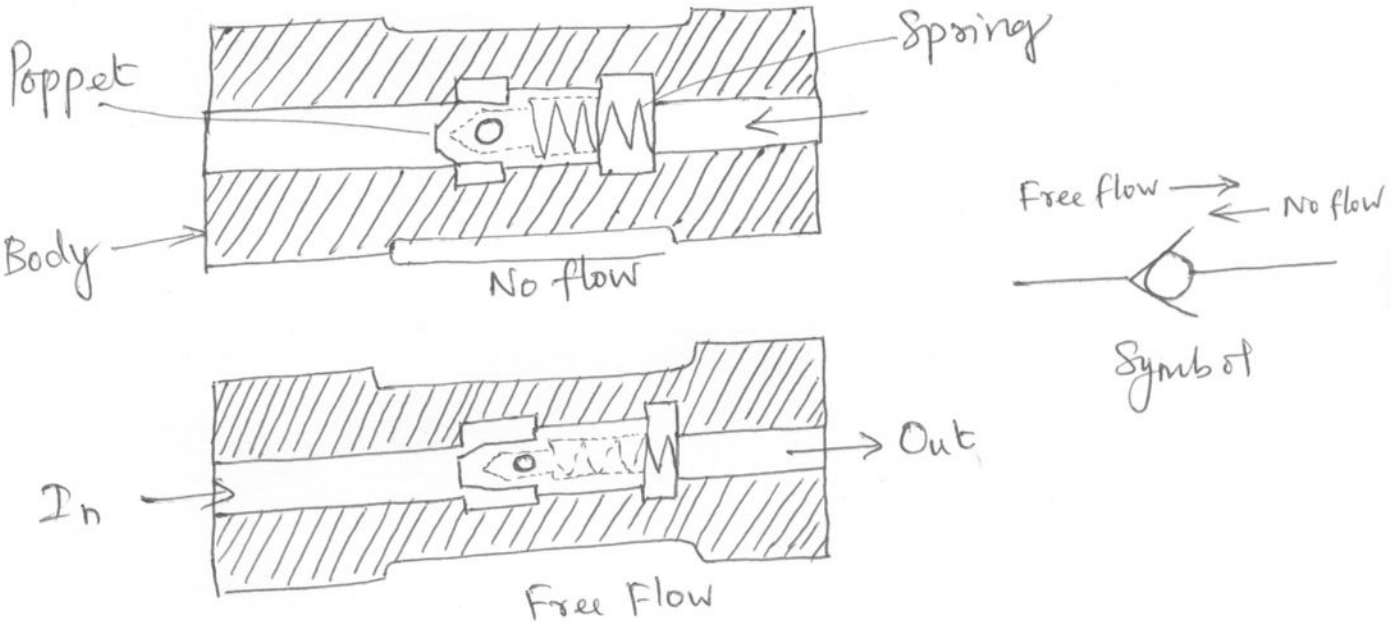
1. Explain the operation of a check valve with neat sketch [NOV. 2007, Dec. 2011]

It is the simplest type of direction control valve, which has two ports and called as a two way valve. The purpose of a check valve is to permit free flow in one direction and prevent any flow in the opposite direction.



Above figures provide two schematic drawings showing the internal operation of a poppet check valve, one for no flow condition other for free flow condition. A poppet is a specially shaped plug element held onto a seat by a spring. Fluid flows through the valve in the space between the seat and poppet.

As shown, a light spring holds the poppet in the closed position. In the free-flow direction, the fluid pressure overcomes the spring force and takes the path of flow. If the flow is attempted in the opposite direction, the fluid pressure forces the poppet (along with the spring force) in the closed position. Therefore, no flow is permitted. The higher the pressure the greater will be the force pushing the poppet against its seat. Thus, any increased pressure will not make the flow in no-flow direction.

(2) Explain the construction and working of following Control Components [May 2011]

(i) 4/2 Direction Control Valve (ii) Shuttle Valve

(iii) Sequence Valve [Dec 2008, May 2012] (iv) Flow Control Valve

(i) 4/2 Direction Control Valve:

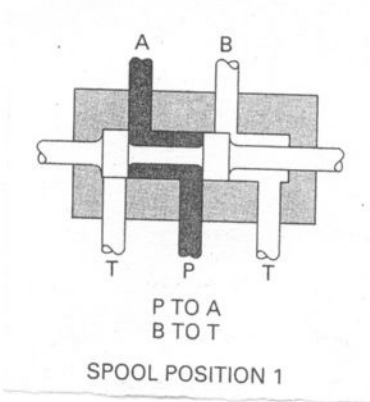


Figure shows the flow paths through a 4-way, 2-position DCV. observe that fluid entering the valve at pump port can be directed either to port A or B.

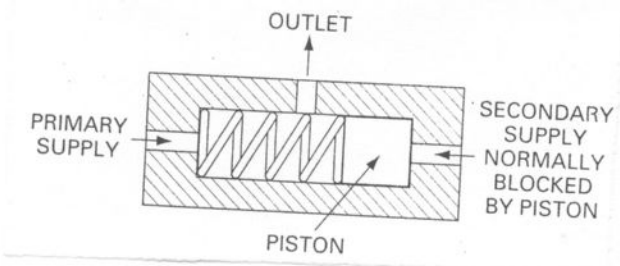
Spool position 1: P to A ; B to T

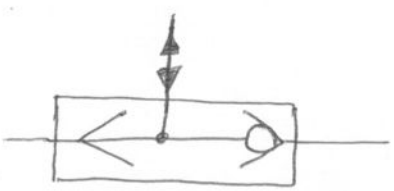
Spool position 2: P to B ; A to T

In the schematic, there are five ports, but fationally only four ports. Two tank ports but function of both are same. In the actual valves these tank ports can be combined inside.

4/2 way valve is typically used to control the flow directions to and from double-acting cylinders.

(ii) Shuttle valve:



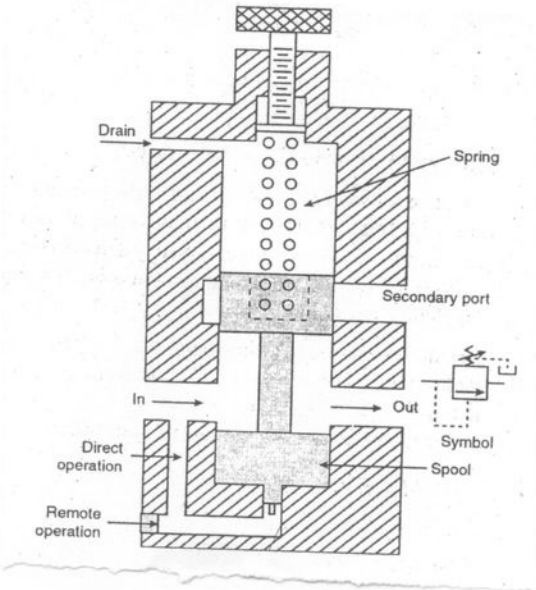


It is an another type of DCV. It permits the system to operate from either of two fluid power sources. One application is for safety in the event that the main pump can no longer provide hydraulic power to operate emergency devices.

A shuttle valve consists of a floating piston that can be shuttled to one side or the other of the valve depending on which side of the piston has the greater pressure.

Shuttle valves may be spring loaded in one direction to favour one of the supply sources or un-biased so that the direction of flow through the valve is determined by circuit conditions. A shuttle valve is essentially a direct-acting double check valve with a cross-bleed, as shown in symbol.

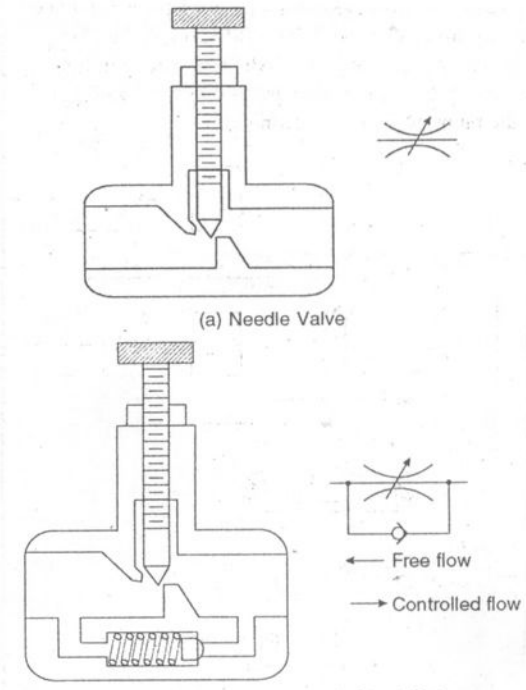
(iii) Sequence valve:



When the operation of two hydraulic cylinders is required to be performed in sequence by using a single direction valve, sequence valve is the solution.
After the components connected to port A have reached the adjusted pressure of the valve, the valve permits flow through port B against spring setting pressure to do some second sequence of operation. It maintains the adjusted pressure at port A until the pressure at B rises to the same value.

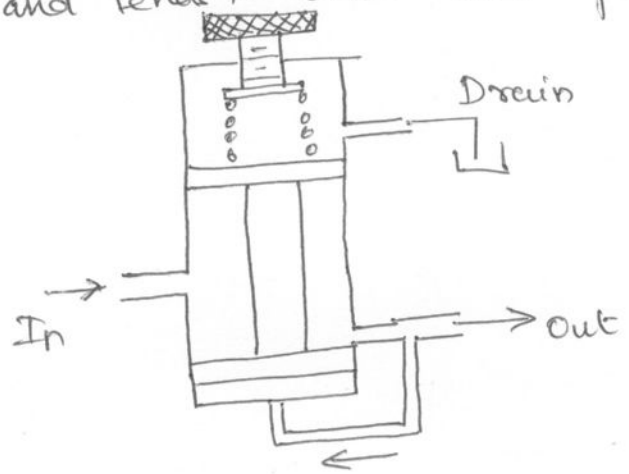
(iv) Flow control valve:

Flow control valves are used to regulate the rate of flow to the actuator. Control of flow is extremely important because the speed of actuator depends on the rate of flow of fluid. The simplest type is a Needle valve. It has a pointed stem that can be adjusted manually to control the rate of flow.
It is basically classified as
(i) Non-pressure compensated
(ii) Pressure compensated.



3. Explain the working of a pressure reducing valve with an example application [May 2011, Dec. 2011, May 2012]

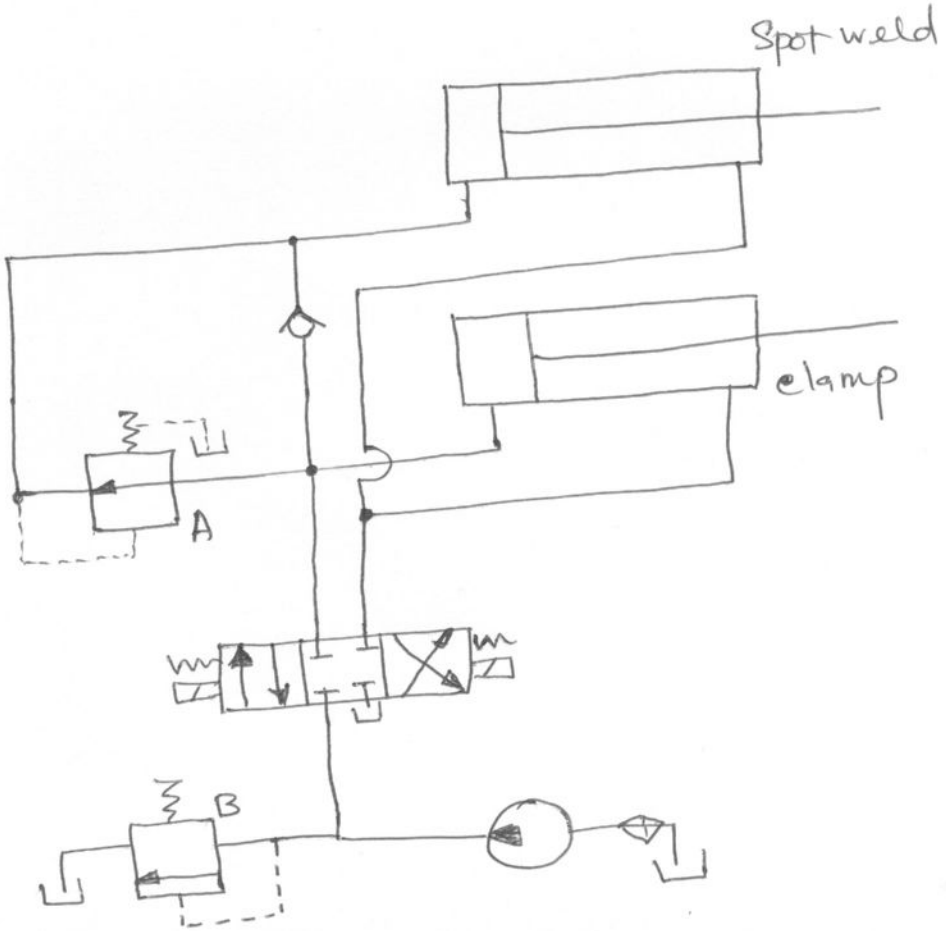
This type of valve is used to maintain reduced pressure in the specified locations of the system. It is normally an open valve. It is actuated by downstream pressure and tends to close when pressure setting is reached.



It uses a spring loaded spool to control the downstream pressure. If the down steam pressure is below the valve pressure, fluid will flow freely from inlet to outlet. When the outlet pressure increases the valve setting, the spool moves up and partially block the outlet port. The extra pressure will be relieved to the tank through the Drain.

Application:

In the spot weld gun, both the weld gun and the clamp are powered by the same pump.

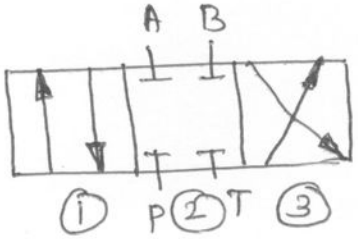


Clamp pressure is determined by the setting of relief valve 'B'. weld gun pressure can be adjusted to any value less than the relief valve B's setting by the pressure reducing valve 'A'. with the 4/3 DCV in its left mode, the forward stroke occurs in both cylinders. The clamp gets full pump pressure while the weld gun gets reduced pressure according to the need for good quality weld being processed.

4. Sketch and explain commonly used 3-position, 4 way direction control valves [May 2009, Dec. 2010, Dec. 2013]

The 4-way valves generally used to ~~genera~~ operate cylinders and fluid motors in both directions. These 4-way valve is manufactured as two, three, four, five or six position valves. The basic type is a 2-position valve, in one position forward stroke is accomplished, in the second position return stroke is accomplished.

In the three position valve, the valve has another position called neutral position or centre position. 3-position valve is used when it is necessary to stop or hold the hydraulic actuator at some intermediate point.

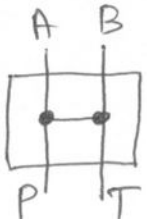


Normally position (1) - Forward stroke
(2) - Neutral (No stroke)
(3) - return stroke.

Different centre position characteristics are available in three position four way valves.

The most widely used are the open, closed and tandem centre position valves. others are special types. While selecting a DCV for a particular application, consideration of the centre characteristics is important.

Open centre:

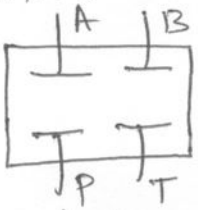


all ports open to each other.

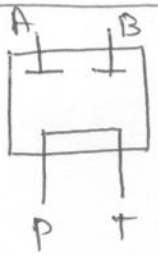
When a three position open centre valve is used in a hydraulic circuit, pump flow is directed to the reservoir when the valve is in the centre. In this design the pump flow can return directly back to the tank at essentially atmospheric pressure. At the same time, the actuator can be moved freely by applying an external force. The major disadvantage is that no other cylinder can operate when the valve is centred and hence, this value is to be used mostly for a single cylinder or single motor circuit.

Closed centre:

In this design, all ports of the valve are blocked at its position as shown. In this way the pump flow can be used for other parts of a circuit. At the same time, the actuator connected to port A and B is hydraulically locked. This means it cannot be moved by the application of external load. In this position, pump flow must go over the relief valve to the tank when it is not being used by the system. It takes more load on the pump.

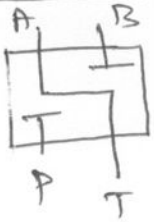


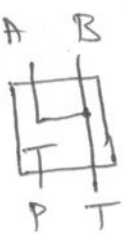
Tandem centre:

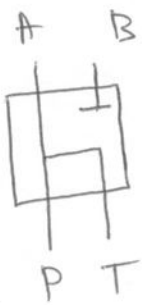


Here P and T are connected and A and B ports get blocked. Hence, in this position, the pump flow go to the tank without passing the pressure relief valve and thus generating less heat. The application of this design is to permit pump flow to be connected to a series of valves for multiple circuitry.

Float centre:

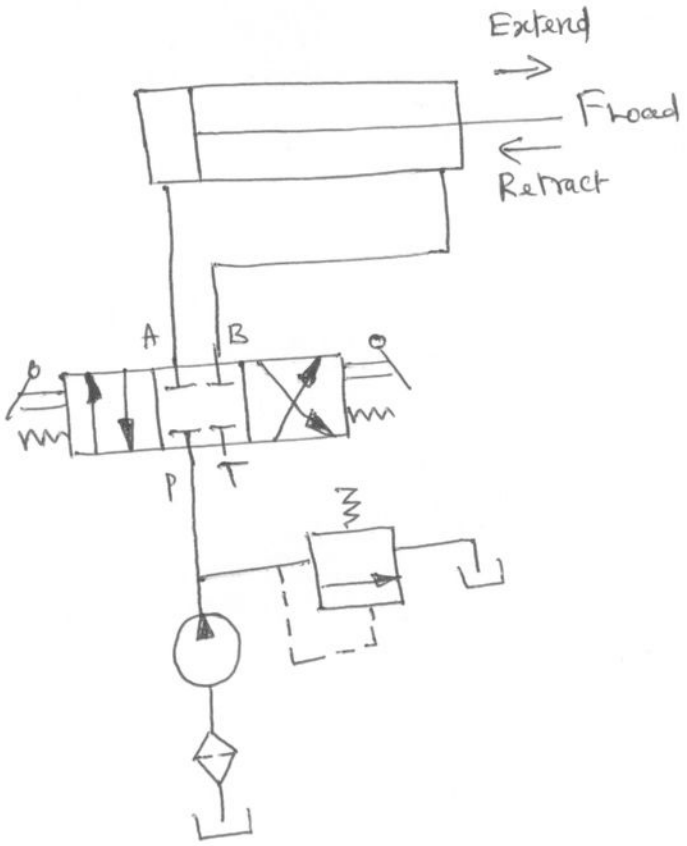






It allows independent operation of cylinders connected to the same power source. But here the load cannot be locked in a particular position.

4.a. Make a circuit for control of a double acting hydraulic cylinder (Dec. 2008)



This is the circuit used to control a double-acting hydraulic cylinder. The operation is as follows.

1. When 4/3 Manual operated Spring centere Dcv is actuated with its left envelop, the pump flow is directed to the blank end of the cylinder and cylinder extends against its Load. At the same time, the oil in the rod end goes to the tanks through the ~~port~~ B port

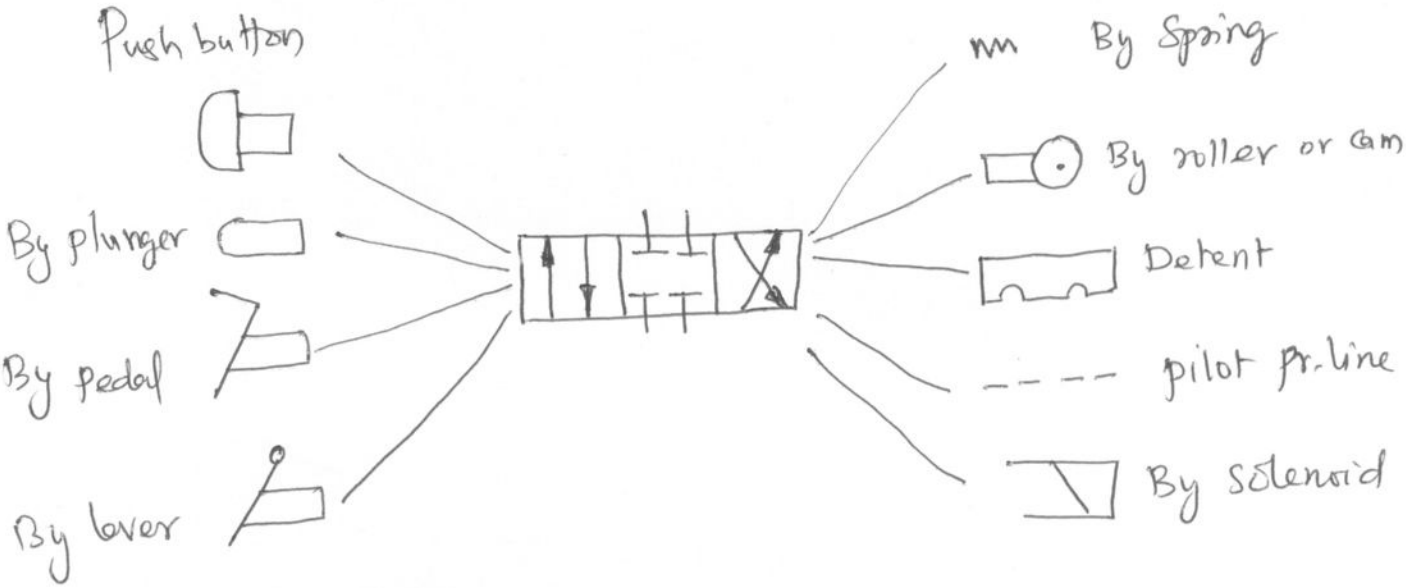
2. When the 4/3 way valve is deactivated, it comes to centre position and the cylinder is hydraulically locked.

3. When the 4/3 ~~W~~ way valve is connected in its right envelop, The pumped flow is directed to the rod end of the cylinder through the port B. The cylinder starts retracting, at the same time, the oil already present in blank end of the cylinder goes to the tank through the port A.

4. This is how the cycle gets repeated, as per our requirement.

Here the Simple pressure relief valve is must to protect the whole hydraulic System from any damages due to overload. Due to any reason, if pressure builds up than the setting of this relief valve, it releases the excess oil to the tank and Protects the system failure. Therefore, it should be connected as close as possible to the pump.

5. Explain the methods of actuation of hydraulic control valves. [Dec. 2010]



Types of actuation

1. Manual actuation
2. Mechanical actuation
3. Electrical actuation
4. Fluid actuation

Direction control valves may be actuated by various methods. Actuation is the method is moving the valve element from one position to another

Manual actuation:

It requires action by an operation, who can make judgement for the requirement of the system. It includes levers, push button and pedals. This type of actuation is commonly employed when the system requirement is not critical. It is widely used in machine tools and mobile equipment.

Mechanical actuation:

Instead of manual operation, spool is shifted by mechanical linkages like cam, spring, rollers etc.

Electrical actuation:

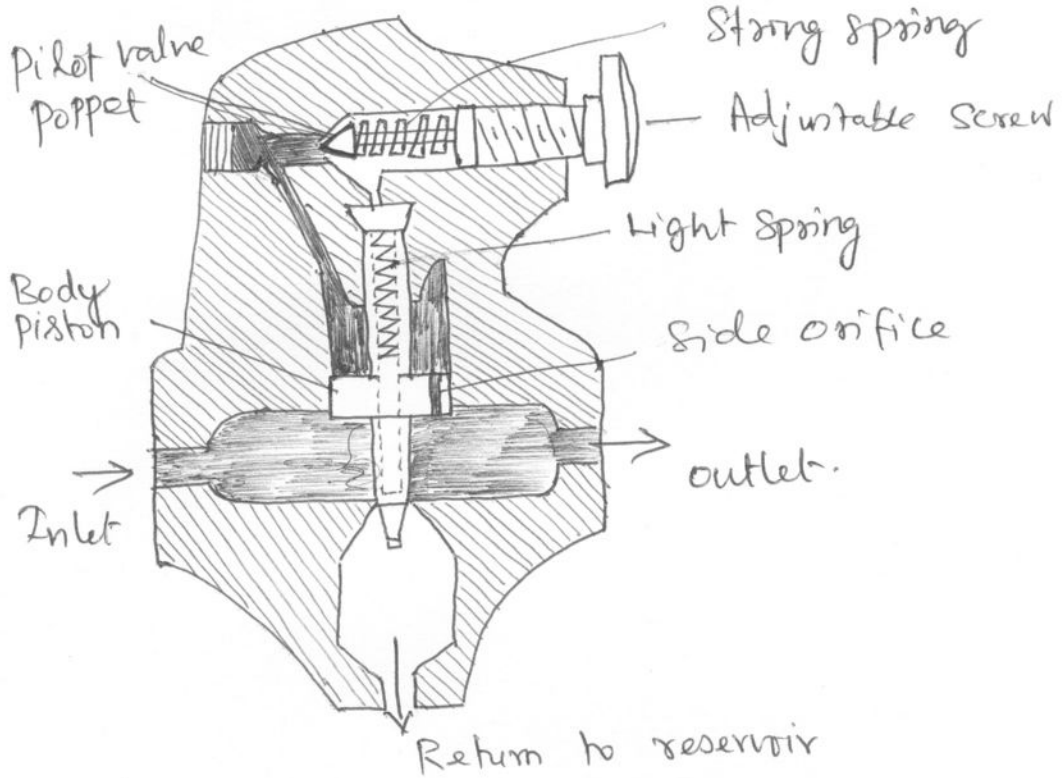
Electrical actuation is nothing but Solenoid actuation When electric coil or solenoid is energized, it creates a magnetic

force that pulls the armature into the coil. this causes the armature to push the spool of the valve.

Fluid actuation:

Here the spool shifting is accomplished by applying a pilot signal (either hydraulic or pneumatic) against a piston at either end of the valve spool.

6. Explain the working of a pilot operated pressure relief valve with neat sketch. (Dec. 2012)



Pilot operated pressure relief valve otherwise called as compound pressure relief valve or two stage pressure relief valve. It operates in two stages.

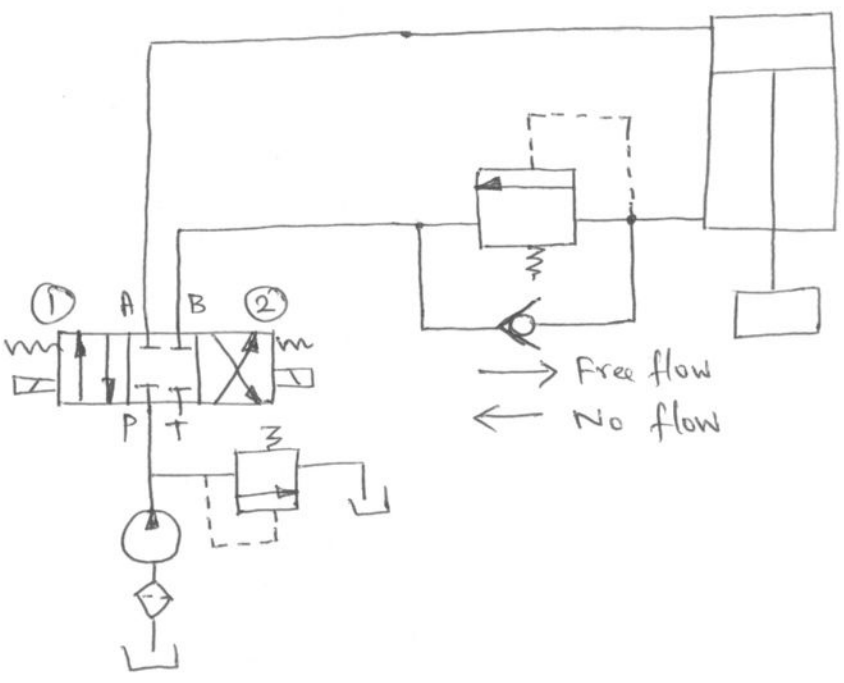
(i) The pilot stage is located in the upper valve body and containing a pressure limiting poppet which is held against a seat by an adjustable strong spring. The range of pressure setting is controlled by an adjustment screw.

(ii) The lower body contains the body piston which is retained to its seat by a light spring. The body piston consists of a drain hole in the centre and another hole in the side. The poppet valve and body are connected by a passage.

During normal operation, the piston is in hydraulic balance. The pressure at the inlet port, which acts under the piston, is the same as the pressure on its top because the side orifice is drilled. So the piston is held to its seat by the light spring. When the system pressure exceeds the settings of the poppet valve, the poppet is pushed from its seat. This permits the escape of the pressurised fluid from the top side to the reservoir through the centrally drilled drain hole of the body piston. This limits the pressure in the upper chamber of the piston. There is an imbalance in the hydraulic forces which tends to raise the body piston from its seat to permit the flow directly to the tank. Due to this, if the pressure in the upper and lower chamber becomes equal, the piston is returned to its original seat.

7. Explain the use of counter balance valve with a circuit (Dec. 2012)

A counter balance valve is used to maintain control over a vertical cylinder so that it will not fall freely because of gravity. This valve is also called as back pressure valve. Applications are vertical presses, loaders, lifts, trucks and other machines that must position or hold suspended loads.



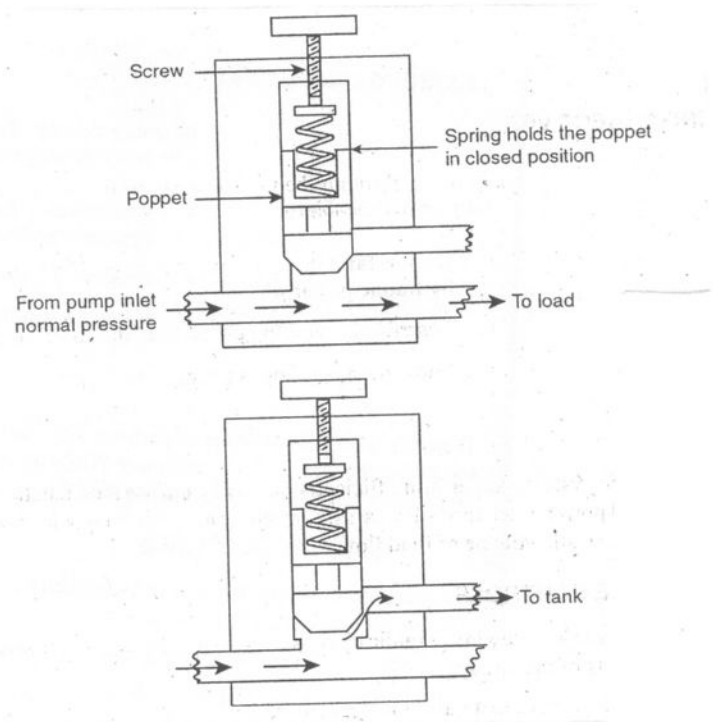
(i) If the DCV – ① position is connected to the pump, the fluid flow goes to the blank end of cylinder, causes piston to move down.

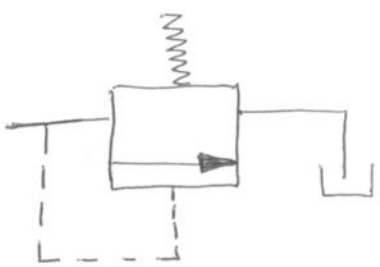
(ii) Due to the force from upper side of piston, the oil from rod end is passing thro counter balance valve. If no force from top of piston, though gravity acts, piston will not move down.

(iii) If ② position of DCV is connected, the retraction of piston starts, thro the fluid of check valve.

8. Explain the Construction of Pressure relief valve with neat sketch. (June 2013)

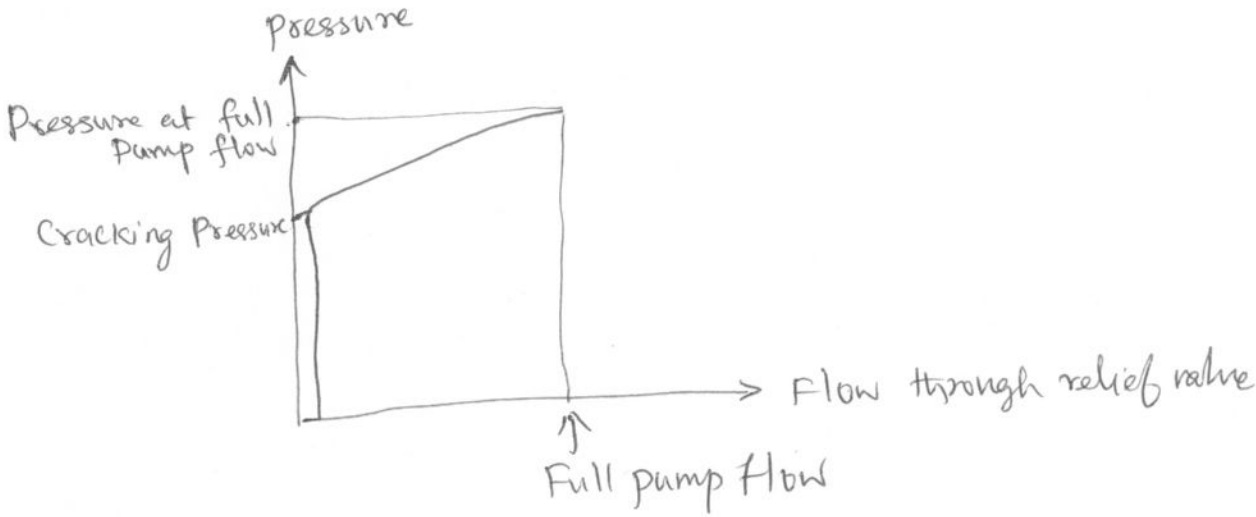
It is the most important and a normally closed valve whose function is to limit the pressure to a specified maximum value by diverting the pump flow to tank.





The figure illustrates the operation of a simple pressure relief valve. A poppet is held seated inside the valve by a heavy spring. When the system (Due to any block or overload) pressure reaches a value that is high enough, the poppet is forced off its seat. This permits the flow from the outlet to the tank until the system pressure drops to or below the set value. The external adjusting screw varies the pressure (cracking pressure) at which the valve begins to open.

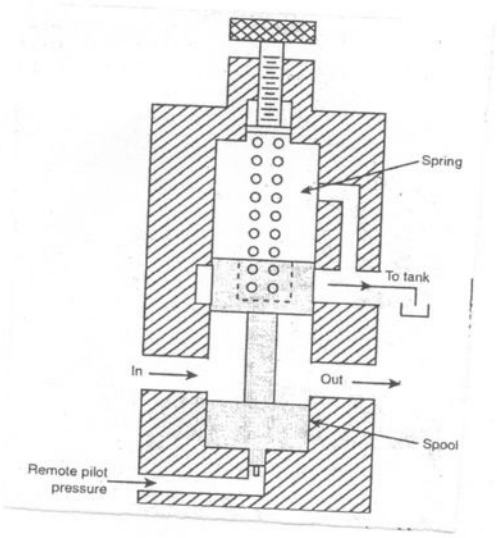
The pressure that exists during full pump flow can be substantially greater than the cracking pressure. The pressure at full pump flow is specified when referring to the pressure setting of the relief valve. It is the maximum pressure level that is permitted by the relief valve.

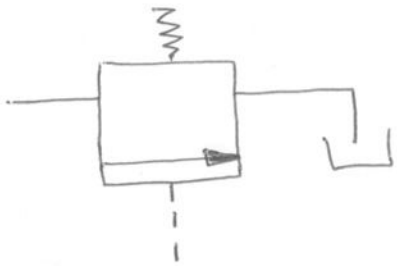


9. Discuss the functioning of an unloading valve with a diagram Dec. 2009

In case of pressure relief valve, the pump delivers full pump flow at the pressure relief valve setting and thus operates at maximum horse power condition, heat generated in the oil which oxidies and corrodes the parts of the system including pipe line, valves and actuator.

An unloading valve is used to unload the pump, by an external pilot force, to operate at minimum load and is therefore at minimum horse power.



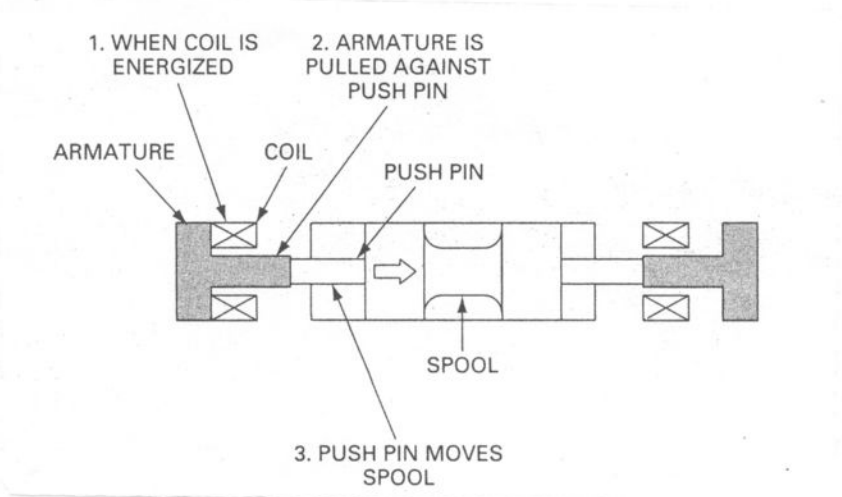


The "In" port of the unloading valve is connected to the line which is to be unloaded. The remote pilot port is to be connected to the line which is supposed to send the pressure impulse for unloading the valve. As soon as the system pressure reaches the setting pressure which is available at the pilot port, it lifts the spool against the spring force. The valve opens and flow goes to the reservoir until the pilot pressure exists.

The unloading valve is useful in controlling the amount of flow to the system containing more than one pump.

10. Discuss the construction and working of a solenoid actuated valve with a diagram [Dec. 2009]

A very common way to activate a spool valve is by using a solenoid is illustrated in the figure below. When the electric coil (Solenoid) is energized, it creates a magnetic force that pulls the armature into the coil. This causes the armature to push on the push pin to move the spool of the valve.



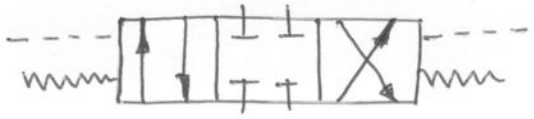
There are two types of solenoid designs used to dissipate the heat created by the electric current flowing in the wire of the coil.
The first type simply dissipates the heat to the surrounding air and is referred to as air gap solenoid.

In the second type, a wet pin solenoid, the push pin contains an integral passage way that allows tank port oil to communicate between the housing of the valve and the housing of the solenoid. As the oil circulates, the heat is carried into the hydraulic system where it can be easily dealt with.

11. How does a pilot operated direction control valve function? Explain with a diagram (NOV. 2007)

Direction Control valves may be direct acting or pilot operated from a remote point. As stated earlier, they may be operated manually, mechanically or electrically also. The valve action is commonly accomplished by the action of the valving element energized by the actuator.

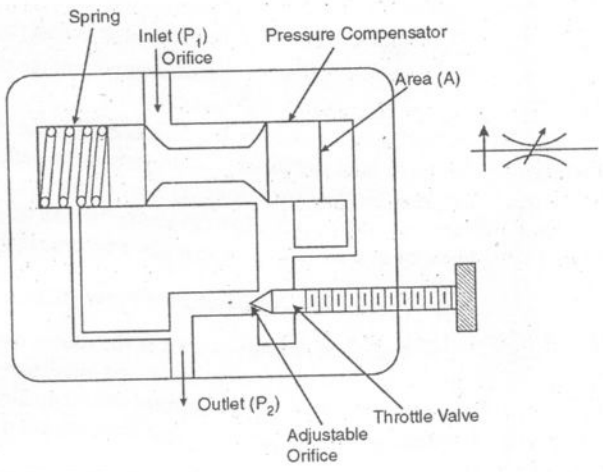
As the hydraulic machines are worked on moderate to high pressure some times bigger size direct acting control valve may require higher amount of actuating force. In such cases, in pilot controlled direction control valves, the main valve spool is operated with the oil pressure which is directed to the spool by the pilot valve mostly by a 4-way solenoid actuated for 4-way main valves.



Pilot operated Spring centred 4/3 way Direction control valve.

12. with a neat sketch describe the construction, operation and Purpose of a pressure compensated flow control valve. (May 2008, Dec. 2010)

The flow through the valve will get effected by any change in pressure at the inlet and outlet. But the pressure compensated flow control automatically adjusts to pressure changes and maintains a constant pressure drop from inlet to outlet, thus providing a constant flow.



The valve has two main parts

(i) the throttle valve which is nothing but a non-Pressure compensated flow control valve or Needle valve. It is an orifice whose area can be adjusted by the external knob. The orifice area setting determines how the flowrate is to be controlled.

(ii) The pressure compensator automatically controls the size of the restriction in the flow passage and maintains a constant pressure drop across the throttle valve.

If P_1 and P_2 are the inlet and outlet pressures. T_s is the Spring thrust and A is the exposed area of the compensator, for the pressure compensator to be in balanced position

$$P_2 \times A + T_s = P_1 \times A$$

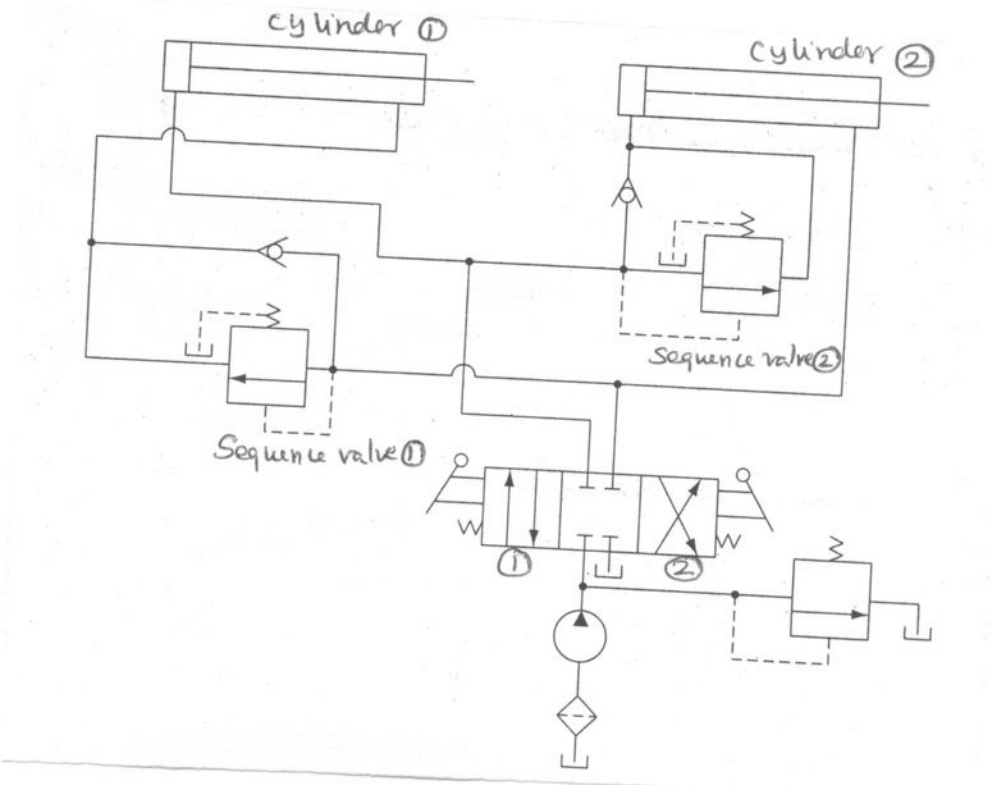
$$(P_1 - P_2) \cdot A = T_s$$

So the pressure drop through the inlet and outlet depends upon the thrust of the Spring and compensator area. Since, T_s and A are constant, $\Delta P = P_1 - P_2$ also remains constant. Due to constant Δp what ever be the fluctuation of pressure at inlet or outlet, the flow is constant.

It is used in the precision machine tools and other equipment need a constant Speed free from influence of external resistance and temperature.

13. Two hydraulic cylinders have to work in Sequence. Design a suitable circuit and explain. [Dec. 2007, 2009, 2010, May 2008, 2009, 2010]

Sequence valve is used for the purpose of making two hydraulic cylinders work in sequence. Here a 4/3 way Direction Control valve and 2 sequence valves are utilised along with other basic Components like, reservoir, filter, pump, pressure relief valve, check valve etc.



In the above figure, when the DCV is shifted to its left envelop mode ①, the cylinder ① extends completely, and then the cylinder ② extends. Then the DCV is shifted to the right envelop mode ②, the cylinder ② retracts fully, and then the cylinder ① retracts. This sequence of cylinder operation is controlled by the sequence valves. The spring centred position of the DCV locks both cylinders in place.

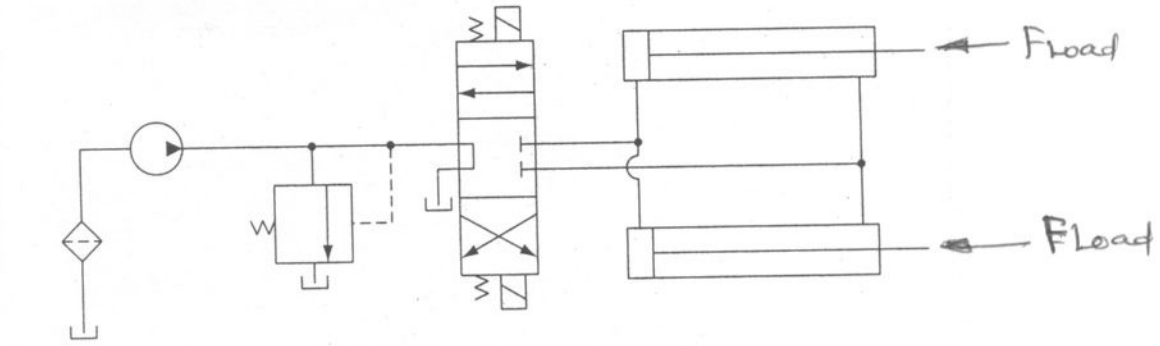
One simplest application of this circuit is a production operation. for example, the cylinder ① extends, it can be utilised for clamping a work piece via a power vise jaw. Then the cylinder ② extends, it can be utilised for drilling a hole in the work piece. After drilling cylinder ② retracts, drill bit comes out from work piece, then cylinder ① retracts, unclamps the work piece. This cycle may be repeated for mass production.

14. With a neat sketch, explain how two cylinder motions can be Synchronized. (May 2008, Dec. 2011)

There are many industrial applications require perfect Synchronization of movement of two or more cylinders in order to complete some phase of operations. This Synchronization of cylinders can be achieved by

(i) Cylinder Connected in parallel
(ii) Cylinder Connected in Series
(iii) Cylinders Connected with flow Control valves.

(i) Cylinders Connected in parallel:



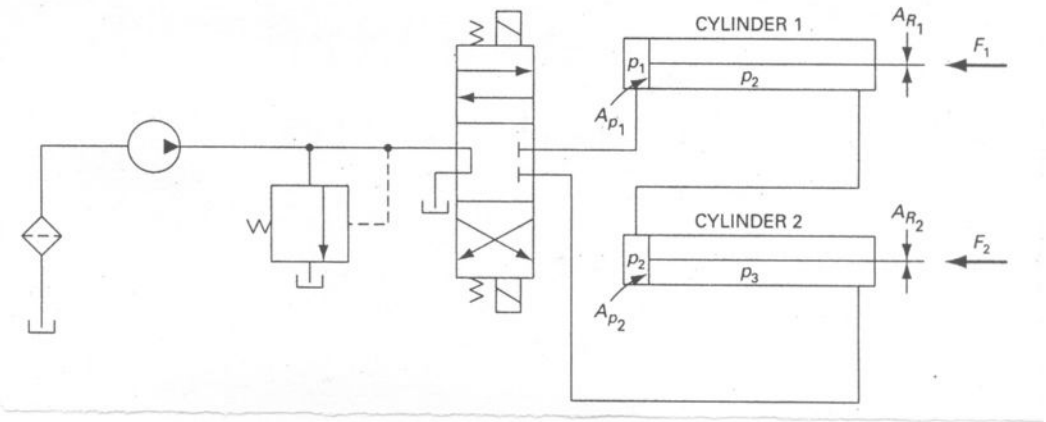
The above figure illustrates how two identical cylinders can be Synchronized by piping them in parallel.

Here
(i) cylinders Should be identical
(ii) Loads Should be exactly identical.

It should be pointed out that No two cylinders are really identical. If there is any small difference in load, the lower load Connected cylinder will move first and the higher load Connected cylinder. Hence, making Synchronization by Connecting cylinder in parallel is little not possible.

(ii) Cylinders Connected in Series:

Connecting two cylinders in series is a simple way to attain synchronization of two cylinders.



During the extension stroke of cylinders, fluid from pump thro left envelop of DCV, is delivered to the blank end of cylinder ①. As cylinder ① starts extend, fluid from its rod end is delivered to cylinder ②'s blank end, hence cylinder ② extends. Note that both ends of both cylinders and entire pipe line is filled with the fluid.

For two cylinders to be synchronized, the area of cylinder ② must be the difference in area between piston and rod of cylinder ①.

By applying continuity equation,

$$Q_{out(cy\,1)} = Q_{in(cy.2)}$$

$$(A_{p_1} - A_{R1})\, V_1 = A_{P_2} \cdot V_2$$

Since for synchronization $V_1 = V_2$

$$A_{p_1} - A_{R1} = A_{p_2}$$

A_{p_1} – Blank end Area of cy 1

A_{R1} – Rod end Area of cy 1

$[\because Q = AV]$

A_{p_2} – Blank end area of cy 2.

A_{R2} – Rod end Area of cy 2.

It should be noted that the pump must be capable of delivering a pressure equal to that required for the piston of cylinder ① by itself to overcome the loads acting on both extending cylinders. It means pressure is equal at blank end of cylinder ② and rod end of cylinder ①.

Summing the forces on cylinder ① yields

$$P_1 A_{P1} - P_2 (A_{P1} - A_{R1}) = F_1$$

cylinder ②

$$P_2 A_{P2} - P_3 (A_{P2} - A_{R2}) = F_2$$

We know $A_{P2} = A_{P1} - A_{R1}$; and $P_3 = 0$ as it connects to tank

Adding forces of cylinder ① & ②

$$P_1 A_{P1} = F_1 + F_2$$

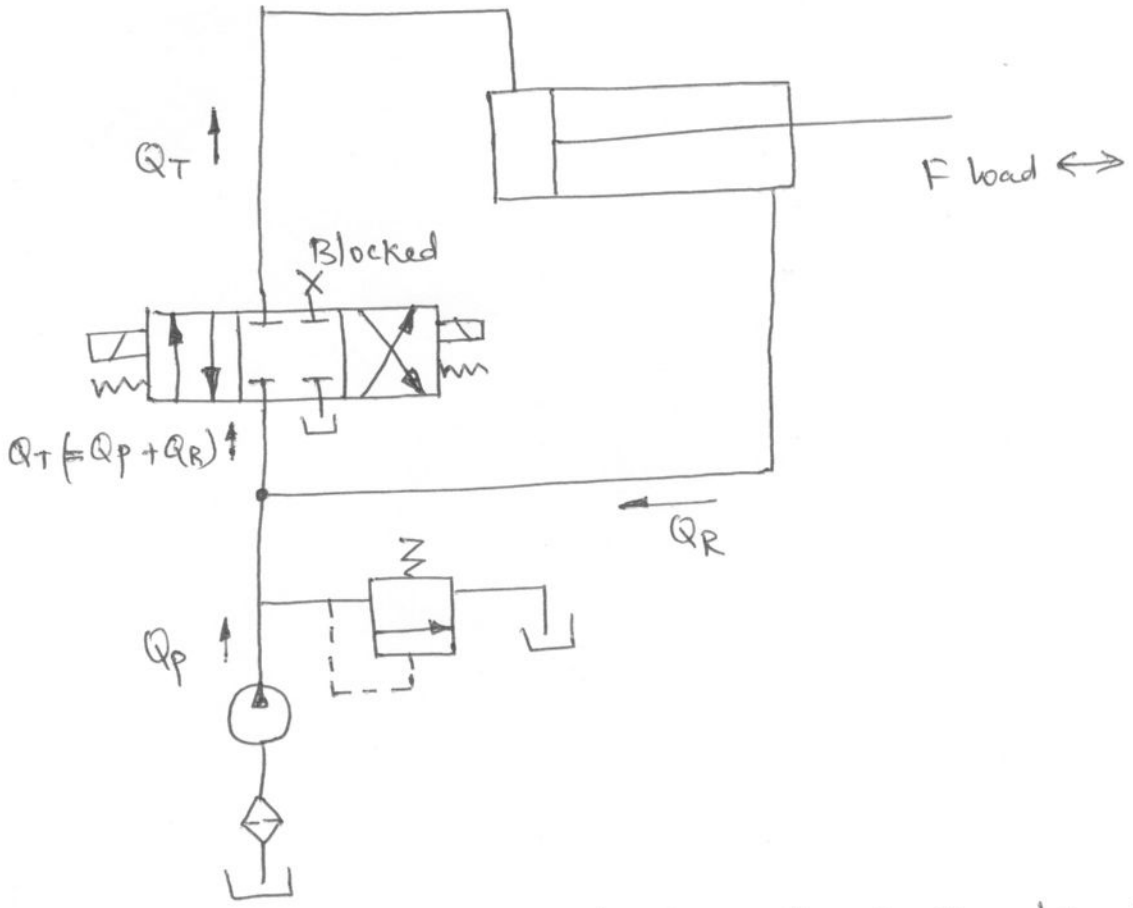
15. Design and explain the working of a regenerative circuit. [May 2009, Dec. 2009, Dec. 2011, May 2013]

A regenerative circuit is used to speed up the extension stroke of a double acting hydraulic cylinder.

When the DCV in its left envelope, the cylinder extends. The speed of the extension is greater than that for a regular double acting cylinder because flow from rod end (Q_R) regenerates with the pump flow (Q_P) to provide total flow rate (Q_T), which is greater than the pump flow to blank end of the cylinder.

When the DCV in its right envelop, the cylinder retracts due to the oil goes to rod end (not thro' DCV),

but the fluid from blank end drain to tank through DCV.



The equation for the extending speed can be obtained

$$Q_T = Q_P + Q_R$$

$$Q_P = Q_T - Q_R$$

$$= A_P V_{p\,ext} - (A_P - A_r) \cdot V_{p\,ext}$$

$$= A_P V_{p\,ext} - A_P \cdot V_{p\,ext} + A_r \cdot V_{p\,ext}$$

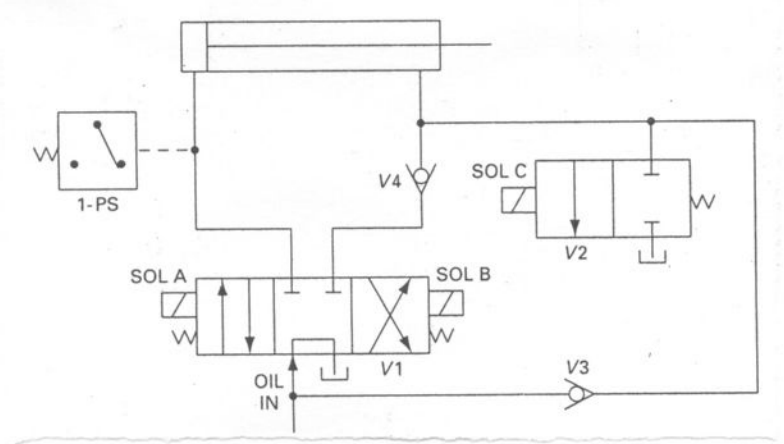
$$V_{p\,ext} = \frac{Q_P}{A_r}$$

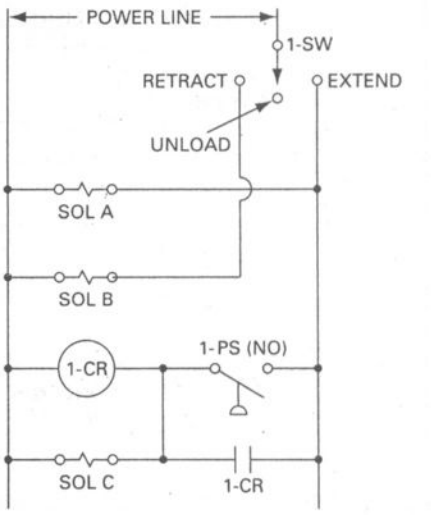
Thus, a smaller rod area provides a large extending speed.

The load-carrying capacity of a regenerative cylinder during extension is less than that obtained from a regular double-acting cylinder.

i.e. the extending speed is increased at the expense of load-carrying capacity.

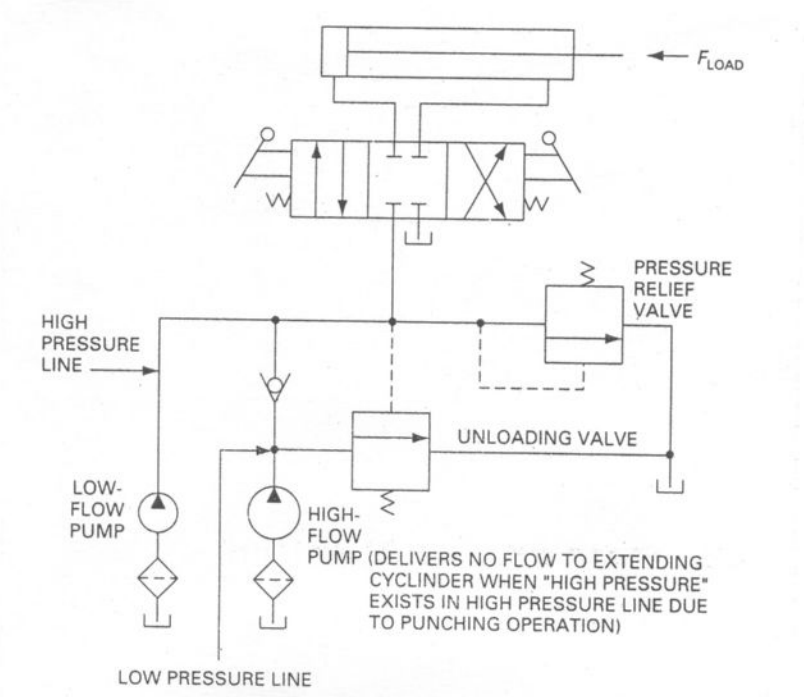
16. Draw and explain the ladder diagram connections for a regenerative circuit [Dec. 2008]





The above figure shows the circuit that provides electrical control of regenerative cylinder. Switch 1-SW is manually placed into the extend position. This energizes SOLA, which causes cylinder to extend. Oil from the rod end passes through the check valve V3 to join the incoming oil from pump provide the rapid extension. When the cylinder starts to pick up its load, oil pressure builds up and actuates pressure switch 1-PS, which in turn energizes coil 1-CR and SOLC. This vents oil through V2 directly to tank. Thus, the extension becomes normal (not rapid) and take load as like a normal cylinder. When 1-SW is placed into the retract position, SOLB becomes energized while relay coil and SOLC become de-energized. Therefore cylinder retracts. When the operator put 1-SW into unload position, all the solenoids and relay coil are de-energized, this puts valve V_1 in centered position to unload the pump.

17. Explain with a circuit, the hydraulic press, using unloading valve. (OR) Double pump circuit. [Dec.2011, May 2013]

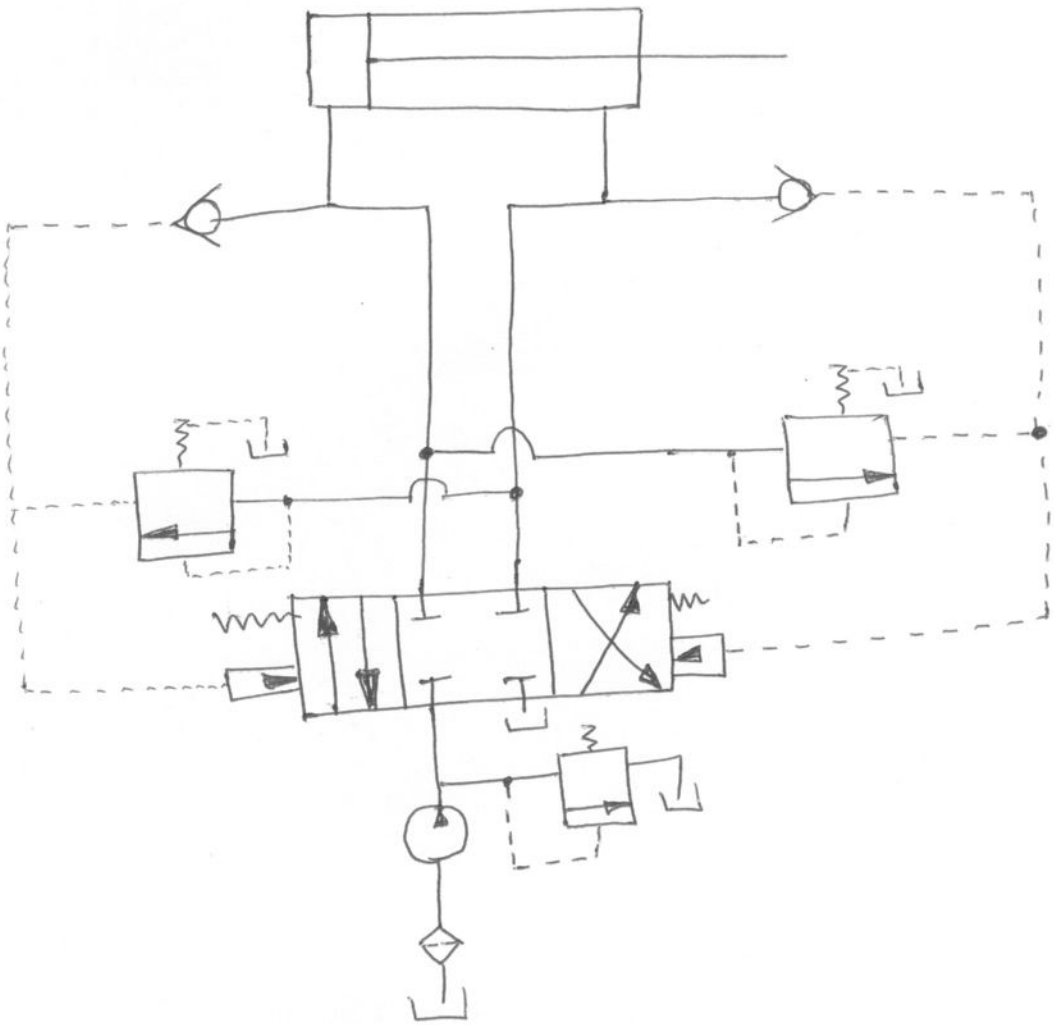


The above figure shows circuit that uses a high pressure, low flow pump in conjunction with a low pressure high flow pump. A typical application is a sheet metal punching press in which ram must extend rapidly over a great distance with very low pressure, high flow. This rapid extension takes place under no external load as the punching tool approaches the sheet metal strip to be punched. At the end, when punching occurs, the pressure requirements are high due to punching load. During this cylinder travel is small and thus low-flow required.

When punching operation begins, the increased pressure opens the unloading valve to unload the high-flow low-pressure pump. The purpose of relief valve is to protect the system from any high pressure. The check valve protects the low-pressure high flow pump from high-pressure low flow pump.

Here the circuit eliminates very expensive high flow high pressure pump by providing double pump (High flow low pressure and low flow high pressure).

18 Draw a Single cylinder continuous reciprocation circuit using suitable components. [Dec. 2011]



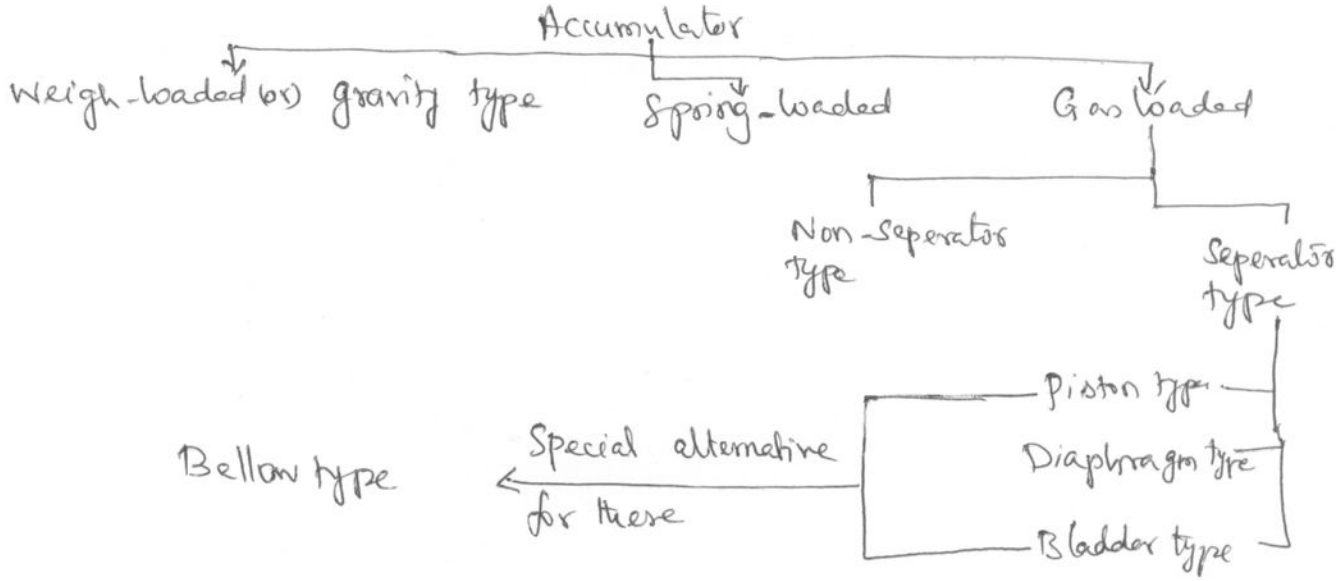
The circuit that produces continuous reciprocation of a hydraulic cylinder is shown in the above diagram.

This is accomplished by using two sequence valves, each of which senses a stroke completion by the corresponding buildup of pressure. Each check valve and the corresponding pilot line prevents shifting of 4/3 valve until particular stroke of the cylinder has be completed.

The check valves are needed to allow pilot oil to leave either end of the DCV while pilot pressure is applied to the opposite end. This permits the Spool of the 4/3 DCV to shift as required.

19. Explain the different types of accumulator with neat Sketch [May 2011, Dec. 2012, Dec. 2013]

An accumulator is a device that stores potential energy by means of either gravity, Mechanical Springs or Compressed gases. The potential energy stored in the accumulator is a quick secondary source of fluid power capable of doing useful work as required by the system.

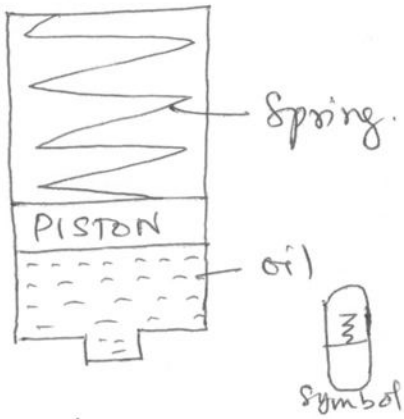


Weight loaded accumulator:

This is the oldest type. This consist of a vertical, heavy steel cylinder which incorporates a piston with packings to prevent leakage. A dead weight is attached to the top of the piston. The force of gravity of the dead weight provides the potential energy to the accumulator. The main disadvantage of this is its large size and heavy weight which makes it unsuitable for mobile equipment.

Spring loaded accumulator

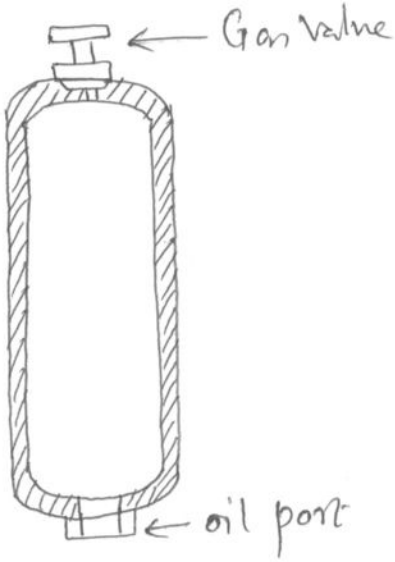
It is similar to the weight loaded type, except that the piston is preloaded with a spring.



The spring stiffness is decided based on the force requirement of the system. As, the spring is compressed to maximum installed length, a minimum pressure is established. When the fluid enters the cylinder, it causes the spring to compress and hence the pressure on the fluid will rise because of the increased load required to compress the spring. Similarly, when the fluid comes out causing the spring to expand, the pressure on the fluid will decrease.

Gas loaded Non-Seperator type accumulator :

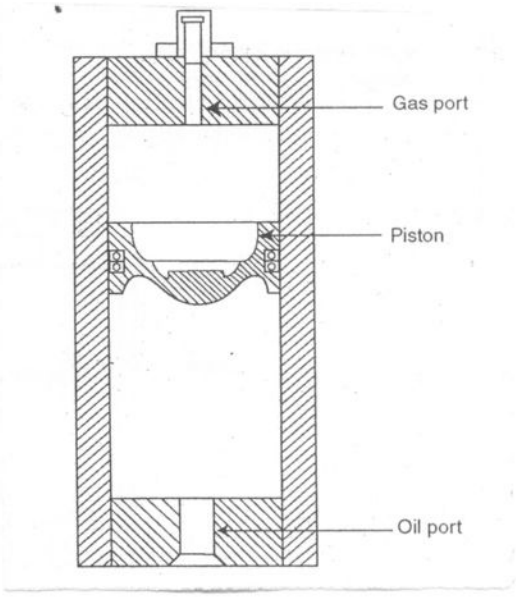
The non-seperator type consists of a fully enclosed shell containing an oil port at the bottom and a gas charging valve at the top. The gas is confined at the top and the oil at the bottom of the shell. There is no physical seperator between the gas and the oil. The gas has direct contact with the oil. When oil enters into the accumulator, it compresses the gas. During discharging, the gas pushes the oil into the system.



The main advantage of this type is its ability to handle large volume of oil. The main disadvantage is the absorption of gas in the oil due to lack of seperator. This type is not recommended for use with high speed pumps because the entrapped gas in the oil may cause cavitation and damage to the pump.

Piston type accumulator :

It consists of a cylinder containing freely - floating piston with proper seals. The piston serves as the barrier between the gas and the oil.

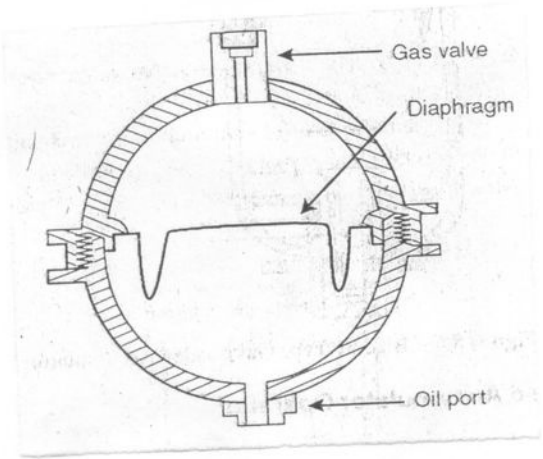


The charged gas is on one side of the piston and the system fluid is on the other side. The main advantage of this type of accumulator is its ability to accomodate very high or low temperature systems fluids by the use of compatible 'o' ring seals.

The main disadvantage of the free piston type accumulator is its cost and size.

Diaphragm type accumulator :

The diaphragm type accumulator consists of a diaphragm secured in the shell which serves as an elastic barrier between the oil and the gas.



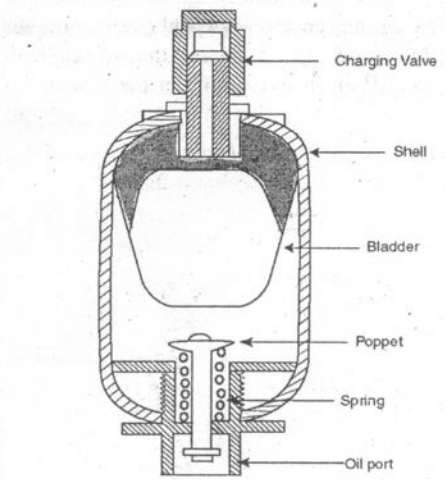
The pump delivers oil into the accumulator, the diaphragm deforms. As the pressure increases the volume of the gas decreases, thus stores energy.

The main advantage of this type accumulator is its small weight-to volume ratio, that makes it suitable for aircraft application.

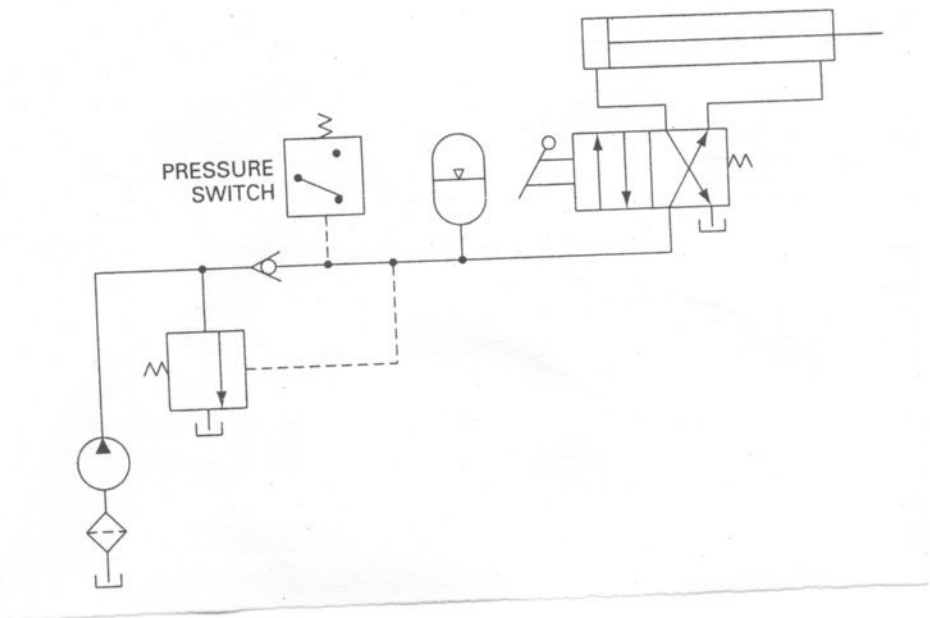
Bladder type accumulator:

It has an elastic bladder, there is a gas valve element at the top of accumulator and a spring operated poppet.

The main advantage is the positive sealing between the gas and oil chamber.



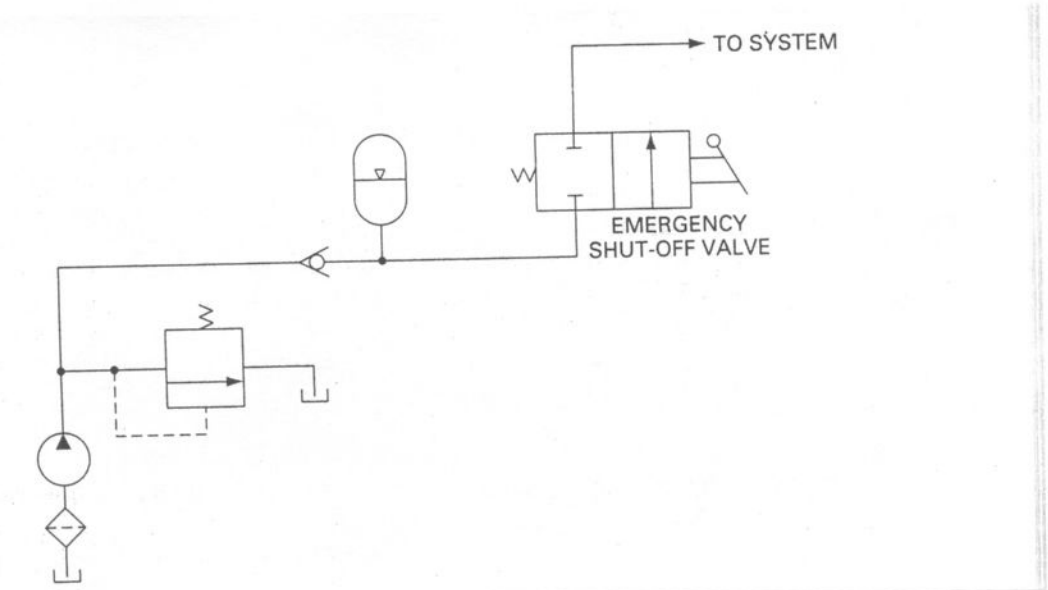
20
~~20~~. Design a circuit with an accumulator as a leakage compensator. [Nov. 2007, May 2011]



The above figure illustrates the accumulator's second important application is a leakage compensator for internal or external leakages during the ~~extended~~ extended period of time during which the system is pressurized but not in operation (utilised). The pump charges the accumulator until the maximum pressure setting on the pressure switch is obtained, then its automatically stops due to contacts on the pressure switch open. The accumulator then supplies oil to the system, if oil get reduced due to leakage. It save electric power by switching off the motor and supplies stored oil as per

necessity from the accumulator.

2) ~~25~~ Make a circuit showing the use of an accumulator as a hydraulic shock absorber. [Dec. 2008]



One of the most important applications of accumulator is the elimination or reduction of hydraulic shock (high-pressure pulsations) Hydraulic shock (water hammering) is caused by the sudden stoppage or deceleration of fluid flowing at very high velocity in a pipe line.

One live example is in the case of a rapidly closing valve. This creates a compression wave which will travel at the speed of sound upstream to the end of pipe and back again to the closed valve, causing an increase in pressure in the line. This wave travels back and forth along the entire length until its energy fully dissipated by friction. This action may damage the components of the circuit.

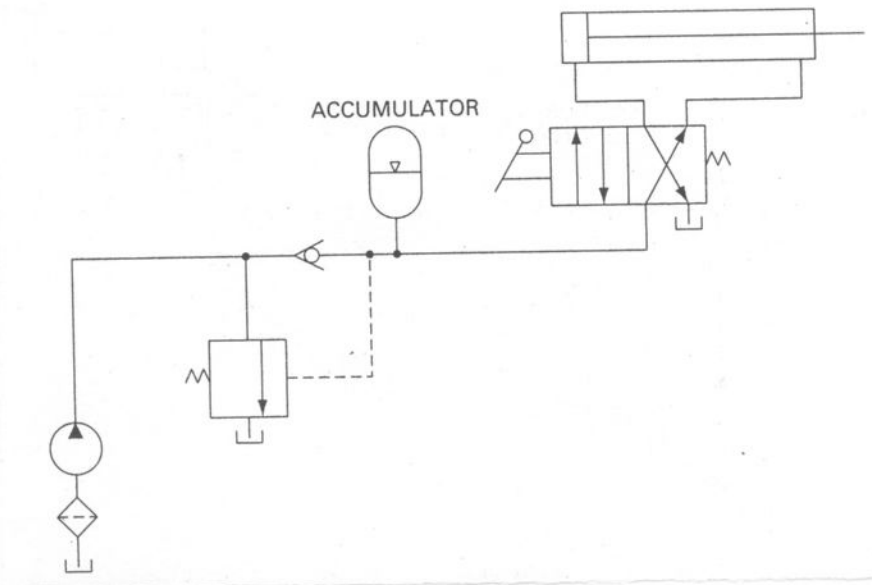
If an accumulator is installed near the valve which may be rapidly closed, as shown in the circuit, the high pressure surges are suppressed.

22. with the help of circuit diagrams, illustrate the applications of accumulators [May 2009, Dec. 2009, May 2010, Dec. 2010, May. 2011, Dec. 2011, May 2013, Dec. 2013]

There are four basic applications where accumulators used in most hydraulic Systems.

1. An auxillary power source
2. A leakage compensator
3. An emergency power source
4. A hydraulic Shock absorber.

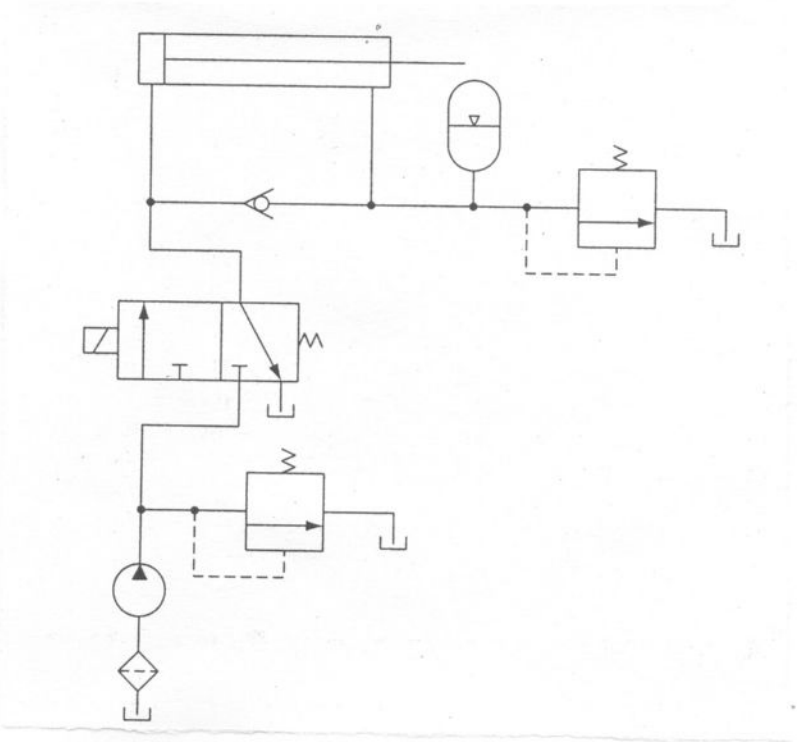
(i) Accumulator as an auxillary power Source:



Here the purpose of accumulator is to store oil delivered by pump during the end of work ~~of~~ cycle. The accumulator releases the oil stored on demand to complete the remaining operation of the cycle, there by serving as a Secondary source of power to assist the pump. Due to this accumulator the small sized pump may be used in the circuit.

When the four way valve is actuated manually, oil from pump goes to the blank end of the cylinder and extension stroke starts and while doing effective work and end of the stroke, as pressure rises, oil get charged in the accumulator. Then the deactivation of four way valve occurs for making the return stroke, during this time along with pumped oil, the oil stored in accumulator help the rapid motion of return stroke.

(ii) An emergency power source:



In some hydraulic system, safety is a major concern, it may require the cylinder be retracted even though the normal supply of oil is lost due to pump or other failure. Such an application is illustrated in the above figure. A Solenoid-actuated 3 way valve is used in conjuction with accumulator.

If the valve energized, oil goes to the blank end, rod end through check valve, does the extension stroke and accumulator get charged.

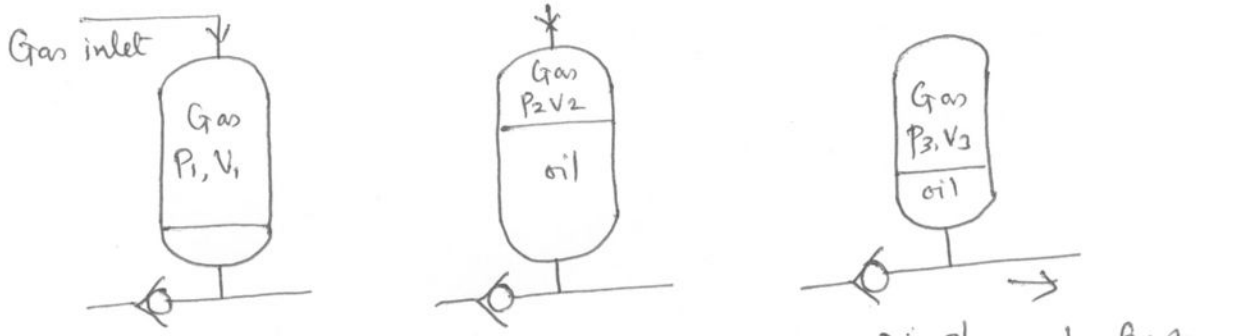
If the DCV deenergized, the oil stored in accumulator makes the return stroke of cylinder.

23. Consider the charging and discharging of a hydropneumatic accumulator to be isothermal and explain the procedure to arrive at the size of accumulator (May 2010).

We know from Boyle's law that,

$$P_1 V_1 = P_2 V_2.$$

In order to find the size of accumulator, the amount of hydraulic fluid needed must be known. This is determined by the cylinder size and working speed.



Precharging with gas | oil charging in accumulator | Discharge to System

The rate of charging and discharging determines whether the process is isothermal or adiabatic.

Isothermal occurs when the process is slower enough to allow heat transfer from accumulator. $P_1 V_1 = P_2 V_2$.

Adiabatic occurs when the process is faster enough to retain all the heat. $P_1 V_1^{\gamma} = P_2 V_2$

For isothermal process,

$$P_1 V_1 = P_2 V_2 = P_3 V_3$$

where P_1 = Pre charge pressure
P_2 = Maximum pressure
P_3 = Discharge pressure

The amount of oil Supplied $= V_3 - V_2$

Then, Size of accumulator $= V_1$.

24. List the adrantages and disadrantages of spring loaded accumulator [May 2012]

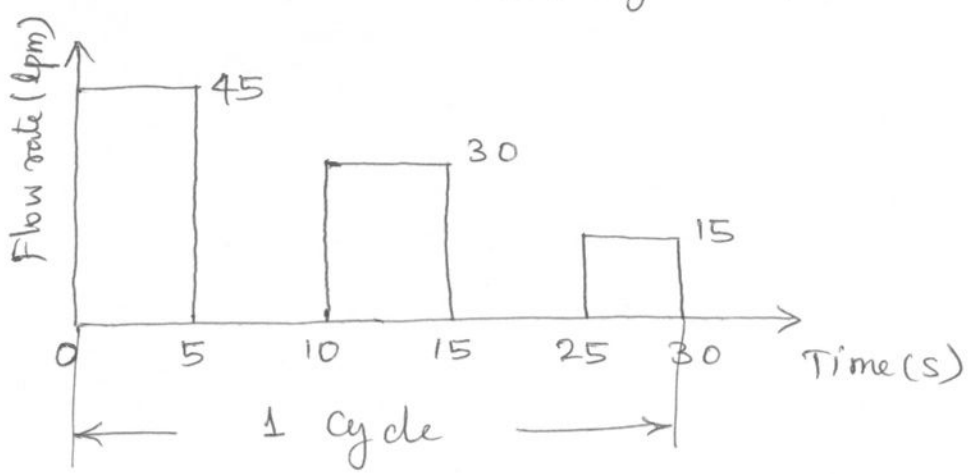
Advantages:

1. It is usually available in smaller size and less expensive than the dead-weight type.
2. It is easy to maintain.

Disadvantages:

1. Pressure exerted on the fluid is not constant.
2. It may be used only for low-volume, low-pressure system
3. They are oversized and costly if used for high-volume and high pressure application.

25. A pump or accumulator power pack is to supply fluid flow demanded by a hydraulic system as shown in fig. The system working pressure is 125 bar and the maximum pressure at the accumulator is 200 bars. Assuming the accumulator pre charge pressure is 90% of its maximum working pressure, determine
(i) The actual pump delivery required
(ii) The maximum volume of fluid to be stored in the accumulator
(iii) The accumulator volume assuming isothermal charge and discharge.



Given Data:

System working pressure = P_3 = 125 bar

Max. Pr. at accumulator = P_2 = 200 bar

Accumulator pre charge Pr. = P_1 = 0.9 × 125

= 112.5 bar

Asked Data:

(i) Qactual = ?

(ii) Max. volume of fluid stored

(iii) Accumulator volume = ?

Solution:

Flow to the System = 45 lpm for 5 seconds +
30 lpm for 5 seconds +
15 lpm for 5 seconds

$$= \frac{45}{60}\times 5 + \frac{30}{60}\times 5 + \frac{15}{60}\times 5$$

= 7.5 lt/cycle.

Cycle average flowrate = $\frac{\text{Flow per cycle}}{\text{cycle time}}$

$$= \frac{7.5}{30} = 0.25 \text{ lt/sec}$$

= 15 lpm

The actual pump delivery = 15 lpm.

We know that the process is isothermal

$$P_1V_1 = P_2V_2 = P_3V_3$$

$$P_1V_1 = P_2V_2 \qquad P_2V_2 = P_3V_3$$

$$\frac{V_1}{V_2} = \frac{200}{112.5} = 1.78 \qquad \frac{V_3}{V_2} = \frac{200}{125} = 1.6$$

The accumulator get charged during 5 to 10 seconds and 15 to 25 seconds in the cycle of 30 seconds.

We know that the pump delivery is 15 lpm
System demand is zero

Hence flow rate into the accumulator

during 5 to 10 Seconds is $\frac{15}{60} \times 5 = 1.25$ lts

during 15 to 25 Seconds is $\frac{15}{60} \times 10 = 2.5$ lts.

Hence, $V_3 - V_2 = 2.5$ lts

$1.6 V_2 - V_2 = 2.5$

$V_2 = 4.17$ lts

$\Rightarrow V_1 = 7.42$ lts = Accumulator Volume.

26. An accumulator is loaded with 400 KN weight. The ram has a diameter of 300mm and stroke of 6m. Its friction may be taken as 5%. It takes 2 minutes to fall through its full stroke. Find the total work supplied and power delivered to hydraulic appliances, when 0.0075 m^3/s of liquid is being delivered by a Pump, while the accumulator descends with the stated velocity. Take the density of oil as 1000 N/m^3.

Given Data:

$W = 400$ KN ; $t = 120$ sec
$D = 0.3$ m ; $Q_{pump} = 0.0075\ m^3/sec$
$L = 6$ m ; $\rho_{oil} = 1000\ N/m^3$
friction = 5% ;

Asked Data:

(i) Total work supplied
(ii) power delivered.

Solution:

Net load on accumulator = 400×0.95 (∵5% Friction)
= 380 KN.

Work done by accumulator = Net load on ram × Distance moved by ram/sec

$= 380 \times \frac{6}{120}$

$= 19$ KNm/sec.

Pressure of liquid leaving accumulator = $\frac{\text{Net load}}{\text{Area}}$

$= \frac{380}{\frac{\pi}{4}(0.3)^2}$

$= 5376.34$ KN/m^2

Work Supplied by pump/sec = WQH [$\because P = \rho g H$, $H = P/\rho g$]

$= 1000 \times 9.81 \times 0.0075 \times \frac{5376.34}{1000 \times 9.81}$

$= 40.323$ KNm/sec.

Total work supplied = workdone by accumulator + work supplied by pump

$= 19 + 40.323$

$= 59.323$ KNm/sec

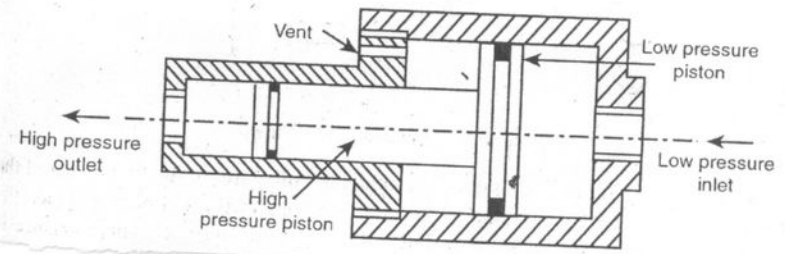
Power delivered = work Supplied

$= 59.323$ KW.

27. Write and explain the working principle of pressure intensifier with neat diagram. [Dec. 2008, May 2011].

A pressure intensifier or pressure booster, is a device or an auxillary unit frequently employed in the hydraulic system for special purposes. It is used to increase the pressure in a hydraulic system to a value above the pump discharge pressure.

It takes a high-volume flow at low-pressure and converts a portion of fluid into high pressure.



Intensifiers are used to multiply forces when a great force is needed for a relatively short distance. Typical applications include hydraulic presses, riveting machines and spot-welders. The pressure intensifier significantly saves the cost in the applications mentioned because it replaces the expensive high-pressure pump.

It consists of two different sized cylinders connected with a common piston. Oil is pushed with pump pressure to the bigger cylinder and exerts a force on the larger end of the piston. The smaller end of the piston exerts the same force on the oil present in the smaller side cylinder, here the pressure exerted is increased or intensified.

P_l - Pressure at the larger end of piston (Inlet from pump)
P_s - Pressure at the Smaller end of piston (outlet to system)
A_l - Area of larger end piston
A_s - Area of Smaller end piston

$$P_s A_s = P_l A_l$$

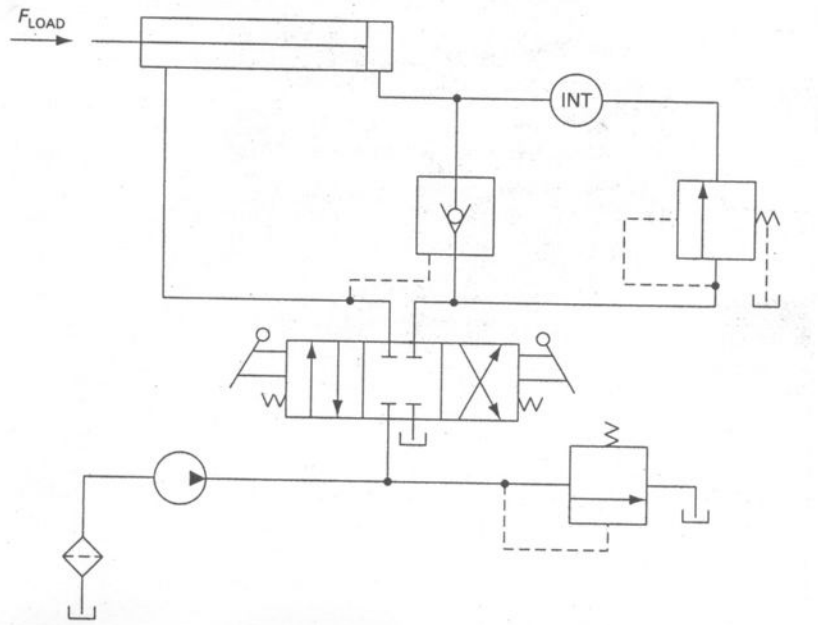
$$P_s = \frac{A_l}{A_s} \times P_l$$

" " A_s " A_s " is lower than A_l, P_s will get intensified.

28. Make a circuit showing an intensifier in a punching Press application. [May 2008, Dec. 2010]

We know the punching press application requires the full stroke of extension should be carried with different speeds and different pressure.

∴ the punching operation will take place at the end of extension stroke which require high pressure (only at the end), the most period of extension stroke, the movement of piston ~~AA~~ is a speedy one (Don't required to take work) until the press starts.

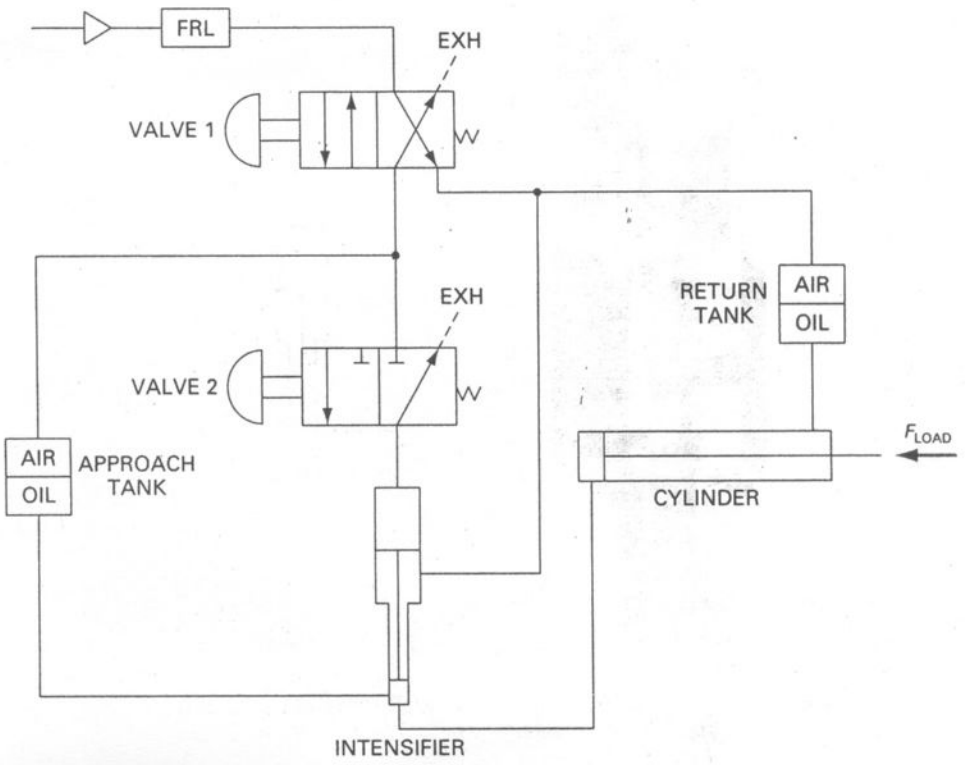


When the DCV is shifted to the right position, pumped flow goes to the blank end of cylinder through check valve and extension stroke starts. When the pressure in the cylinder reaches the setting of sequence valve, the intensifier starts to operate. The high-pressure output of the intensifier, closes the pilot check valve, goes to the blank end of cylinder to perform the punching press application. After completing the pressing work, the DCV is shifted to left position, oil flows to the rod end of cylinder. Retraction starts due to

the pilot signal opens the check valve and return fluid from blank end of cylinder reaches the tank through ~~pbi~~ pilot check valve.

The intensifier should be installed near the cylinder to keep the high pressure lines as short as possible.

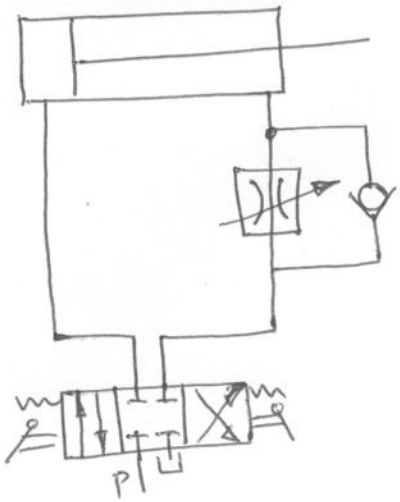
29. Explain Air-over-oil intensifier system with the help of a Circuit.



The above circuit illustrates an air-over-oil intensifier ~~circuit~~ system, which drives a cylinder over large distance at low pressure and then over a small distance at high pressure.

- upon pressing valve 1, Air comes to the approach tank and pushes the oil which goes to the blank end of cylinder and extension starts.

Meter-out circuit



Here, the flow control valve is located on the return side of cylinder, so that the speed of work cylinder is controlled by monitoring the discharge flow. Machine tools like mills and drills often require such a kind of control.

Bleed-off circuit

Here the flow control valve is not directly in the feed line but is connected with its outlet port which is connected to the reservoir.

The valve regulates the flow to the work cylinder by diverting an adjustable amount of pump delivery to the reservoir.