# Module - 5 : Pneumatic Control Circuits.

## Simple Pneumatic Control:

A Pneumatic Control system is built into a Pneumatic Circuit to control and direct the air flow. The first Control element is the air regulating valves, which is set to obtain a flow to achieve the required operating Pressure in the line. Next comes the master Control Valve, which is nothing but a Directional Control valve (DCV), whose purpose is to allow the the flow to the required Port to cause cylinder actuation. Then the flow Control valves (FCV) are used before the actuator or after the actuator to Control the speed of the Cylinder, the Speed of Cylinders Can be increased by the use of quick exhaust valves. A quick exhaust valve allows the return-air to escape directly to the atmosphere, without being Passed through the DCV route,

## Direct actuation of Cylinder

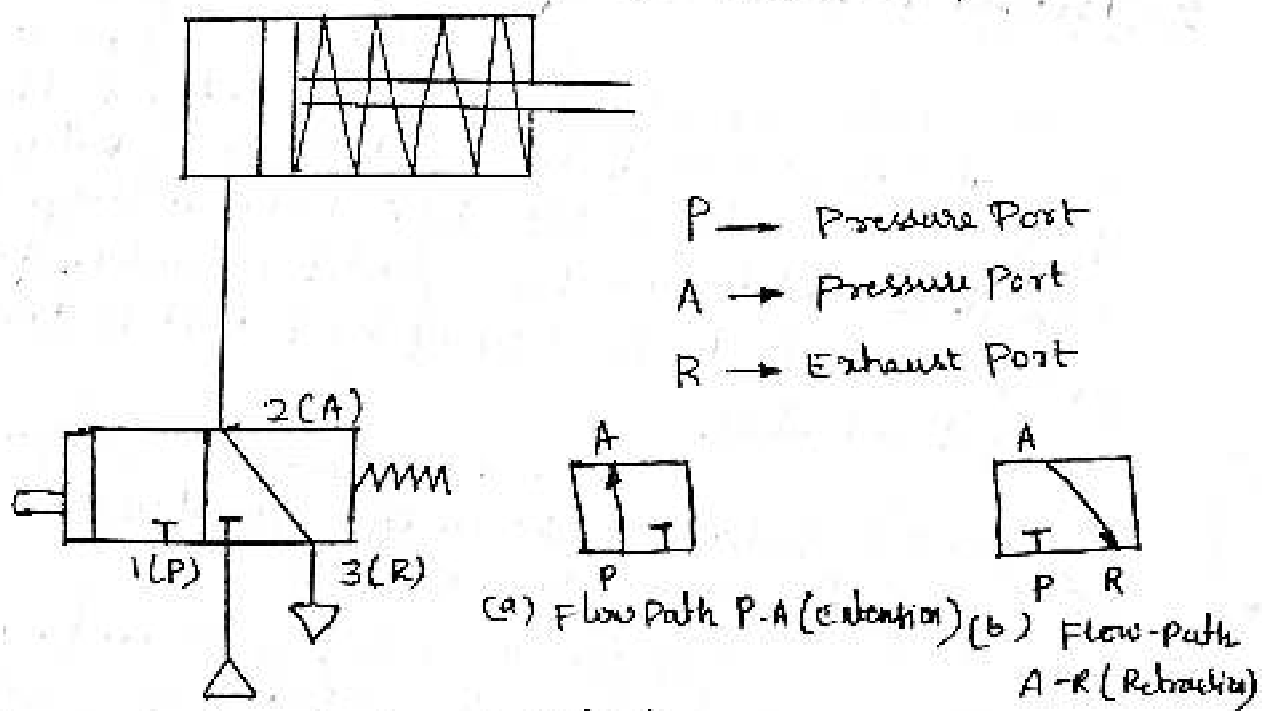



Fig Direct actuation of Cylinder

In direct actuation cylinder, the cylinder operation is controlled directly by the operation of the DCV. The DCV is directly linked to the cylinder and the DCV in turn is operated by some actuation means like pedal or button. A typical pneumatic circuit involving direct actuation of a cylinder is shown in fig.

It has a spring returned single-acting cylinder connected to a 3/2 NC (Normally closed) directional control valve. The DCV in its unactuated position, connects the cylinder port to the exhaust so that the cylinder remains in retracted position. Thus, the operation of the DCV directly helps in actuating the cylinder.

In operation, when the DCV (Normally closed) is actuated, high pressure air flows from Port 1(P) to Port 2(A), keeping the exhaust port in blocked condition. Due to this, the cylinder extends. When the DCV is de-actuated (released), the cylinder port 2(A) is directed to the exhaust line 3(R). Keeping the 1(P) pressure port in blocked condition. The cylinder retracts under spring pressure.

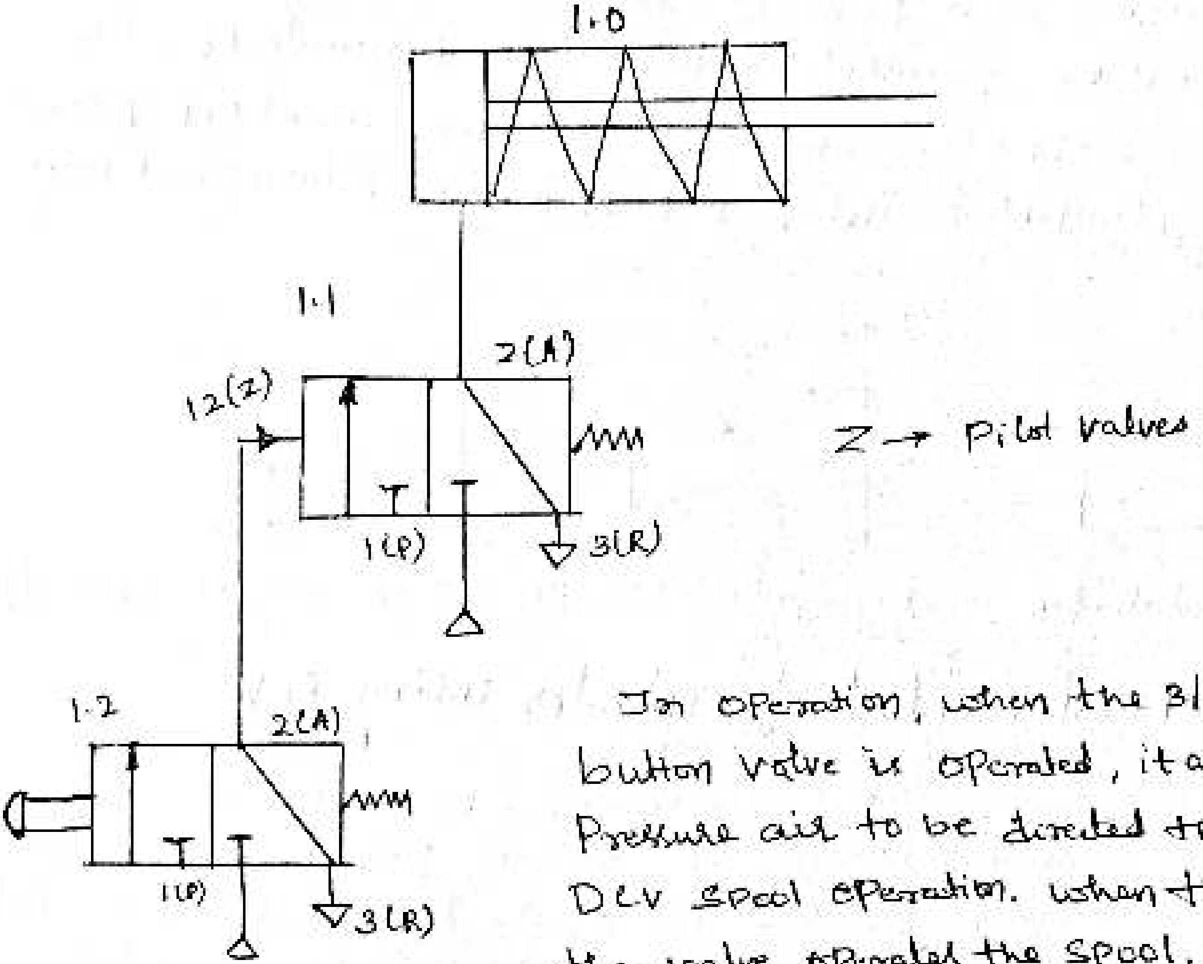
2. Indirect actuation of cylinder

In this case, the DCV is operated by another button operated DCV. The advantage is that small manual force is enough to operate the pilot valve, which in turn actuates a large size DCV: hence a large size cylinder can be actuated. Since the cylinder actuation takes place due to the indirect operation of the DCV it is termed indirect actuation.

A typical pneumatic circuit with the use of two 3/2 valves for the indirect actuation of a single acting cylinder is as shown in fig.

It has a spring-returned single acting cylinder connected through a 3-position 2-way (3/2) pilot operated DCV. This valve in turn is operated through a

Push button 3/2 DCV. This Push button valve indirectly actuates the cylinder through the DCV




In operation, when the 3/2 NC Push button valve is operated, it allows a low Pressure air to be directed to the main DCV spool operation. when the spool in the valve operates the spool, the high Pressure air line 1(P) is connected to the cylinder Port 2(A). this causes the extension of the cylinder.

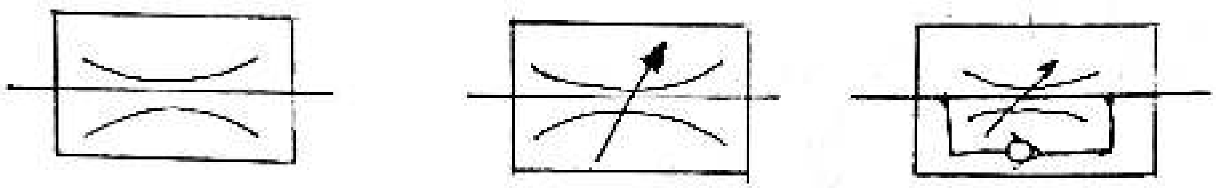
when the Push button is released, the Pilot valve returns, thus closing the low Pressure line and opening the exhaust. Due to this, the spool valve under spring Pressure closes the high Pressure line and opens up the exhaust Port. Because of this, the cylinder retracts under spring Pressure.

3. Flow Control valve (FCV)

In Pneumatic System, flow control valve are used to reduce the flow rate of air in the line and in turn control the speed of the actuator. In fact, a FCV acts as a restriction to the flow of air by the reduced area of opening.

The opening can be varied, hence the flow rate can also be varied. Most FCVs are adjustable type, so that the flow rate can be manipulated to suit the pneumatic operations.

The Graphical symbols for a FCV (fixed area), FCV (variable area / adjustable) and FCV with a bypass return check valve.



(a) Fixed area type (b) Adjustable area type (c) one-way (check valve) type.

# 4. Speed Control of cylinder using FCV

The actuation speed of a cylinder can be controlled with the use of FCVs. The FCV regulates the flow rate of air in a pneumatic line, and hence controls the actuation speed. The speed control is possible either by regulating the air at the inlet port while actuation or at the outlet port. These are termed as supply air throttling and return air throttling (Equivalent of meter-in and meter-out controls, respectively in hydraulic power system)

## 4.1 Supply air throttling

This is similar to the meter-in flow control explained in this. A simple pneumatic circuit using supply air throttling to control the cylinder actuation speed is shown in fig.

In this circuit, a 4/2 DCV with a by-pass check ~~valve~~ type flow control valve is used. The FCV is located in the supply line to the cylinder port 2(A). The FCV is such that in the supply direction the check

Valve closes, and the flow is only through the orifice.

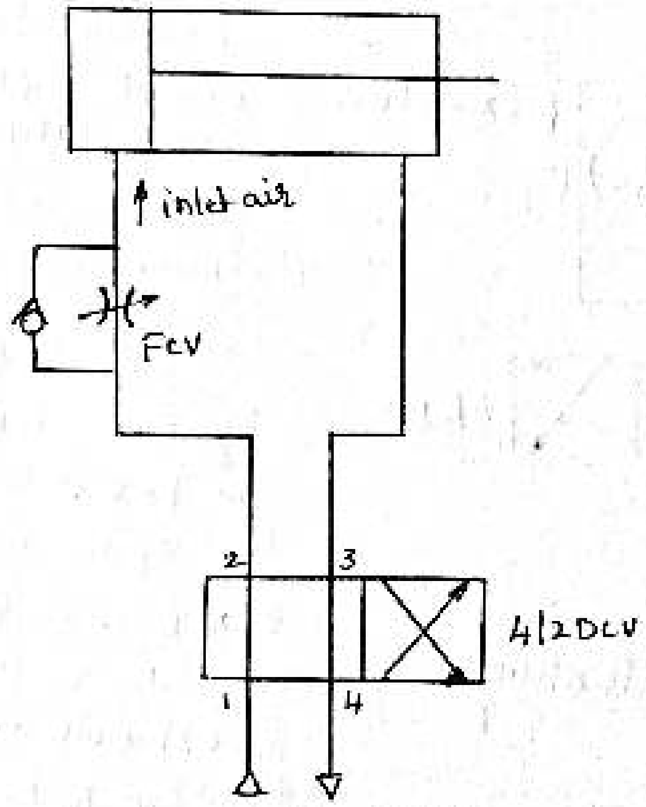



Fig Supply air throttling

In Operation, whe the DCV is actuated, the supply Pressure 1 (P) is directed to the FCV, and then to the cylinder Port 2(A). Since the Check valve blocks the flow, the air has to pass through the restricted orifice opening, thus Controlling the flow rate to the cylinder. The cylinder speed will be in Proportion to the flow rate, During this, the return air is exhausted from Port 3(B) to Port 4 (R). Since, the Cylinder Speed is controlled by Controlling the air supply at the cylinder inlet, it is termed supply air trottling.

When the Cylinder retracts, the check valve opens up and allows a free flow Path to the air, hence the cylinder returns with full design speed.

## 4.2 Exhaust air Throttling.

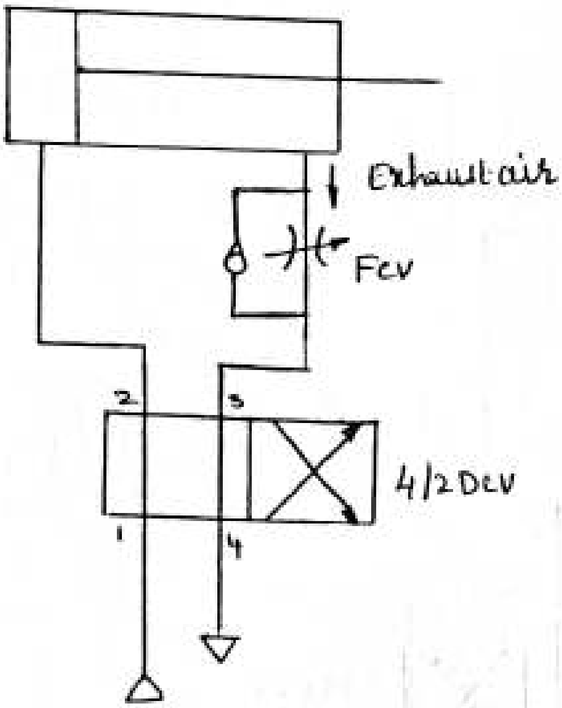



Fig Exhaust air throttling.

This is similar to the meter-out flow control. A simple Pneumatic Circuit employing the exhaust air throttling to control the cylinder actuation speed as shown in fig.

In this, a 4/2 DCV with a by-pass check type FCV is used. The FCV is located in the exhaust line of the Cylinder Port 3(B). The FCV is such that it completely closes the ball valve in the direction of exhaust such that the air flow has to be only through the orifice opening.

In operation, when the DCV is actuated; the Supply Pressure 1(P) is directed to the cylinder Port 2(A). It Causes the extension of the cylinder. At the same time, the air on the rod end of the cylinder starts exhausting through Port 3(B) via the FCV. Since, in this direction, the ball valve is closed, the exhaust air Passes through the restricted opening of the FCV, and flow rate is Controlled. This in turn Controls the speed of extension of the cylinder. Since, the Cylinder speed is controlled by Controlling the air at the exhaust line, it is termed exhaust air throttling. when the cylinder has to be retracted, the air flow easily Passes through the check valve without any restrictions. hence the cylinder retracts with its full design speed.

## Signal Processing element

Pneumatic signal Processing involves the use of Pneumatic logic elements. Pneumatic logic uses air valves and other Pneumatic devices for various Control actions. These Control actions are then applied to Power systems to obtain the required actuation. In Pneumatic logic devices, a minimum amount of Pneumatic force is required, which send Signals to power devices that operate with high Pressure Control valves.

"Advantages of Pneumatic logic devices over electrical logic devices"

1) They are simple by design and fabrication
2) unlike electrical devices, Pneumatic logic devices do not undergo Self destruction under extreme Pressure and heat.
3) They are quite safe and Convenient in explosive environments
4) They have longer life of operation
5) They are highly reliable
6) They have a faster response time (10-12ms) as Compared to electrical relays (50-60 ms) and Solenoids (75ms)

## LOGIC GATES

In Pneumatic logic operations, logic gates are used. The five basic logic gates in use are AND, OR, NOT, MEMORY and TIME gates. The use of AND and OR gates with Pactical applications in described below.

There are two types of Pneumatic logic devicers moving - Part logic (MPL) and non-moving Part logic devicers. MPL devicers use Spool and Poppet valves as the pilot valves to generate the signals, while non-moving logic ~~ate~~ uses miniature devices based on the dynamics of small steam or air. The logic gates discussed here are based on MPL devices.

## OR Gate

In an OR logic circuit, if any one of the several signals is present at the input, it produces an output signals. Hence, all the input signals should be absent for the output signal to be absent. A typical OR gate with the use of DCVs in parallel is shown in fig.

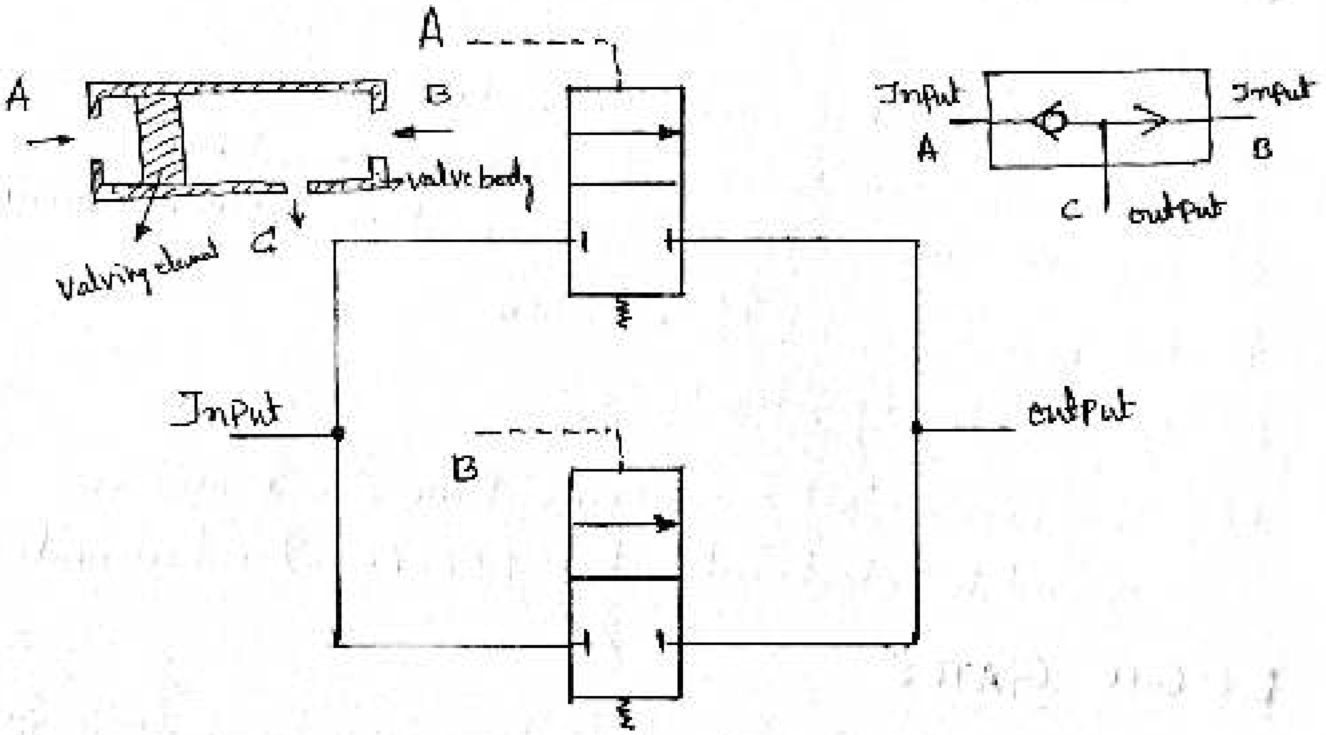
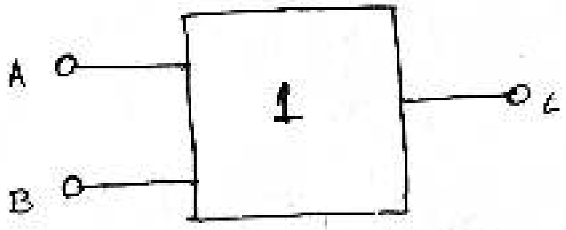



Fig OR logic gate.

In this logic circuit the DCVs are stacked in parallel. The 2 DCVs are connected in parallel in this example. If the input signal is provided to any one of these DCVs, it produces an output signals.

In another design, OR logic can be generated using a shuttle valve. For example, in the OR logic shown in fig the input from any one of the pilot valves to shuttle valve produces an output, which in turn actuates the main DCV.

The symbolic representation of OR logic and the truth table for two inputs A and B, and the output C is as shown in fig.




(a) OR logic symbol

| Input | | output |
|---|---|---|
| A | B | C |
| 0 | 0 | 0 |
| 1 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 1 | 1 |

(b) Truth table.

The truth table clearly indicates that when all the inputs are absent. there is no output signal: while any one or both the input signals are present, it gives an output signals.

## Practical examples involving the use of OR logic

(Or)

## Actuation of double acting cylinder using OR logic.

A typical pneumatic circuit with OR logic using a shuttle valve is as shown in fig.

This circuit is designed to actuate a double acting cylinder using a 5/2 DCV. The actuation of DCV takes place by the signal received from any one of the two pilot valves. A shuttle valve is placed at the junction between the two 3/2 push button pilot valves.

In operation, when one of the pilot valves is actuated by the push button, a signal is input at the X or Y side of the shuttle valve. Input

P – Pressure Port
A – Signal output
S & R – Exhaust port
B – signal output.
Z = Pilot line opens 1 to 2

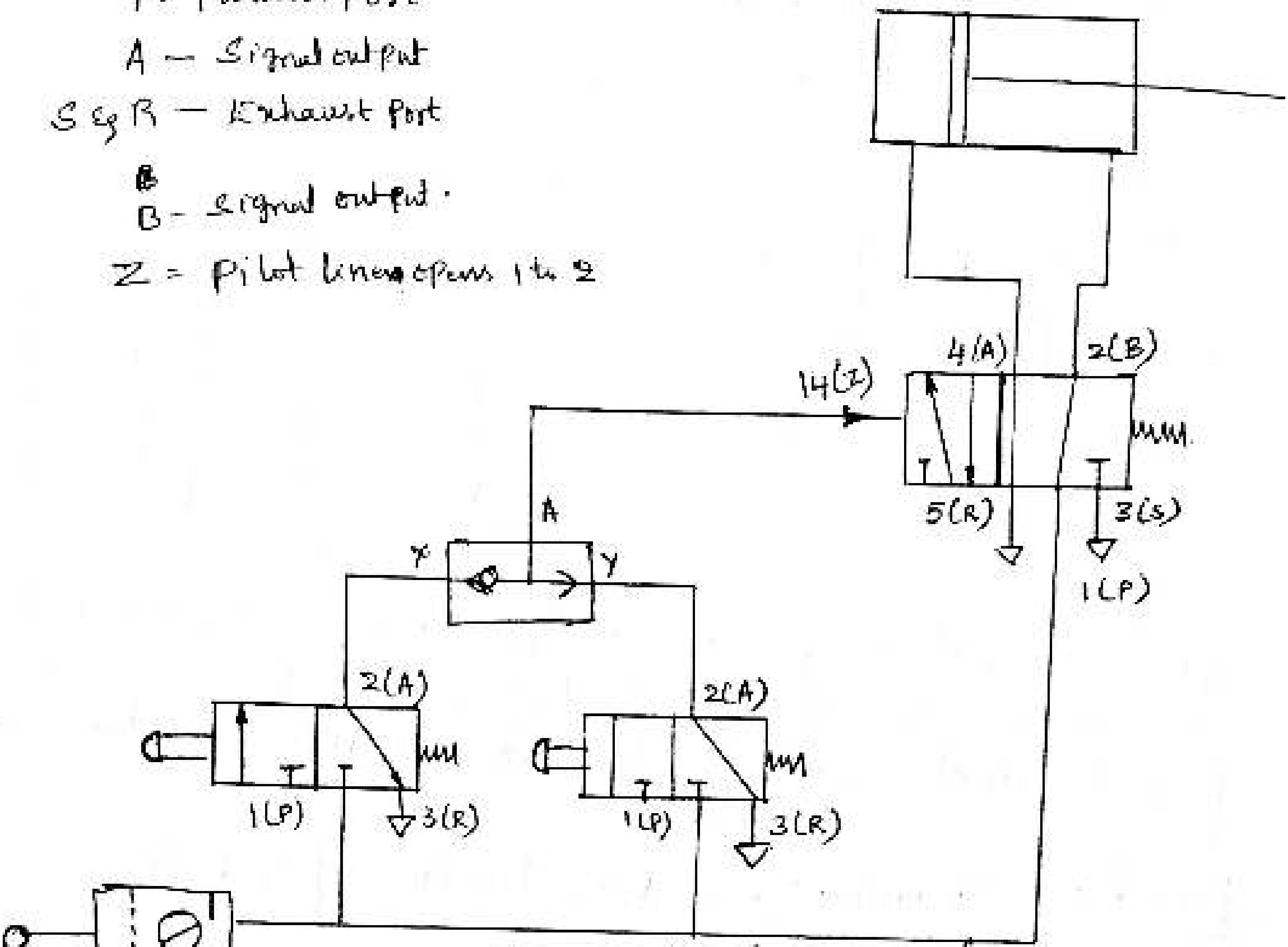



Fig Circuit with OR logic

from any one signal generates an output signal A at the shuttle valve and this Pilot signal actuates the main DCV, Causing the Cylinder extension. Upon release of this pilot signal (by the release of Push button), the 5/2 DCV returns to its normal Position under spring Pressure, which causes the Cylinder retraction.

## AND Logic :-

In an and logic function, two or more input signals must be Present to obtain an output signal. If one of the input signals is absent, the output signal is also absent. A typical AND logic function using two DCVs is shown in fig below.

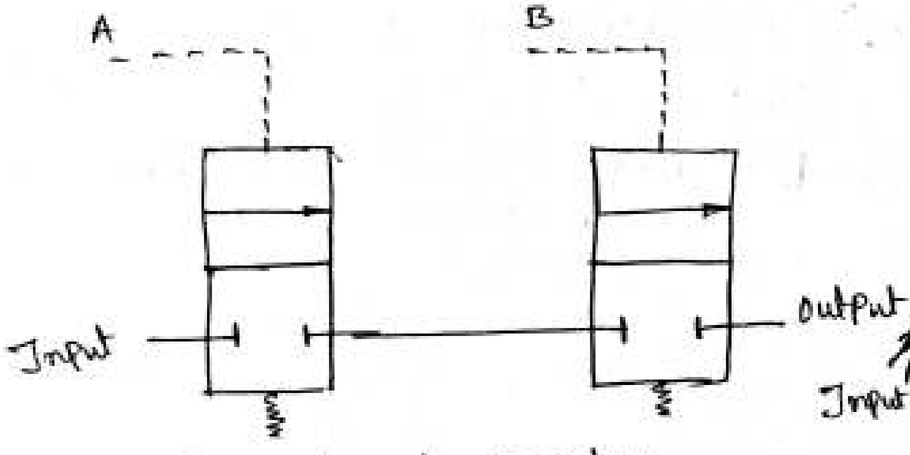
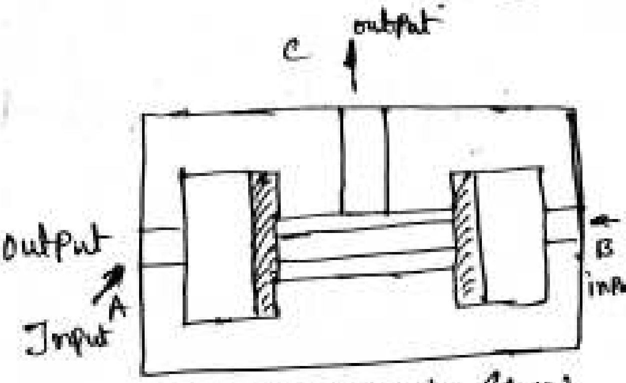


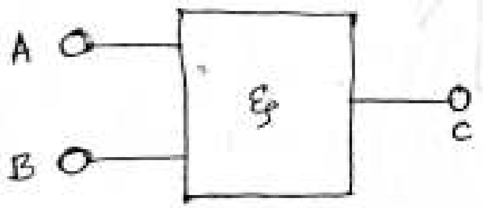

Fig AND logic gate.




Twin Pressure Valve (AND)

In this, two DCVs are Connected in Series, and the Supply Pressure in input at the first DCV. Now for the output signal to be Present, both the input signals at the DCV must be Present. That means unless both the DCVs are actuated, there is no output from the System.

The Symbolic representation of AND logic with the truth table for two input signals A and B, to Produce output C in as shown below.




(a) AND logic Symbol.

| Input | | output |
|---|---|---|
| A | B | C |
| 0 | 0 | 0 |
| 1 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 1 | 1 |

(b) Truth table.

Fig AND logic Symbol and truth table.

The truth table clearly shows that the output is Zero when one of the input signals A or B is absent. The output signal is generated at C only when both the input signals A and B are Present.

## Practical example involving the use of AND logic

(Or)

## Actuation of double acting Cylinder using AND logic

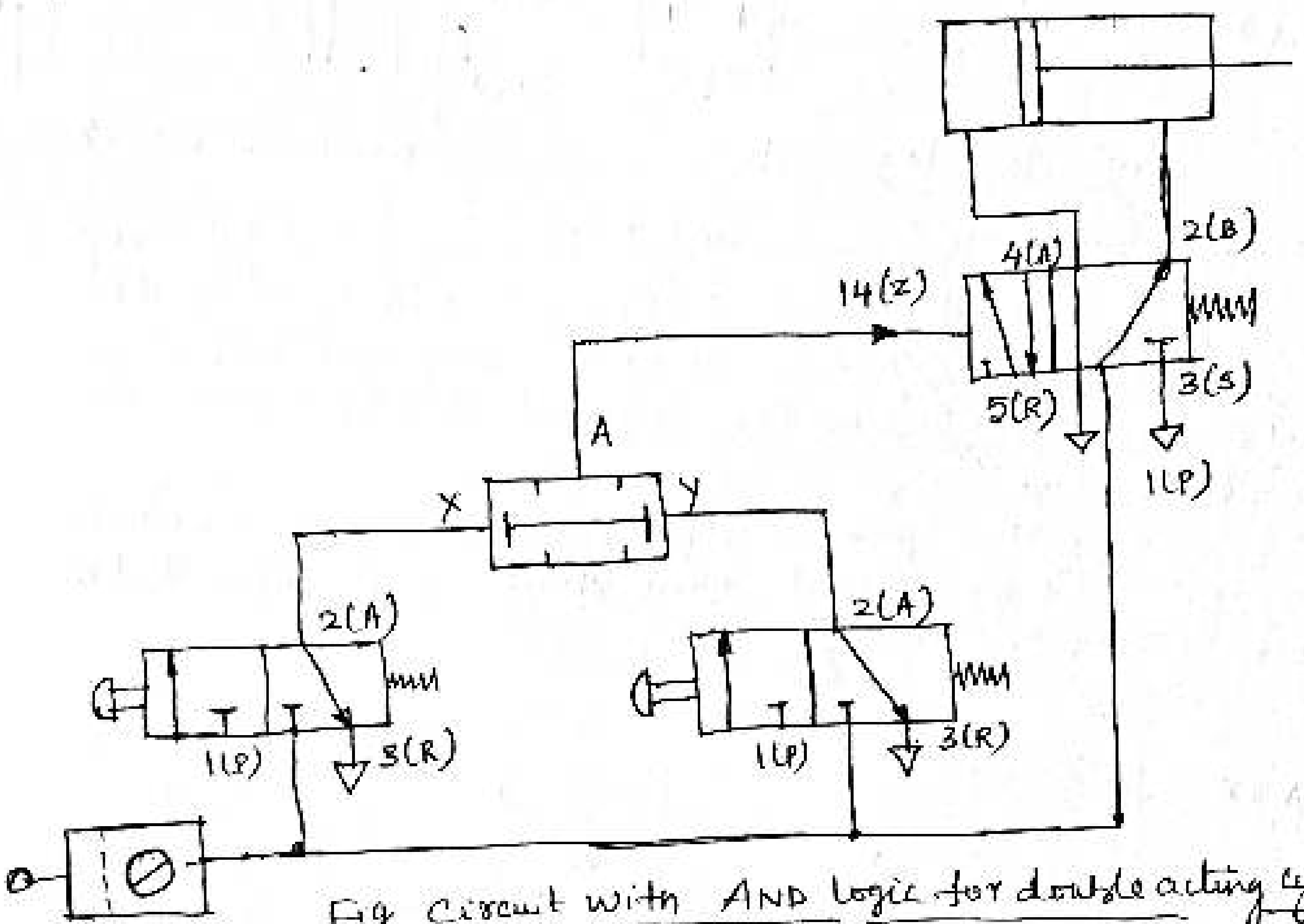



Fig Circuit with AND logic for double acting cylinder

A typical Pneumatic circuit based on AND logic function using a two-pressure valve as shown in fig above.

A two pressure valve requires input force on both sides of the spool so that it remains open. If the pressure is absent on any of the sides, the valve remains closed.

In this circuit, the two-pressure valve is connected to the junction between the two 3/2 push-button pilot valves. The output from the two-pressure valve (which acts as the AND logic) actuates the 5/3 DCV and supplies pressure for cylinder operation.

In operation, when one of the pilot valve gives a signal to the two-pressure valve, it generates signal at the X or Y sides. This signal is blocked by the two pressure valve. as it is unbalanced. If the second signal from the other 3/2 pilot valve in given to the two-pressure valve, the valve comes to a neutral position and produces a signal output A. This pilot signal actuates the 5/3 DCV and in-turn operates the cylinder.

A typical example of AND logic function is the control of a hydraulic press. In this, one pilot signal is from the manual operation button. while the second pilot signal is from the press guard. unless both the signals are present there is no output signal, hence DCV is actuated; unless the safety gaurd in closed the second signal is not produced and the DCV remains closed, hence the press does not operate.

## Multi-cylinder applications

Many industrial applications make use of multiple air cylinders to perform a single job. The main purpose of using multi-cylinders in to increase the load operating capacity, perform clamping operation, carry-out sequential operations, and so on. Multicylinders are also used when the use of a single cylinder cannot meet the requirements applications, special pneumatic circuits are designed using various DCVs and pneumatic logic functions to perform the required operation: such as coordinated motion, sequential operation, cascading and so on. Some of the basic multi-cylinder pneumatic circuits and their applications are briefly discussed below.

In any fluid application, Circuit diagram are drawn using different hydraulic or Pneumatic elements. They are then tested with simulation tool to check whether each element in general and the system as a whole is functioning satisfactorily as per the design of the system.

But in multicylinder application, the Circuit alone may not be sufficient to adequately represent the functional sequence of each of the cylinder or the inter-relation between the cylinders. The functional sequence and inter-relation between Cylinders can be best represented and understood with the help of a functional diagram.

Functional diagrams are means of representing the functional sequences of different Controls such as mechanical, electrical, electronics, Pneumatic and hydraulic, as well as Combinations of these control such as electropneumatic, electro-mechanical, electro-hydraulic etc.

The main objective of a functional diagram is to project a clear and distinct sequence of operations of all pneumatic elements used in the Pneumatic circuit.

Functional diagrams are of two types. They are

a. Motion or Movement diagram
b. Control diagram.

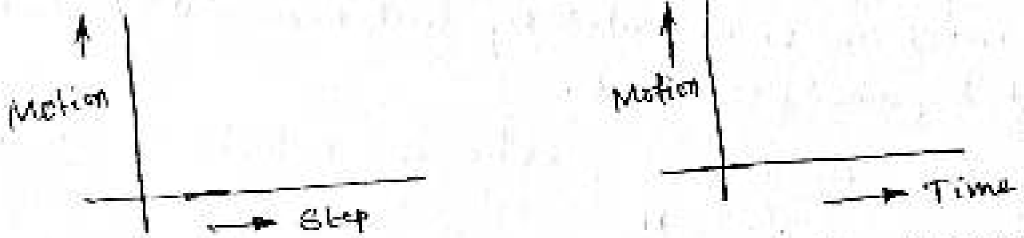
## Motion Diagram

Motion diagram is a graphical representation of Conditions relating to working elements or Components. Varieties of motion diagrams are used in engineering Control system. Motion diagram can be drawn in a single co-ordinate system or in two co-ordinate system. However two co-ordinate system gives a better understanding and clarity, and hence Commonly adopted.

Motion diagrams are drawn for two variables of the working element such as step and time. Correspondingly the diagrams are called

a. Motion - Step or Displacement - step diagram

b. Motion or displacement - time diagram.




(a) Motion - step diagram (b) Motion - time diagram.

Fig Concept of motion diagram

Illustrate motion control diagram for a 2-cylinder circuit. (07)

Illustrate function-diagram for doubleacting, two cylinders for a sheet metal bending applications

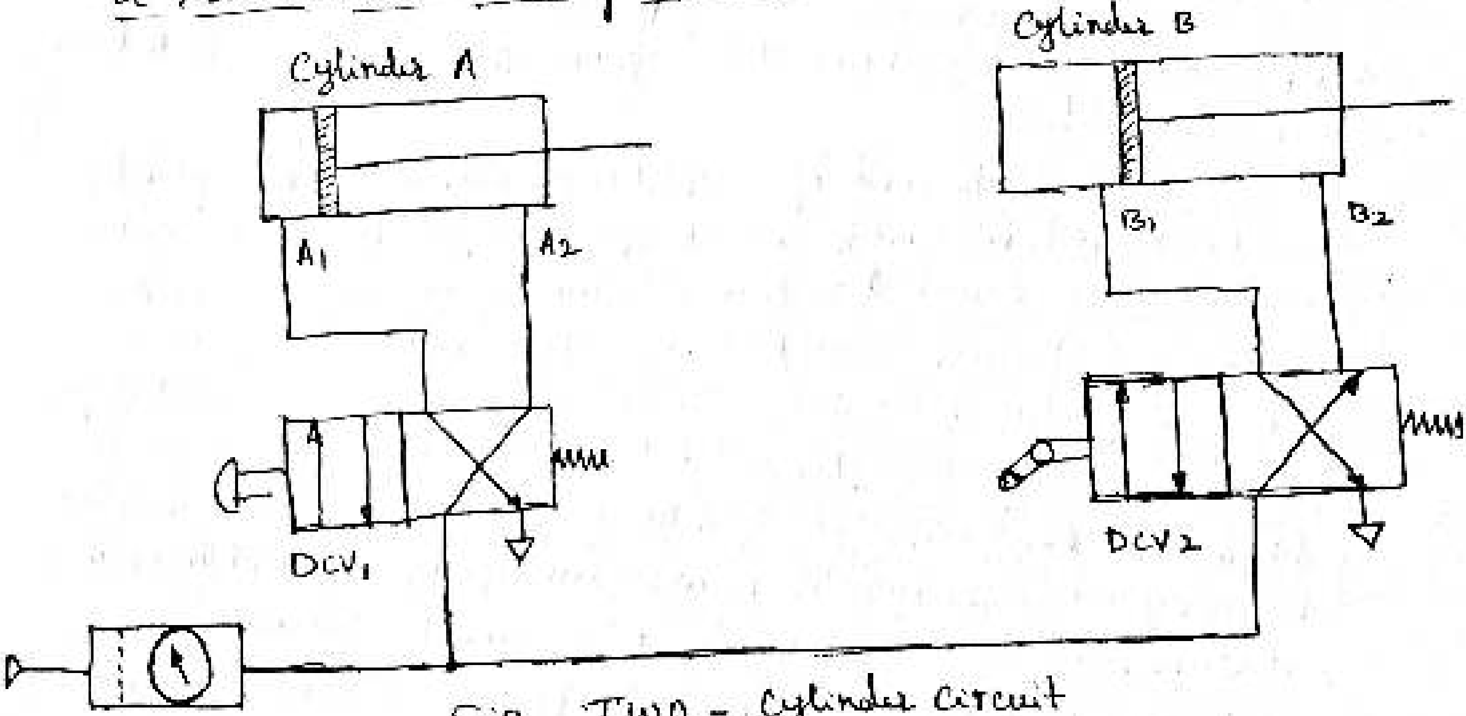



Fig TWO - Cylinder circuit

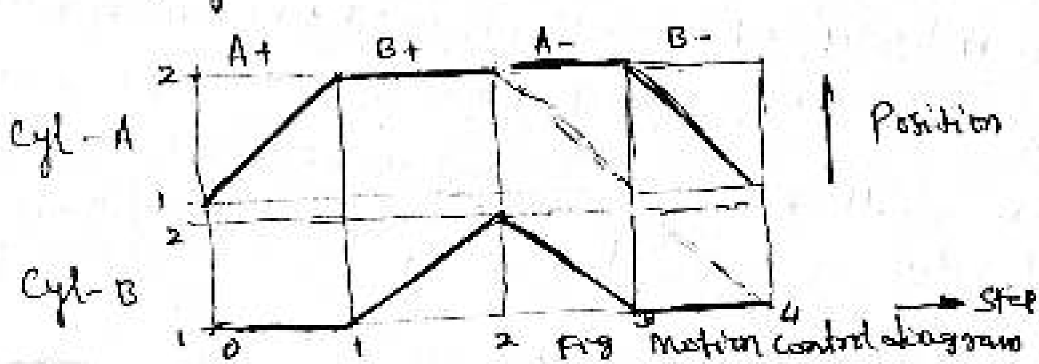



Fig Motion control diagram

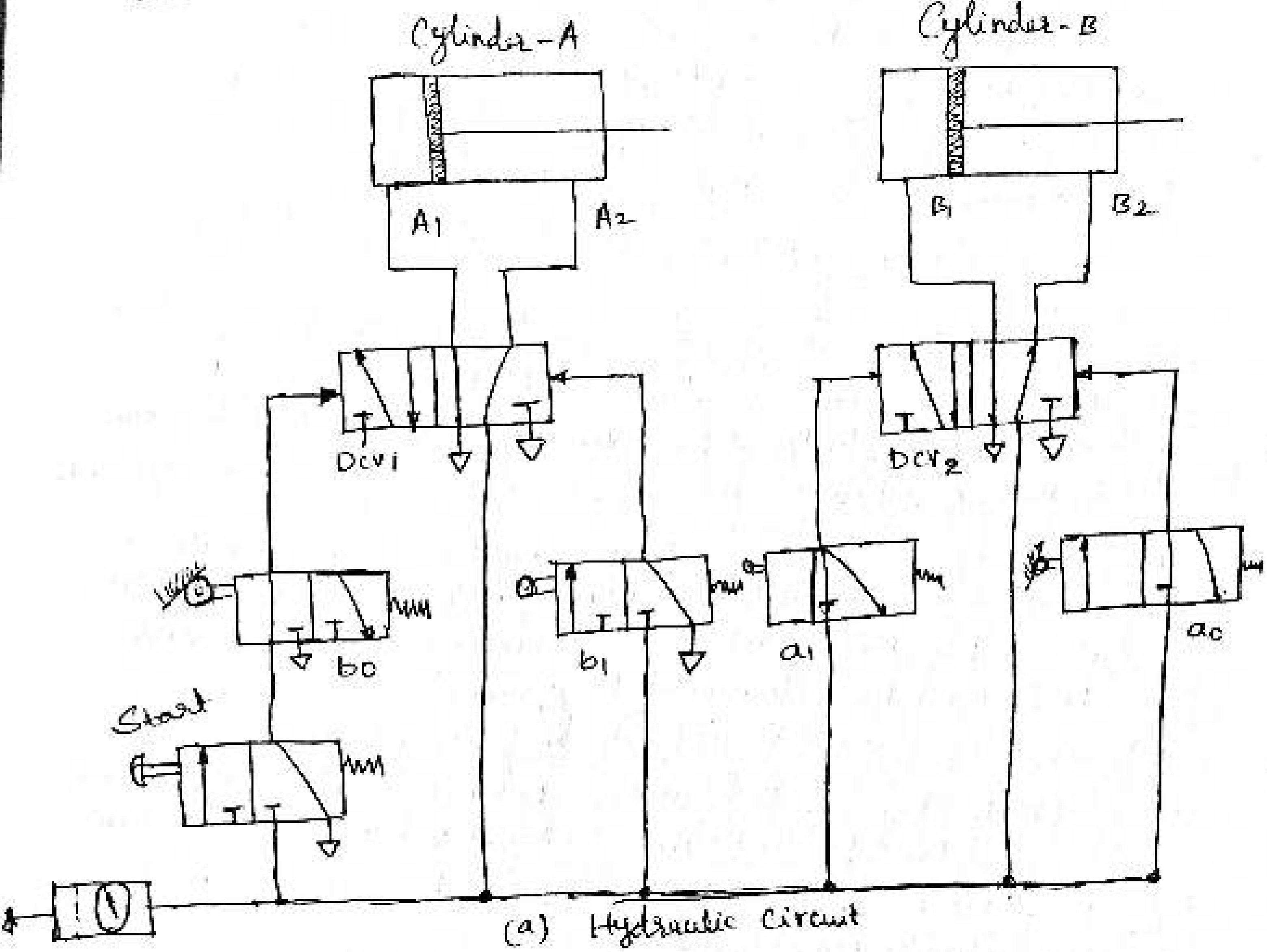
In this circuit, the cylinder A activates ~~a limit switch~~, ~~which~~ at its initial position to by the operation of push-button of $DCV_1$ supplying air pressure to port $A_1$. This causes the cylinder A to under go extension (A+). This extension will be used to clamp the work piece. this is indicated by the thick diagonals line on the motion control diagram of cylinder A. During this the cylinder B remains stationary and is indicated by thick horizontal line on the motion control diagram of cylinder B.

At the end of extension, cylinder A activates a limit switch, which in turn activates the $DCV_2$, supplying air pressure to port $B_1$ of cylinder B causing its extension (B+). This extension is used for to bend the work piece. This is indicated by the thick diagonal line between steps 1 and 2 on the motion-control diagram of cylinder B. Immediately after its (cylinder B) complete extension, another limit switch is operated that releases the $DCV_2$ to its normal position under spring pressure, there by supplying air pressure to port $B_2$. This causes the cylinder B to retract (B-). This is indicated by the thick diagonal line between step 2 and on 3 the motion control diagram. This is used for withdrawing of bending tool.

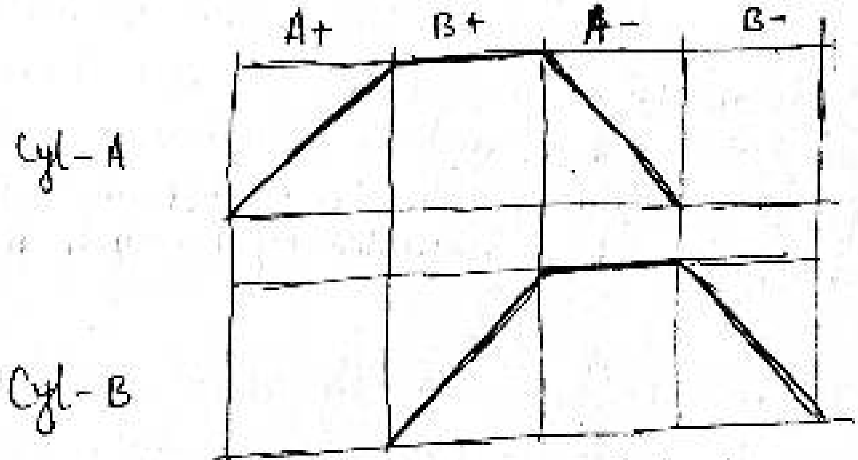
At the end of completion of retraction, the cylinder B operates a limit switch, which de-energies the $DCV_1$ so that air pressure is supplied to port $A_2$ causing its retraction (A-). This causes release of work piece. ~~by~~ This is indicated by a thick diagonal line between step 3 and 4 on the motion control diagram of cylinder A. The thick horizontal line between step 1 & 3 on the motion-control diagram of the cylinder A, indicates that it remained stationary when the cylinder B was undergoing both extension and retraction. Similarly, the cylinder B remained stationary, when the cylinder A was undergoing extension and retraction. which is indicated by the thick horizontal lines on the motion control diagram between steps 0 and 1, and steps 3 and 4, respectively.

Thus, motion control diagrams are useful in multi-cylinder circuits to understand the sequence of operation of different cylinders.

## Coordinated motion Control




(a) Hydraulic circuit




(b) Motion Control diagram

Fig Simple two-cylinder Circuit.

In a Coordinated motion Control, the multi-cylinders operate in such way that there is no conflict between the opposing pilot signals across the DCVs. For example, in a simple two cylinder circuit, where the first cylinder (A) Completes its cycle before the second cylinder (B) Complete its cycle. A typical two-cylinder circuit of this example is as shown in fig above.

The functioning of this Coordinated motion Control circuit is as follows.

(a) The valve bo gets the start signal, actuated by cylinder B at rest, and sends a pilot signal to DCV1. This causes extension of cylinder A (A+ on the motion-Control diagram) cylinder A actuates, as there is no opposing signal from valve b1.

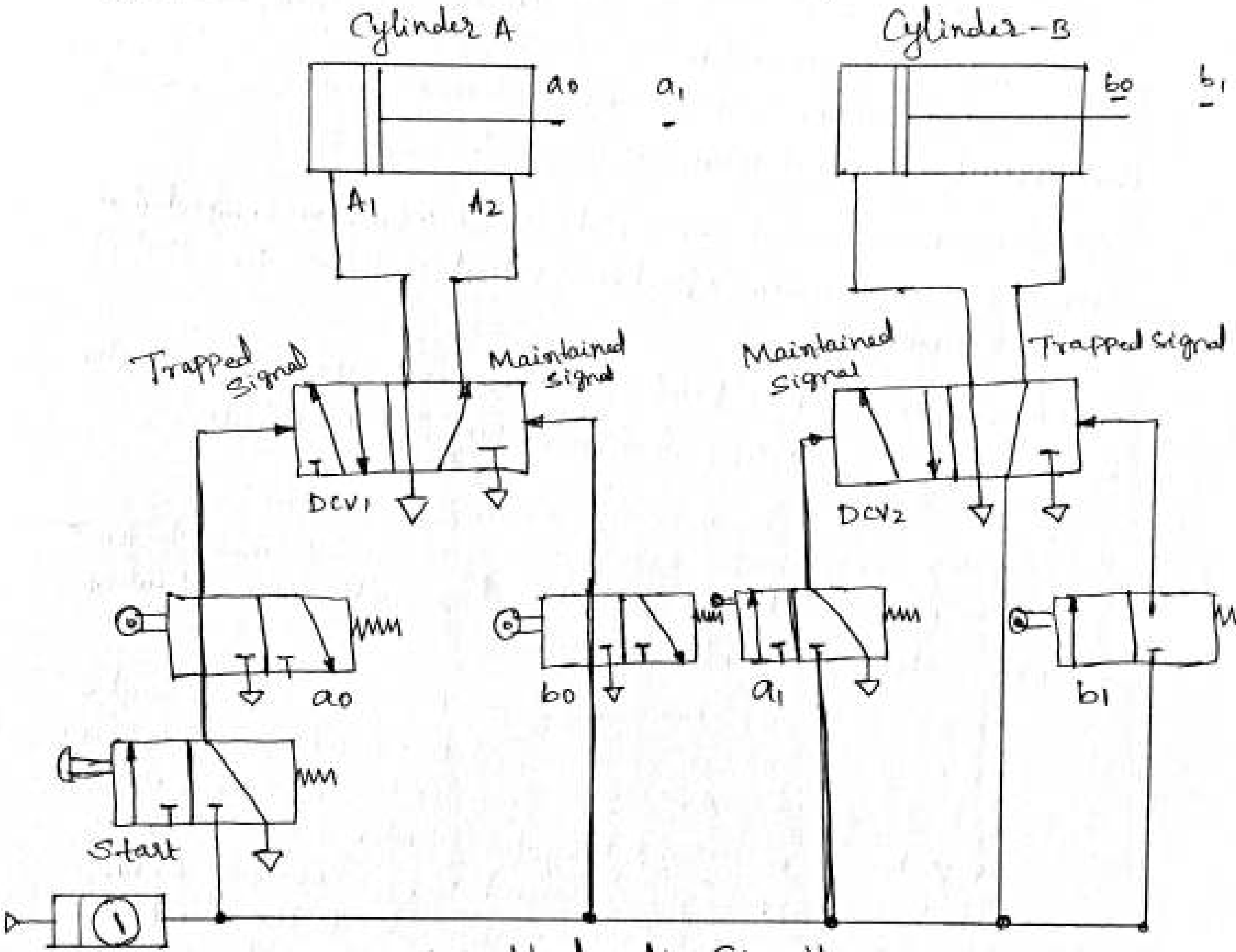
(b) when cylinder A hits the limit switch of a1, the valve a1 actuates DCV2 which supplies air pressure to cylinder B. is free to extend as it has no opposing signal from valve ao (B+ on the motion Control diagram)

(c) when cylinder B hits the limit switch of b1, the valve b1 actuates DCV1 to its right position envelop, which supplies air pressure to retraction of cylinder A. Cylinder A retracts freely because valve bo is not actuated. This movement is indicated by A- on the motion Control diagram.

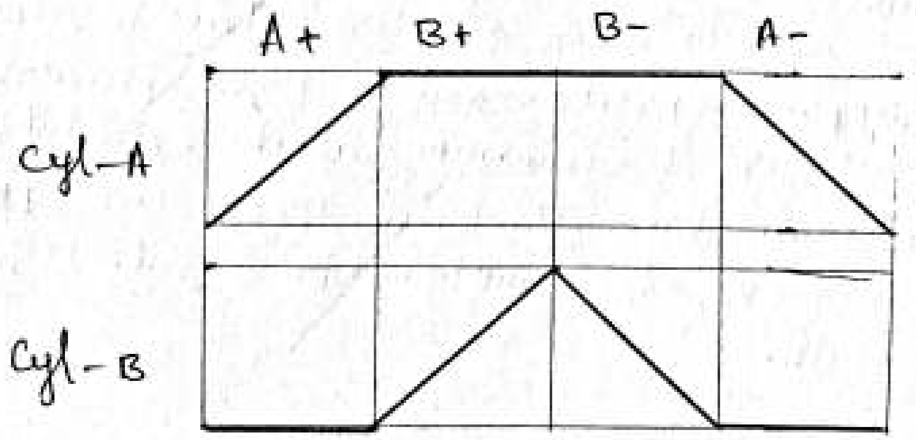
(d) when cylinder A retracts Completely, it hits the limit switch ao, and in turn ao sends a pilot signal to DCV2 to allow air pressure to cylinder B to undergo retraction. Again, cylinder B undergoes free retraction as there is no opposing signal from valve a1. This movement is indicated by B- on the motion-Control diagram.

(e) when cylinder B retracts Completely, it hits the limit switch bo, which actuates valve bo. This, in turn, sends a pilot signal to DCV1 to send air pressure to cylinder A. Then, it becomes a start signal to start the new cycle for the cylinder operation as explained in the above steps.

# Sequential Motion Control - Signal elimination




(a) Hydraulic Circuit.




(b) Motion Control diagram

Fig Ineffective Circuit in Sequencing.

In some sequential operations where the function of one cylinder is enclosed within the function of another cylinder, the signals remain active and lead to conflicting signals. These are termed trapped signals and maintained signals due to which the circuit does not work as desired.

A maintained signal is a pilot signal which has completed its function and remains effective so that it blocks the effect of other signals.

A trapped signal is a pilot signal ~~[illegible]~~ applied to a valve with an opposing pilot signal remaining still effective.

As shown in fig an ineffective cylinder sequencing circuit. The circuit does not function due to the presence of trapped and maintained signals. Two situations can be notted from the circuit:

(a) When the start signal is passed to valve a0, actuated by the cylinder A at rest, it sends a pilot signal to DCV1 to extend cylinder A. However, cylinder A cannot extend since valve b0 is actuated by the cylinder B at rest. This results in an opposing pilot signal to be applied to DCV1. hence no actuation takes place. Thus, due to the maintained signal of b0, the a0 signal gets trapped resulting in nil action.

(b) Similarly, when cylinder B tries to retract b1, it applies a pilot signal to DCV2. However, since the cylinder A remaining at its extended position actuates valve a1, which applies an opposing signal to DCV2, thus nullfying the signal. Hence, no actuation results.

# Cascade Control action



**Principle of Cascade system:-** Cascade is simple and most effective method to eliminate the maintained and trapped signals is the use of cascade control action. In a cascade system, the circuit is divided in to different zones in which the air supply is latched by additional DCV. The principle of a cascade system is as follows.

1. Follow a simple design procedure to determine the minimum number of groups in the circuit. To eliminate the trapped signals, allocate the signal valve (limit switches) between these groups.
2. Unlike the previous circuits where a single supply bus bar was used to carry the main supply pressure to all components, in a cascade system a separate supply bus bar is provided to each group.
3. Provide a conventional arrangement of selector valves to direct the supply only to the active group.

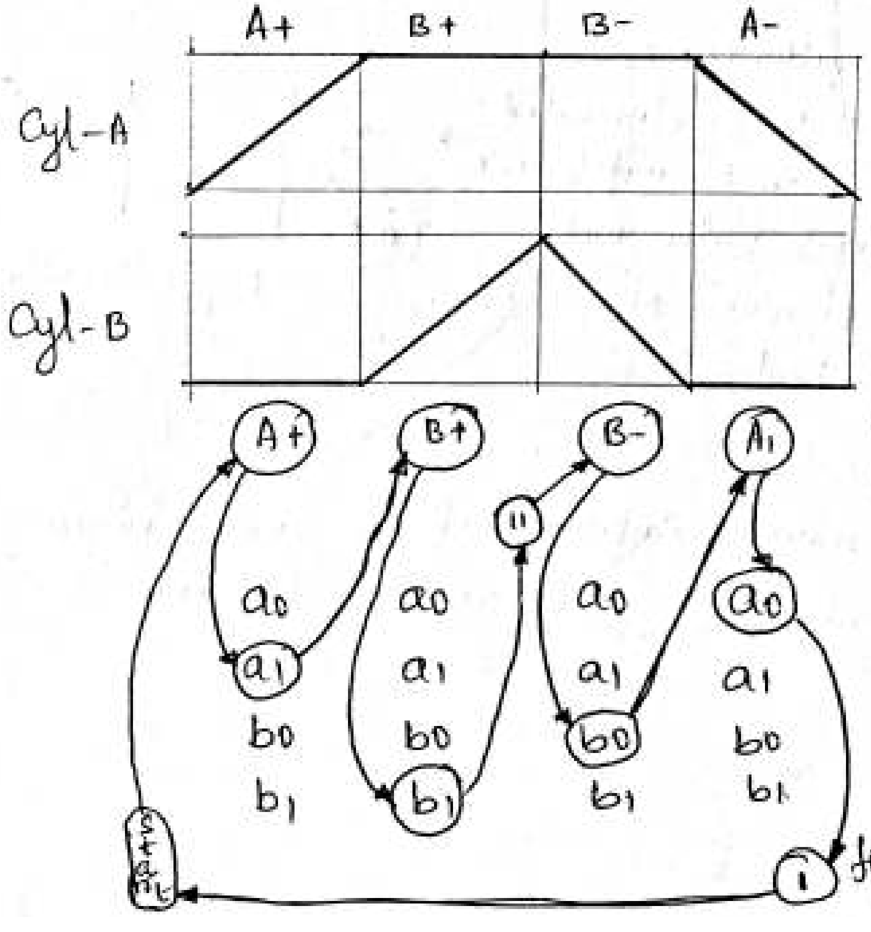



fig Cascade Circuit design.

Cascade circuit design

## Signal elimination Technique.

In this technique it is Possible to eliminate signals either mechanically or by means of suitable Circuitry.

### Mechanical Methods

In this method the signal elimination is by means of (a) Short impulse transmitter or (b) Idle return roller.

Short impulse transmitter method is composed of DCV with Overcentre function and the respective type of Control. when using such a type of valve one should have the following Points

(a) The operating reliability depends to a great extent on the speed of actuation (max 0.1 to 0.15 m/sec)

(b) The valve is actuated in the middle part of the stroke and not at the ends of the stroke. That is the actuator must be operated as far from the stop, otherwise a Continuous signal will exist.

Idle return roller can be used if the signal to be eliminated is provided by a limit switch. The use of roller lever valves with idle return to eliminate signal overlapping has the following disadvantages

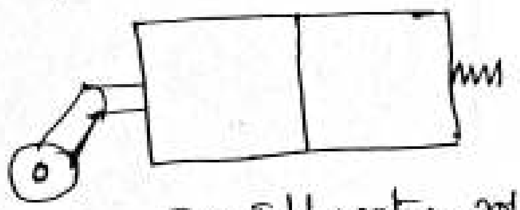


Fig Idler return roller

(a) The end Position cannot be sensed accurately
(b) Function may be impaired due to Contamination
(c) Fast Control of systems are not Possible..

# Electro-Pneumatic Control

The valves used as intermediate devices between the Pneumatic Power source and actuators are the control elements. Infact, these valves can be operated by various means such as manual, electrical and mechanical methods. Certain actuators (such as Pneumatic cylinders) may also use some electrical means to limit / Control their movement. when an electrical means used as a mode of actuating the Pneumatic valves (to Control the actuators) such systems are termed electro-Pneumatics system.

Two Popular equipments that are widely used in electro-Pneumatic systems are electro-Pneumatic valves and Pressure switches.

The main advantage of electro-Pneumatic system is the Case of Control / actuation even at remote locations in Plants and machineries. The switch to supply the electric-current for actuation of the system is kept at an accessible point.

**Solenoid** is the most common element used in electro-Pneumatics for actuation. Solenoid is a electromechanical system, which uses Push button switches, relays, Contactors and limit switches for its operation.

Direction Control valves used in Pneumatic Power systems are Solenoid Controlled, and are the most Common electro-Pneumatic devices used in industries and machine tools.

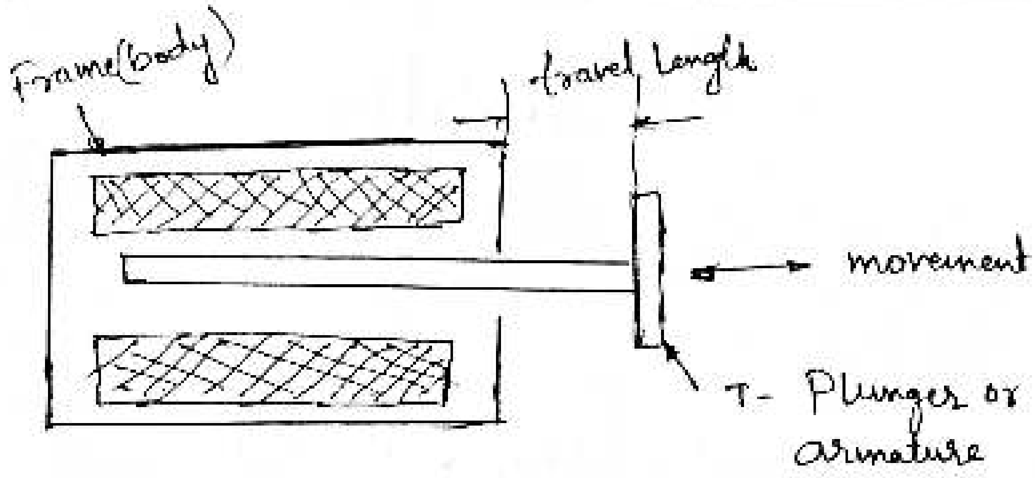



Fig 13-1 Solenoid

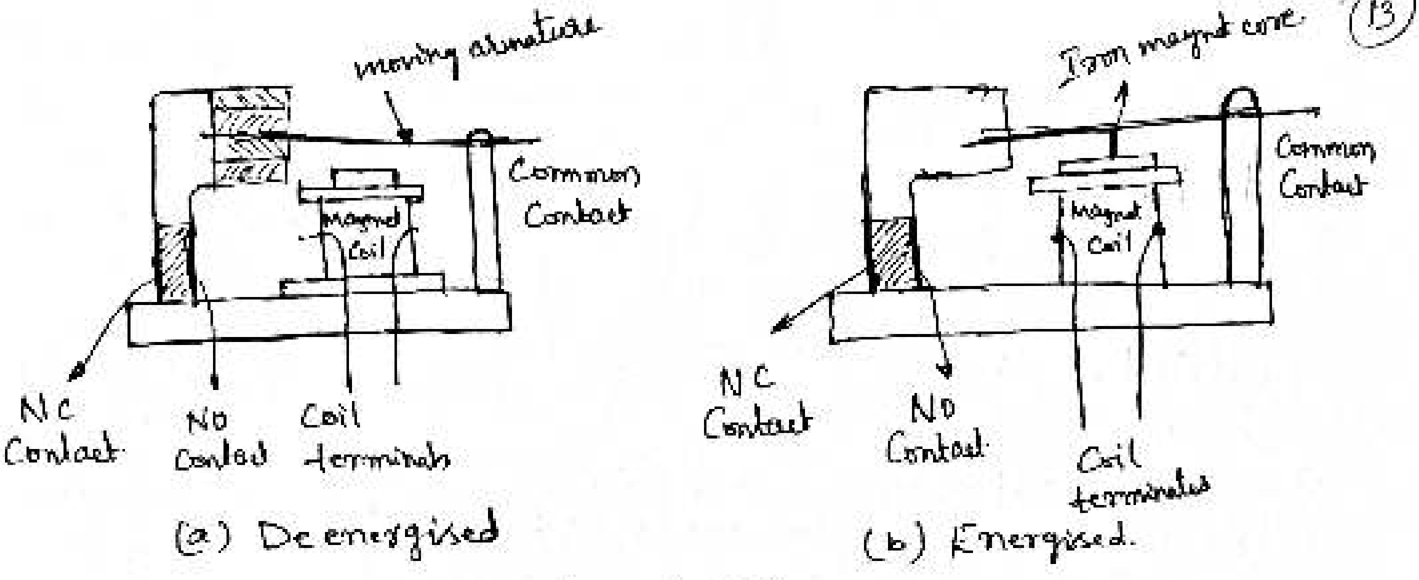
Basically a Solenoid is nothing but an electromagnet, which is electromechanical device. An electromagnet is a temporary magnet that gets energised when an electric Current is Passed, and de-energised when the Current flow is stopped. thus, it Converts electrical Power to mechanical force and motion through an armature. The Construction of a typical Solenoid is schematically illustrated in fig

It Consists of an electrical coil, an armature (usually a T-Plunger) and a cylinder in which the Coil is wound on a bobbin and located in the Cylindrical frame.

In Operation, when an electric Current is Passed through the Coil, a magnetic field is set up. Normally the armature is kept in extended mode under spring Pressure. Due to the magnetic field the plunger is Pulled inside the Coil. The plunger, which is Connected to a directional Control valve in turn operates the valve, thus Controlling the flow Path of the air.

## Relay

Electrical relay is another electromagnetic device. It is basically actuated switch. The relay uses a small Current magnet to operate the Contacts to Control a large Current in the Circuit. The Construction and operation of an electric relay is illustrated in fig below.




(a) De energised (b) Energised.

Fig Electrical Relay.

It Consists of a magnetic Coil, a moving armature and a set of electrical Contacts. when a Current flows through the Coil a magnetic field is generated, which in turn attracts the armature. This Causes the internal Contacts to change Position (open to closed, or closed to open). For the relay shown in fig. there is one normally open (NO) and one normally Closed (NC) set of Contacts. when the Coil is de-energised, the Contacts are are in closed Position fig(a). That means, there will be a Condinious flow of current through the switch and the device is activated. when the coil is magnetised (energised), the armature under attraction breaks Contact with the NO Contact. thereby cutting the supply to the System Fig(b). please note, that a small electrical signal to the magnetic Coil actuates the switch, which in turn Controls the supply to another actuating device like a valve or drive motor.

## Applications of Relays

1) Beaking of the Control Circuit from the main Circuit
2) Delaying and Conversion of signals and multiplication of Signals

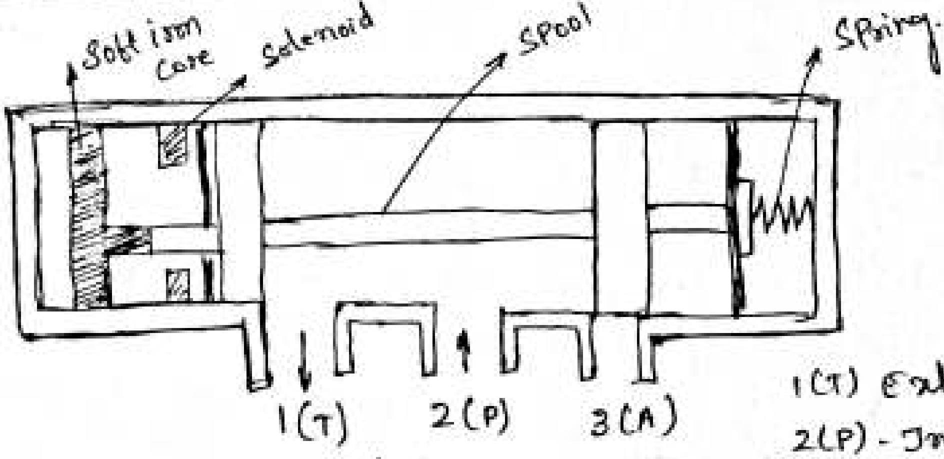
## Contactors :-

Electrical Contactors are Control elements that are used to make or break the Circuit in electro Pneumatic and other electrical systems. Basically these are made of highly Conducting materials like Copper or brass. The selection of suitable Contactor in electro Pneumatic system depends on the type of operation, reliability, location, Space availability, and so on. The Contactors form the Point of Contacts in switches (such as single Pole, and so on)

## Applications of Contactors

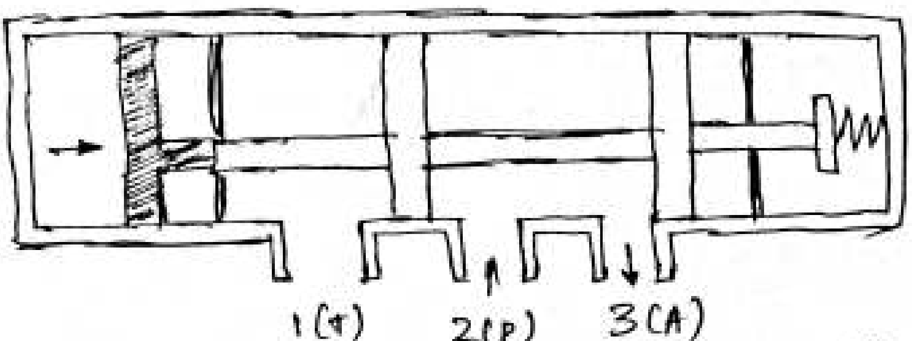
1) For Switching high Current Circuits (3 to 30 kW)
2) TU Switch Control and logical function Circuits.

## Solenoid Operated DC valve




(a) Unactuated Position

1(T) Exhaust Port
2(P) - Inlet Port from Pump
3(A) - Supply Port to device.




(b) Actuated Position

Fig Solenoid Operated DCV.

In the normal Position fig (a), the Ports 1 and 2 are open ie the fluid from the Pressurised supply (compressed air) is simply returning through the exhaust port (to atmosphere). That means, there is no fluid supply to the device. When the Solenoid is operated, by passing a current through it, it magnetises and pulls the iron core towards it. This in turn moves the spool valve to right fig (b)

This movement now opens the Port 3 and cuts off the Port 1 from 2, causing the flow from port 2 to port 3 starts. That means the device is connected to Port 3 starts getting the required Pressurised fluid and gets activated. When the fluid supply to the device through Port 3 is to be stopped, the solenoid is deactivated by stopping the current supply to the solenoid which in turn gets demagnetised. Then the spool is pushed back to its original position by the spring pressure.

## Solenoid Controlled Pilot-Operated DCV

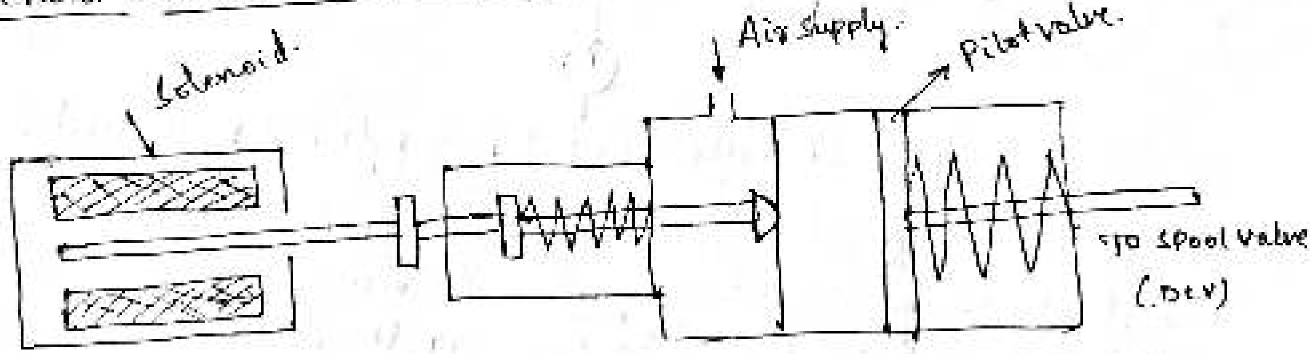



Fig Solenoid Controlled Pilot-operated DCV.

The use of solenoids to operate large DCVs is quite difficult. Since large valves require higher forces to operate, large size solenoids operating on high currents are required. To overcome this difficulty usually the valves are pilot-operated; while solenoids are used to control the pilot-operations. The construction of such a valve is shown in fig. above

In operation, a small capacity solenoid actuates the Pilot valve. The Pilot valve, in turn, controls the pneumatic supply to the DCV. Since the Pilot valve can control large supplies of air, the DC can be actuated easily.

Advantages :- (1) Small capacity solenoids can be used

(2) AC solenoids can be used at low current levels, which improves contact life of the relays

(3) Since low currents are used, the temperature rise is low and thus failure of solenoids (burn-out) is minimum.

## Control Circuit for Single acting Cylinder

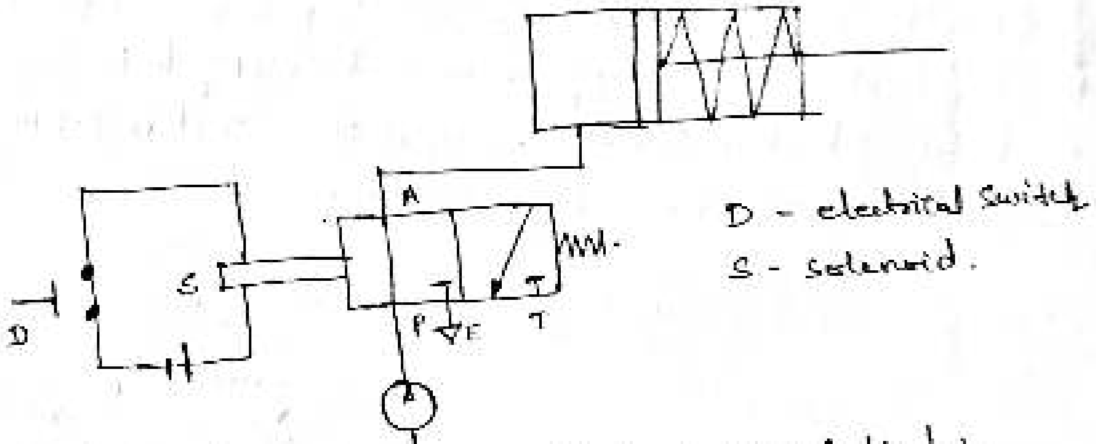



Fig Control circuit for single acting Cylinder

In this solenoid controlled 3/2 DCV (3 port, 2 Position) is used to actuate the single acting cylinder. It is a spring return cylinder, hence it is actuated by pneumatic power in the extension mode. The solenoid (S) is energised by a manual switch (D), which in turn operates the normally closed (NC) DCV. By this the pressure line is directed to the cylinder port to cause the cylinder actuation. When the switch is released, the valve returns to NC position, by which the cylinder port is directed to the exhaust line. The cylinder then returns back under the spring pressure.

## QUESTIONS FROM PREVIOUS YEAR QUESTION PAPERS:

### DEC 2015/JAN 2016

1) Explain a typical pneumatic circuit with OR logic using shuttle valve.
2) With a neat circuit diagram, explain Electro pneumatic control of a double acting cylinder using a 4/2 solenoid actuated spring return cylinder.
3) Explain the cylinder pneumatic circuit and its motion control diagram.

### JUNE/JULY 2016

1) Explain the principle of cascade control system.
2) List advantages of solenoid controlled pilot operated direction control valve.
3) What are flow control valves? Draw graphical symbols for FCV

### DEC 2016/JAN 2017

1) Briefly explain the following: i) OR gate ii) AND gate iii) Solenoids iv) Motion Diagrams

### JUNE/JULY 2017

1) With a neat sketch explain how OR functions are generated in pneumatic systems.
2) Explain control circuitry for single acting cylinders with circuit diagram.
3) Explain signal elimination using reversing valves.

### DEC 2017/JAN 2018

1) Explain with neat sketch of circuit of sequencing of two pneumatic cylinder that can be done by using solenoids, limit switches and valves.
2) Explain with a neat circuit diagram, the working of two step speed control system.

### JUNE/JULY 2018

1) Explain the different methods employed for controlling the speed of pneumatic cylinders with neat sketches.

## CRASH COURSE – MAY 2017

1) Explain with a neat pneumatic circuit for cylinder sequencing.
2) Explain with a neat sketch solenoid controlled pilot operated direction control valve.

## ONE TIME EXIT SCHEME – APRIL 2018

1) Explain OR and AND gates used in pneumatic system.
2) Write a short notes on cascading method.