K.K. COLLEGE OF ENGINEERING & MANAGEMENT

Branch: Mechanical Engineering

Semester: VI

Industrial Fluid Power
MEC605

SYLLABUS

Chapter	Name of the topic	Hours
01	**Introduction toil hydraulic systems** 1.1 General layout of oil hydraulic systems. 1.2 Practical applications of hydraulic systems. 1.3 Merits and limitations of oil hydraulic systems. 1.4Propertiesofoil used in oil hydraulic circuit– specific gravity, viscosity,de-mulsibility, lubricity etc.	03
02	**Components of Hydraulic systems** 2.1 Pump – Construction, working principle, applications and symbol of Vane pump, gear pump, Ge-rotor pump, screw pump, piston pump 2.2 Valves–Construction, working and symbols of Pressure control valves, pressure relief valve-direct, pilot operated, pressure reducing, pressure un loading, sequence valves, and counter balancing. Direction controlvalves–Poppetvalve,spoolvalve,2/2, 3/2,4/2, 5/3 Flow control valves–pressure compensated, non-pressure compensated flow control valve. 2.3 Actuators- Construction, working and symbols of Rotary Actuators-Hydraulic motors Linear Actuators–Cylinders-single acting, double acting. 2.4 Accessories –construction,working principle and symbols of Pipes, Hoses, fittings, Oil filters, Seals and gaskets, Accumulators.	11
03	**Hydraulic Circuits** Draw layout of oil different hydraulic circuit and explain their working 3.1Meterin,Meteroutcircuits 3.2Bleedoffcircuit 3.3Sequencingcircuit–traveldependent,pressuredependent 3.4 Hydraulic circuits for Milling machine, Shaper machine, Motion synchronization circuit.	07
04	**Introduction to pneumatic Systems** 4.1Generallayoutofpneumaticsystem 4.2Applicationsofpneumaticsystem 4.3Meritsandlimitationsofpneumatic systems 4.4 Comparison of pneumatic system and hydraulic system	04

05	**Components of pneumatic system** 5.1Compressor–Construction, working and symbol of Reciprocating & Rotary compressors. 5.2 Control Valves – Construction, working and symbol of Pressurere gulating valves, Flow Control valves, Direction Control Valves. 5.3 Actuators– Construction, working principle of Rotary–Airmotors, Linear-Actuator – Single acting cylinder, double acting cylinder 5.4 Accessories–Pipes, Hoses, Fittings, FR Lunit (Construction, working principle and symbols of all components)	12
06	Pneumatic Circuits Speed control circuits—for double acting cylinder --for bidirectional air motor Sequencingcircuits --Positionbasedsequencingcircuit	05
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CHAPTER-1 Introduction to Oil Hydraulic System

Topics covered:

1. General layout of Oil hydraulic system.
2. Practical application of hydraulic system.
3. Merits and limitations of oil hydraulic systems.
4. Definition: Viscosity, Demulsibility, Lubricity etc. (Definition of hydraulic fluid).

CHAPTER 1

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Introduction to Oil Hydraulic System.

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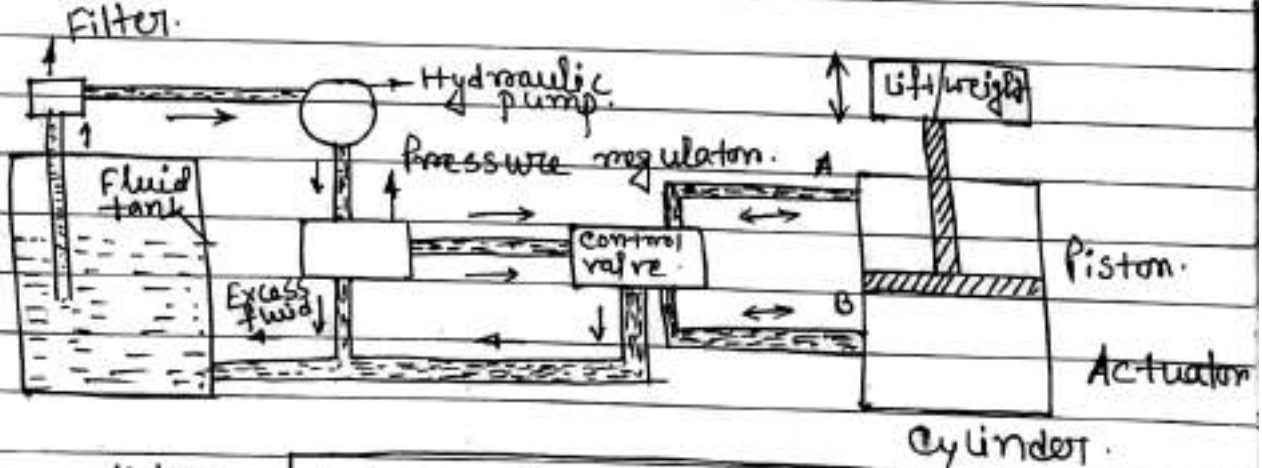
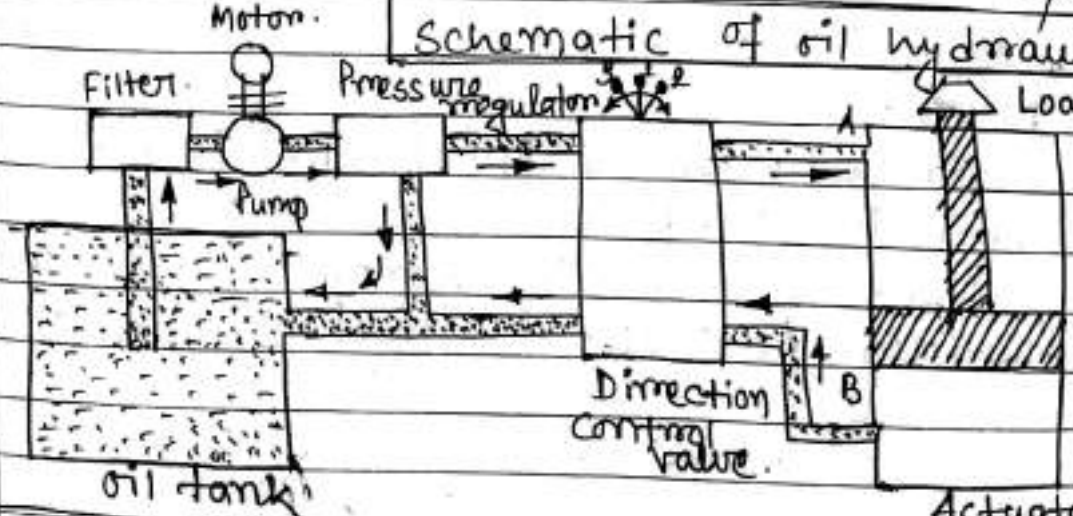
Topics
1) General layout of oil hydraulic System.
2) Practical applications of hydraulic System.
3) Merits and limitations of oil hydraulic Systems
4) Definition : Viscosity, Demulsibility, Lubricity. (Prooperties of hydraulic fluid).

- Hydraulic System (Hydra means water in greek) is the technology that deals with the generation, Control and transmission of forces and movement of mechanical element or System with the use of pressurized fluids in a Confined System. In Oil hydraulic System liquid petroleum oils and synthetic oils etc are used.

General layout of oil hydraulic System:

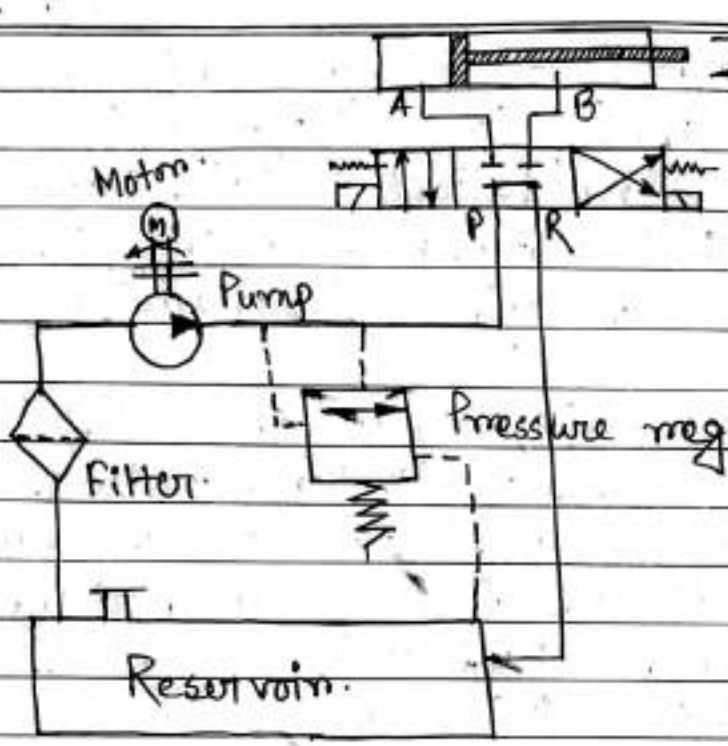


Schematic of oil hydraulic System.



Oil-hydraulic System

① = off.
② = Forward.
③ = Return.



Symbolic representation of oil hydraulic System.

1. The hydraulic pump is used to force the fluid from the reservoir.
2. valves are used to control the direction Pressure and flow rate of fluid flowing through the circuit.
3. The hydraulic actuator is a device used to convert the fluid power into mechanical Power.
4. External power Supply (motor) is require to drive the pump.
5. Filters are used to remove any impurities, Particles to keep the fluid System clean and efficient.
6. Pressure regulator regulates the require level of Pressure in hydraulic fluid.

Initially the working fluid (hydraulic oil) is stored in a reservoir. When the electric motor is switched ON, pump draws hydraulic oil through the filter and delivers at high pressure. The pressurized oil passes through the regulating valve and does work on actuator. oil from the other end of the actuator goes back to the tank via return line. Direction control valve control the movement of the actuator. If fluid pressure exceeds the required level, then the excess fluid return to the reservoir and remains there until the pressure acquires the require level. The cylinder movement will be —

1) When Pressure Port 'P' is connected with actuator port 'A' and Release Port 'R' is connected with actuator Port 'B', Pressure will increase on the backside of Piston, as a result Piston goes forward.
2) When 'P' is connected with 'B' and 'R' with 'A' Pressure increase in front side of Piston, as a result it goes backward.
3) When 'P' and 'R' are connected with each and disconnected with 'A' and 'B', there will no movement in Piston. This is called 'OFF' or 'normal' condition

Practical application of Hydraulic System:

1) Production and assembly of vehicles.
2) Machine tool and transfer lines.
3) Lifting and Conveying devices.
4) Metal-forming Process.
5) Plastic machinery (Injection-moulding machine).
6) Rolling Machines.
7) Lifts.
8) Food Processing machinery.

⑨ Automatic handling equipments and robots.

Merits (Advantages) of oil hydraulic system:

① Oil hydraulic system is simple, easy to operate and can be controlled accurately.
② It has multiplication and variation of forces, multifunction control, constant force and low weight to power ratio.
③ It is economical and it is used when safety is vital Importance.
④ Hydraulic motor can be reversed (clockwise and anticlockwise).
⑤ Limiting and balancing of hydraulic force can be control easily.
⑥ It is a self lubricating system.
⑦ Noise and vibration produced in this system is very low.
⑧ Frictional resistance is very less.

Limitations of oil hydraulic system:

① Due to high degree of precision installation cost of the system is high.
② Pressure drop occure when there is leakage of hydraulic oil in system.
③ Maintenance cost is high.
④ In different location different hydraulic oil is required. For example there is a electric heater require for liquefy the oil in the cold climate. Similarly it should have high flash point in hot climate.

Properties of hydraulic fluid:

1) **Viscosity**: Viscosity is a measure of a fluid's resistance to flow. It depends on its composition and temperature. Low viscosity is limited by its resistance to cavitation and upper viscosity is limited by the ability of the oil to be pumped. It should have low temperature Sensitivity of viscosity.

2. **Demulsibility**: It is the property of oil to release water from it. i.e how easily it can Separate water, and how much it is insoluble in water.

3. **Lubricity**: It is the measurement of the reduction in friction of a Lubricant. It Should have good lubrication property (anti-wear, anti-stick Properties, low coefficient of friction).

4. Thermal and chemical stability.

5. Low Compressibility.

6. Hydrolitic Property (ability to retain properties in the high humidity environment).

7. Low Pour Point (the lowest temperature, at which oil may flow).

8. Filterability.

9. Rust and oxidation protection Properties.

10. Low flash Point.

11. Low foaming.

12. Compatibility with Sealant materials.

Comparison Between Hydraulic and pneumatic Systems:

	Hydraulic System.	Pneumatic System
1.	It employs a pressurized liquid as a fluid.	It employs a compressed gas usually air, as a fluid.
2.	An oil hydraulic System operates at pressure upto 700 bar.	A pneumatic system usually operates at 5-10 bar.
3.	Usually designed as closed system.	usually designed as open system.
4.	The System slows down when leakage occurs.	Leakage does not affect the system much.
5.	valve operation are difficult.	valve operations are easy.
6.	Heavier in weight.	Lighter in weight.
7.	Pumps are used to provide Pressurized Liquids.	Compressors are used to provide Compressed gases.
8.	Automatic lubrication is provided.	Special arrangement for lubrication are needed.
9.	The system is unsafe to fire hazards.	The system is free from fire hazards.

CHAPTER 2

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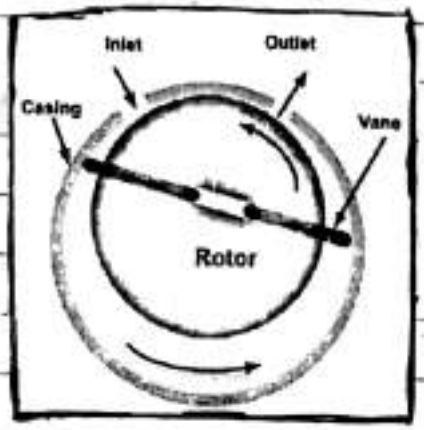
Components of Hydraulic Systems.

Topics:
1. Pumps. [vane pump, Gear pump, Gerrotor Pump, Screw Pump, Piston Pump]
2. Construction and working of Pressure Control valve
3. Direction Control valve.
4. Flow Control valve.
5. Actuators: Linear and Rotary type.
6. Pipe, Hoses, fittings, oil filters, Seal, gaskets and Accumulator. (working).

Hydraulic Pump: The Combined Pumping and driving motor unit is known as hydraulic Pump. It takes hydraulic fluid from the storage tank and delivers it to the rest of the hydraulic Circuit. The Speed of the Pump is constant and delivers an equal volume of oil in each revolution. They are characterized by flowrate capacity, Power Consumption etc.

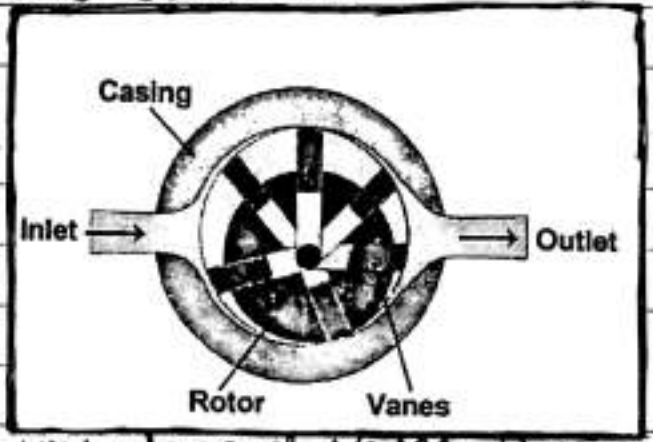
Vane pump:



Vane Pump generally generate a pumping action by tracking of vanes along the casting wall. The vane pump generally Consists of a rotor, vanes, ring and a port-plate with inlet and outlet Ports. The rotor in a vane pump is Connected to the Prime mover through a Shaft. The vanes are located on a slotted rotor. The rotor is ecentrically placed

inside a cam ring. The rotor is sealed into Cam by two Side plates. When the Prime mover rotates the rotor, the vanes are thrown outward due to centrifugal force. The vanes track along ring. It Provides a tight hydraulic seal to the fluid which is more at the higher rotation Speed due to higher centrifugal force. This produces a suction Cavity in the ring as the rotor rotates. It creats vacuum at the inlet, therefore, the fluid is Pushed into the Pump through the inlet. The fluid is carried around by the vanes whose retraction causes the fluid to be expelled. The capacity of the pump depends upon the eccentricity, expansion of vanes, width of vanes and Speed of rotor. The applications are —

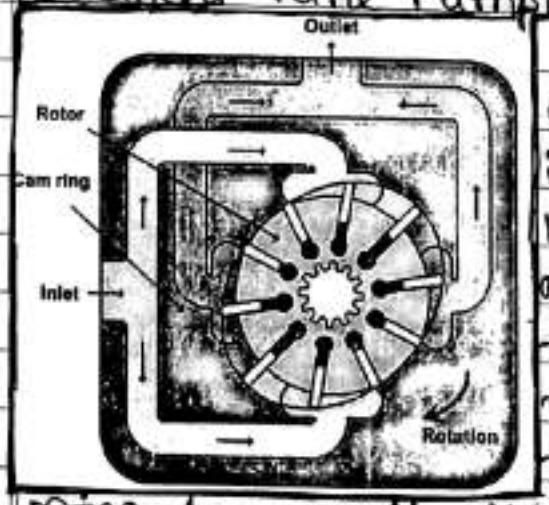
1. Aerosol and propellants.
2. Aviation Service – Fuel transfer
3. Auto Industry – Fuels, lubes, Refrigeration Coolants.
4. LPG Cylinder Filling.
5. Alcohols.
6. Refrigeration – Ammonia.
7. Solvents.
8. Aqueous Solution.



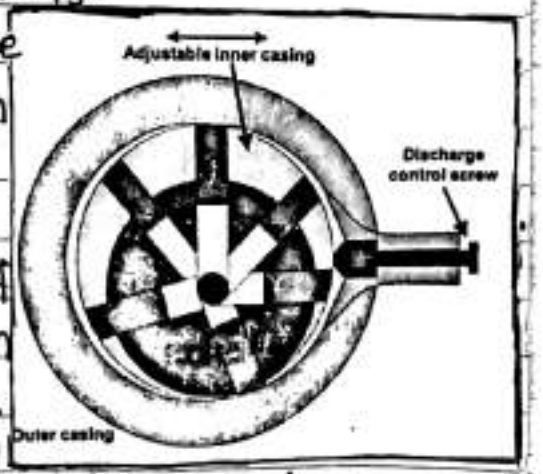
Unbalanced Vane Pump.

The types of vane pump are:

- **Unbalanced vane pump**: The rotor is offset within the housing and the vanes are constrained by a cam ring as they cross inlet and outlet ports. Although the vane tips are held against the housing, still a small amount of leakage exists between rotor faces and body sides. Also, the vanes compensate to a large degree for wear at the vane tips in the housing itself. The pressure difference between inlet and outlet ports creates a large amount of load on the vanes and a significant amount of side load on the rotor shaft which can lead to bearing failure. This type of pump is called unbalanced vane pump.
- **Balanced vane Pump**: Balanced vane pump has an eliptical cam ring with two inlet and outlet ports. Pressure loading still occurs in the vanes but the two identical pump halves create equal but opposite forces on the rotor. It leads to the zero net force on the shaft and bearings. When rotor rotates, vanes moves out due to centrifugal force and touch the cam ring. As a result oil trap in between two vanes. Due to increasing trap chamber volume, oil gets pressurised and goes out through delivery ports.

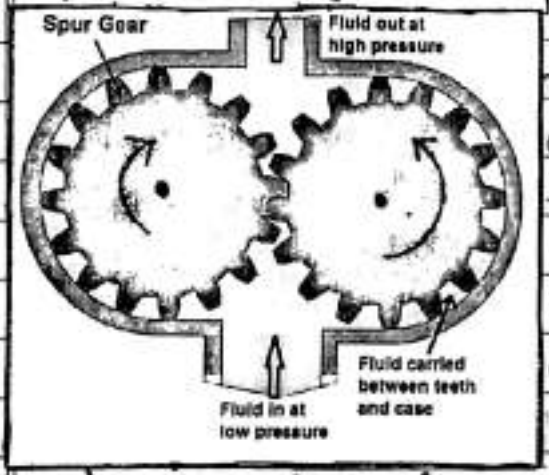


- **Adjustable vane Pump**: Adjustable vane pump consist of a rotor, vanes, cam ring, Port Plate, thrust bearing for guiding the cam ring and a discharge control screw by which the position of cam ring relative to the rotor can be varied. The amount of fluid that is displaced by a vane pump running at a constant speed is determined by the maximum

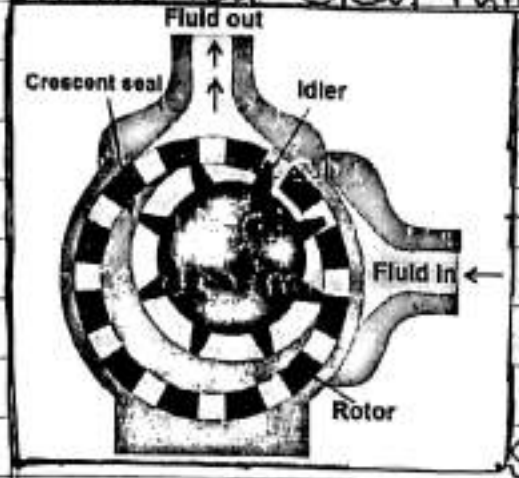


extension of the vanes and the vanes width. The eccentricity of the rotor with respect to the Cam ring is adjusted by the movement of the screw. The delivery volume increases with increase in the eccentricity. This kind of arrangement can be used to achieve a variable volume from the pump and is known as variable displacement vane pump.

- **Gear Pump:** Gear Pump has two meshed gears revolving about their respective axes. The rigid design of gears and houses allow for very high pressure and ability to pump highly viscous fluids. Based upon design gear pumps are classified as :
  (1) External gear Pump.
  (2) Internal gear Pump.
- **External gear Pump:** The external gear pump consists of externally meshed two gears housed in a pump case. one of the gear is coupled with prime mover called driving gear and another is called driven gear. when the gears rotate, volume of the chamber expands leading to pressure drop below atmospheric value and vacuum is created. As a result fluid is pushed into the void due to atmospheric pressure. The fluid is trapped between housing and rotating teeth of gears. Due to rotation the oil is forced out through delivery port located on opposite side of suction port. Thus external gear pump deliver oil from inlet to delivery port.

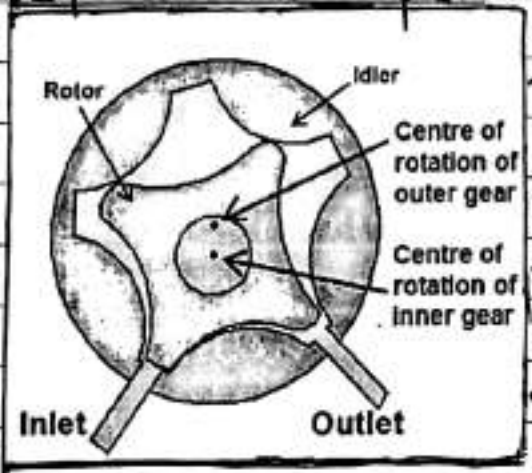


Internal Gear Pump:



Internal gear pumps are exceptionally versatile. They are often used for low or medium viscosity fluids such as solvents and fuel oil. This is non-pulsing, self-priming and can run dry for short periods. It is a variation of the basic gear pump. It comprises of an internal gear, a regular spur gear, a crescent-shaped seal and an external housing. Liquid enters the suction port between the rotor (large exterior gear) and idler (small interior gear) teeth. Liquid travels through the pump between the teeth and crescent. Crescent divides the liquid and act as a seal between the suction and discharge ports. When the teeth mesh on the side opposite to the crescent seal, the fluid is forced out through the discharge port of the pump. Thus internal gear pump works but they are not suitable for high speed and high pressure applications.

Gerotor Pump:

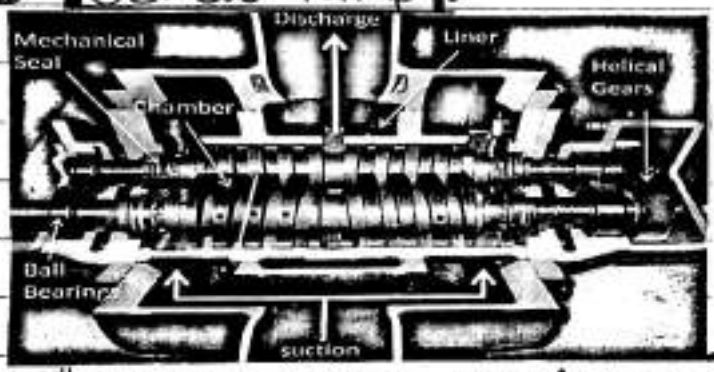


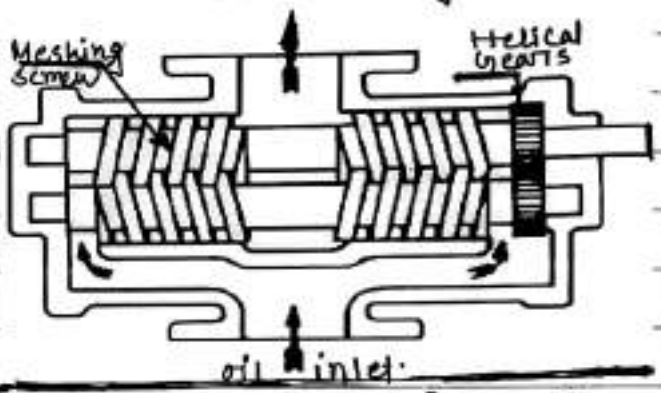
Gerotor pump is consists of two rotors, i.e inner and outer rotor. The inner rotor has 'N' teeth while outer has (N+1) teeth. The geometry of the two rotors partitions the volume between them into 'N' different dynamically-changing volumes. During the rotation, volume of each partition changes continiously. Therefore, any given volume first increases and then decreases. An increase in volume creates vacuum and vacuum creates suction and thus this part of the cycle sucks the fluid. As the volume decreases, compression occurs. During this compression period

fluids are pumped through discharge port.

The main advantage of this pump is that high speed operation, constant discharge in all pressure condition, less sound in running condition and less maintenance. Gerotors are widely used in industries in lubrication system and hot oil filtration system.

Screw Pump:

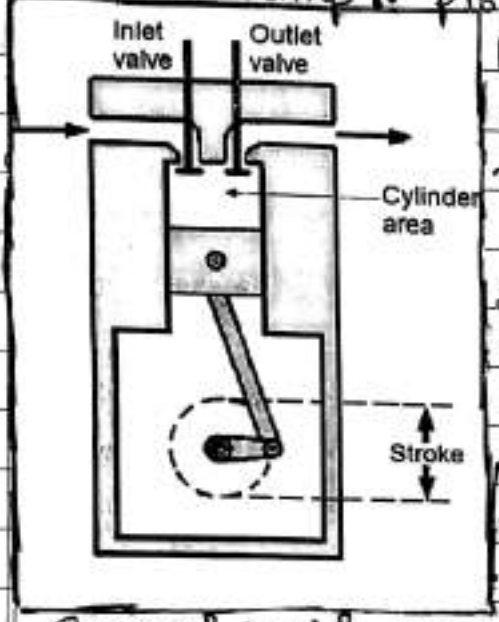




Screw pump having right hand and left hand threads on same sank within a closed housing. One screw is connected to prime motor called driving screw and other one is driven screw. Below the pump has inlet port and above the discharge port.

Initially screw starts rotating and as a result in beginning air moves out and vacuum generated. Once vacuum is generated, oil draws in from suction chamber into pump housing. Then oil moves on the helical grooves of screw and due to close meshing of screw, oil moves in small gap between meshing threads and threads and inside surface of the housing. Due to special design of screw, oil gets divided into two compartments and advances towards the centre of the pump and pressurised oil comes out through discharge port at centre.

Piston Pump: Piston Pump is a positive displacement pump. It is often used where relatively small quantity is to be handled and the delivery pressure is quite large.



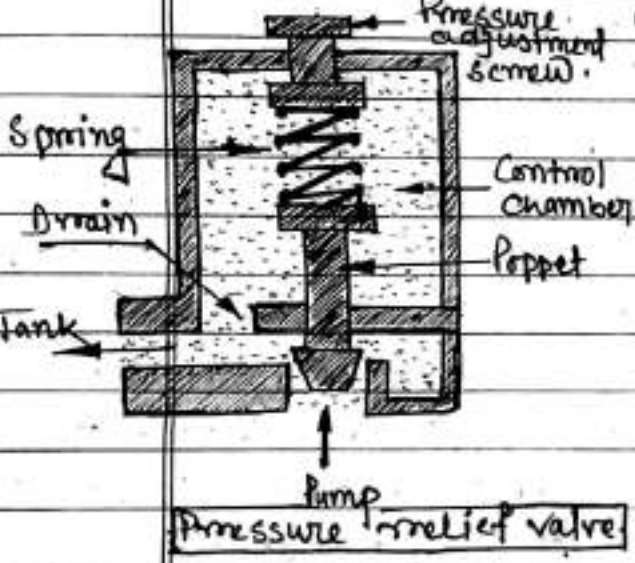
The crank is driven by some external rotating motor. The piston of the pump reciprocates due to crank rotation. The piston moves down in one half of crank rotations, the inlet valve opens and fluid enters into the cylinder. In second half crank rotation the piston moves up, the outlet valve opens and the fluid moves out from the outlet. At a time only one valve is opened and another is closed, so there is no fluid leakage. Depending on the area of cylinder the pump delivers constant volume of fluid in each cycle independent to the pressure at the outlet port.

Valves: In hydraulic system hydraulic energy available from a pump is converted into motion and force by means of an actuator. The proper control selection ensures the desired output and safe function of the system. In order to control the hydraulic outputs, different types of control valves are required. There are basically three types of valves employed in hydraulic system—

(i) Pressure control valve.
(ii) Direction control valve.
(iii) Flow control valve.

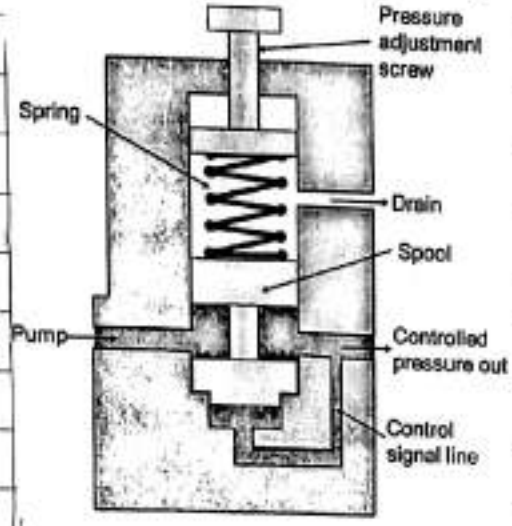
Pressure Control valve: Pressure control valve use to maintain a desired pressure level in a hydraulic circuit. It is basically three types —
(1) Pressure relief valve.
(2) Pressure reducing valve.
(3) Pressure unloading valve.

• Pressure relief valve: Pressure relief valves are used to protect the hydraulic components from excessive pressure. Its primary function is to limit the system pressure within a specific range. It is normally closed type and it opens when the pressure exceeds a maximum value. As a result fuel is flow back to tank. Basically It has two ports; one is connected to the pump and another to the tank. It consists of a spring chamber where poppet is placed with a spring force. Generally, the spring is adjustable to set the maximum pressure limit of the system. The poppet is held in position by combined effect of spring force and dead weight of spool. As the pressure exceeds the combined force, the poppet raises and excess fluid bypassed to the reservoir tank. The poppet again reseats as the pressure drops below the pre-set value. A drain is also provided in the control chamber. It sends the fluid collected due to small leakage to the tank and thereby prevents the failure of the valve.

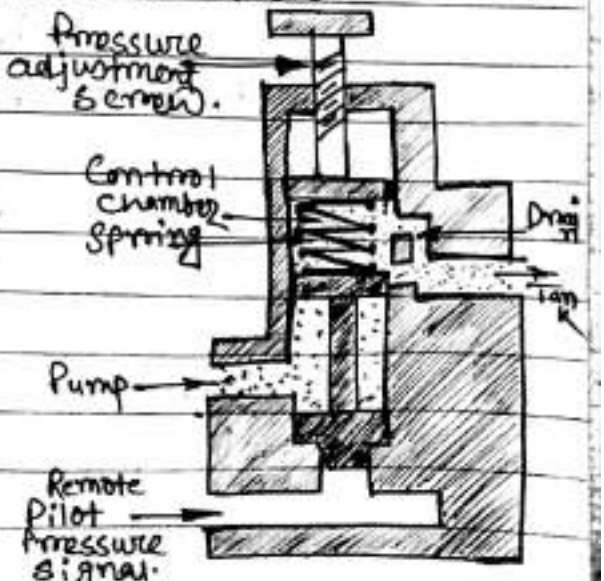


Pressure relief valve

Pressure Reducing valve : Pressure reducing valve is need to maintain a lower Pressure. These valves are used to limit the outlet pressure. Generally they are used for the operation of branch circuits where the pressure may vary from the main hydraulic Pressure lines. These are open type valve and have a Spring Chamber with an adjustable Spring and a movable Spool. A drain is provided to return the leaked fluid in the Spring Control Chamber. A free flow Passage is provided from inlet port to the outlet port until a signal from the outlet port tends to throttle the passage through the valve. The pilot Pressure opposes the spring force and when both are balanced, the downstream is controlled at the pressure setting. When the pressure in the reduced pressure line exceeds the valve setting, the Spool moves to reduce the flow passage area by Compressing the Spring. It can be seen that if the Spring force is more, the valve opens wider and if Controlled Pressure has greater force, the valves moves towards the Spring and throttles the flow.



Pressure unloading valve :
Pressure unloading valve Consists of a Control chamber with an adjustable Spring which pushes the Spool down. The valve has two ports one is connected to the tank and another to Pump.



The valve is operated by the movement of Spool. Normally the valve is closed, when tank Port is closed. These valves are used to permit a pump to operate at the minimum load. The pump delivery is diverted to the tank when Sufficient pilot pressure is applied to move the Spool. The pilot pressure maintains a static pressure to hold the valve opened. The pilot pressure holds the valve until the pump delivery is needed in the system. As the pressure is needed in the hydraulic circuit; the pilot pressure is relaxed and the Spool moves down due to the Self-weight and Spring force. Now the flow is diverted to the hydraulic Circuit.

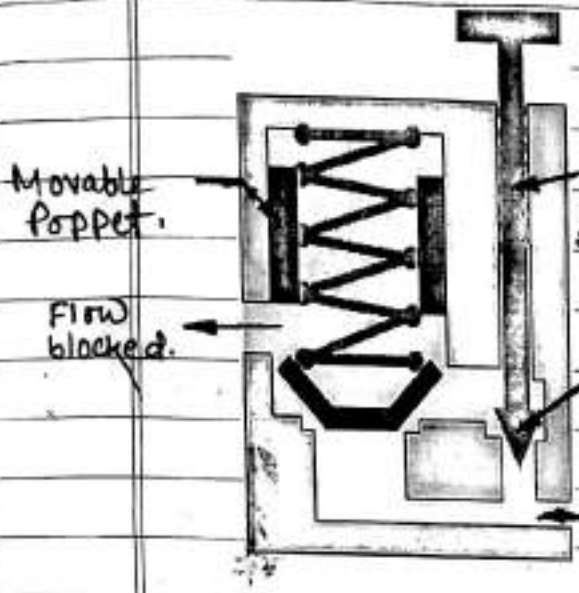
The drain is provided to remove the leaked oil collected in the control chamber to prevent the valve failure. The unloading valve reduces the heat buildup due to fluid discharge at a preset pressure value.

- **Direction Control Valve**: Direction Control valves are used to Control the direction of fluid flow in a fluid power system. These valves are used to Control the start, Stop and change in direction of the fluid flow.

Direction Control valves can be classified as:

- Types of Construction.
  (I) Poppet valves and (II) Spool valves.
- Number of ports.
  (I) Two-way valves.
  (II) Three-way valves.
  (III) Four-way valves.

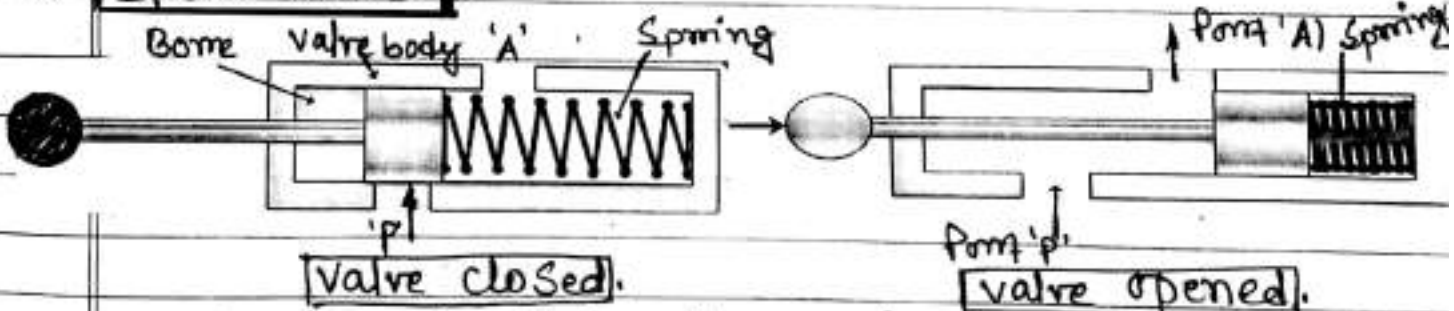
- **Poppet valve** : Poppet valve permit the free flow in one direction only. These valve have two ports, one is entry of fluid and another is for discharge. They are consists of a housing in which Poppet is held by a small spring force. The fluid flow is not possible from the spring side but the fluid can pass by lifting the Poppet against spring force.



The advantages of the poppet valves include no leakage, long life and suitability with high pressure applications.

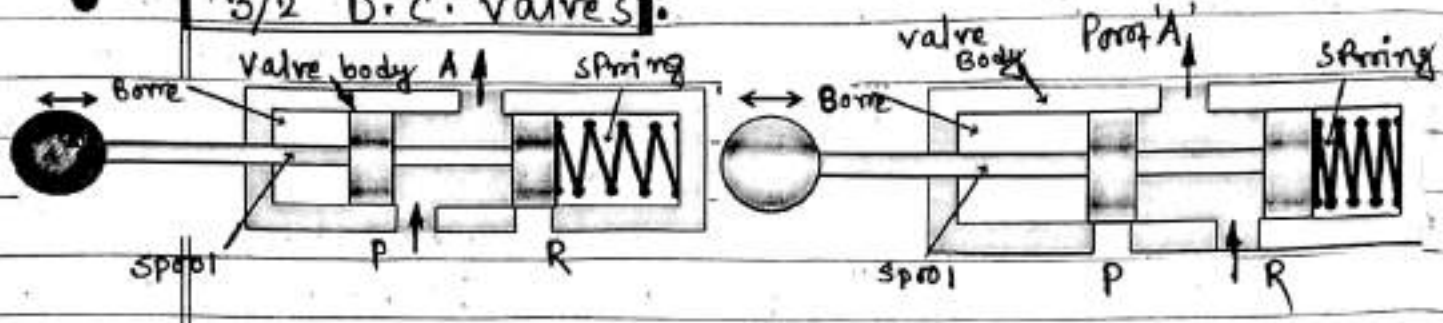
Flow adjustment screw is provided to control the fluid flow.

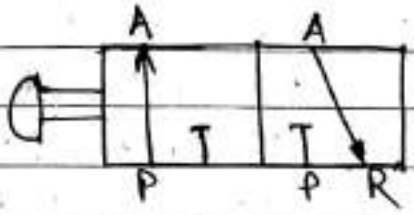
- **Spool valve** :



Spool valve consists of a shaft sliding in a bore which has large groove around the circumference. The Spool is sealed along the clearance between moving Spool and housing. The grooves guide the fluid flow by blocking the ports. The actuator movement is controlled by the Spool valve by pusing or release it as per our requirements.

3/2 D.C. valves:





(Symbol of 3x2 D.C. valve)

In the 3/2 D.C. valve pressure Port 'P', Release Port 'R' and Actuator Port 'A' is connected and divided by grooves in a housing operated by spool.

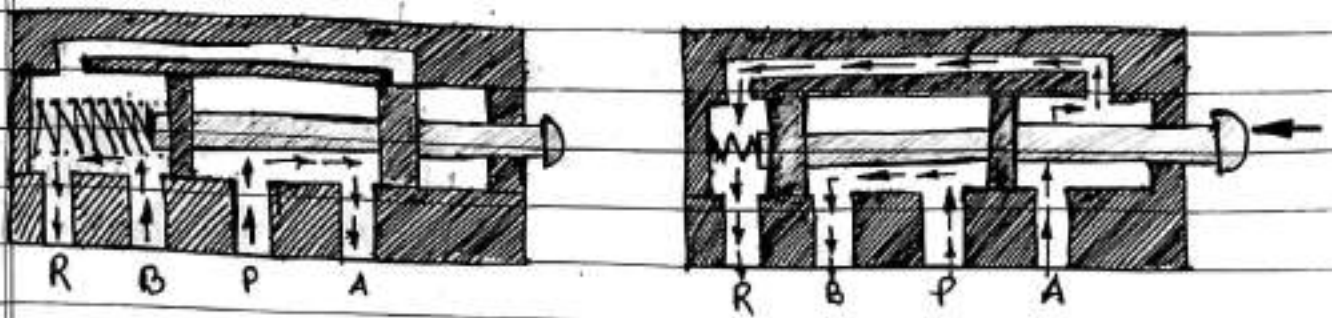
Initially Pressure Port 'P' is connected with Actuator Port 'A'. As a result fluid will Passes from P to A Port and 'R' Port will be in rest condition.

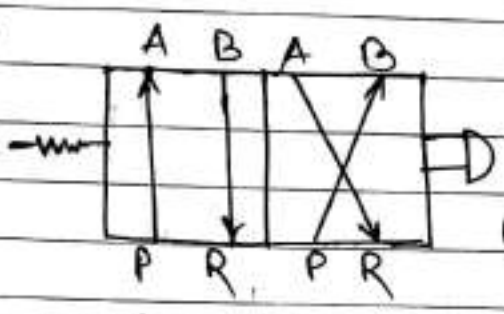
Next when we Push the Spool, there will be a movement of groove, as a result 'P' Port will disconnected and 'A' Port will Connect with 'R' Port. As a result fluid will Passes from 'A' Port to 'R' Port.

In 3x2 D.C valve we get only two motion of a linear actuator. one is forward and another is [redacted] normal/neutral.

3X2 means 3 Ports and 2 Positions.
one is actuated Position when P and A Connected
another is normal Position when R and [redacted] 'A' Connected.

4X2 D.C. Valves :





(Symbol of 4X2 D.C valve).

In 4X2 D.C valve there is a Pressure Port 'P' and a release Port 'R', Actuator Port 'A' and 'B'.

When 'P' is connected with 'A' and 'R' is Connected with 'B', oil will flow from 'P' Port to 'A' Port and 'B' Port to 'R' Port. As a result it will be in normal/neutral condition.

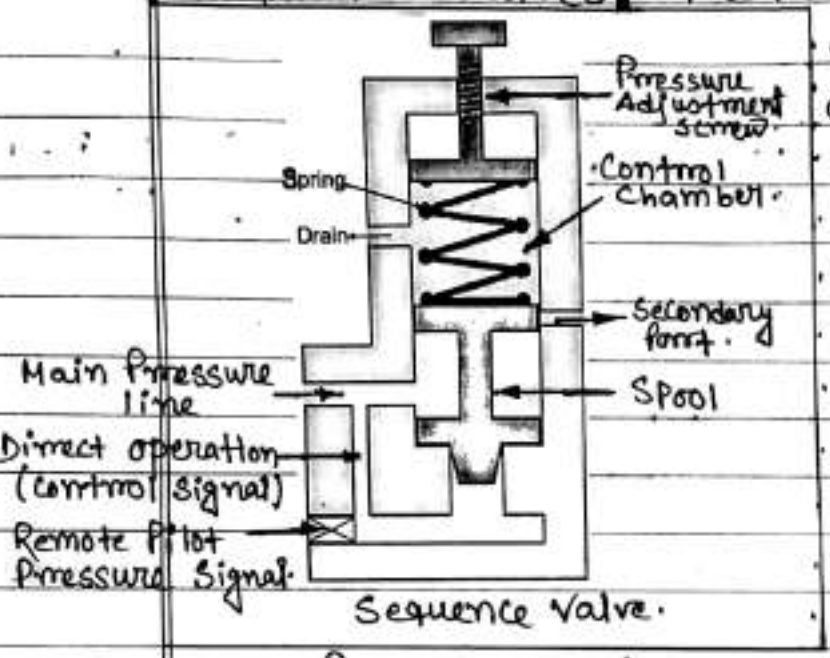
When 'P' Port is connected with 'B' and 'R' is Connected with 'A', oil will enter in B Port and oil will realease from A Port to R Port. As a result we can see actuated position of actuator.

In 4X2 D.C valve we can see only two position using 4 Ports. one is.

$P \rightarrow A$ / normal condition. and another is
$R \leftarrow B$

$P \rightarrow B$ / Actuated Position.
$R \leftarrow A$

Sequence Valves: The primary function of Sequence valve is to divert flow in a pre-determined Sequence. It is used to operate the cycle of a machine automatically. A Sequence valve may be of direct Pilot or remote Pilot operated type.

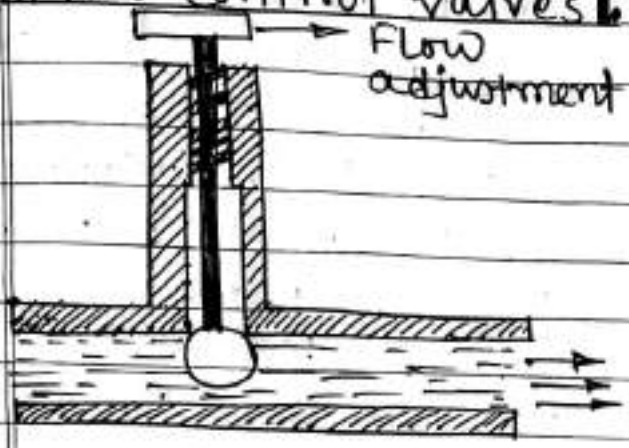


Sequence Valve.

It consists of two ports, one is connected to main pressure line and another with a secondary circuit. The secondary port is usually closed by a spool. The pressure on the spool works against the spring force. When the pressure exceeds the preset value of the spring, the spool lifts and the fluid flows from the primary port to the secondary port.

For remote operation the passage used for the direct operation is closed and a separate pressure source for the spool operation is provided in the remote operation mode.

Flow Control valves:

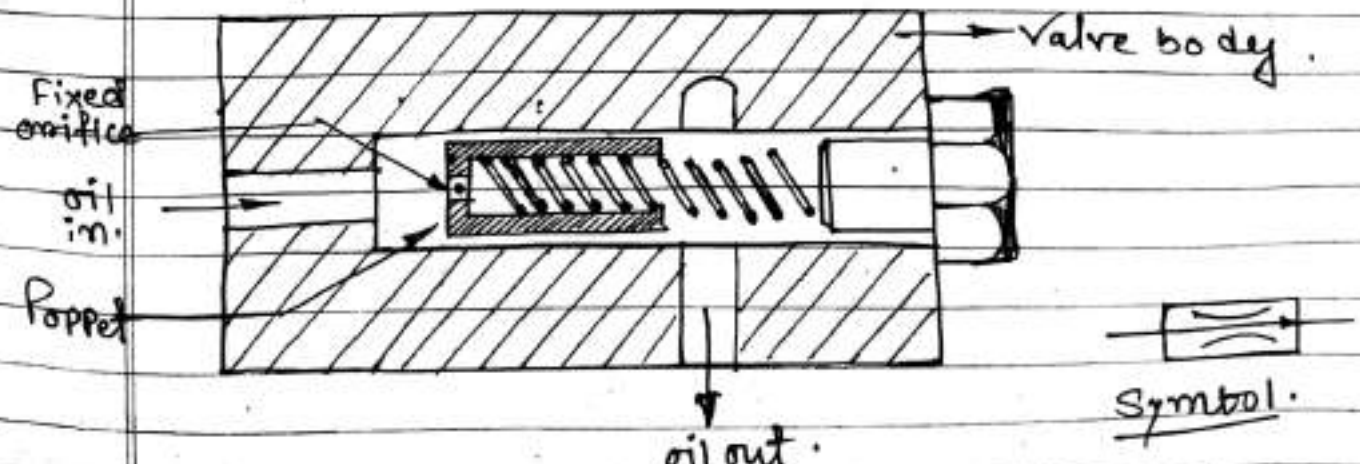


A flow control valve can regulate the flow or Pressure of the fluid to control the speed of actuator to get the desired output. The fluid flow is controlled by varying area of the valve opening through which fluid passes. The fluid flow can be decreased by reducing the area of the valve opening and it can be increased by increasing the area of the valve opening.

Flow control valves are basically two types.

(i) Pressure Compensated flow control valve
(ii) Non-Pressure Compensated flow control valve.

(1) Pressure Compensated flow Control valve:



For the Constant flow regardless of input and output Pressure variation, Pressure Compensated flow Control valve is used.

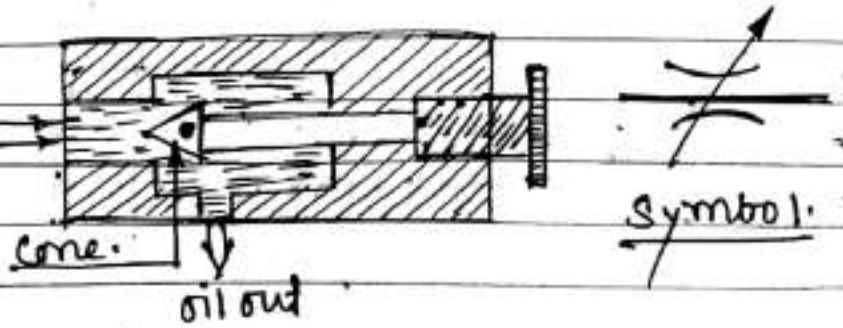
It consists of hollow cylinder shaped Poppet at the bottom of fixed orifice. Inside the poppet there is spring support.

Initially through inlet pressurized oil will enter and apply full force on the bottom of Poppet As a result it try to compress the spring by moving the poppet to right. Then the Poppet will close the outlet port and flow through orifice will start. Initially oil will occupy the bore of cylinder and equilize the pressure of inlet and outlet Port.

During Poppet balancing process Spring will expand and poppet will move slowly towards left and outlet Port will open slowly. Balancing is automatically done and Constant oil flow will start.

This type of valves mainly used in material handling plant.

(11) **Non-Pressure Compensated flow Control valve:**



Non-Pressure Compensated flow Control valve control the flow by throttling or restricting the fluid flow.

In this valve it consist of a cone, which fixed with a screw at the end. The pointer of the cone is fitted at the inlet port. For adjustment a constant flow initially cone is located at a pre-determined point/location by rotating the screw.

As a result when pressure of incoming oil changes, the outlet flow will not change.

Non-Pressure compensated flow control valve used where accuracy is very high.

Actuators: Actuators are used to convert the fluid pressure into mechanical work.

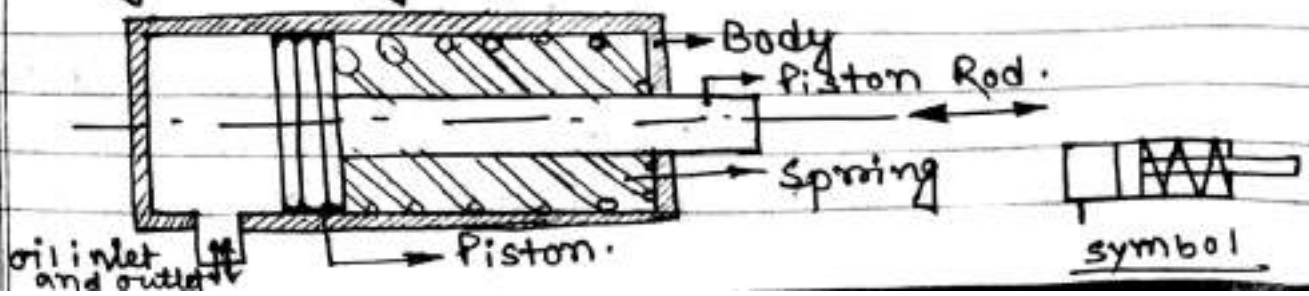
Hydraulic actuators are classified as two categories.

(I) Linear Actuators.
(II) Rotary Actuators.

(I) Linear Actuators: Linear actuators are also known as Hydraulic cylinders. It is a device which convert fluid power into linear mechanical work. Linear actuators can be classified as -

(i) single acting cylinder.
(ii) Double acting cylinder.

Single acting cylinder:

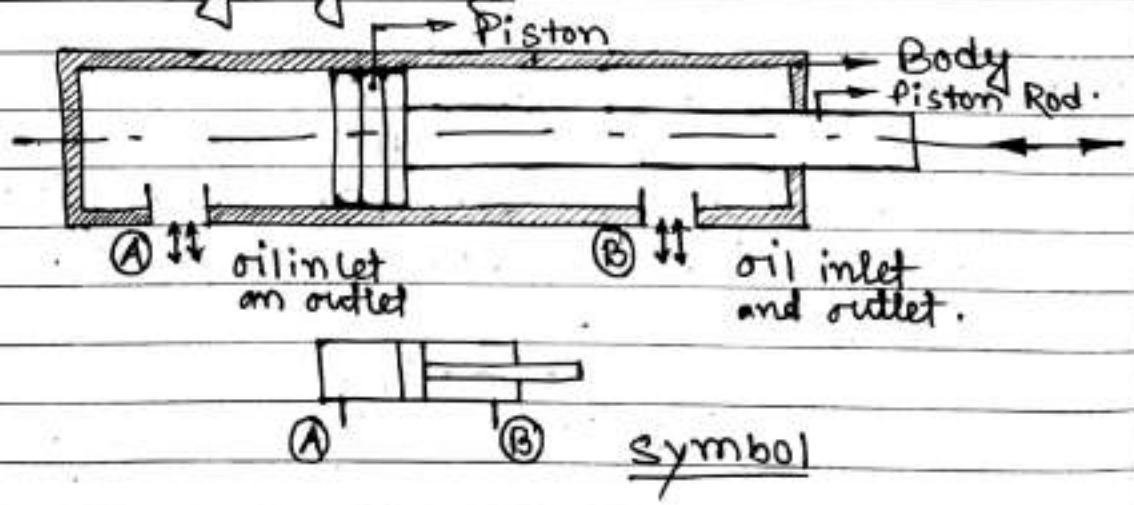


In Single acting cylinder there is a spring on one side of the piston and another side oil Pressure is present. This is a closed system.

In normal condition Spring Pressure is equal to oil Pressure. when oil inlet will increase, Pressure on the piston side will also increase. As a result Piston will start moving in forward direction as oil Pressure is increased than spring Pressure.

After that when work done is completed, oil will release from same Port. As a result oil Pressure will start decreasing than Spring Pressure and Piston will come back in its neutral or normal Position. Here is only one inlet and outlet for oil come in and out.

(11) **Double Acting Cylinder:**



symbol

In double acting cylinder there is two ports for oil inlet and outlet (Port A and Port B). Port A is in the front surface of Piston and Port B is in the back surface of Piston.

When system is in normal condition

i.e Port A and Port B are disconnected with system Port, Pressure on the both Surface of Piston are normal and equal. It is called neutral condition.

When Pressurized oil will entey through 'A' Port, at the same time same amount of oil will release from 'B' Port. As a result Pressure on front face will increase and Piston will move in forward direction.

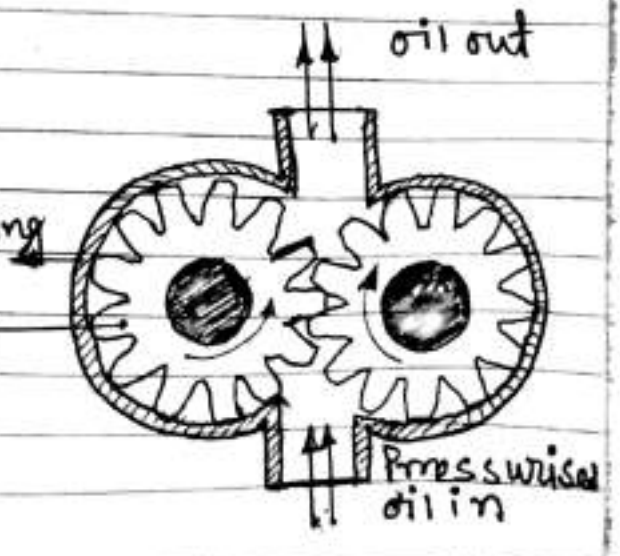
on the other hand when pressurized oil will entey from 'B' Port, oil will start release from 'A' Port. As a result Pressure on back side of Piston will increase and Piston will move in Backward direction.

Here forward and backward both motion we get from a cylinder. That's why it is called double acting cylinder.

●● **Rotary Actuators**: Rotary actuators are also known as hydraulic motors. It is a device which convert fluid Power into rotation - al mechanical work or rotational motion. Rotary actuators can be classified as —

(i) Gear moton.
(ii) Vane moton.

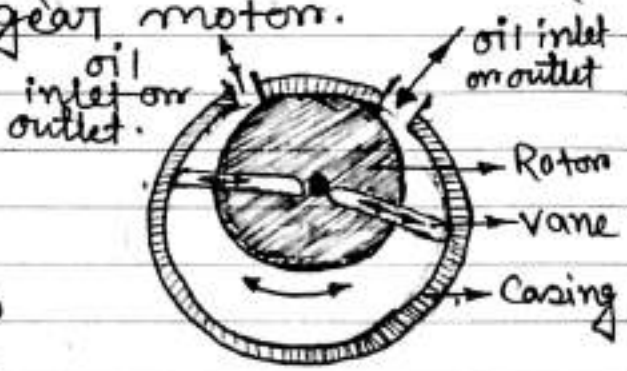
●●○ **Gear Motor**: Gear motor consists of a closed casing, two meshing gears connected with shafts.



Initially Pressurized oil will enter from bottom port and entire in the casing. It will create pressure on the face of the two matched gears, which causes imbalance of forces on two gears. As a result gears start rotation. After rotating low Pressure oil passes through upper port or release port.

Both clockwise and anticlockwise motion we get from gear motor.

(ii) **Vane Motor:**



Vane motor consists of a close casing, sliding vanes, a rotor and two oil inlet and outlet ports.

Initially Pressurised oil will enters from left port and causes the force on vanes which unbalances the motor. And as a result motor starts rotation. After work done low Pressure oil will release from the right port and delivered to the storage tank again. In this way we get rotation from vane motor in both direction i.e clockwise and anticlockwise direction both.

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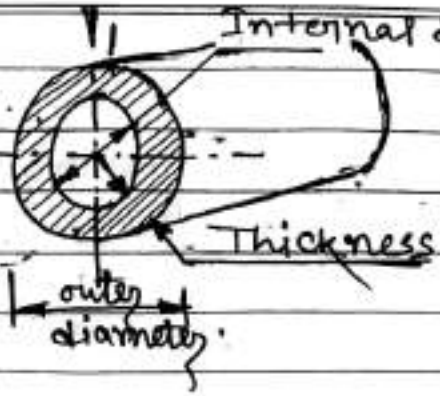
: Accessories :

• **Pipes** : Pipes are used to deliver hydraulic oil from tank to the other part of the circuit.



A Pipe is Specified in terms of internal diameter, outer diameter and thickness. As per this Specification. Pipe are three types.

- Standard.
- Extra Strong
- Double extra strong.

and

on the other hand three types of Pipes are used in hydraulic System. They are

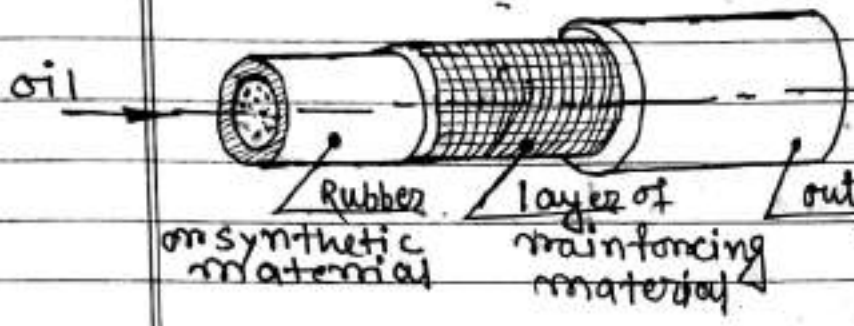
(i) Rigid Pipes.
(ii) Semi rigid Pipes. and
(iii) Flexible Pipes.

Depending upon pressure oil, Mechanical strength and type of fluid we have to choose the Pipe type with a particular Specification. In general rigid Pipes are steel Seamless Pipes, Semi-rigid Pipes are Copper tube, aluminium tube and flexible Pipes are PVC, Nylon and Plastic Pipes.

Materials for Pipes i.e steel, Aluminium, Copper should be choose depending upon the factors —

(I) Highly resistance to corrosion.
(II) work in any temperature (hot temperature).
(III) Amount of Pressure.
(IV) weight "
(V) Ductility (Ability to be drawn into wires).
(VI) Cost of the Pipe.

Hoses:



In hydraulic system the drive units are assemblies needed to move along with pipelines. In such cases flexible pipes are called 'hoses'. Hydraulic hose has 3 layers.

In the inner layer is called 'hose material' layer as inner layer direct contact with pressurized hydraulic fluid. oil will flow through inner tube. The materials used in this layer are plastic, Nylon, PVC, Teflon, Compounded rubber etc.

In the middle layer is called 'hose reinforcement' layer. It increases the strength of a inner layer. This layer provides structural strength to entire hose to withstand against hydraulic pressure of oil which is very high in hydraulic system. This layer is made of cotton, steel wires, Rayon, synthetic yarn etc.

The outer layer is called Protective cover. The reinforcement layer or middle layer is protected from corrosion, abrasion and other damages which can occur during accidents. The materials used in this layer are Neoprene, Cotton, Synthetic GRS rubber etc. The outer layer colour is black. But sometime red colour is also used.

The main advantages of hose are —
(i) It can withstand at high pressure.
(ii) Absorb heavy shocks.
(iii) Easy to quick connect and fittings.

The disadvantages of hose are that
(i) initial cost is very high.
(ii) Improper oil damage the hose.

Fittings:

Male Fixed Couplings

Compression fitting.

Among the basic elements of every hydraulic system is a series of fittings for connecting tube, Pipe, and hose to Pumps, valves, actuator and other components. If the components within hydraulic system never had to be removed, Connections could be welded to maximize reliability. However for servicing and replacing components we need easily removable fittings.

Fittings seal fluid within the hydraulic system by one of two techniques.

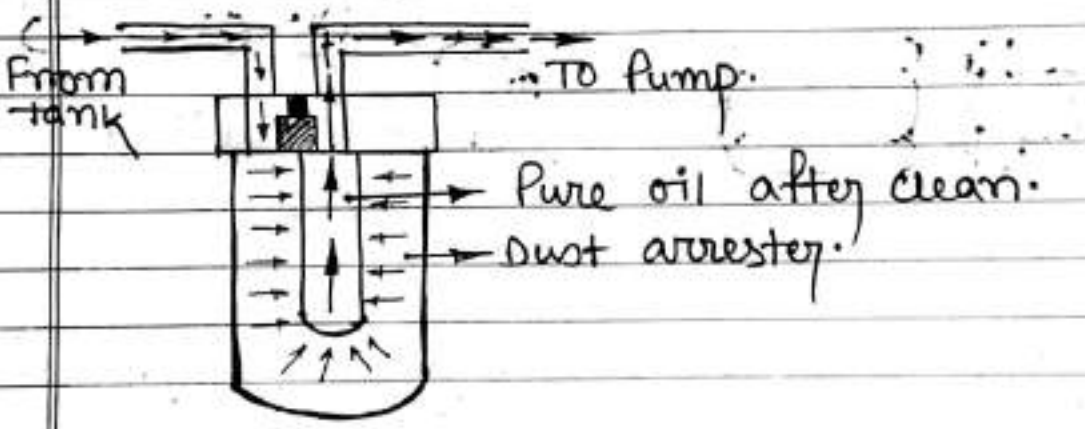
All metal fittings rely on metal to metal contact, while 'O' ring type fittings contain pressurized fluid by compressing an elastomeric seal.

In either case tightening threads between mating halves of the fitting (or fitting and component Port) forces two mating

Surface together to form a high-Pressure seal.

The main purpose of the fitting is to make the system safe, make it leakage less, easy to connect and disconnect and quick replacement of any damage Component.

Oil filters:



oil filter

Hydraulic filters protect hydraulic System Components from damage due to contamination of oils or other hydraulic fluid in use Caused by Particles. A hydraulic filter helps to remove these particles and clean the oil on a continuous basis. The Performance for hydraulic filter is measured by its Contamination removal efficiency.

Initially oil from the tank is entered in oil filter outside and after filtering its enter into center of the oil filter and from there due to Suction its go to Pump. In this way oil filter remove all the particles from oil and keep the System efficient.

Seals and gaskets: Seals and gaskets are very important element to prevent leakage in a hydraulic circuit through joints. Without this seal and gaskets are used in a hydraulic circuit to maintain a constant pressure, to enhance the working life of the system and to enhance the functional reliability of components over a longer period.

Seals and gaskets are two types. one is called "static seal", which is used to seal two matching parts which are not moving. Gaskets are the one type of static seal. Another one is called "Dynamic seal", which is used to seal two matching parts which are having relative motion between them. "Dynamic seal" used in between piston and cylinder.

There are various types of seals used in a hydraulic circuit, like as 'O' seal, 'V' seal, 'U' seal, 'T' seal and so on. These all are the dynamic seal, as well as we can use as a static seal also.

Seal and gaskets are used in a circuit depends on various conditions/factors. They are-

(1) Type of oil used in system.
(2) Temperature of the system at working time.
(3) working pressure.
(4) Environmental condition.
(5) Cost of the seal and gaskets with expected tool life.

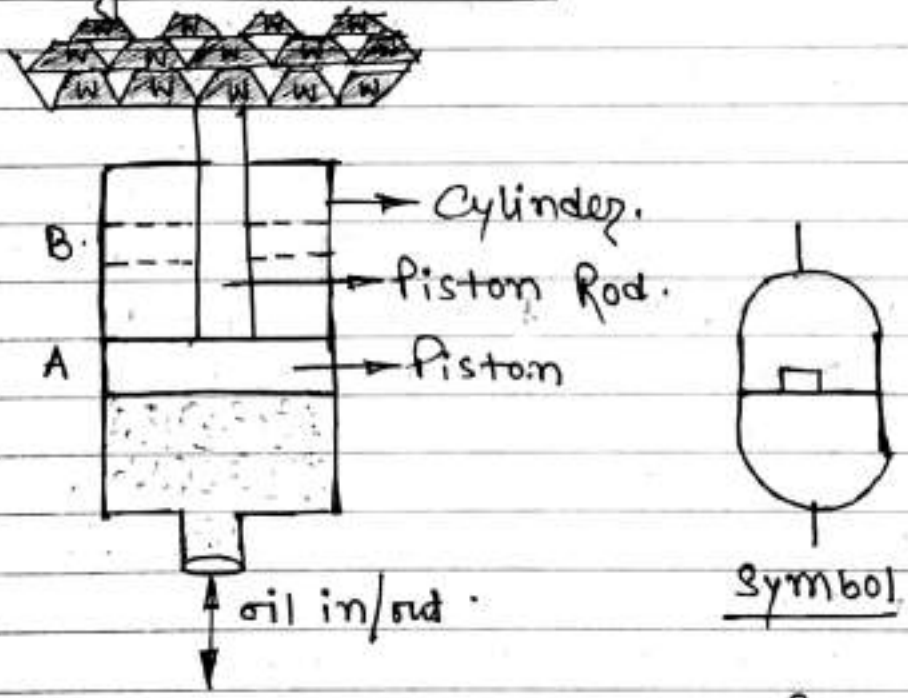
gaskets. 'O' ring seal. 'V' ring seal 'U' shaped seal

Accumulators: Accumulators is an element to store excess hydraulic energy and on demand make the stored energy available to the System. Hydraulic system using accumulators are most efficient systems as there is very little energy loss.

Basically there are three basic types of hydraulic accumulators.

(1) Dead weight accumulators.
(2) Spring loaded accumulator.
(3) Gas pressurised accumulator.

Dead weight Accumulators:



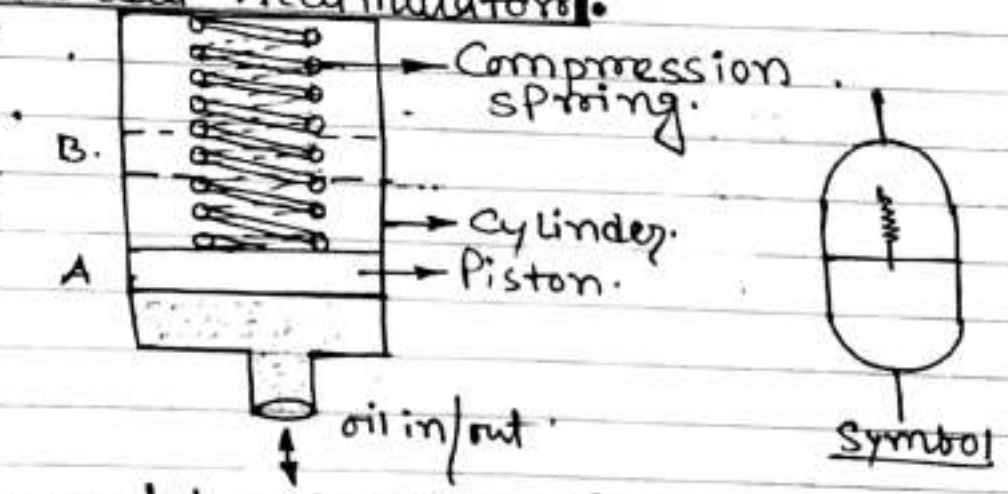
This accumulator Consists of a sliding Piston in a cylinder. The oil under Pressure from pump enters into the cylinder through inlet Port. The Pressurised oil forces the Piston upwards until it reaches Position 'B' from 'A'. Dead weights are kept on the top of the Piston rod and weight is depend upon the predetermined pressure.

When the Piston reaches Point 'B' it is 'fully charged' and oil in the cylinder having Pressure energy due to dead weight.

When there is sudden pressure drop in the System, Pressurised oil will enter in the System from accumulator and try to maintain a constant Pressure overall the system for a Certain time.

The main advantages is that it can supply large amount of oil under Pressure. But it is bigger in size and occupy more Space.

- **Spring Loaded Accumulator:**

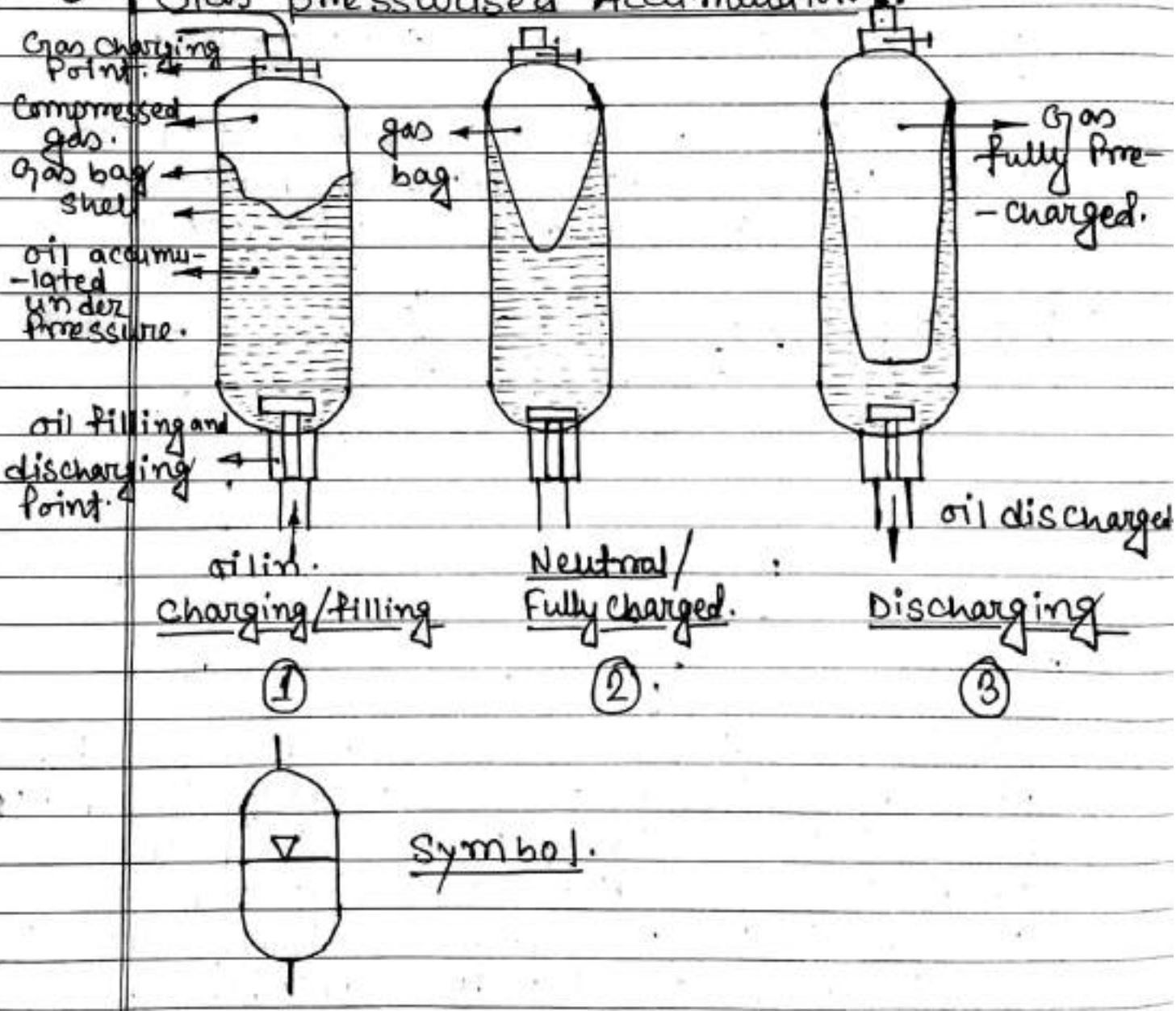


This accumulator consists of a Spring loaded piston. The oil under pressure usually from pumps enters into the cylinder through inlet port and due to oil Pressure Piston moves upward and Spring will compressed. When Piston reached 'B' Point from 'A' Point it is called fully charged and Spring will be under full compression.

When there is pressure drop in system, pressurised oil will enter in the system from accumulator and maintain a constant pressure for a certain time.

The main advantage of this accumulator is that no parts are outside and it is compact in design and handy. But due to spring fitted, the stroke of piston become limited.

Gas pressurised Accumulator :



Symbol.

This accumulator consists of a gas charged bag/bladder is fixed in a shell of accumulator. That's why the another name of this accumulator is "Bladder Type Accumulator" or "Gas filled Bladder Accumulator".

When pressurised oil enters into accumulator, the gas bag compresses. when the system requires oil under pressure, the oil goes out and the bladder expands. Generally Nitrogen or any inert gas are used to fill the gas bag.

The main advantage of this accumulator is that it is compact and light in weight. It is cheaper than any other accumulator. As the gas bag is made of flexible material like rubber, hence it gives quick response to expansion and compression.

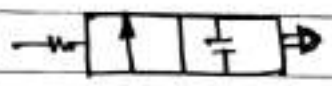
The disadvantage of this type accumulator is that volume of oil storage is less and high temperature fluid we cannot use.

Symbols used in Hydraulic Circuits:

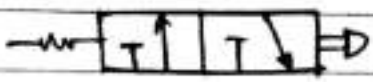
Reservoir/oil tank

Filter

2×2 D.C valve.

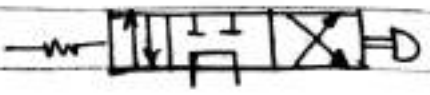


3×2 D.C. valve.



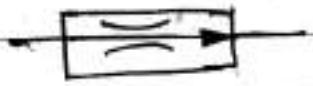
4×2 D.C Valve.

4×3 D.C. Valve.

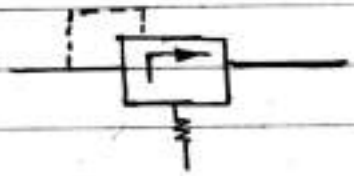


Non-Pressure Compensated flow Control valve.

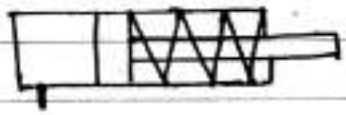
Pressure Compensated flow Control valve.



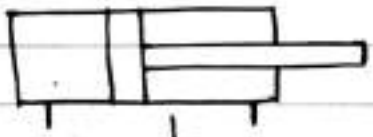
Pressure relief valve.



Single acting Cylinder. (S.A. Cylinder)



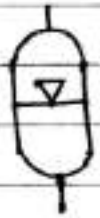
Double acting Cylinder.



Dead weight accumulator.

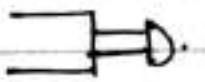
Spring loaded accumulator.

Gas pressurized accumulator.

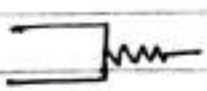


Pressure Gauge.

Push button Control



Spring Control



Solenoid Control

CHAPTER 3

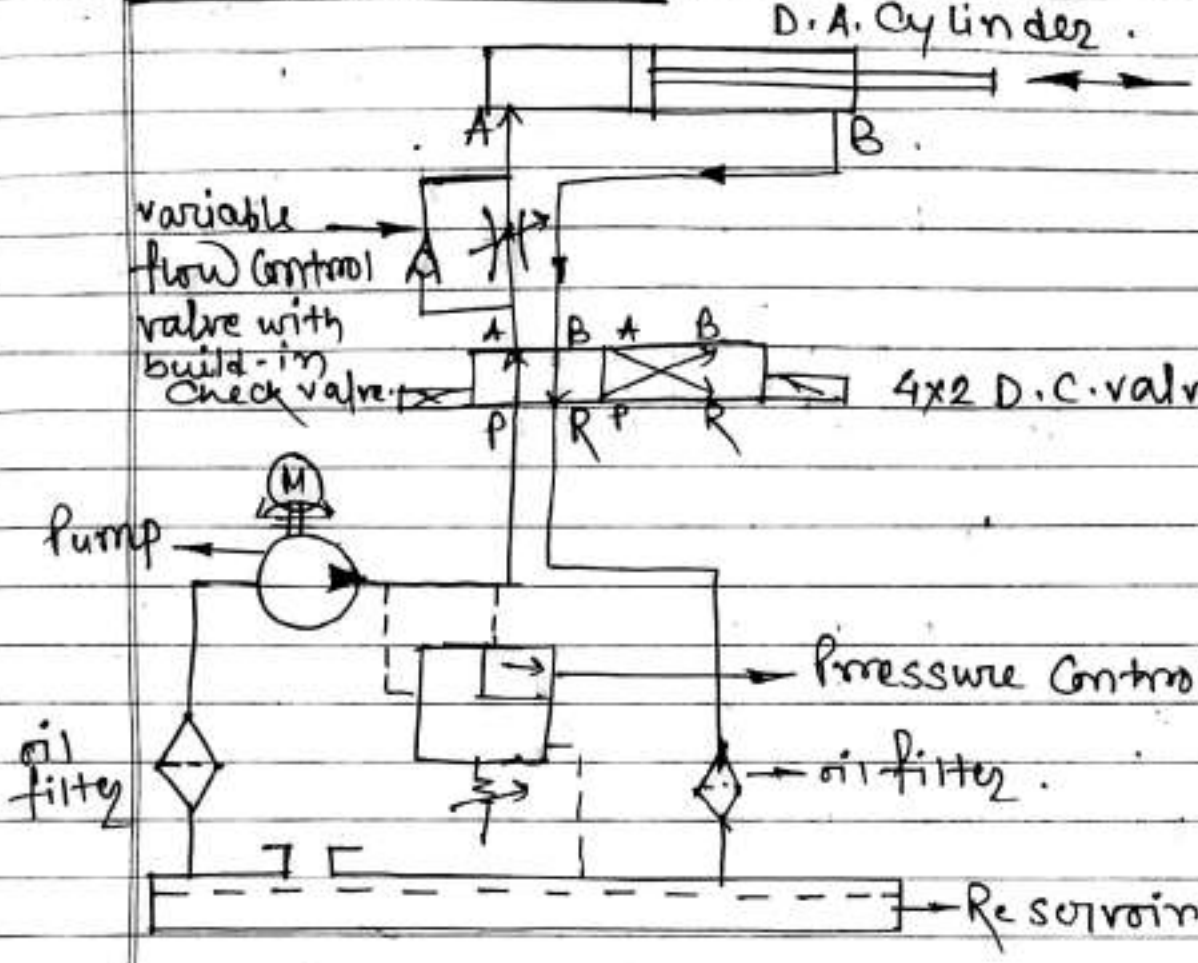
Hydraulic Circuits.

Marks: 16

Topics:

(1) Meter in Circuit.
(2) Meter out Circuit.
(3) Bleed - off Circuit.
(4) Pressure dependant Sequencing Circuit.
(5) Travel dependant Sequencing Circuit.
(6) Hydraulic Circuit for Shaper Machine.
(7) Hydraulic Circuit for Milling Machine.
(8) Motion synchronization hydraulic circuit.
8.(a) Linear motion.
8.(b) Rotary motion.
8.(c) Combined motion.

Meter in Circuit:

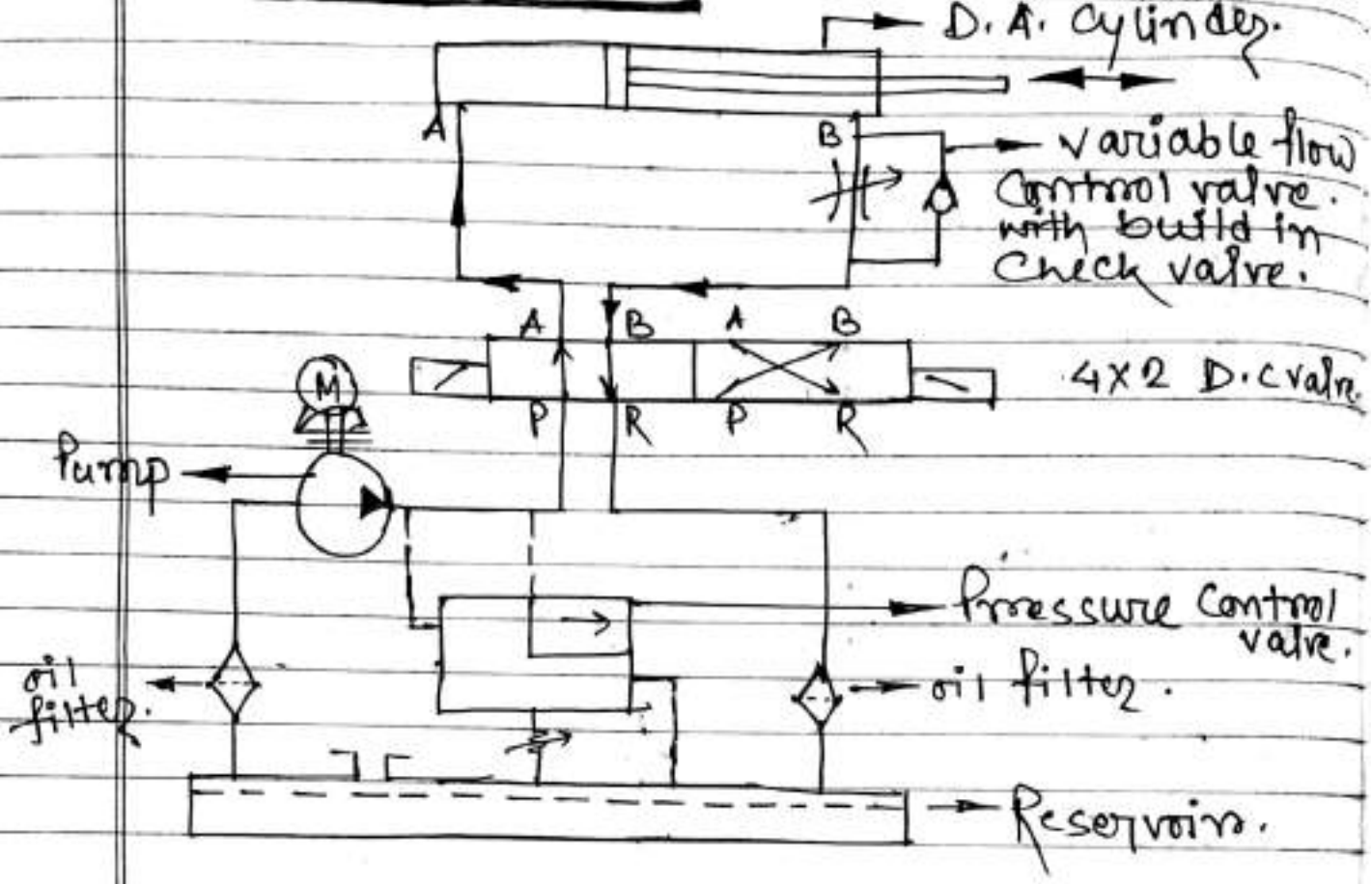


In Meter-in circuit flow control valve is placed in the pressure line before load. That's why it is called meter-in circuit. Intially pressurised oil will enter from pressure port 'P' to Actuators port 'A' and Return line is connected with Actuator port 'B'. As a Result piston will move in forward direction.

when 4x2 D.C. valve will operated, 'P' Port will connected to port 'B' and 'R' Port is connected to Port 'A'. As a result piston will move in Backward direction.

The main advantage of this circuit is to it can operate at higher pressure system and gives very low piston movement.

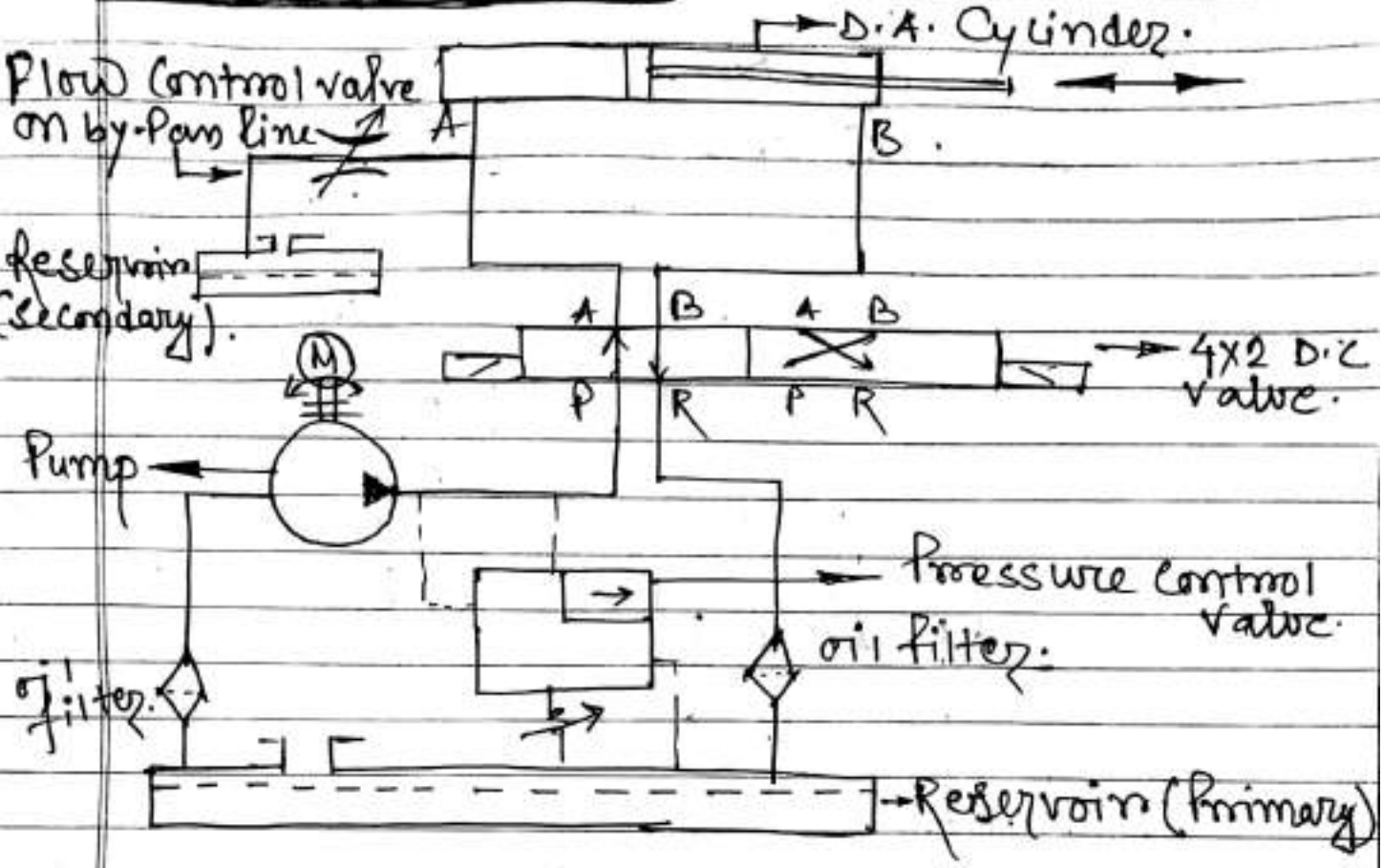
Meter out circuit :



Here variable flow control valve is is placed in the return line which is connected to the oil reservoir. In this circuit Speed Control is done by controlling the flow Control valve in such way that flow coming out to the tank controlled by the flow control valve. Initially 'P' Port is connected to 'A' Port and 'R' to 'B'. As a result Actuator movement will be in stable condition. Here also actuator move in forward and backward direction, Controlled by 4X2 D.C valve. The main advantage of this circuit is to stable the movement of the Actuator.

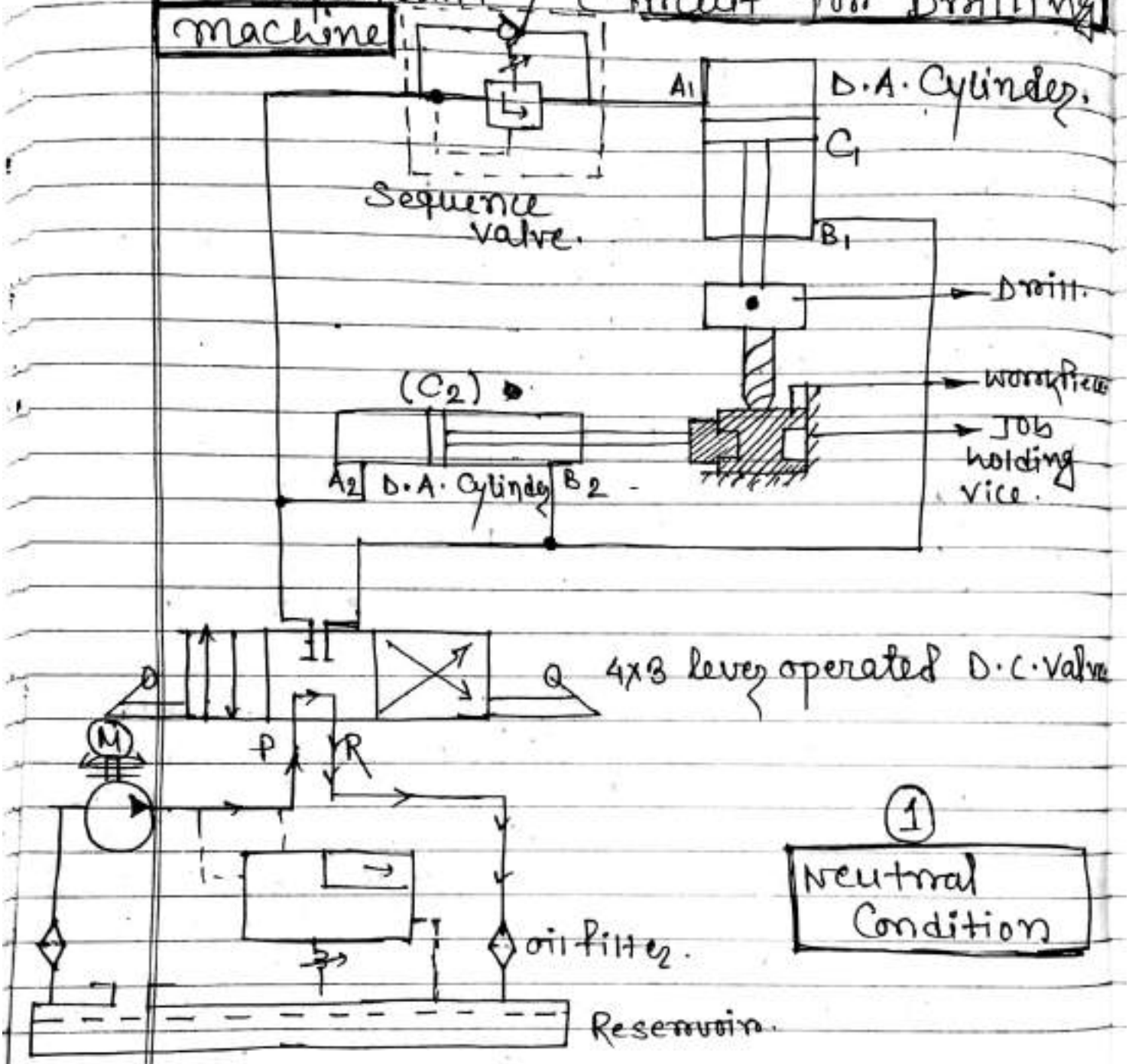
Such type of circuit are suitable for drilling, boaring, reaming operation.

② Bleed off Circuit:



In Bleed off circuit pressurized fluid from pump is diverted and by passed to the oil reservoir. Here flow control valve is placed in the by-Pass line. Due to the by Pass arrangement Speed of the actuator is controlled in forward as well as return Stroke. Due to by Pass of oil flow it is called "Bleed-off" circuit and Sometime it is called by-Pass Control Circuit. The main advantage of this circuit is that no excess flow is enter in the actuator. So System is efficient. This type of circuit used in broaching machine, Sometime hydraulic Shaping machine where pressure is constant.

Sequencing Circuit Pressure dependant Circuit for Drilling machine

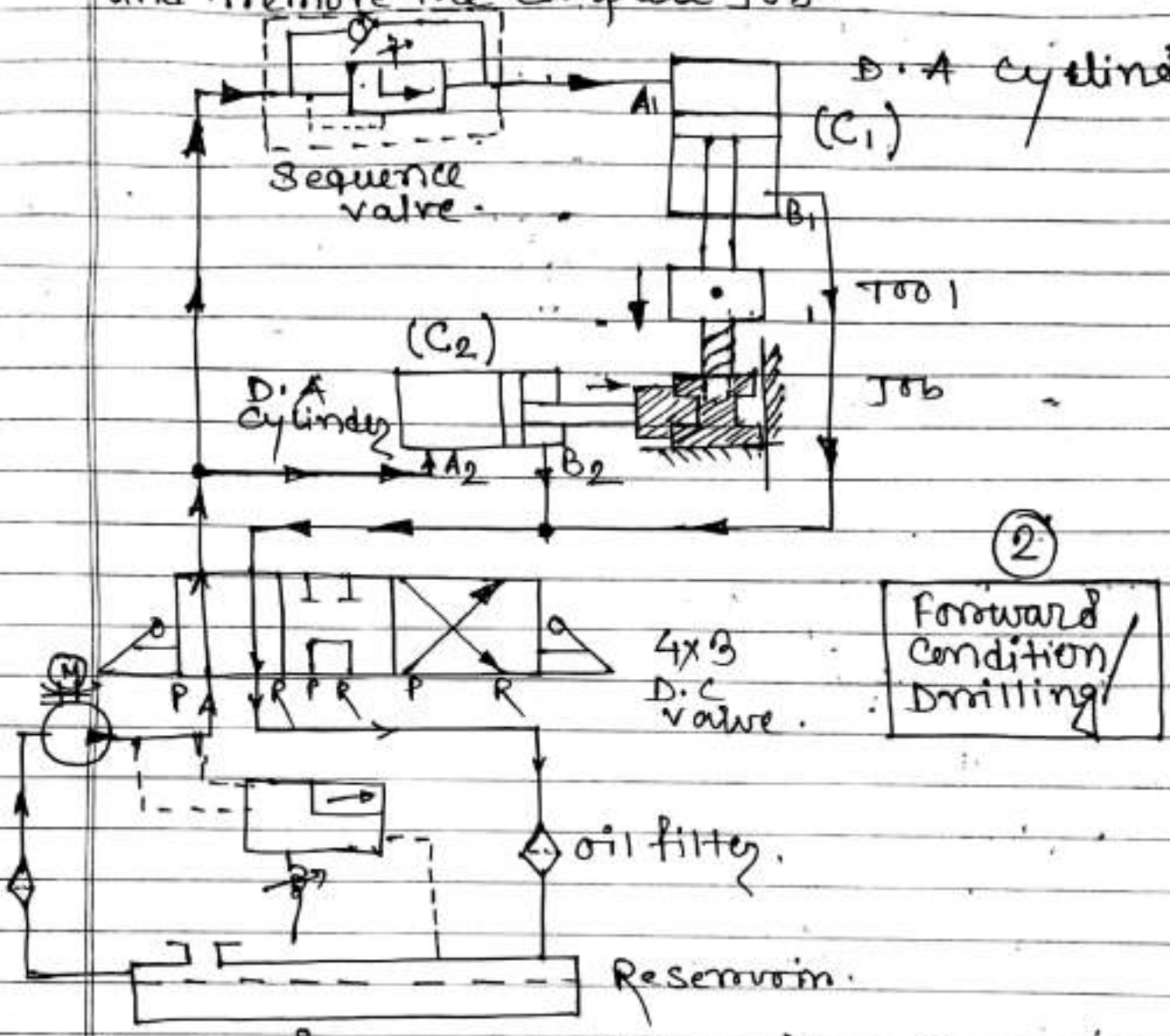


(1) Neutral Condition

This Circuit has 3 Sequence of operations.
1) clamping the workpiece.
2) Drilling
3) Drill taken out from job and declamping.

Initially at Neutral condition 'P' and 'R' are interconnected. So we cannot get work done from C_1 and C_2. This is called Neutral condition

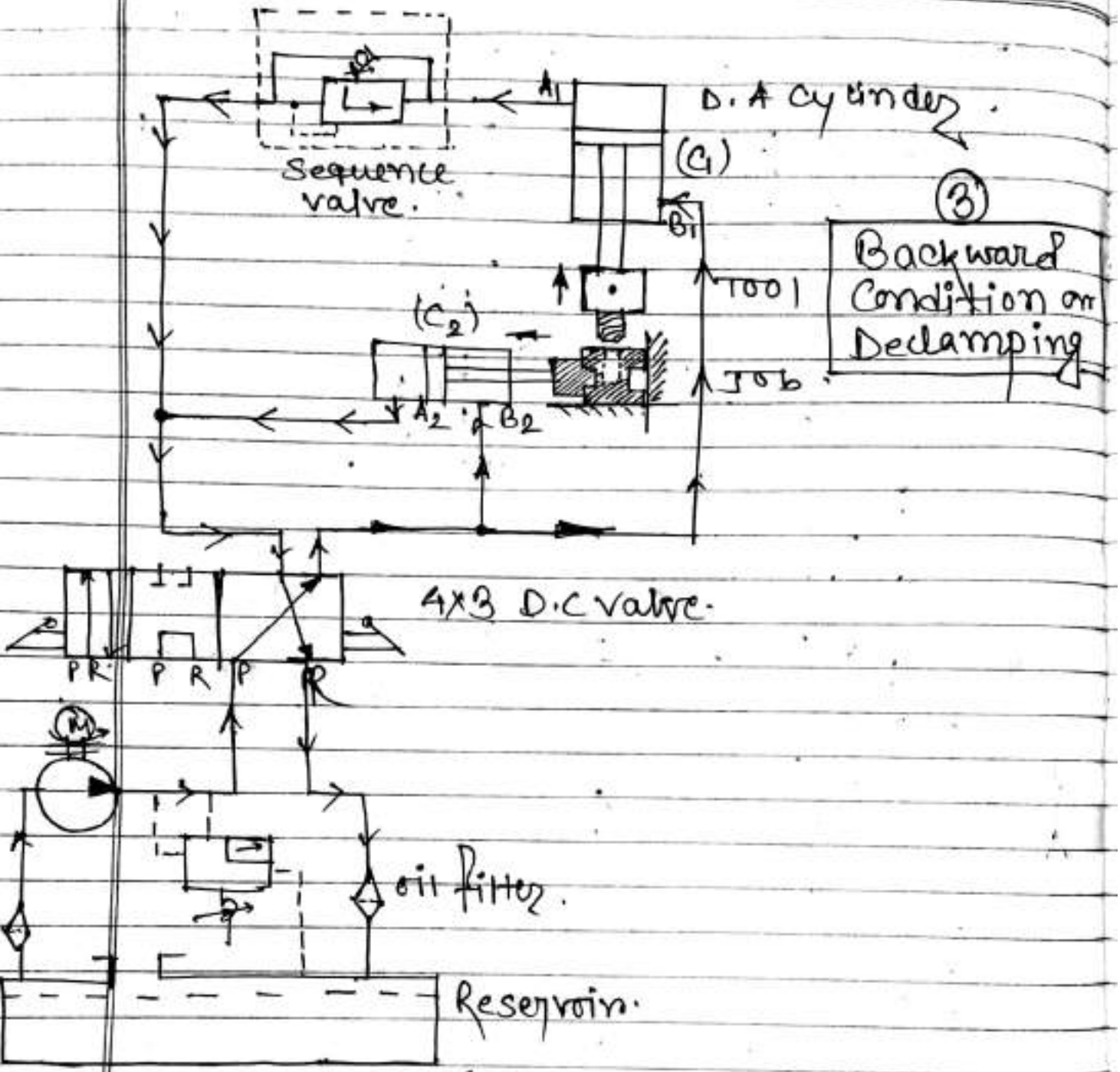
of circuit used for fit a new job in Work vice and remove the complete job.



(2)

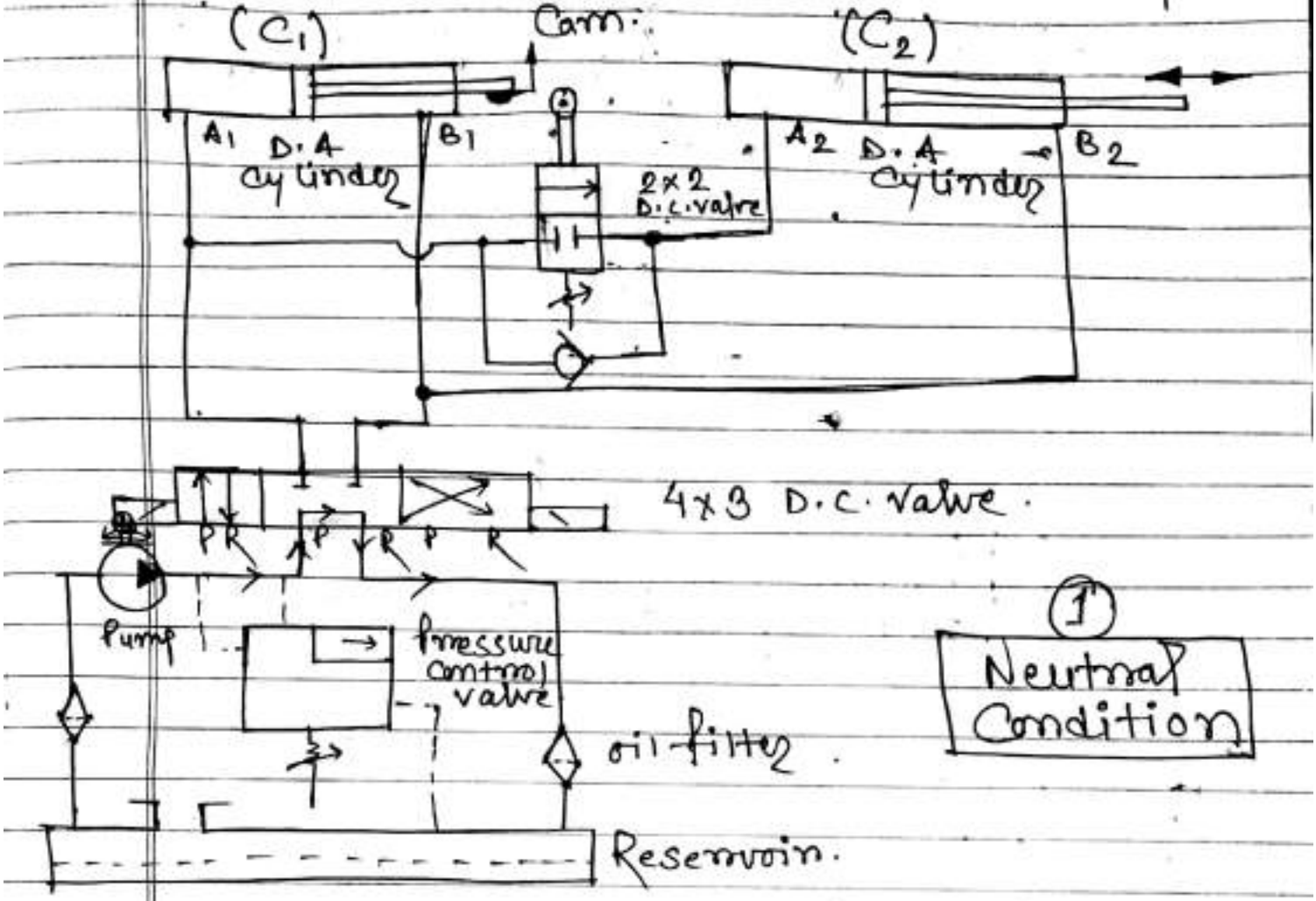
Forward Condition/ Drilling

In the forward condition first pressurized oil will enter in C2 and piston move in forward direction untill clamping is done. whenever it is completed Sequence valve will open and oil will enter in C1. As a result drill bit move forward direction slowly due to flow control valve and touch the job surface and start drilling as shown in fig.



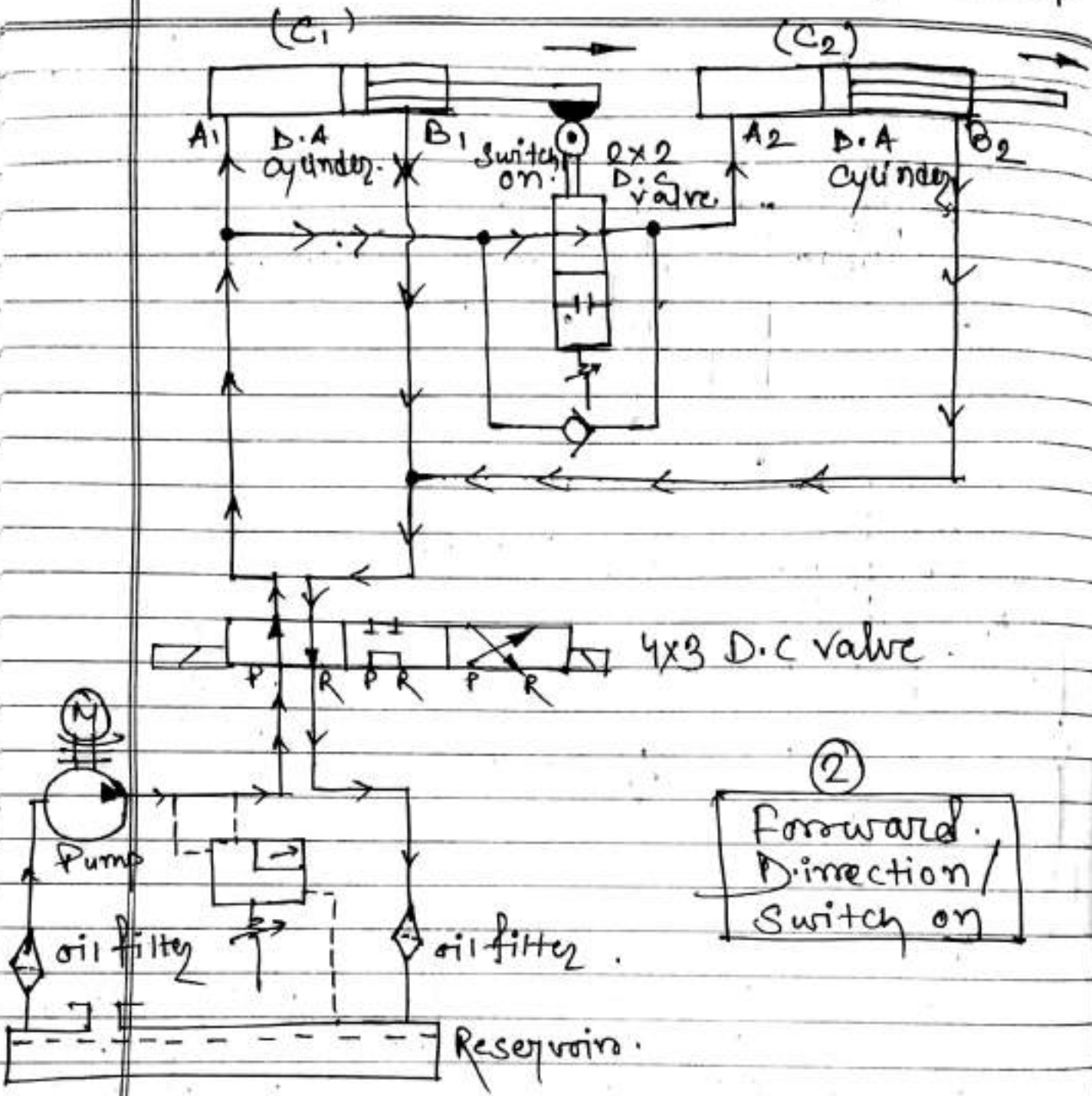
When drilling is completed, using D.C. valve we change the pressurized oil direction and as a result first oil will enter in C_1 and lifted up the drill bit. when this operation is completed, then pressurized oil will enter in C_2 and declamping is done.

Sequencing Circuit for travel Dependant



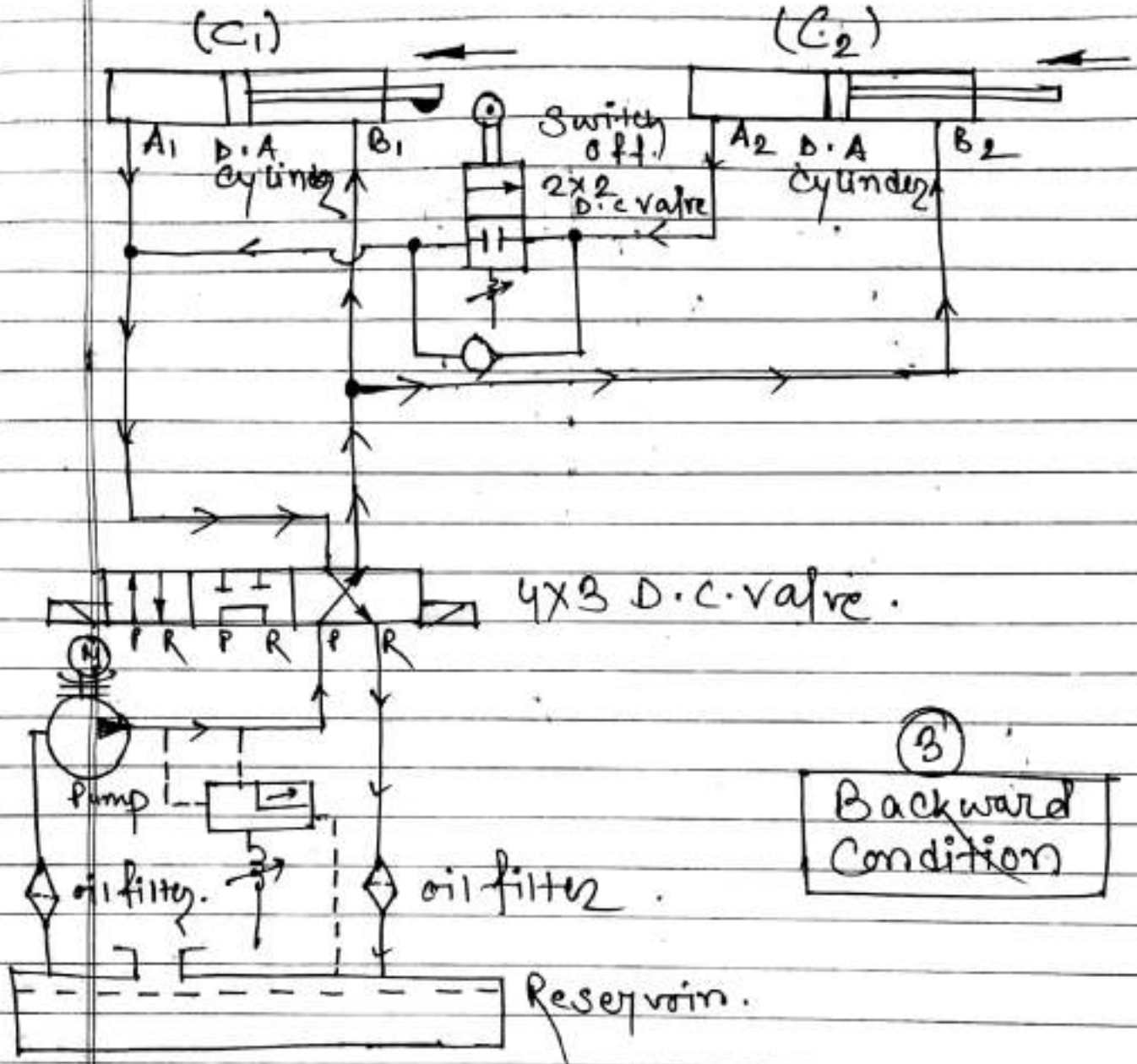
In the travel dependant Sequencing circuit two double acting cylinder C_1 and C_2 Connected through a 2×2 D.C valve. In the piston rod of C_1 a Cam profile is attached which act to on/off the 2×2 D.C valve.

In neutral condition Pressurized oil will passes through 'P' port to 'R' port and actuator ports are dis connected. As a result there will no movement in actuator. This is called the Neutral Condition of the circuit.



(2)
Forward Direction / Switch on

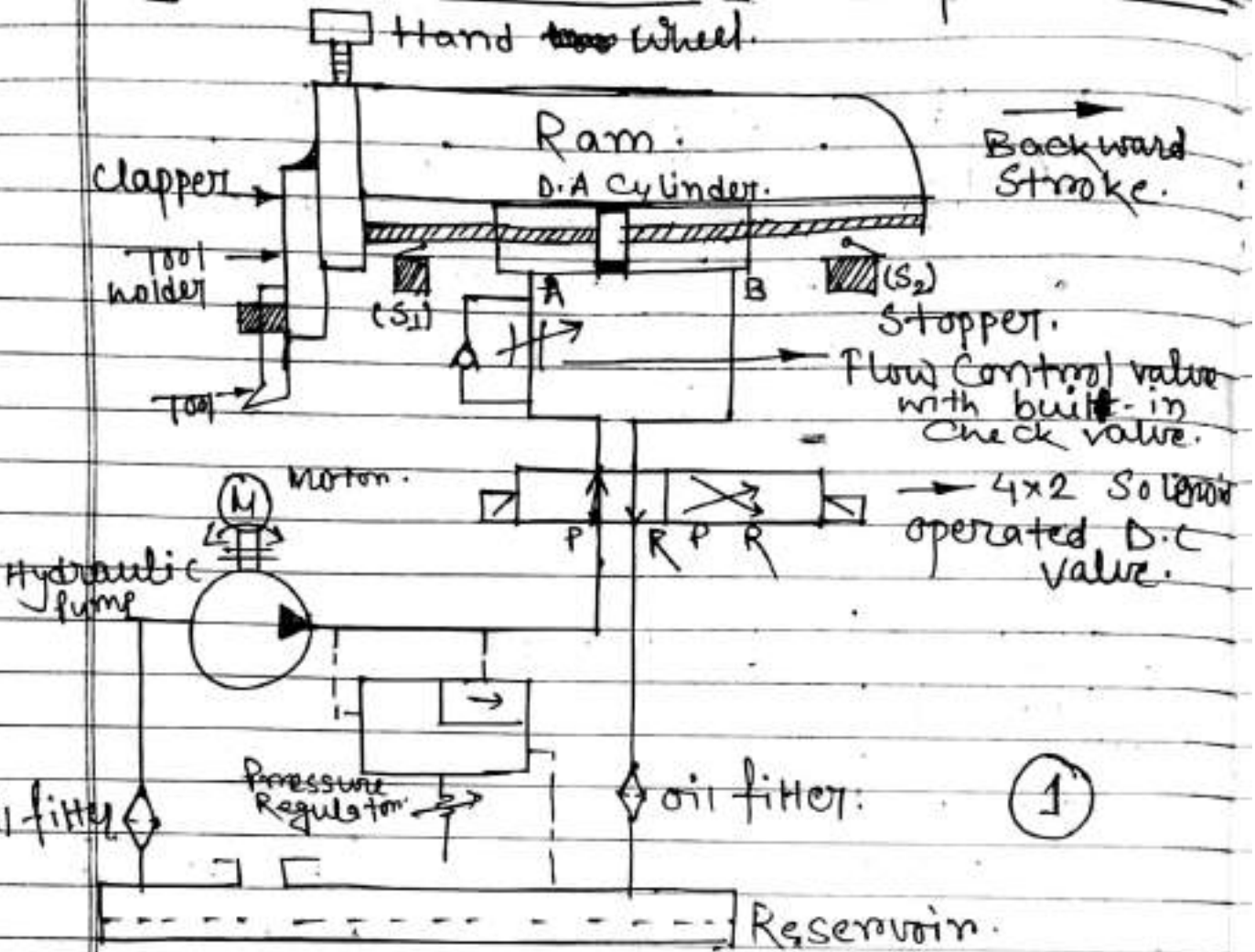
When 4×3 D.C valve is operated in forward direction oil will enter in C_1 Cylinder and Piston move in forward and on the 2×2 D.C valve. As a result oil will passes through switch to C_2 Cylinder and Piston of the C_2 Cylinder move forward direction. One cylinder will open another cylinder sequentially by travelling the Piston, that's why it is



(3)
Backward Condition

Called travel dependent sequencing circuit when 4x3 D.C valve operated in Backward direction oil will entes in C_2 cylinder and piston move backward direction. After compliting full movement of piston of cylinder C_2, oil will entes in C_1. As a result Cam moved its neutral condition and Disconnect the connection of 2x2 switch.

Hydraulic circuit for Shaper Machine:



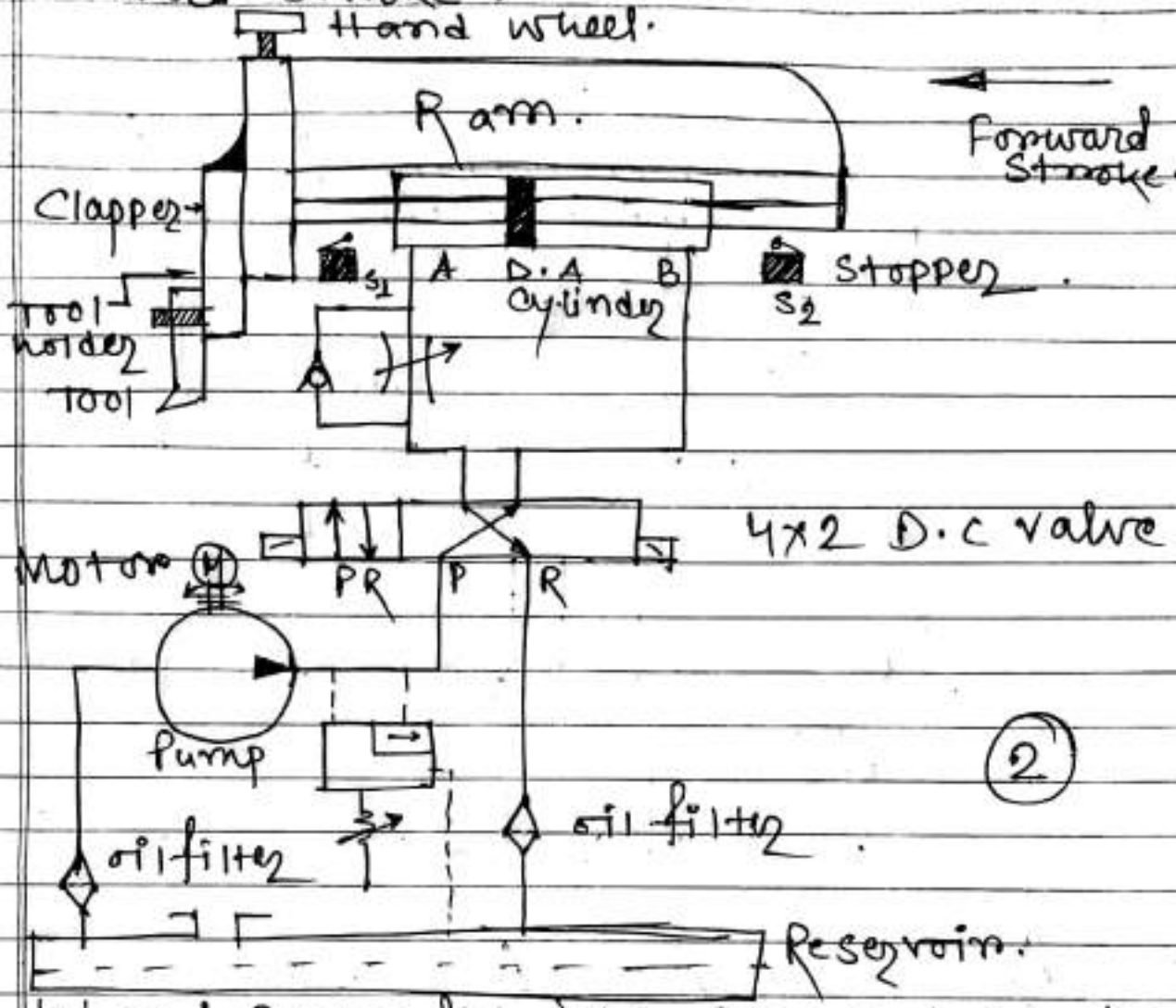
In shaper Machine Job is fixed and tool is movable in forward direction for forward stroke or cutting stroke. and in backward direction for return stroke.

The main components of shaper Machine are —

(i) Reservoir, (ii) oil filter (iii) Hydraulic Pump (iv) Pressure Regulator, (v) 4×2 solenoid operated D.C valve. (vi) D.A Cylinder.

In Forward stroke Pressure line 'P' is Connected with Actuator Port

Forward stroke :



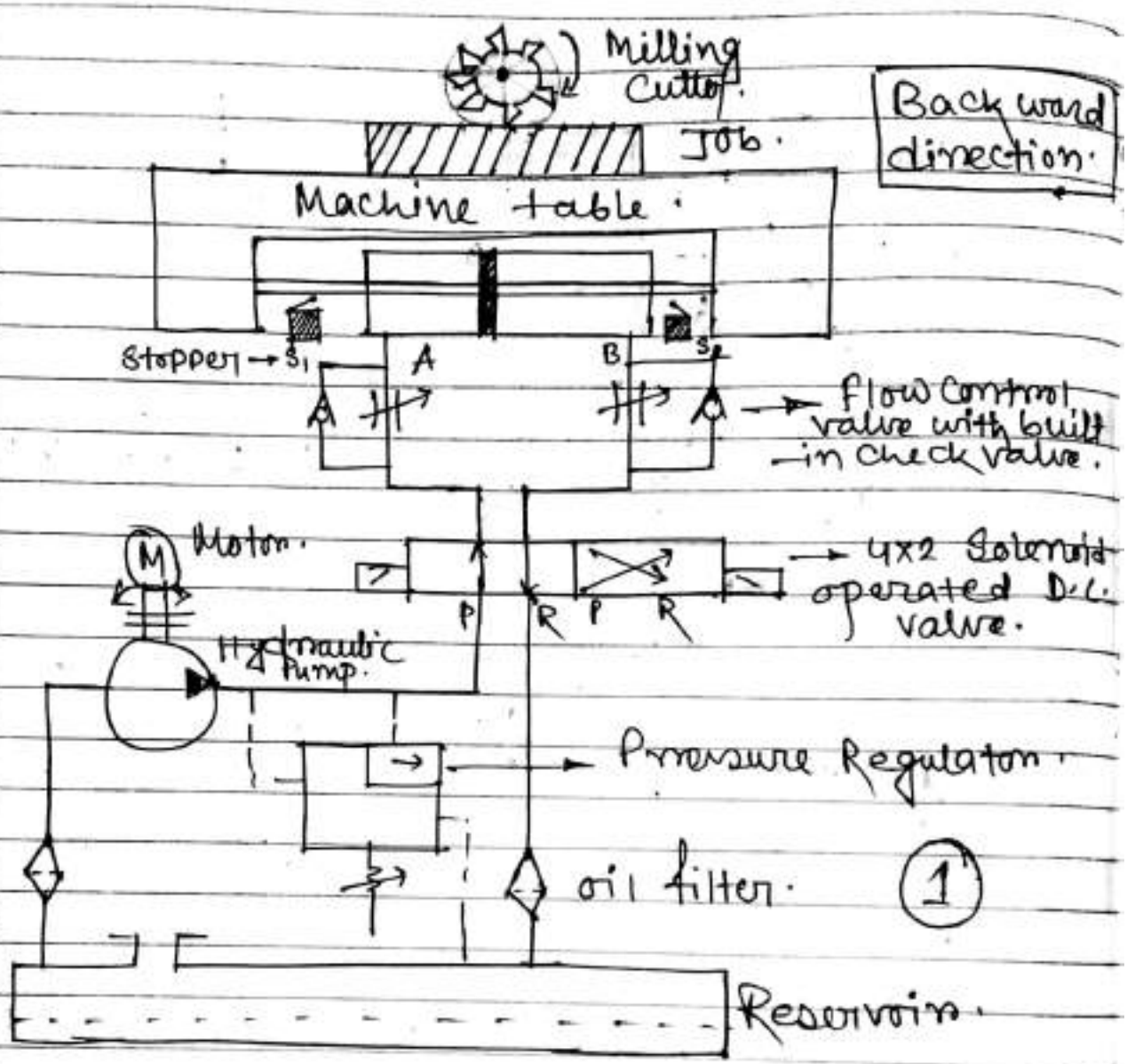
(2)

'B' and Release line 'R' is connected with Actuator Port 'A'. As a result Pressurised oil will enter in D.A cylinder and Ram will move in forward direction.

In Backward Stroke. Pressure line 'P' is connected with Actuator Port 'A' and Release line connected with actuator Port 'B'. As a result Pressurized oil will create pressure in 'A' side and as a result Ram will move in Backward direction.

Stoppers are used to control the movement of the Ram.

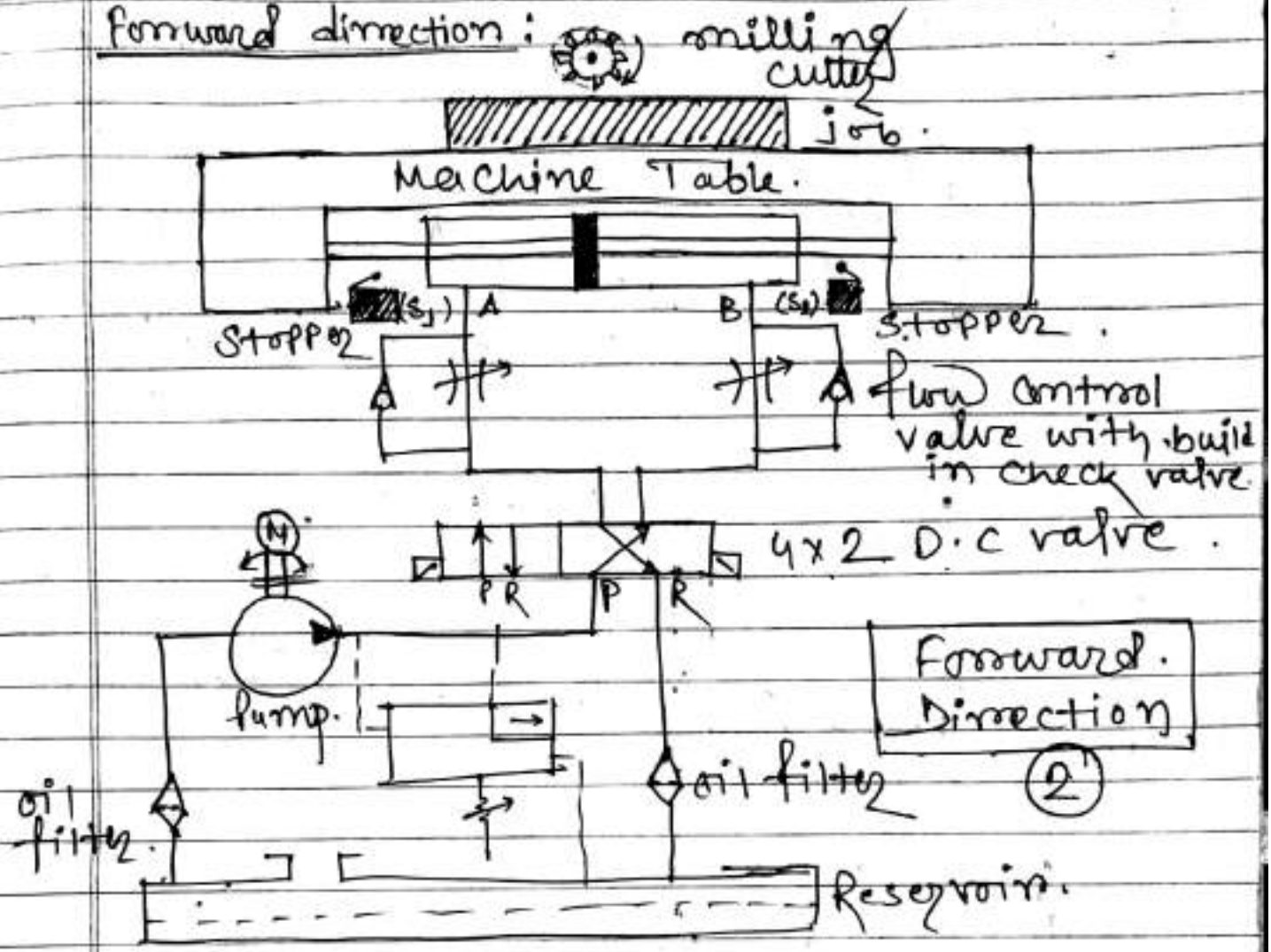
Hydraulic Circuit for milling Machine:



In Milling Machine tool is fixed and Job with Machine table will move in forward and Backward direction.

The main components of milling Machine are (i) Reservoir, (ii) oil tank, (iii) Pressure Regulator, (iv) 4x2 Solenoid operated D.C valve (v) two flow control valve with built in check valve. (vi) D.A cylinder.

Forward direction :



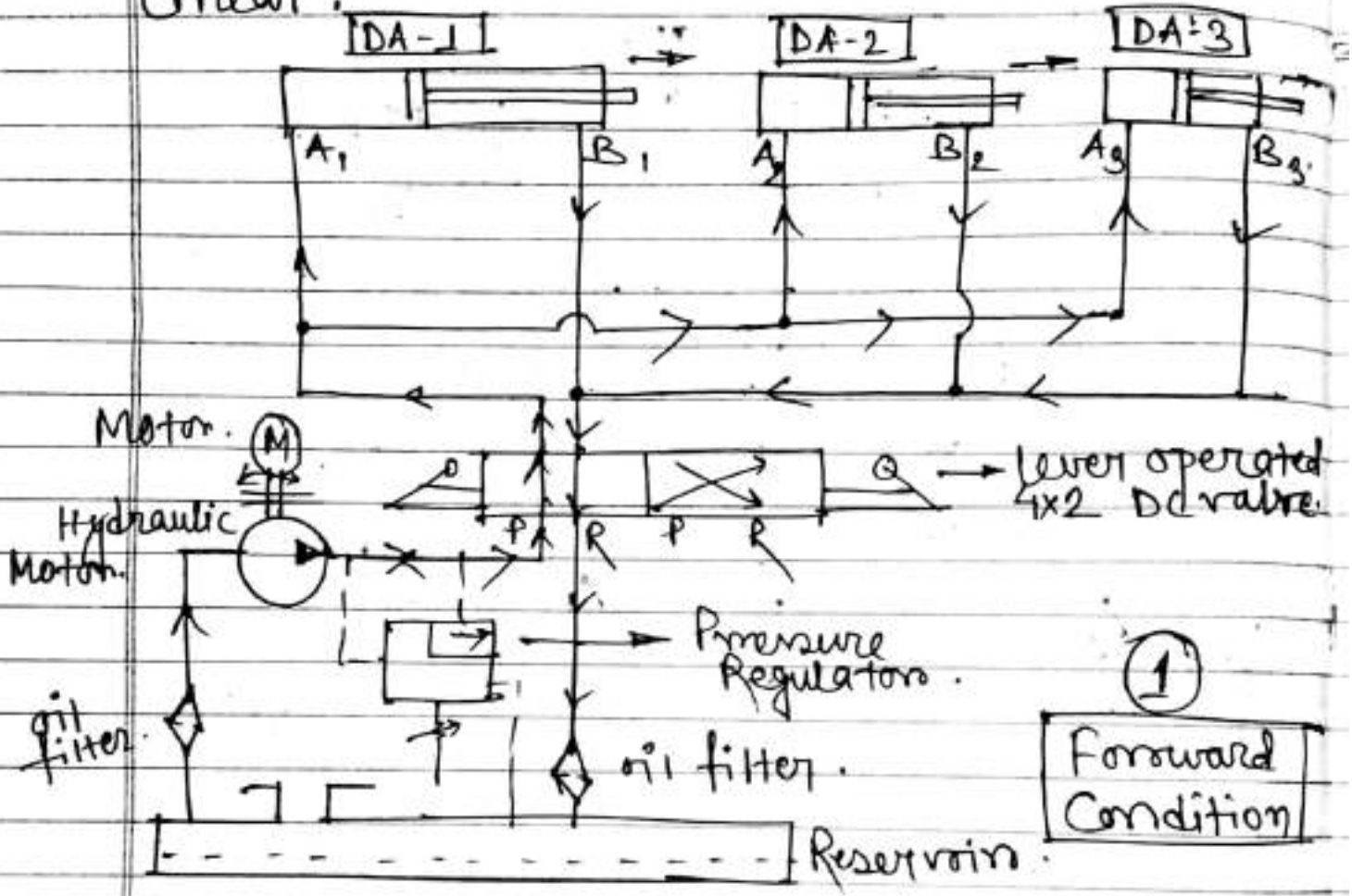
In forward direction pressure line 'P' is connected with Actuator Port 'B' and Release line 'R' is Connected with actuator Port 'A'. As a result table will move forward direction as. Pressure will generated on 'B' side.

In Backward direction 'P' Port Connected with 'A' Port and 'R' Port will Connect with 'B' Port. As a result Pressure will generated on 'A' Port and table will move backward direction.

But flow control valve opening in both Port 'A' & 'B' will be same as because table will move at constant speed.

Hydraulic Circuit for motion Synchronization Circuit.

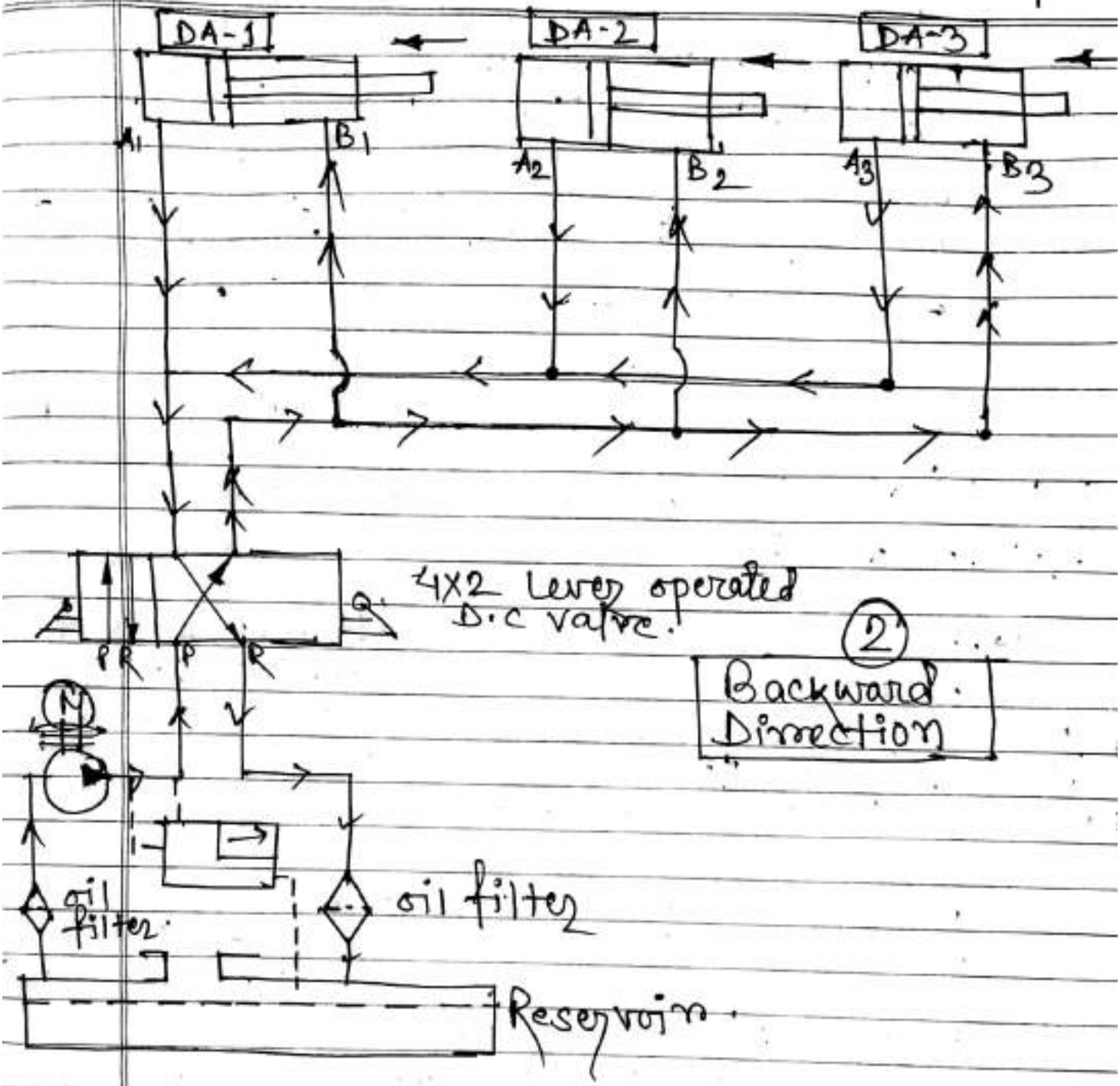
Linear :



Synchronization Circuit means two or more than two Actuator will move/work at a same time.

Here Pressure line will connected with 'A' Port of all three Double acting Cylinder and Release line with 'B' Port.

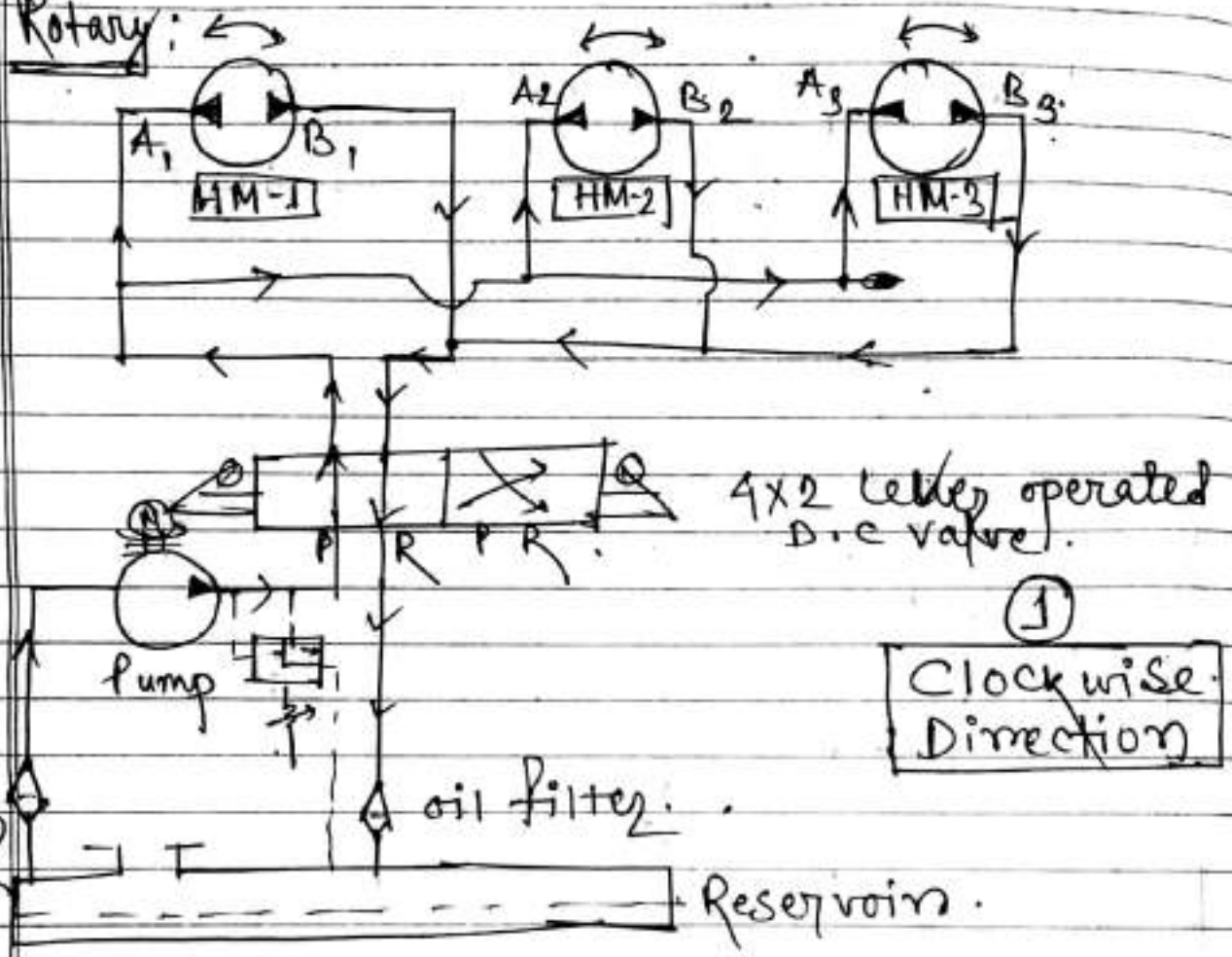
As a result all three cylinder will go forward direction at a same Speed. linearly.



(2)
Backward Direction

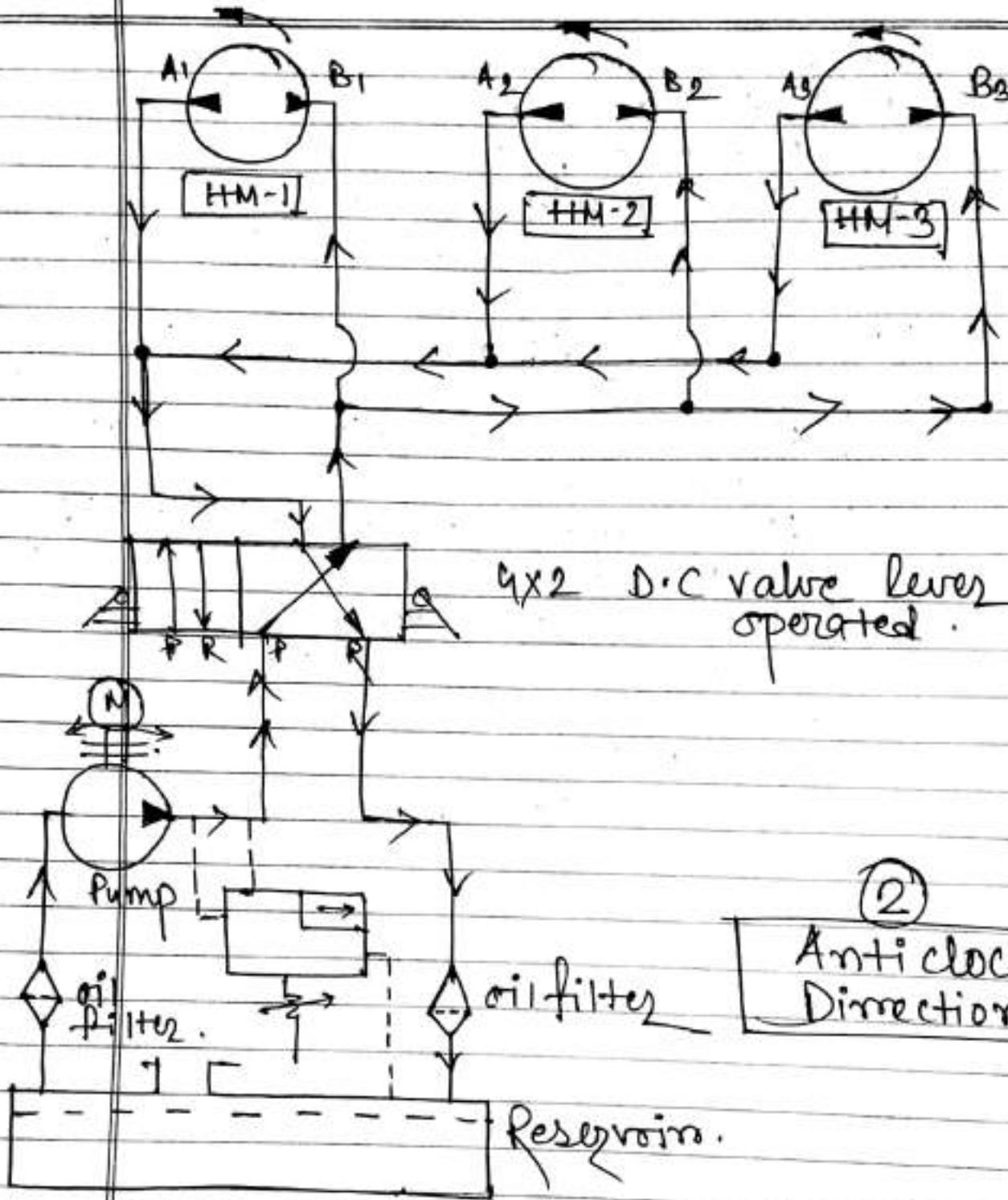
When 4X2 D.C valve operated, Pressure Line 'P' is connected with actuator port B_1, B_2, and B_3. Return line 'R' is connected with A_1, A_2 and A_3. As a result pressurized oil will enter through 'B' port and release through 'A' port and Piston will move in Backward direction.

Hydraulic Circuit for motion Synchronization Circuit.



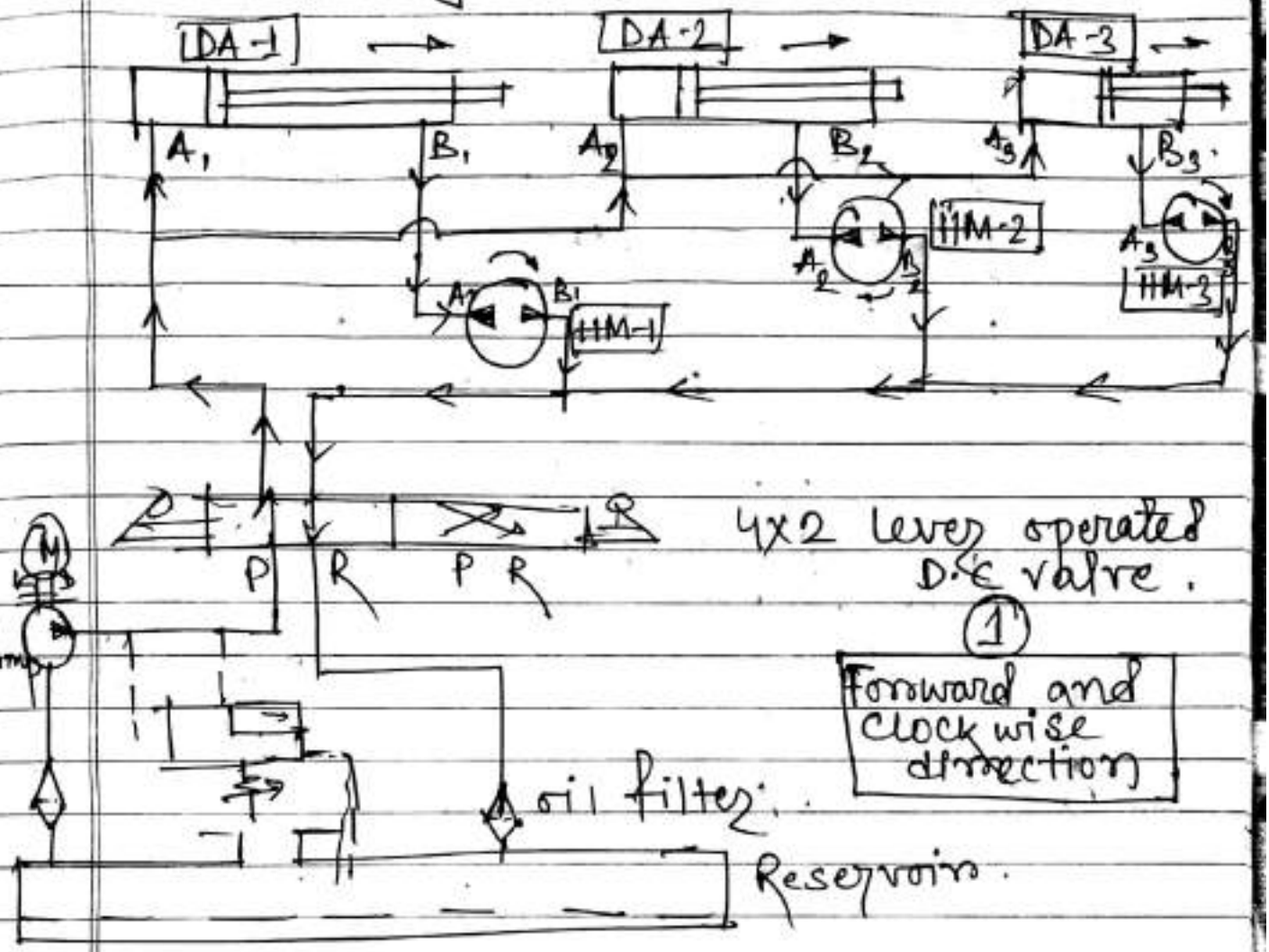
In this circuit hydraulic motors are connected with each other. In the initial condition A_1, A_2 and A_3 Port are interconnected and on the other hand B_1, B_2 and B_3 port are interconnected.

When P port will connected with A_1, A_2 and A_3 and 'R' Port is connected with B_1, B_2 and B_3 then oil will enter in A_1, A_2, A_3 and rotation will start As a result by changing the 'P' Port direction and 'R' Port direction we can get both clockwise and anti clockwise movement.

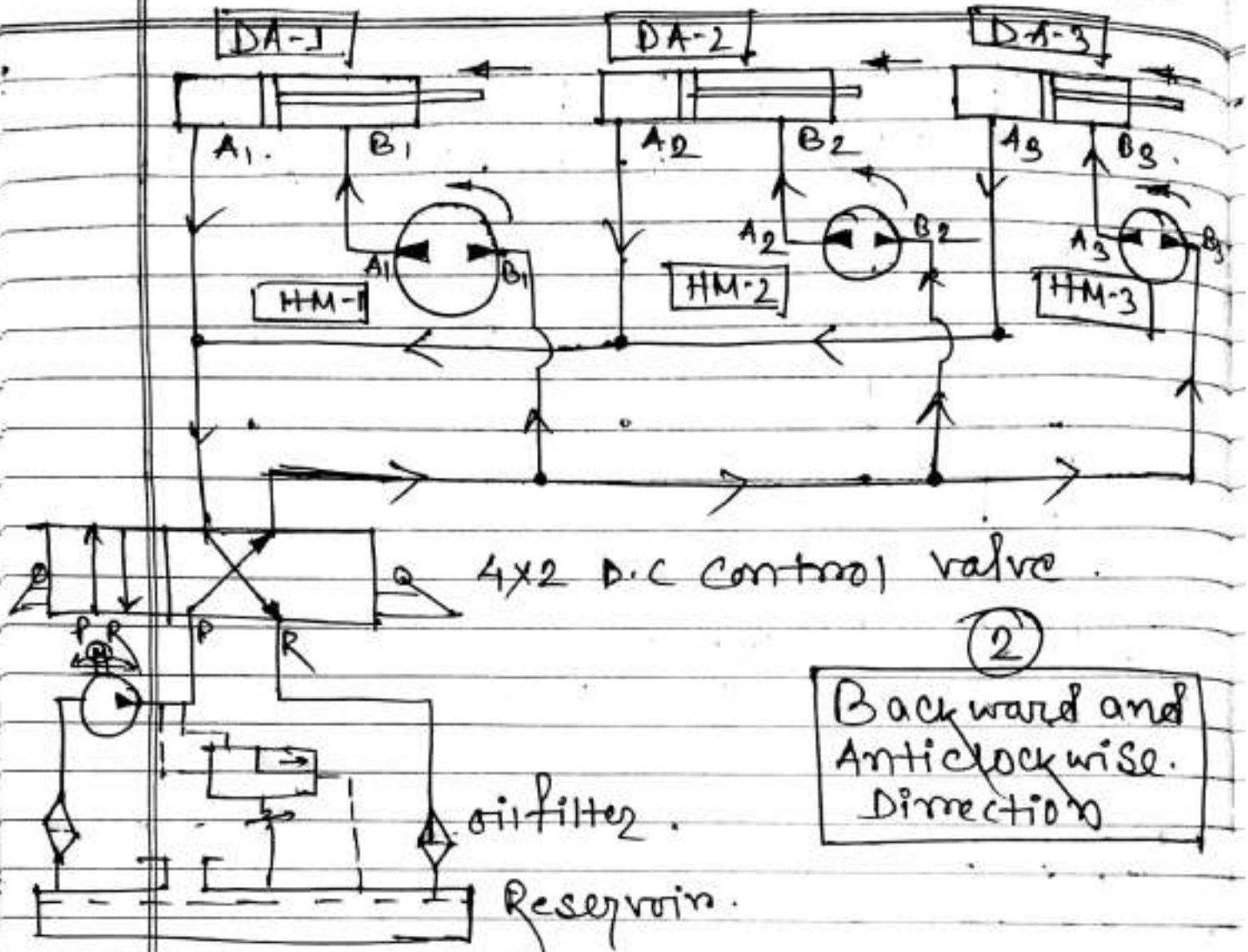


when 4x2 D.C valve operated, Pressure line 'P' is connected with Actuators Port B_1, B_2 and B_3. Return line 'R' is connected with A_1, A_2 and A_3. As a result pressurized oil will enter through 'B' Port and release through 'A' Port and motor will rotate in Anticlockwise direction.

Combined hydraulic motion Synchronization Circuit



In the Combined Synchronization Circuit Linear actuator and rotary actuator both are inter Connected. In this Circuit with the 'B' Port of linear actuators three rotary actuator/ hydraulic motors is connected. In intial Condition pressurize oil will enter in all 'A' port of Linear actuator and Piston move in forward direction. At the Same time oil from 'B' Port of linear actuators will enter in 'A' Port of Hydraulic motors and from the 'B' Port of motor it return to the oil tank.



(2)
Backward and Anticlockwise. Direction

In this way we get combined motion from this circuit. That's why it is called motion synchronization hydraulic circuit.

In the Backward and anticlockwise direction pressure line is connected with 'B' ports of rotary actuator and Return line is connected with 'A' Port of all linear actuators. Pressurize oil will rotate rotary actuator first in anticlockwise direction and after that it will enter in the linear actuator and movement of the piston will be in backward direction.

CHAPTER 4

classmate

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Introduction to pneumatic Systems.

Marks: 04.

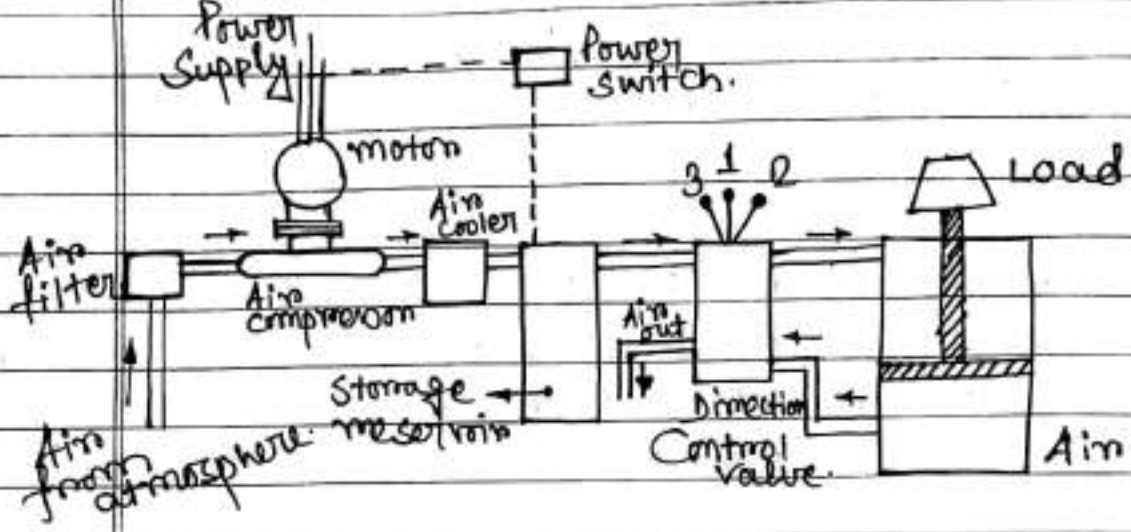
Topics: (1) Applications of pneumatic System
(2) General layout of Pneumatic System
(3) Merits and limitations of Pneumatic Systems.

Pneumatic System (Pneuma means air in greek) is the technology that deals with the generation, Control and transmission of forces and movement of mechanical element and System with the use of pressurized air in a confined System.

Applications of pneumatic System:

1. In automobiles air break system, Rubber tyres.
2. In mines drilling of rock is done by Compressed air.
3. Pneumatic hammer, Pneumatic drilling is used in Construction sites.
4. In Injection molding Compressed air is used for manufacturing plastic Components.
5. In the press compressed air is used.
6. Pneumatic System is used to coat metal protective coatings on marine engine, Components of turbine etc.
7. Pneumatic System is used in manufacturing, tool rooms, holding device and so on.
8. Pneumatic System is used in assembly shop for fitting and assemble mechanical Components.

General Layout of Pneumatic System:



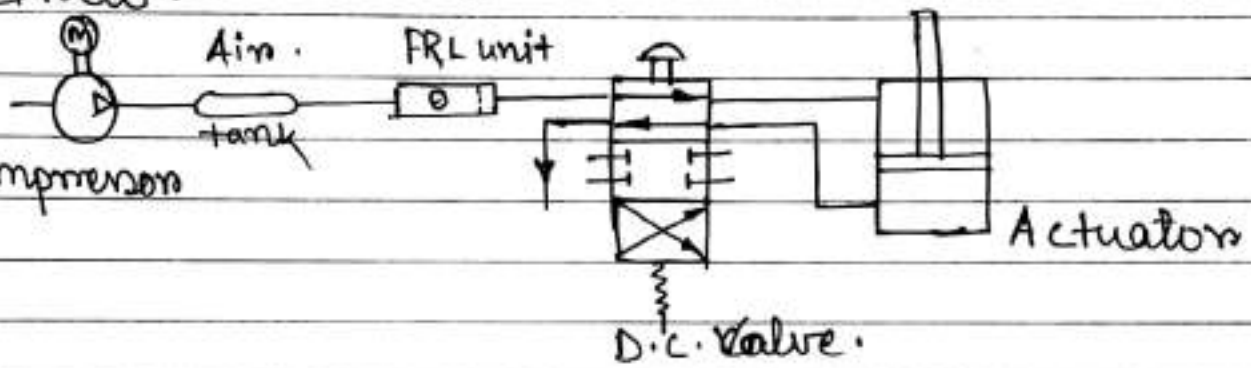
1 – off 2- forward
3- Return.

A pneumatic system carries power by employing compressed gas, generally air for transmitting energy.

1) The pneumatic actuator converts fluid power into mechanical power to perform useful work.
2) The compressor is used to compress the fresh air drawn from the atmosphere.
3) The storage reservoir is used to store the compressed air.
4) External motors [redacted] used to drive the compressor
5) The valves are used to control the direction, flow rate and pressure of compressed air.
6) The piping system carries the pressurized air from one location to another.

Air is drawn from the atmosphere through an air filter and raised to required pressure by an air compressor. As the pressure rises, the temperature also rises, hence air cooler is provided to cool the air with some preliminary

treatment to remove the moisture. The treated pressurized air then needs to get stored to maintain the pressure, with the storage reservoir a pressure switch is fitted to start and stop the electric motor, when pressure falls and reaches the required level. The three position change over the valve delivering air to the cylinder operates in a way similar to the Pneumatic Circuit.



Pneumatic System using Symbol.

Merits of pneumatic System:

1. Air is easily and freely available.
2. Air is dry, hence pneumatic System is clean.
3. Air Cannot be exploded.
4. Equipments used in pneumatic System easy to handle, easy in working and easily available.
5. Equipments used in pneumatic System are chipper, light weight.
6. The main tenance cost is low.
7. we can run Pneumatic System any time when air tank is full. Thus no need of Compressor running all the time i.e Save in electric power.

Limitations of Pneumatic Systems :

① A Pneumatic System usually operates at 5-10 bar pressure.
② If the pressure of stored air in air tank drops below required pressure, then circuit stop working.
③ Due to compressing nature of air, accurate motions in actuator are not possible to obtain.

—o—

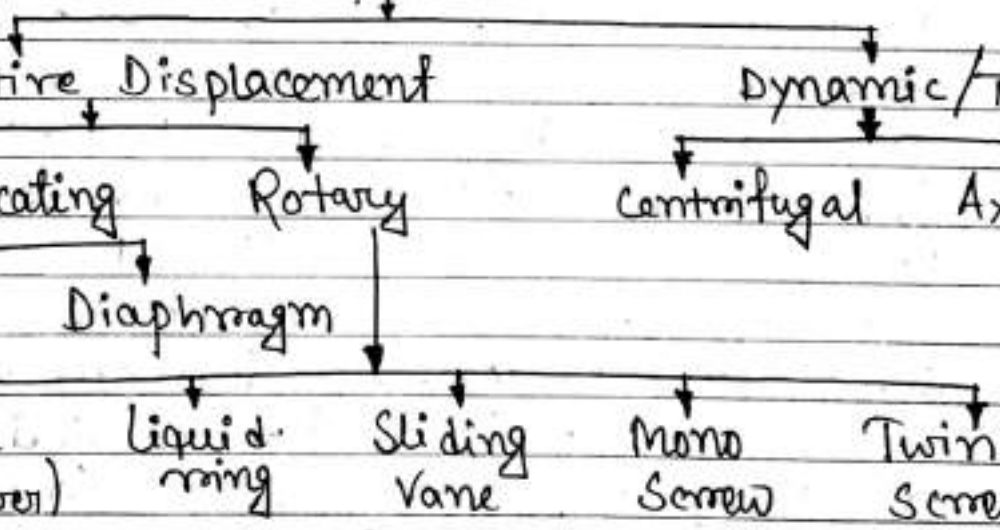
CHAPTER 5

1. Components of Pneumatic System.

Marks: 32

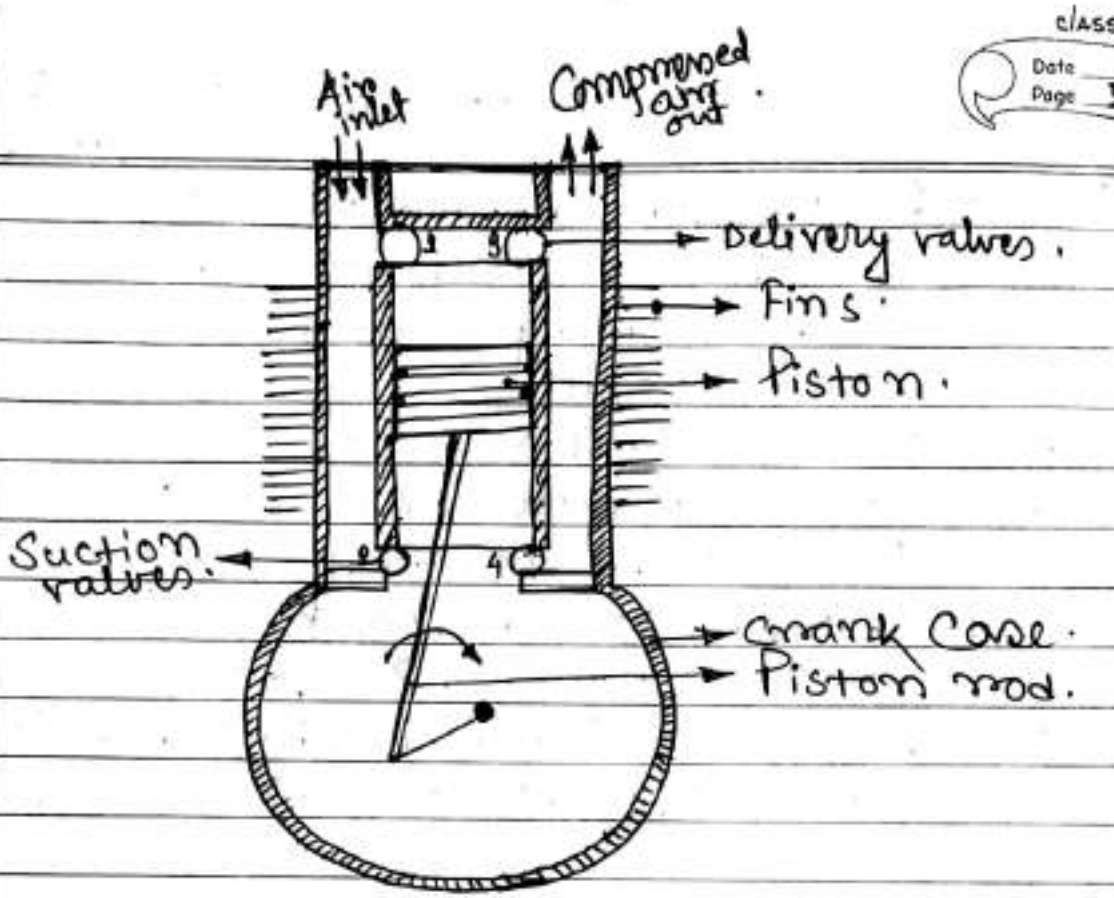
- Topics :
  1. Reciprocating Compressors.
  2. Rotary Compressors.
  3. Pressure regulating valves.
  4. Flow Control valves.
  5. Direction Control valves.
  6. Rotary - air motor types Actuator (Construction & working principle).
  7. Linear - cylinders - type Actuators (construction & working principle).
  8. Types, Construction, working principle and Symbols of Pipes, Hoses, Fittings and FRL unit.

Classification of Compressors:



Reciprocating Compressors:

Reciprocating Compressors consists of Cylinder, Piston, Piston rod, Connecting rod, Crank, Crank case, Suction valves, delivery valves and inlet Port and outlet port.



This is the simplest form of reciprocating compressor. There are 4 valves; 2 Suction valves and 2 delivery valves. Here fins are used are cooler. The crank rotates on electric motor, engine. In this Compressor Compression of air takes places in both Side of Piston. When crank rotates, the Piston starts reciprocating. During the upward movement, the vacuum is created on bottom Side of the Piston, Suction port '2' opens and air come in. At that time delivery Port '4' remains close and '3' remains open. and '1' remains close. During upward motion air starts compressing and when piston reach 'Top dead centre' the stroke is complete and air is fully compressed which goes out through delivery Port '3'. when piston comes down and reached "Bottom dead Centre" then air Comes through port '1' and bottom Side of Piston

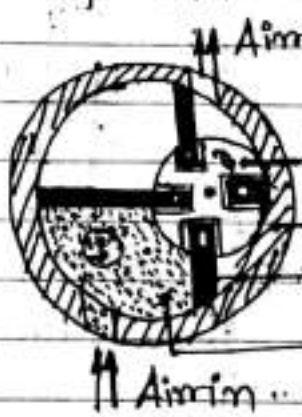
air start Compressed and goes out through delivery port '4'. In this Compressor the air supply to air receiver is more Smooth and we get continious work.

The reciprocating air Compressor are basically three types.

(i) Single acting reciprocating air Compressor
(ii) Double acting.
(iii) 2 Stage or multistage.

2 Stage reciprocating air Compressor are Common compressor used in Industry. The main function of Compressor is to Compress the air and increase the pressure of air.

Rotary Compressor:



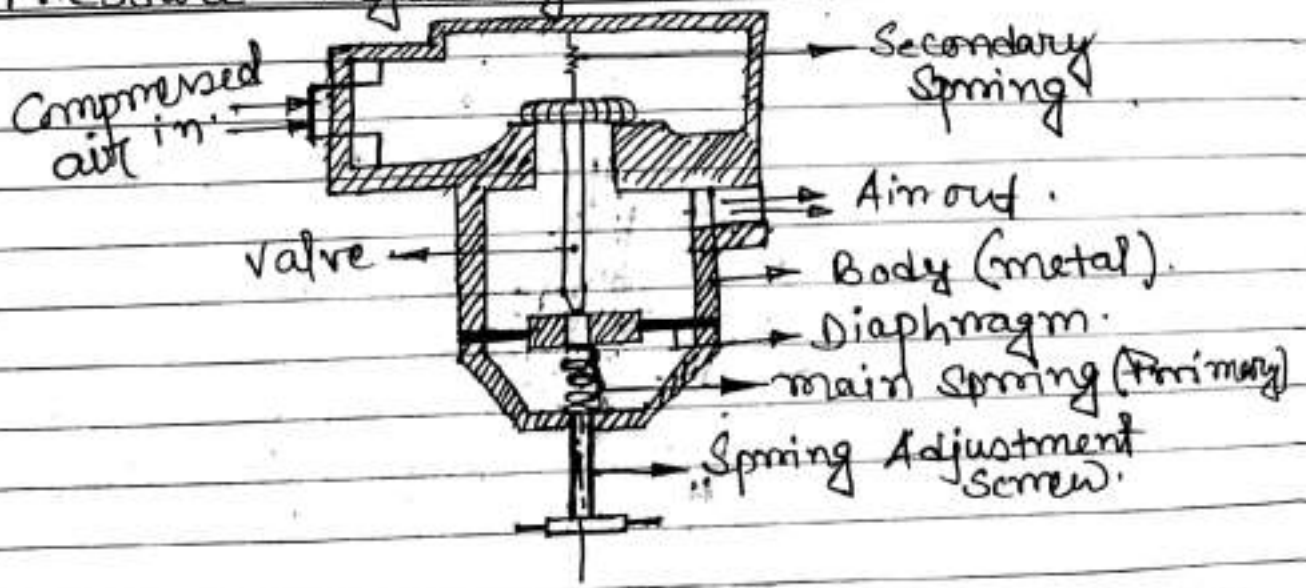
Rotary vane Compressor.

Rotary Compressor Consists of simple vane rotor which is having slots in which vane slides freely. The rotor is eccentrically located inside stator housing or casting. The rotor is coupled to motor. When rotor

starts rotating, all vanes flow out from centre due to centrifugal force and touches the inside surface of casting. Due to rotating, partial vacuum is created in ① compartment. So air rushes in this compartment. The trapped air is carried towards delivery Port. Due to reduction in area air gets compressed and goes out. In rotary compressor delivery pressure is low (upto 5 bar) but discharge volume is very high.

Rotary compressors are screw compression, vane type compressor and lobe compressors type.

Pressure regulating valves:

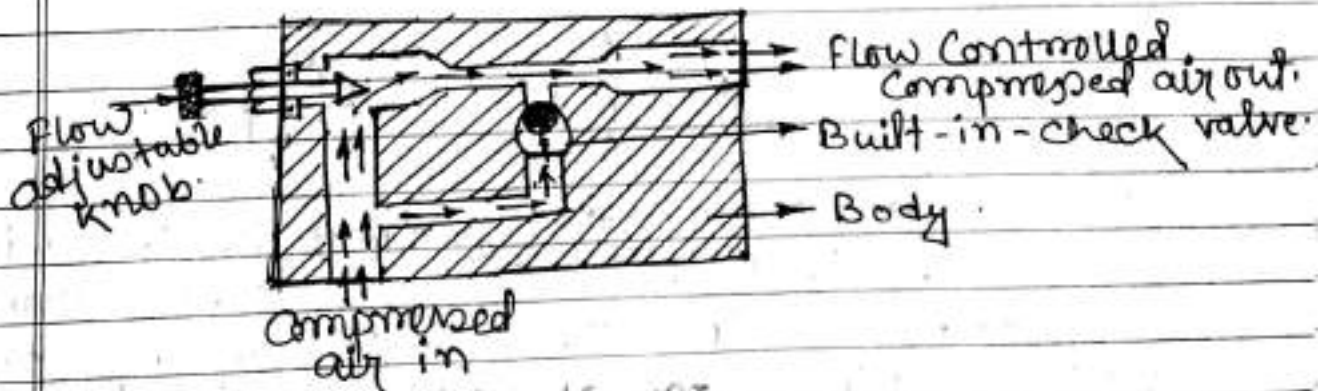


Pressure regulator has metallic body, one inlet and another outlet port and one primary or main spring and one secondary spring. The primary spring is compressed by spring adjustment screw and the diaphragm is controlled by main adjustment screw. The high pressure compressed air is coming in

the regulator. As per our requirement we have to control the pressure by rotating main spring adjustment screw. When main spring moves upward, there will be a small gap on top valve surface and extra pressure will reduced by creating a opening to allow the air flow through outlet. When the spring compression is less, pressure will be high, when spring compression is high, pressure will be less.

Pressure regulating valves are mainly two types. one is pressure control valve and another is pressure relief valve. Pressure relief valve is used when main pressure control will fail and it is closed by spring tension.

Flow control valves:

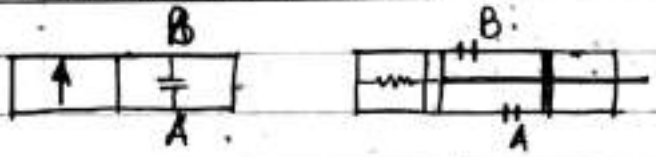


Flow control valve mainly used to control the flow of compressed air. In flow control valve there is flow adjustable knob or by which flow is controlled. Flow adjustable knob is rotating clockwise and anticlockwise for rotation / opening the passage of air flow.

In the flow control valve Built-in-valve show the error in the system. If there is any chocking or jamming, that is shown by Built-in-valve by movement of the ball upward and downward direction. Flow Control valve is two type. one is Fixed type flow Control valve and another is adjustable type flow control valve.

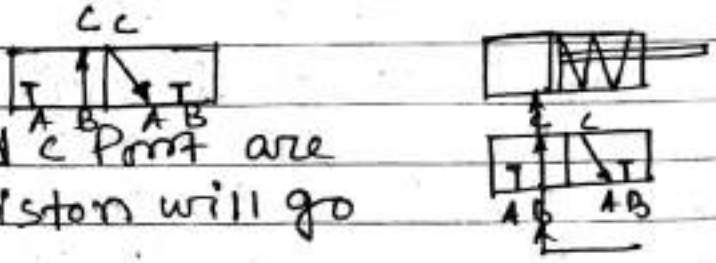
- **Direction Control valves:** Direction Control valve Control the movement of actuators or cylinder and Piston movement by Control the air flow direction. Direction Control valves are.
  - 2×2 DC valve.
  - 3×2 DC valve.
  - 4×2 DC valve.
  - 5×2 DC valve.

- **2×2 Direction Control valve.**



When Compressed air in through A Port the Spool will move backward, Spring will Compressed and air will movent through B. when air released then Spool regain its original position

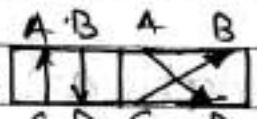
- **3×2 Direction Control valve.**

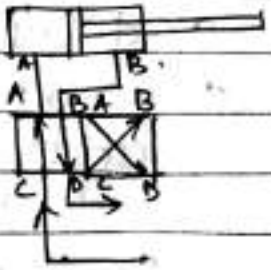


When B and C Port are Connected Piston will go forward.

When C and A Connected Piston will go backward.

4x2 Direction Control valve

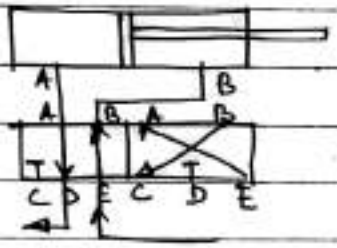




When A & C and B & D connected piston will go forward.

5x2 Direction Control valve

C = easy exhaust port.
D = Normal exhaust port
E = Pressure in.

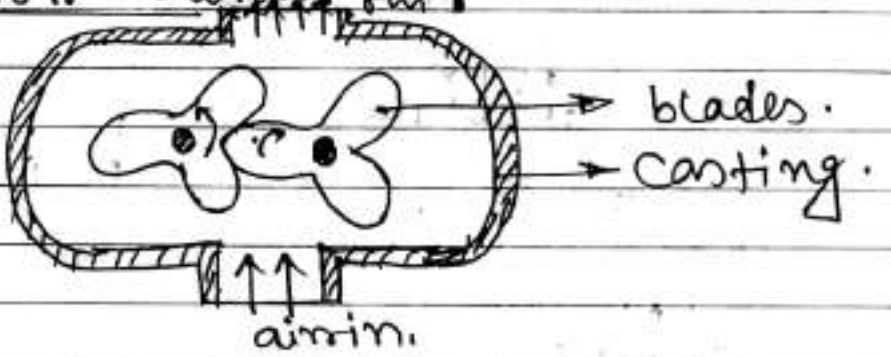


Rotary - air - motor types actuator: A pneumatic motor (Air motor) is a type of motor which does mechanical work by expanding Compressed air. Pneumatic motors Convert the compressed air energy to mechanical work through rotary motion Rotary motion Supplied by vane type air motor, gerrotor motor, Piston air motor and air turbine.

The rotating element is a slotted rotor which is mounted on a drive shaft. Each slot of the rotor is fitted with a freely sliding rectangular vane. The vanes are extended to the housing walls using springs, Cam action

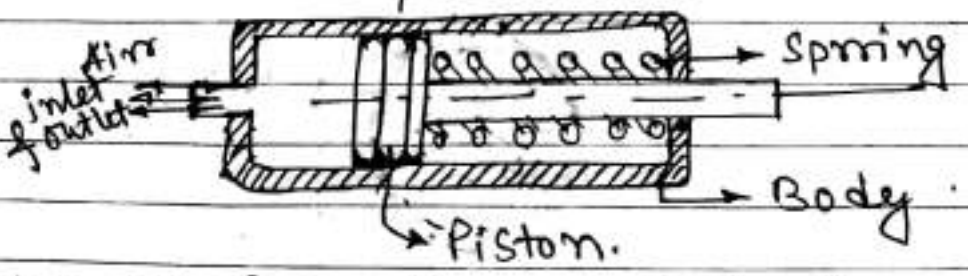
and air pressure. Air is pumped through the motor input which pushes on the vanes creating the rotational motion of the central shaft. Rotations Speed can vary between 100 and 25000 rpm.

- **Gerrotor Motor:**



- **Linear - cylinders type Actuator:** Linear cylinders type actuators are known as air cylinders. Linear cylinders type actuator can be classified as.
  (i) Single acting cylinder.
  (ii) Double acting cylinder.
  (iii) Diaphragm cylinder.

- **(i) Single acting cylinder**

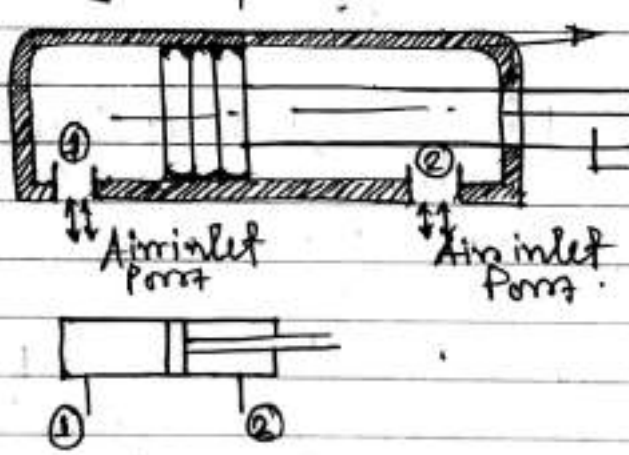


In the single acting cylinder there is a spring on one side of piston and another side is air pressure. This is a closed system.

In normal condition spring

pressure equal to air Pressure. when we increase the air pressure, Piston will start moving forward. after that when we decrease the pressure then it will come back its normal or neutral position. there is only one inlet or outlet port to air come in or out.

Double acting Cylinder:



In double acting cylinder there is two air port for air in and out. one is top surface of the piston (Port ①) and another port (2) is bottom of the piston.

when air pressure through port ① and port ② are equal then piston is in normal condition. when we increase the air inlet through port ① and open port ② then piston will go forward and when we increase air inlet in port ② and open port ① then piston will go back-ward. here we get both forward and backward motion in a cylinder. That's why it's name is double acting cylinder.

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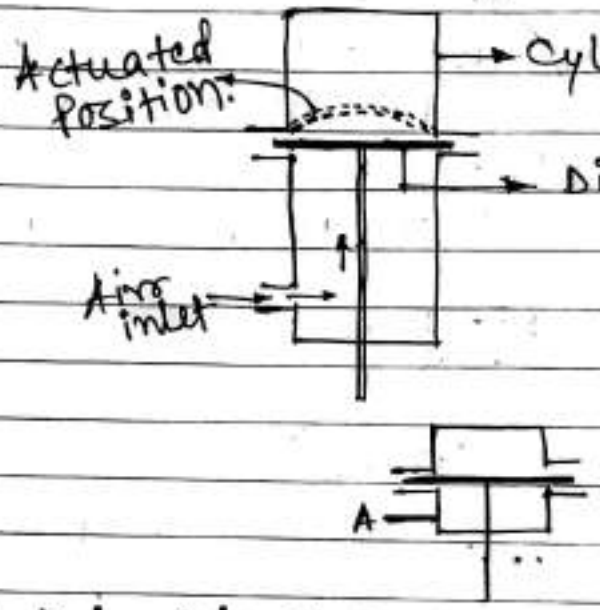
Diaphragm Cylinder:

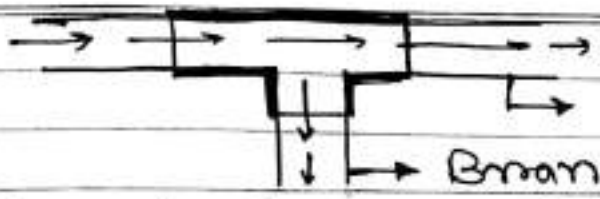


In this Diaphragm cylinder diaphragm is used as an actuating element. This diaphragm is flexible. when pressurised air comes in, due to the pressure force the diaphragm stratches and rod lifts up. when the air release then it come back its original position. Here we get only backward motion. This one is single acting cylinder.

Pipes:

The 'Air main' is the pipe line coming from air receiver. The branch pipes are a branch taken out from air main, known as 'Branch-off'. The selection of pipeline material depends on the Pressure of air, it will carry. In general 'Air main' pipelines are GI pipes and 'Branch-off' Pipes are used as nylon, polyethelene and copper Pipes.

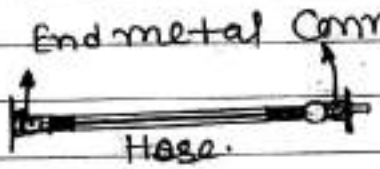
GI = Galvanized Iron.

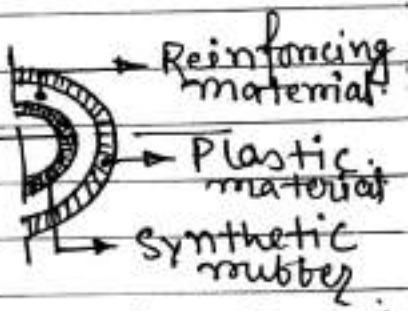


Here is Some condition for good pipe line.

① 'Air main' must be kept at slight slope in the direction of flow of air.
② Branching should be top of the main line.
③ use narrow open ducts.

- **Hoses:**



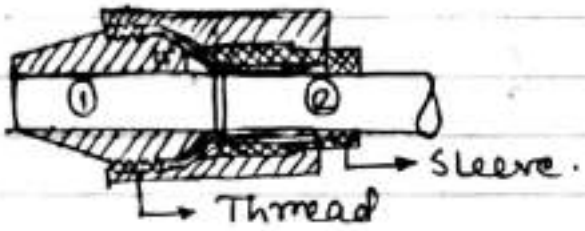


Hoses are manufactured 3 layer pipe, generally black in colour. The outer layer is of Plastic, middle layer is a layer of reinforcing material (wire or cloth braid) and inner layer is synthetic material layer. Inner layer is actually a tube through which air passes. Two ends of hoses are metal (high grade steel) so that we can easily connect and disconnect the hose with circuit.

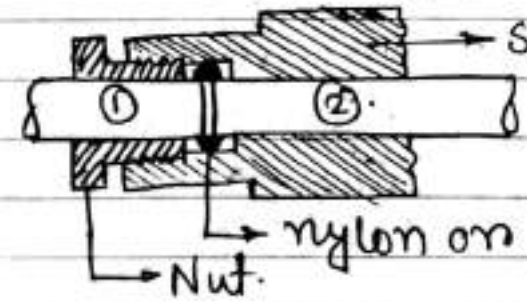
- **Fittings:** When two pipes need to be joined we have to use pipe fittings. welding, soldering is the method to join two pipes. This methods are permanent joint, so air leakage is zero. Fittings are four types.
  ① Bell mouth tube fitting.
  ② Compression type fitting.

③ Screwed Connections.
④ Quick Connectors.

- **Ball mouth tube fitting:** Ball mouth tube fitting also known as Flared fitting. The end of the pipes is flared (conical shape) by using flaring tool. Flaring angle is 37° to 45°. Two pipes are joined by using packing sleeve and loosening nut.



- **Compression Type fitting (Ferrule fitting):**



In this joint nut and ferrule are placed on the tube along with Socket. Nut is tightened in socket threading. The ferrule is used as seal. By loosening the nut we can disconnect the joint.

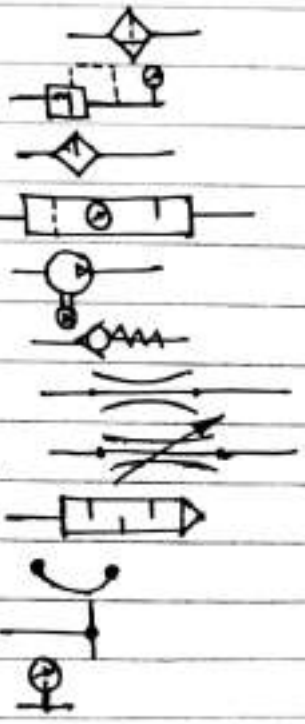
FRL Unit:

F - Filter.
R - Regulator.
L - Lubricator.

These three units are called Service unit or FRL unit. These three units are in bunch and are installed on pneumatic pipe lines. Compressed air passes through these three unit one by one. First air enters into filter and gets filtered from particles (dust particles) Then it enters into regulator for regulate the pressure required by Pneumatic System. Then it enters into lubricator for mixing very fine oil with air and go to circuit for smooth running.

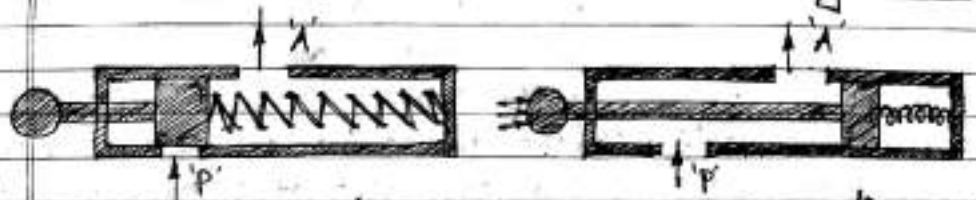
Symbols:

Filter
Regulator
Lubricator
FRL
Compressor
Non return valve
Fixed type flow control valve
Variable type flow control valve.
Muffler (silencer)
Flexible hose
Line Junction
Pressure gauge

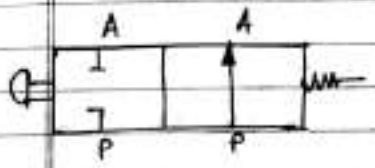


Direction Control valve at a glance:

2x2 D.C valve.



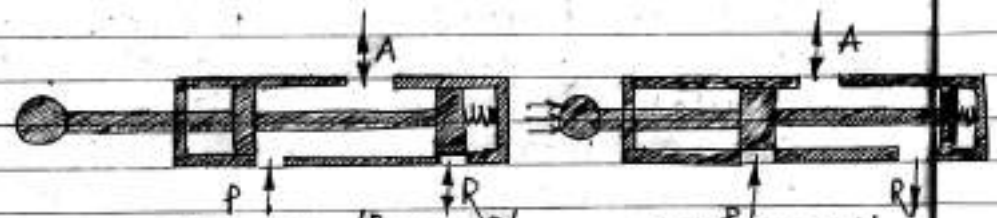
Valve closed/Neutral. Valve open/Forward/Backward



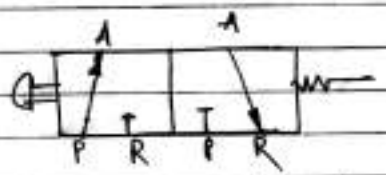
Symbol (2x2).

Suitable for Single acting cylinder (Linear Actuator).

3x2 D.C valve.



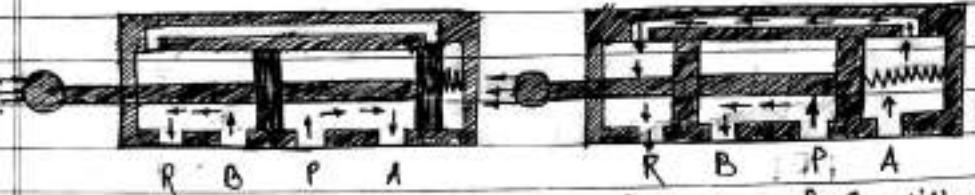
Valve open/forward/Backward. Valve closed/Neutral.



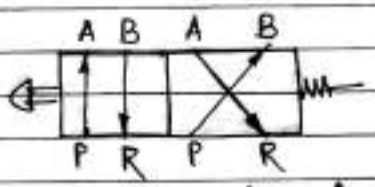
Symbol (3x2)

Suitable for Single Acting cylinder.

4x2 D.C valve.



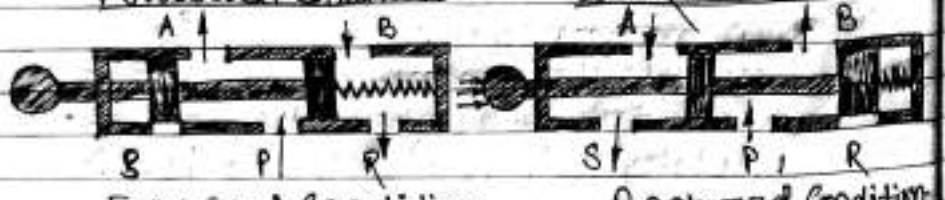
Forward Condition. Backward Condition



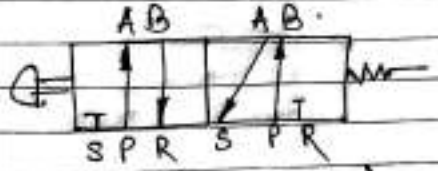
Symbol (4x2).

Suitable for Double Acting cylinder and Air motors.

5x2 D.C valve.



Forward Condition. Backward Condition



Symbol (5x2).

Suitable for Double Acting cylinder and Air motors.

CHAPTER 6

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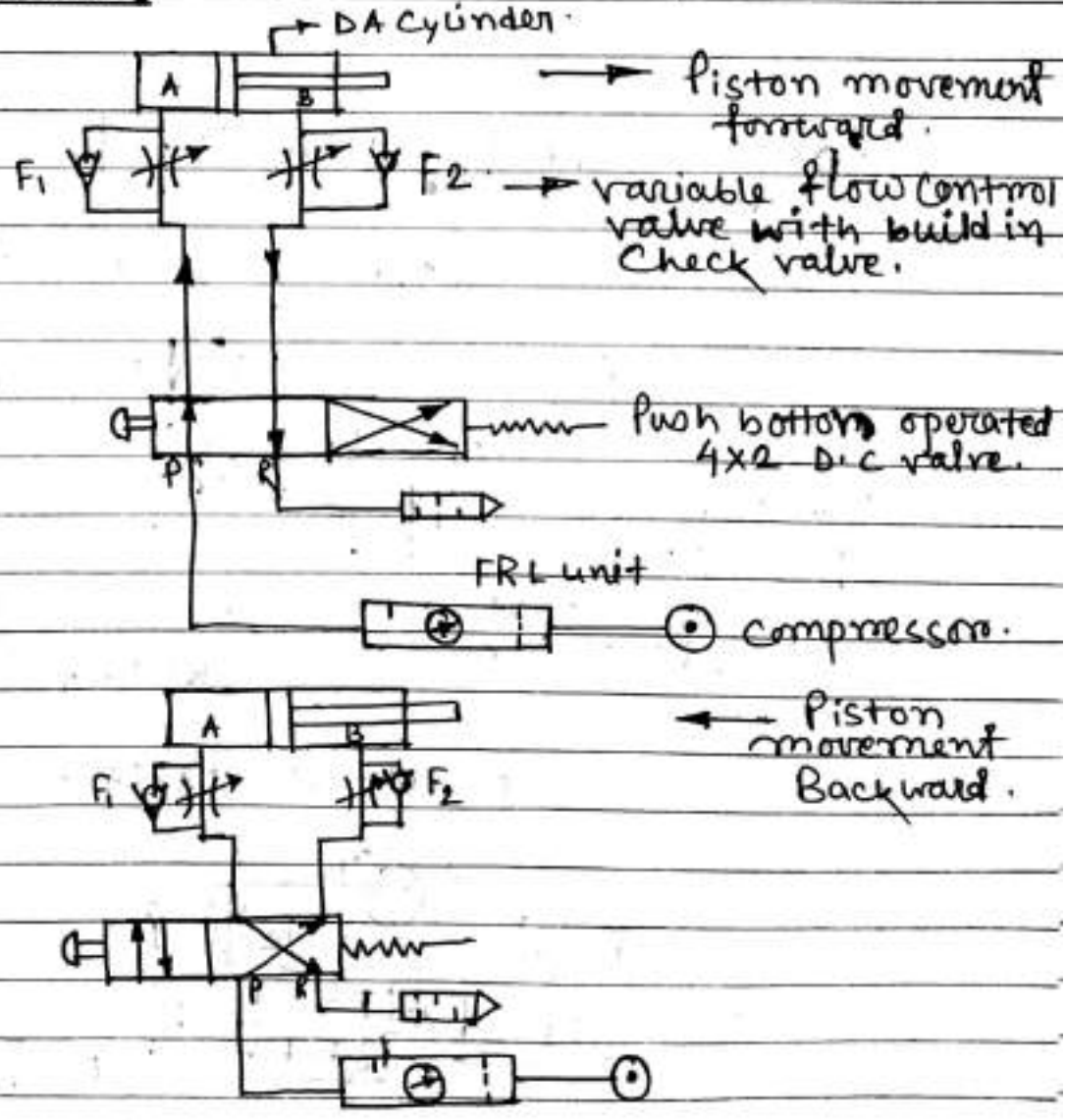
Pneumatic Circuits.

Marks: 12.

Topics:

① Speed Control Circuits for double acting cylinder.
② Speed Control Circuits for bidirectional air motor.
③ Sequencing Circuits Position based.
④ Time delay Sequencing Circuit.

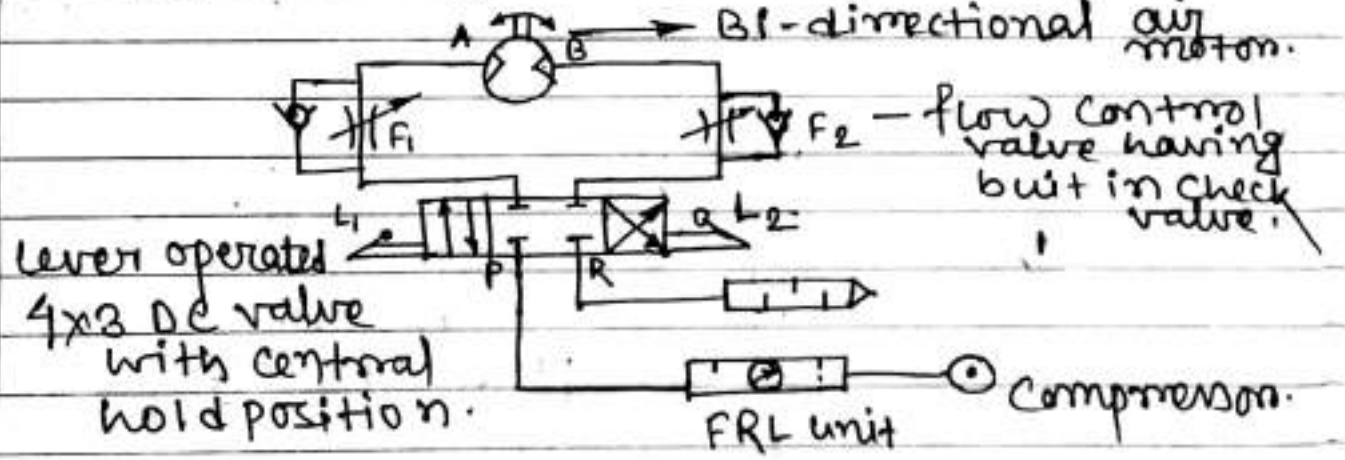
Speed Control Circuits for double acting Cylinder:



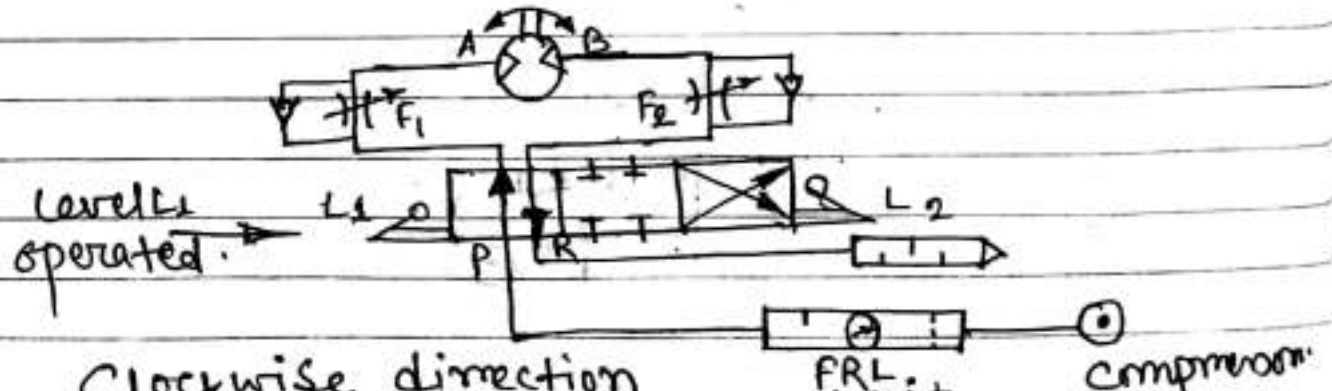
When pressure port 'P' is connected with A Port of DA cylinder and return port 'R' is connected with port 'B' of DA cylinder, Piston goes forward as on the 'A' face of Piston pressure increase.

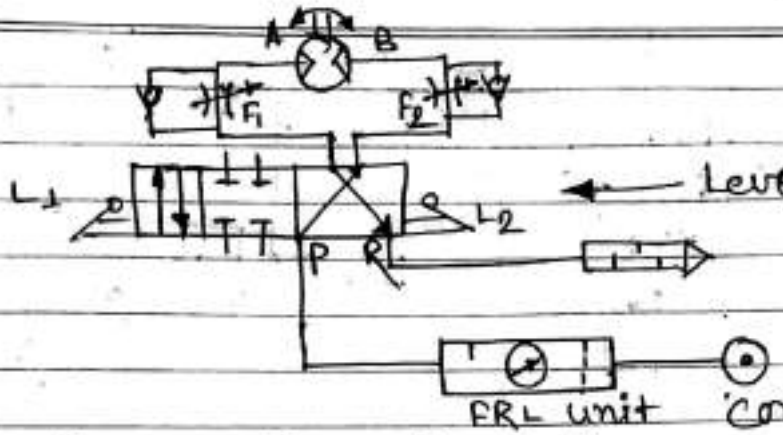
When pressure port 'P' is Connected with Port 'B' of DA Cylinder and return port 'R' is connected with port 'A' of DA Cylinder, Piston goes backward direction as on the 'B' Port Pressure will increase. In this way Speed control DA Cylinder runs.

Speed Control Circuits for Bi-directional air motor:



Neutral Position.



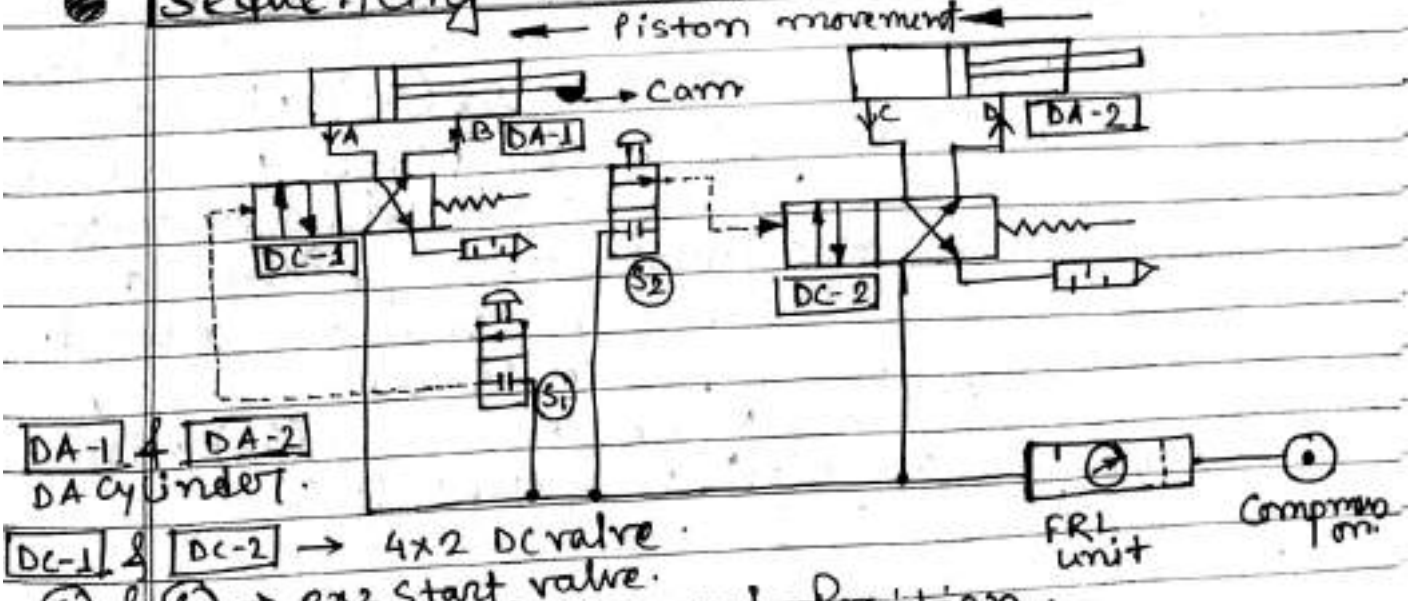


anticlockwise direction.

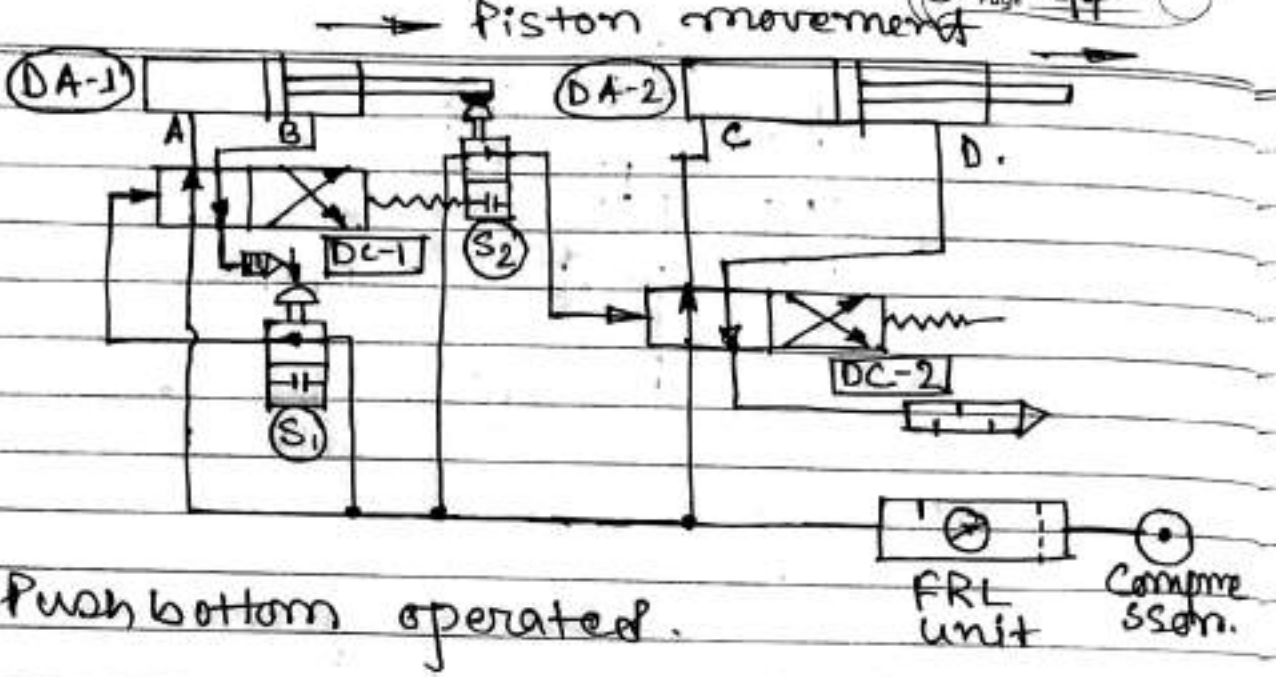
When lever L_1 operated P will be connected with Port A of air motor and R will Connected with Port B. and motor start rotating in clockwise direction.

When lever L_2 operated Pressure Port P is connected with Port B of air motor and exhaust Port R is connected with Port A of air motor and motor start rotating in anticlockwise direction.

Sequencing Circuits Position based:



Backward Position.



Push bottom operated.

· Forward position.

Initial Condition air is admitted at Port 'B' of (DA-1) and Port 'D' of [DA-2] cylinder. Hence both Pistons are moving backward directions. When Push botton of start valve. S_1 is operated the air signal will be supplied to DC valve (DC-1). The air will admitted through Port 'A' of DA-1 and Piston will move towards right. The Cam is attached to the end of Piston rod. This cam will Push the Push botton of start valve (S_2). Dut to this air signal will be Supplied to direction Control valve (DC-2) and it will operate. Now air will be admitted through Port 'C' of DA-2 and the Piston will go forward.

The Sequence is achieved by Cam of (DA-1) unless and until (S_2) will not be operated with the help of cam, the Piston of (DA-2).

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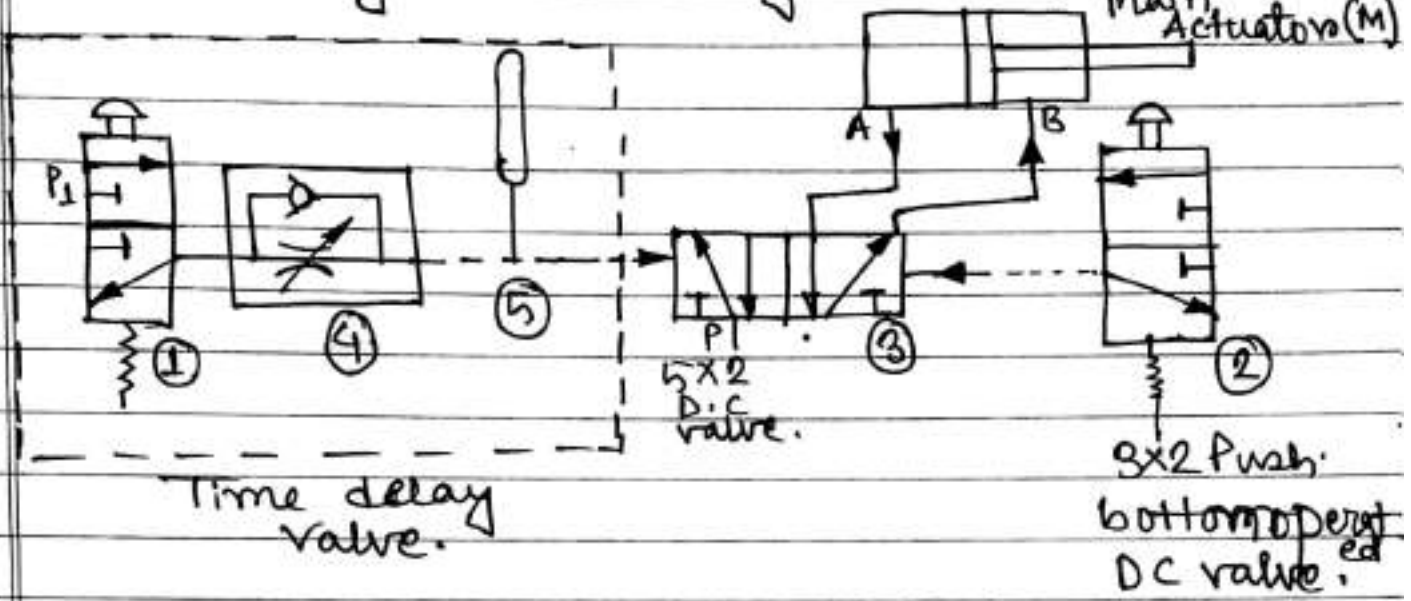
Time delay Sequencing circuit:



Push botton 3X2 DC valve (1) is operated i.e Pressed. Then P_1 will be connected to check valve (4) and air will start accumulating in reservoir (5). Pressure builds in the reservoir slowly causing time delay. When Pressure in the reservoir is high enough, the air signal will operated 5X2 main DC valve and will connected Port P to A thereby moving the Piston of actuator (M) towards right. When push button of valve (2) will be pressed the 5X2 DC valve will switch, triggering the release of air and Causing the Piston to move towards left.

PREVIOUS YEAR QUESTIONS

12242

MECH

6th Semester Diploma Engineering Examination, 2017

Subject : Industrial Fluid Power **Full Marks : 100**

Subject Code : IFP-12242

Time : 3 Hours **Pass Marks : 40**

Answer any five questions.
All questions carry equal marks.

1. (a) Define Hydraulic Circuit? What is the difference between meter-in & meter-out circuit?
   (b) Describe a hydraulic circuit used for milling machine.

2. (a) What are the different properties of hydraulic fluid? Explain any two properties.
   (b) Explain axial piston pump with sketch.

3. (a) Write down the different types of linear cylinder actuater
   (b) Describe the construction and working principle of linear Actuater.

4. (a) Give classification of air motors. Explain any one with neat sketch
   (b) Classify pipe fittings in pneumatic system. Explain any one.

5. (a) What is speed control circuit? Explain speed control circuit for double acting cylinder
   (b) What is sequencing circuit? Explain time delay circuit.

6. (a) What is accumulator? Explain any one type of accumulator
   (b) What do you mean by hydraulic valves? What is pressure relief valve and poppet valve?

7. Write short notes on *any four* of the following: 5×4=20
   (a) Speed control circuit for double acting cylinder
   (b) FRL unit
   (c) Reciprocating Compressor
   (d) Spool valve
   (e) Air motors
   (f) Fittings
   (g) Oil Filters

MECH. ENGG.

6th Semester Diploma Engineering Examination, 2018

Subject : Industrial Fluid Power **Full Marks : 100**

Subject Code : IFP-12242 **Pass Marks: 40**

Time : 3 Hours

Answer in your own words.

Answer five *questions in which* Question No. 1 *is compulsory and answer* any four *from rest questions.*

All questions carry equal marks.

1. A. Choose correct answer: 2×7=14

(i) Which of the following is used as a component in hydraulic power unit?

(a) Reservoir

(b) Pressure gauge

(c) Valve

(d) Filler gauge

(ii) In fixed displacement vane pump

(a) flow rate increases with increase in working pressure

(b) flow rate decreases with increase in working pressure

(c) flow rate is constant and does not change with working pressure

(d) All of the above

(iii) What is the function of a flow control valve?

(a) flow control valve can adjust the flow rate of hydraulic oil

(b) flow control valve changes the direction of oil flow

(c) Both (a) and (b)

(d) None of the above

(iv) Which of the following factors is considered while selecting a compressor?

(a) viscosity for the liquid used

(b) type of oil filter required

(c) volumetric efficiency

(d) All of the above

Please Turn Over

(v) How is the arrangement of piston in a piston pump?
(a) Radially
(b) Axially
(c) Both (a) and (b)
(d) None of the above

(vi) Which type of motion is transmitted by hydraulic actuators?
(a) Rotary motion
(b) Linear motion
(c) Both (a) and (b)
(d) None of the above

(vii) The flow control is on the outlet side of the cylinder to control the flow coming out is called
(a) Meter in circuit
(b) Meter and circuit
(c) Bleed of circuit
(d) None of the above

B. Define the following: 2×3=6
(a) Lubricity
(b) Oil filters
(c) Pressure unloading

2. Answer *any two* of the following:
(a) What is pump? Explain piston pump with sketch.
(b) What is a valve? Explain construction and working of a pressure control valve.
(c) What is hydraulic motor? Explain construction and working of a rotary actuator.

3. (a) What do you mean by accessories? Explain seals and gaskets.
(b) What is bleed of circuit? Explain hydraulic circuit for milling machine.

Or,

What is sequencing circuit? Explain pressure dependent.

4. Answer *any two* of the following:
(a) What do you mean by Pneumatic System? Explain reciprocating compressor.
(b) What is the meaning of control valve? Explain direction control spool valve.
(c) What is a air motor? Explain its working principle.

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5. Answer *any two* of the following:

(a) What do you mean by pneumatic circuits? Explain speed control circuit for bidirectional air motor.

(b) What is time delay circuit? Explain sequencing circuit.

(c) Explain

(i) FRL unit

(ii) Fittings of pneumatic system

6. Write short notes on *any five* of the following:

(a) Merits of Pneumatic System

(b) Symbols of valves

(c) Meter in

(d) Flow control valve

(e) Accumulators

(f) Gear pump