Type of control
5. Type of fluid
6. Pump noise
7. Size and weight of pump
8. Efficiency

b) Sketch of two stage air compressor (2 Marks and label it's parts 2 Marks)

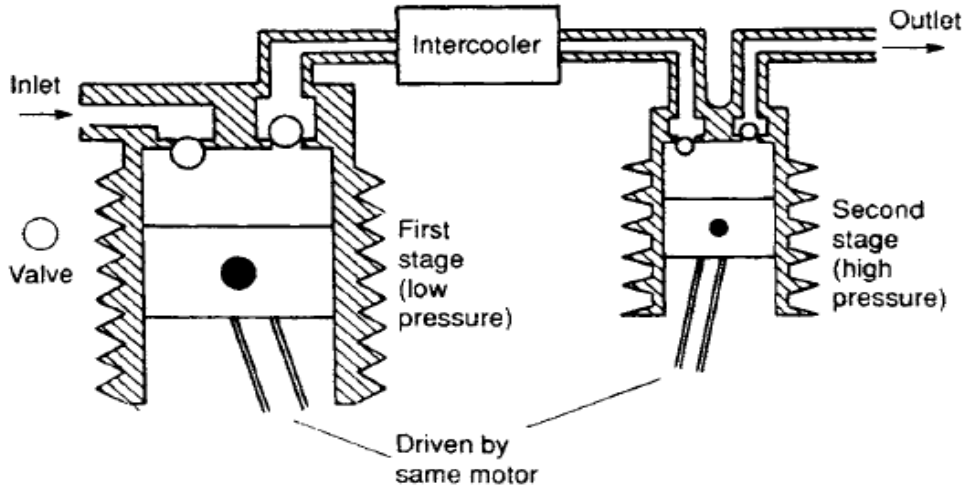


Fig. No 6.b

c) Reasons of failure of hydraulic seals: (any four, 1 mark each) (1 x4=4)

- 1- Incompatibility of seal material with oil.
- 2-Low speed of actuators
- 3-Not correct installation of seal.
- 4-Unbalanced shaft , bend shaft, improper bearing cause vibrations on shaft.
- 5- Due to high temperature of oil.
- 6- Old seals used.

d) Speed of bidirectional air motor is controlled.(2-sketch, 2 explanation) (2x2=4)

Speed control of motor by using variable flow control valve having built in check valve and

4x3 DC valve . When lever L1 is operated ,port P will be connected to port A of air motor and motor will start rotating in say clockwise direction. Its speed can be controlled by using variable flow control valve F1. Port B of motor will be connected to exhaust R. The air motor will be exhausted through port R via DC valve. When lever L2 is operated ,pressure port P

will be connected to port B of motor and naturally motor will start rotating in anticlockwise direction. Port A will be connected to port R and air in motor will exhausted through port R via DC valve

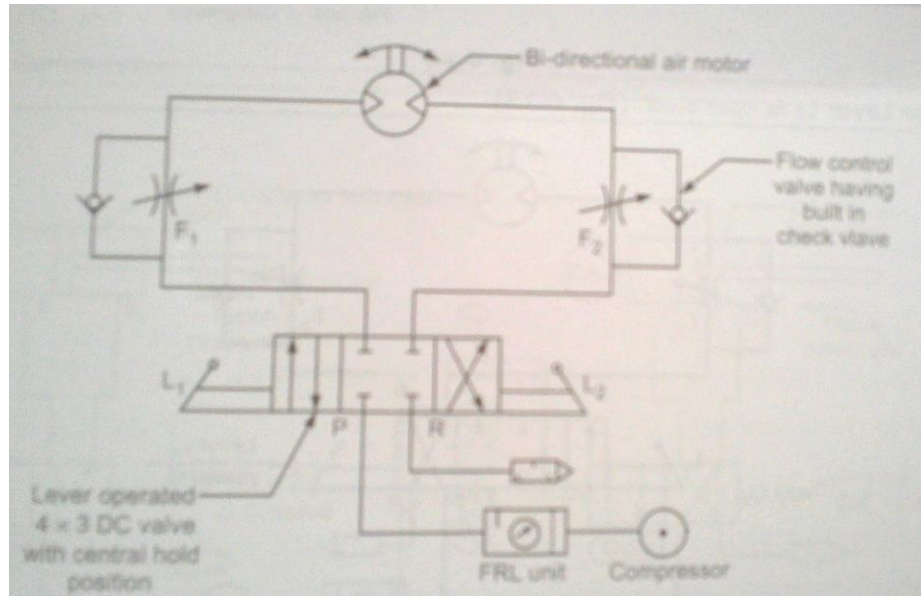
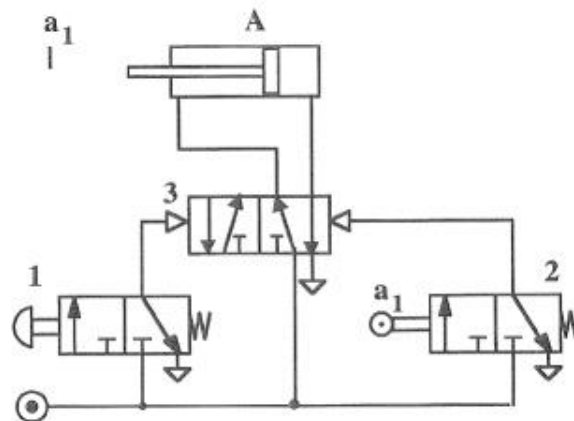


Fig no 6.d

e) Impulse pneumatic circuit: (2-sketch, 2 explanation) (2x2=4)

Figure shows a symbol circuit of an impulse-valve controlled double acting pneumatic cylinder (A). The position of the impulse-valve (3), which is controlled by the start/stop-valve (1) and the end position valve (2), determines if the cylinder piston shall make a positive (A^+) or negative (A^-) stroke. Positive piston stroke is initiated by manual activation of the start-valve (1). Negative piston stroking takes place when valve (2) is activated by the cylinder rod at the position a_1 .



Impulse control of a pneumatic cylinder.

f) Push button operated 5 x 2 DC valve : (2-sketch, 2 explanation) (2x2=4)

5/2 way DC valve in which uses single spool. Spool controls the opening and closing of ports. This spool can be moved by pilot pressure at port P. A and B are consumer ports attached to actuator to obtain useful work P is pressure port and R is normal exhaust port and S easy exhaust port.

Normal position

- Port P is connected to port B
- Port A is connected to port R
- Port S is closed or disconnected

Push button is operated: spring will compress

Movement of spool from left to right

- Port P is connected to port A
- Port A is connected to port S
- Port R is closed or disconnected

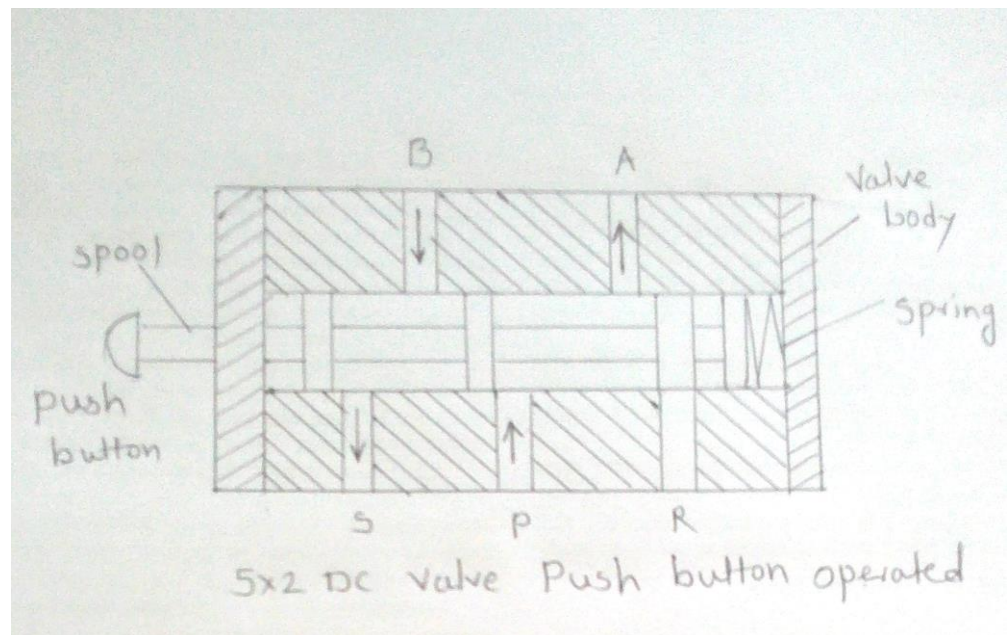


Fig no.6.f