ELECTRO PNEUMATIC TRAINER WITH PLC

INSTRUCTION MANUAL

NOTE :

1. THE EXPERIMENT MANUAL CONSISTTS OF EXPERIMENT WITH MANY DIFFERENT TYPES OF COMPONENTS

2. PERFORM EXPERIMENT ONLY FOR THOSE COMPONENTS AVAILABLE WITH YOU

ELECTRO PNEUMATIC TRAINER

Electro Pneumatic Trainer is a very versatile self - contained training package for the teachers & students in advanced pneumatics. It is designed for fail safe operation & ease of learning. **Electro Pneumatic Trainer** meets the requirements of providing practical "**HANDS ON**" training and can be used both as an experimental kit and as a demonstrator. Various basic / advanced pneumatic circuits can be built easily die to special design pf the trainer. The commonly used industrial pneumatic components & sine electro - pneumatic components are provided for preparing various pneumatics circuits. Many experiments can be performed. A detailed and comprehensive instruction manual is provided along with the trainer.

INTRODUCTION TO PNEUMATICS :

HISTORY OF PNEUMATICS :

The name pneumatics was originally coined to give a name to the science of motions and properties of air. Today the terms pneumatics refers to the entire sphere of activities that deal with use of compressed air for industrial purpose especially the driving and controlling the machinery and equipment.

The awareness of air is working medium dates back even prior to the Christian era. since then use of air is being made for verity of application such as.

1. Kidling of fires.
2. Driving sailing vessels and
3. Windmills.

Another universal use of air is for blowing away swarf and dust.

In the modern day application of Pneumatic equipment were introduced over a brief period of time about a century ago e.g. air brake, pneumatic riveter pneumatic rock drill and other many tools.

However, a much wider application of pneumatics in industry started with growth of automation after the second world war, when there was growing awareness for increasing productivity and for reduction in the unit cost of production to make industries more profitable.

Today pneumatic has into grown in to a mature and versatile branch of engineering. Large verities of pneumatic equipment are available in the market. Pneumatic applications are expected to grow further in their verity and efficiency in future. Repeated releases of new developments in equipments and announcements of ever newer fields of application demonstrate that pneumatics in a continuous process of growth.

One of the most important features of pneumatics is the flexibility in applications which extent in to almost every segment of industrial production.

Any automation application can be worked out in a number of ways. But wide spread application of pneumatics today in industry, is simplicity and economy.

ADVANTAGES OF PNEUMATICS IN AUTOMATION :

1. **AVAILABILITY :**

   Air is universally available. Most of the factories, industrial plant and may other commercial operation have compressed air lines in most working areas.

2. **DEPENDABILITY :**

   Pneumatic equipments is extremely reliable over long working life period and usually more rebuts than other types of equipments.

3. **FLEXIBILITY :**

   The equipment is easy to fit and is simple in design. pneumatic equipment can often with stand conditions were other power sources cannot used effectively and also pneumatic equipment are less vulnerable to conditions such as dust, corresive atmosphere, explosive atmosphere, paint spraying splishing etc.

4. **CLEANLINESS :**

In contrast to hydraulic fluids, air does not drip or create mess, if it escape from system.

5. **LINEAR MOTION :**

   Pneumatic equipment are eminently suitable for providing linear motion.

6. **VARIABLE SPEED :**

   Pneumatic equipment can readily deliver variable speeds of operation.

7. **SURGES OF POWER :**

It is possible with compressed air to provide momentary higher output of work. Compressed air is almost invariably delivered from an air receiver. Which is similar to a power reservoir.

8. **TOLERANCE IN OVERLOADING :**

The pneumatic cylinder provide thrust and movement and perform the actual work or function in automation application.

9. **SAFETY :**

There is relatively low risk while operating with compressed air. Because of lower pressure involved.

FUNDAMENTAL OF PENUMATICS :

PHYSICAL FUNDAMENTS :

Air is an abundant gas mixture with the following composition :

* Nitrogen Approx – 78 Vol %.
* Oxygen Approx – 21 Vol %.

It is also contain traces of carbon dioxide, organ, hydrogen, neon, helium, krypton, xenon.

To understanding of the natural laws as well as the behaviour of air the physical dimensions are employed.

BASIC UNITS :

QUANTITY	SYMBOL	UNITS
Length	L	Meter (m)
Mass	m	Kilogram (Kg)
Time	t	Second (S)
Temperature	T	Kelvin (K, $0^{o}C$ = 273.15K

DERIVED UNITS :

QUANTITY	SYMBOL	UNITS
Force	F	Newton (N) = 1 Kg /cm^2
Area	A	Square Meter (m^2)
Volume	V	Cubic Meter (m^3)
Flow Rate	qv	(m^3 / S)
Pressure	P	Pascal (Pa)

Newtons Law = Force = mass x acceleration.

F = m x a.

Where a is replaced by acceleration due to gravity

$g = 9.81\ m / s^2$

Pressure = 1 pascal is equal to the constant pressure on a surface area of $1m^2$ with the vertical force of 1N (Newton)

The pressure prevailing directly on the earth's surface is known as atmospheric pressure (P_{amb}). The range above this pressure is known as excess pressure range (Pe > 0) the range below is referred to as vacuum range (pe < 0) The atmospheric differential pressure be is calculated according to the formula :

pe = pabs – pamb

This is illustrated by the following diagram.

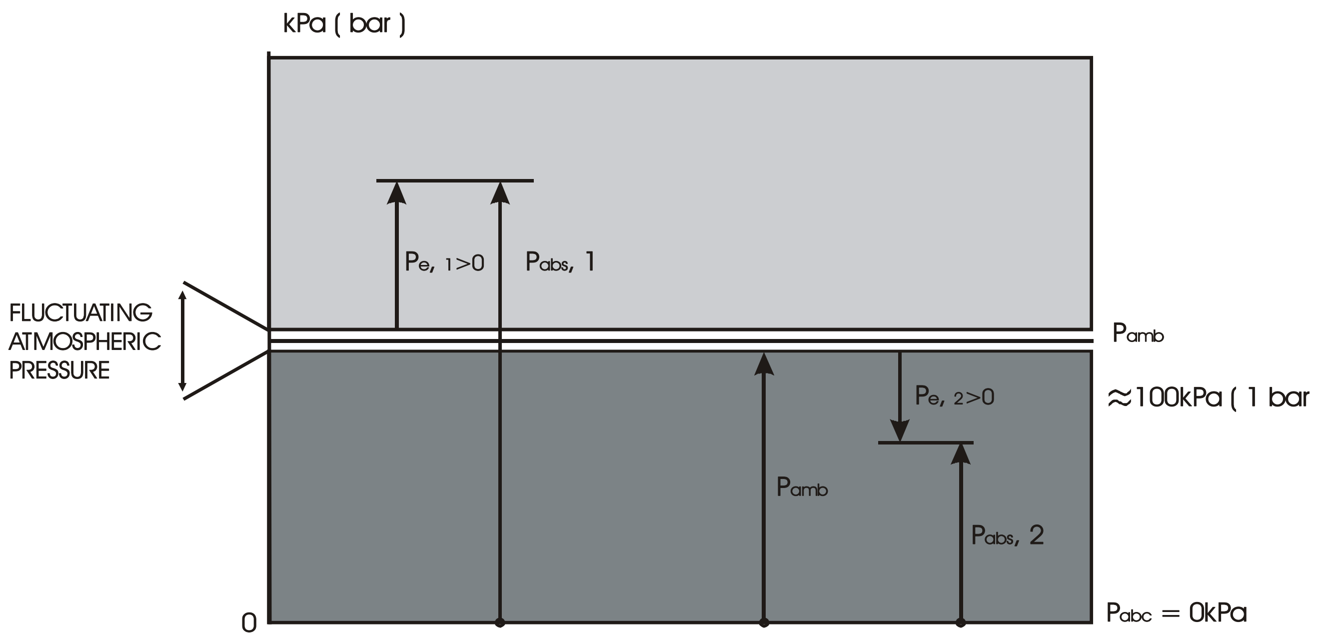


FIG.1

CHARACTERISTICS OF AIR :

A characteristics of air is it's minimal cohesion i.e. the forces between the air molecules are to be disregarded for operating conditions usual in pneumatics. In common with all gases, air has no particular shape. It's shape changes with the slightest resistance. i.e. it assume the shape of its surrounding.

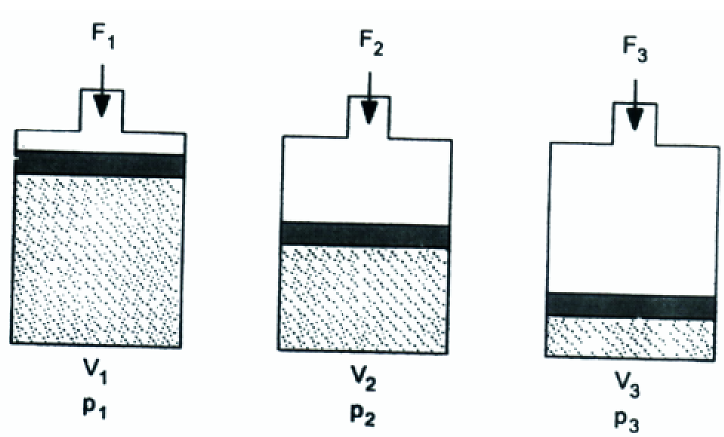


FIG.2 BOYLE – MARIOTTE'S LAW

BOYLE – MERIOTTE'S LAW :

Air can be compressed and it endeavours to expand. The applicable relationship is given in Boyle – Meriotte's law. It's constant temperature the volume of a given mass of gas is inversely proportional to the absolute pressure i.e. the product of absolute pressure and volume is constant for given mass of gas :

$$P_1 \times V_1 = P_2 \times V_2 = P_3 \times V_3 = \text{Constant}$$

AIR GENERATION AND DISTRIBUTION :

The air compressor plays a vital role in the overall pneumatic system performance. Various types of compressor are used in the industry. But positive displacement compressor is more popular. The equipment to be considered in the generation and preparation of air includes.

1. Air Compressor.
2. Air Reservoir.
3. Air Dryer.
4. Air filter with water separator.
5. Pressure Regulator.
6. Air Lubricator.

As rule pneumatic components are designed for maximum operating pressure of 800 to 1000kpa (8 to 10 bar).

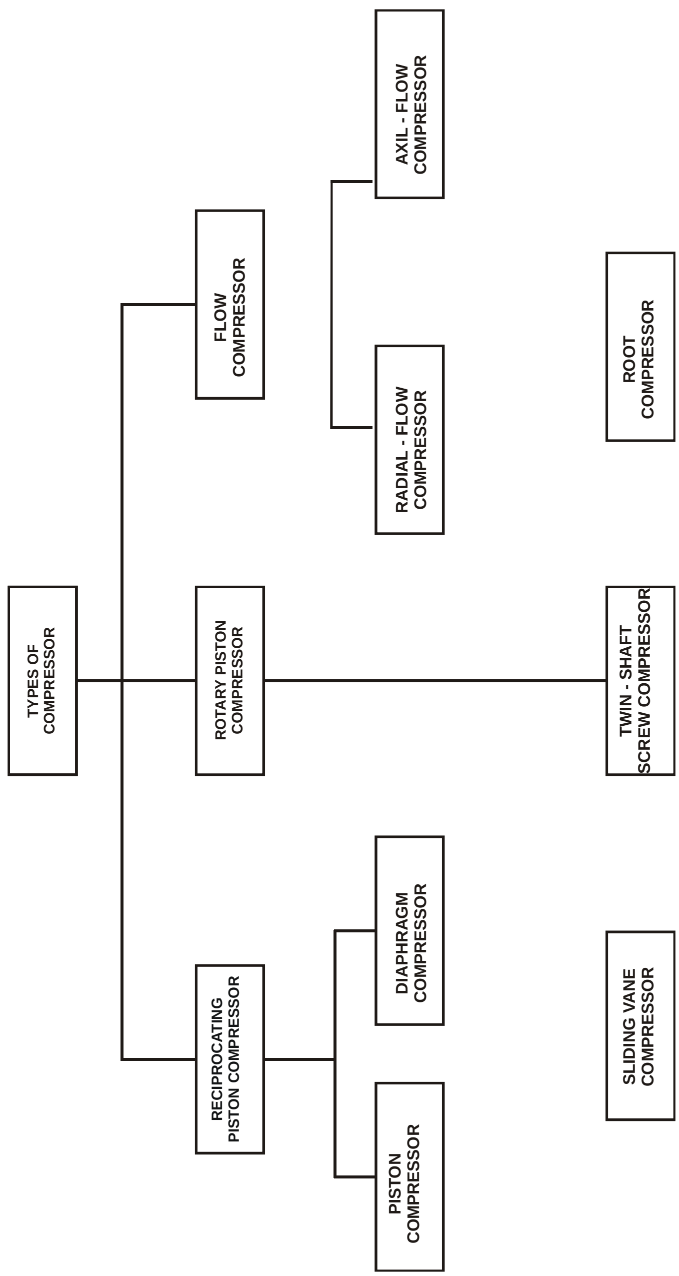
Practical experience has shown however, that approximately 600Kpa (6 bar) should be used for economic operation.

Pressure losses of between 10 and 50 Kpa (0.1 and 0.5 bar) must be expected due to the restrictions, bends leaks and pipe – runs, depending on the size of piping system and method of layout. The compressor system should provide at least 650 to 700Kpa (6.5 to 7 bar) for desired operating pressure level of 600Kpa (6 bar).

AIR COMPRESSOR :

The selection from the various types of compressors available is dependent upon quality of air pressure, quality and cleanliness and now dry the air should be there are varying levels of these criteria depending upon the type of compressor.

COMPRESSOR TYPE :



The unit provided by us uses the piston compressor.

AIR COMPRESSORS

Air can be compressed by using various type of compressors, some of which are listed below :

1. Piston compressor.
2. Two stage piston compressor v - type.
3. Piston - diaphragm.
4. Rotation compressor.
5. Screw compressor.
6. Roots compressor.
7. Axial turbine compressor.
8. Turbine compressor.

The kit provided by us uses the piston compressor.

1. Piston Compressor :

Piston compressors compress atmospheric air against an existing higher pressure at the exit port. The piston compressor consists of crank shaft piston rod piston cylinder inlet valve exhaust valve.

Piston compressor compress atmosphere air against an exiting higher pressure at the exit port. The piston compressor consist of crank shaft and piston rod. Piston moves down words and suck air from atmosphere valves open due to the differential pressure.

After passing through lower dead point inlet port closes and exist port opens. The air is being pushed against the prevailing pressure point of valve opening depending on valve designed.

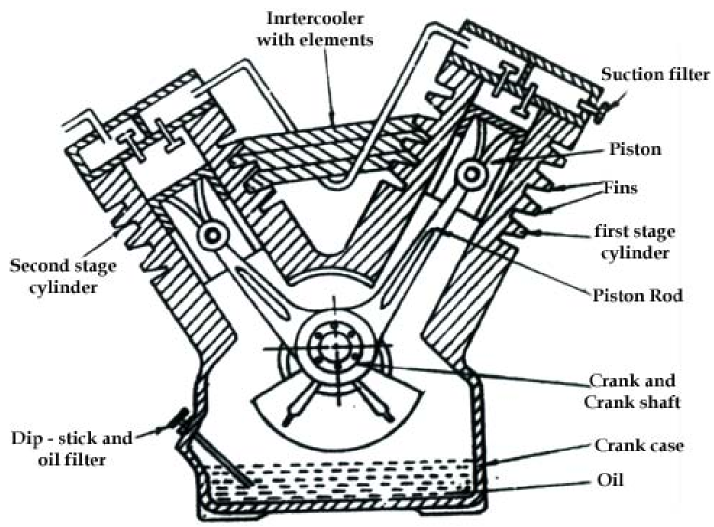


FIG.3

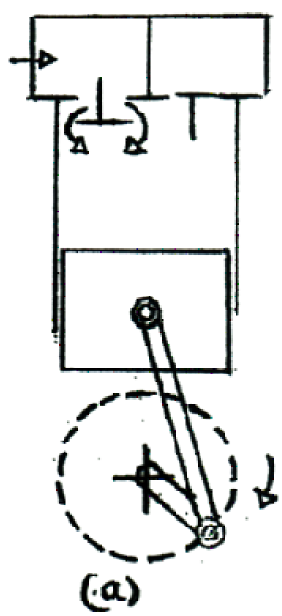
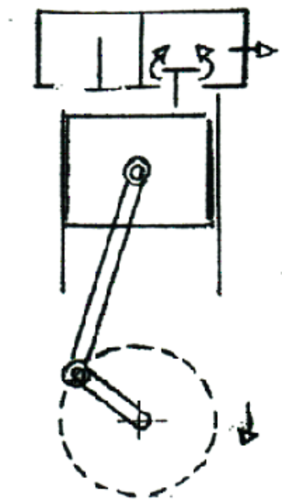


Fig. 3 (a)

The crank shaft rotates clock wise, crank shaft and piston are connected to piston rod. Piston moves down wards and sucks air from the atmosphere. Valves open due to differential pressure and not mechanically.



(b)

Fig 3 (b)

After passing through lower dead point inlet port closes and exist port opens. The air is being pushed against the prevailing pressure. Point of valve opening depends on valve design.

RESERVOIRS :

A reservoirs is configured downstream of compressor to established compressor. A reservoirs compensates the pressure fluctuations. When the compressed air is taken from the system. If the pressure in the reservoir drops below a certain value, the compressor will compensate until the set higher value is reached again this has the advantage that the compressor does not need to operate continuously.

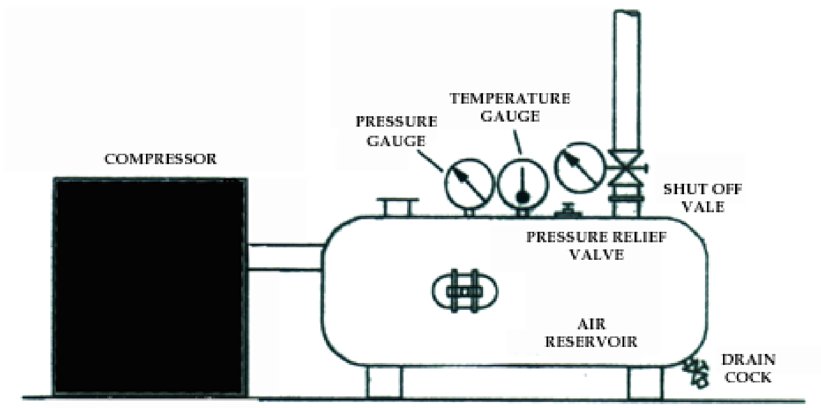


FIG.4

AIR DRYERS :

Condensate (water) enter into the air net work through the air in take of the compressor. The accumulation of condensate depends largely on the relative air humidity. The relative air humidity is relative air humidity is dependent on the air temperature and weather situation.

The air which contains moisture in atmosphere conditions the same even after compression and hence before this air is fed to any control system. It requires dehyderation to achieve this there are two fundamentals methods used universally one being mechanical drying of air which employ a mechanical device to lower the temperature or pressure. The other method is chemical were is subjected to hygroscopic chemical to dry it.

AIR PREPARATION UNIT :

Compressed air obtained from an air main line is contaminated with dirt, water and it is pressure fluctuates over the wide range. The compressed air therefore should pass through a filter to remove dirt and water.

a. FILTERATION :

CONSTRUCTION AND WORKING OF FILTER.

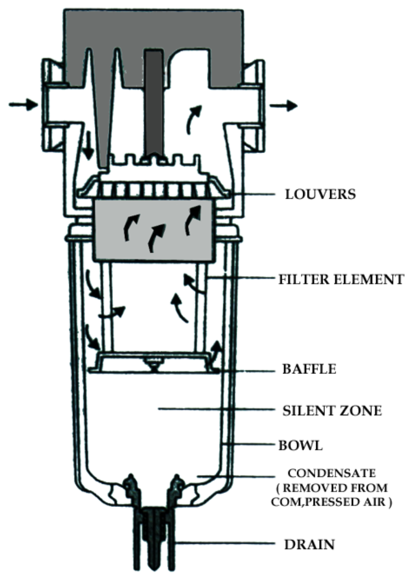


FIG.5 SCHRADER

When compressed air flows into a filter inlet the directional louvers import a spinning motion to the air. As the air stream whirls downloads. The centrifugal force hurls the larger solid and liquired particles outwards. They collect on the inner surface of the bowl and migrate down to the "quiet Zone" in the lower portion of the bowl. The buffle keeps the turbulent air away from the lower portion of the bowl so that the sold particles and liquid collected at the bottom do not re - enter the air stream.

The air stream meanwhile reverses direction at the battle and follows a convoluted bath through the porous filter element where even the smaller solid particles are mechanically strained out finally the cleaned air reaches the center of the filter element and flows through the outlet port to down stream system.

b. **PRESSURE REGULATION :**

CONSTRUCTION AND WORKING OF REGULATOR.

Once the compressed air properly cleaned its necessary to regulate in to the required level of pressure regardless of fluctuations in compressed air mainline (Inlet pressure is always required to be more than operating regulated pressure).

The pressure regulator mainly works on the principle of "balanced valve" construction.

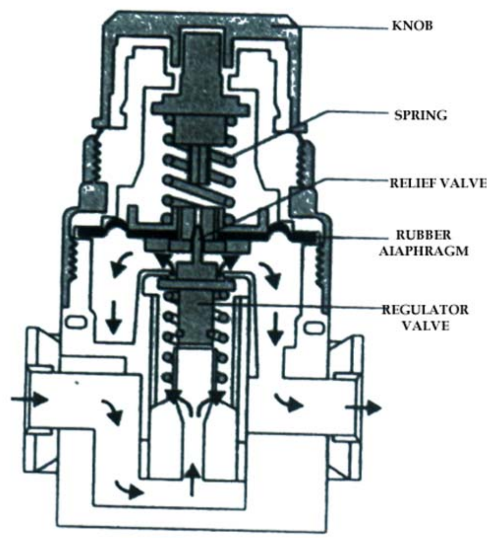


FIG.6

Unregulated compressed air moves through the inlet port and through the regulator valve and gets connected to the outlet port air in the outlet port is also connected to the space below the rubber diaphragm. Depending upon the set pressure (which is set by adjusting the pressure setting knob) corresponding spring force is applied to the upper side of the rubber diaphragm. When the pressure at the out let port is less than the set pressure, the spring force applied towards downward side on the rubber diaphragm is more than upward force applied by air pressure at the out let port hence the rubber diaphragm is pushed down and turn it pushes down the regulator valve to open and allows more air to pass from inlet port to outlet port. This increases the pressure at the outlet port. At one point of the time when the pressure at out let port becomes enough to exert equal force on rubber diaphragm from bottom side, to balanced the spring force form the top - side. The regulator valve closes and outlet pressure is held at the same level.

The set pressure can be reduced by turning the setting knob of regulator. At this point the spring pressure exerted on the top of the rubber diaphragm becomes lower than the force exerted by the outlet air pressure from the bottom side. Hence the rubber diaphragm lifts upwards and the extra air pressure at the outlet port is released through the relief valve.

The pressure regulator thus regulates the pressure at the out let port and maintains it as per the setting of regulator. Selection of regulator is mainly related to selection of proper pressure range and flow capacity required for the specific application.

c. <u>LUBRICATION :</u>

CONSTRUCTION AND WORKING OF LUBRICATOR :

Pneumatic automation components extensively use sealing material made out of rubber compounds. For efficient and trouble free working of these seals, they need to be oiled or lubricated to reduce frication and corrosion.

To lubricate compress air actuated equipment, the most efficient and economical method is to object the lubricant into the compressed air that powers this equipment.

The air line lubricators function by introducing a fine mist or fog of oil into the compressed air supply and then to the working parts of pneumatics equipment.

Small part of compressed air entering lubricator inlet port is delivered to the oil reservoir oil bowl through the check valve. This applies continuous pressure on the top of surface of lubricating oil in the lubricator bowl. The major part of the inlet air is diverted through the venturi section or the throat of the lubricator to the outlet port and to the downstream system. This creates a low pressure area inside the tubular passage connecting to the sight feed dome. This low pressure thus generated and the pressure applied on the lubricating oil in the bowl in turn causes lubricating oil in the reservoir to flow up the siphon tube to the sightfeed dome. Here the flow of oil is controlled by the needle valve and the oil is permitted to drip at the desired rate of feed through the tubular connecting passage in to the main air line passage. As the oil enters the main air stream, it is atomized into an air borne oil fog or oil mist which is carried to the pneumatic device.

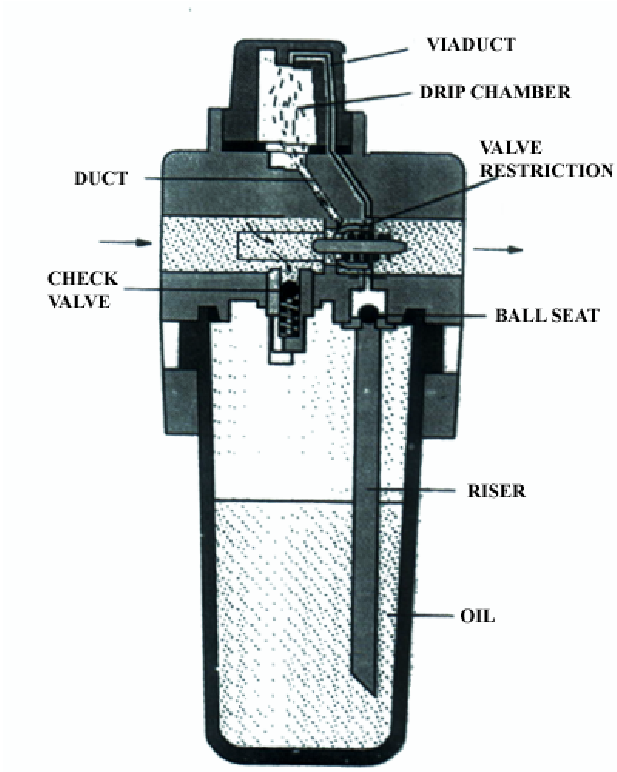


FIG.7

Important in lubrication if used should be on regular basis since mist lubrication can wipe out original lubricants.

Preferred rate of lubrication is, 2 to 3 drops of oil per minutes.

Recommended oil viscosity for lubrication is ISO VG32 and preferred brands are :

1.	Bharat Petroleum	-	Hydrol 32.
2.	Hindustan Petroleum	-	Enklo 32.
3.	Indian Oil Corporation	-	Servo system 32.
4.	Mosil	-	Spintech 32.

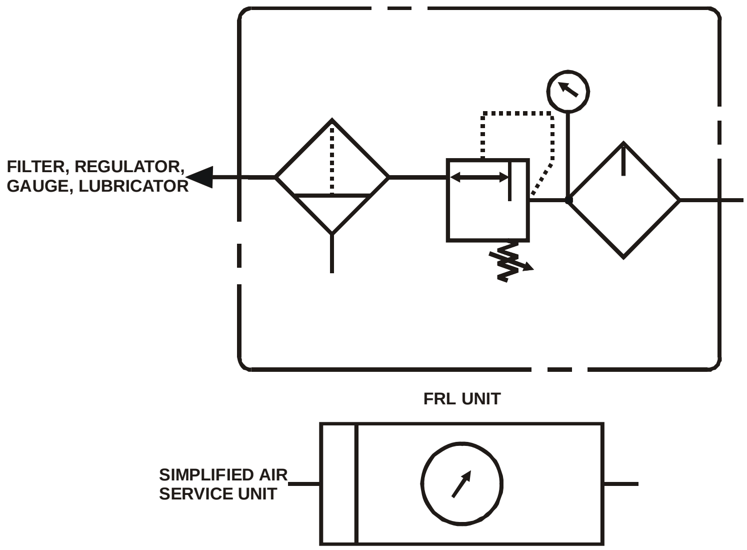


FIG.8 AIR SERVICE UNIT SYMBOL

PNEUMATIC ACTUATORS :

Actuators are those components of pneumatic system, which perform work, for e.g. air cylinder and air motors in short they are the muscles of pneumatic system.

The energy stored in compressor is converted into work. The higher the pressure, greater is the force or thrust.

In practice the economical range of application has been found to be between 5 to 8 bar, leading to pneumatic actuators being operated at an average air pressure at 6 bar.

CLASSIFICATION :

Pneumatic actuators are broadly classified according to the type of motion produced namely.

1. Linear and.
2. Rotary.

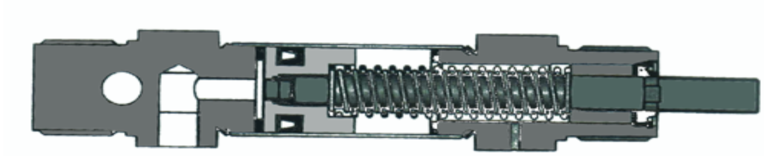
Linear Motion Acuators	:	1.	Single acting cylinders.
		2.	Double acting cylinders.
Rotary Motion Actuators	:	1.	Air Motor.
		2.	Rotary Cylinders.
		3.	Rotary Actuator.

LINEAR MOTION ACTUATOR :

SINGLE - ACTING CYLINDER :

In the construction of single - acting cylinder compressed air is applied on only one side of the piston face - the other side is open to the atmosphere. The cylinder can produce work in only one direction. The return movement of the piston is effected by a built - in spring or by the application of external force.

The single acting cylinder has a single piston seal, which is fitted on the air supply side. Sealing is by a flexible material that is embedded in metal or plastic piston.



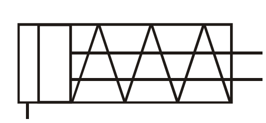
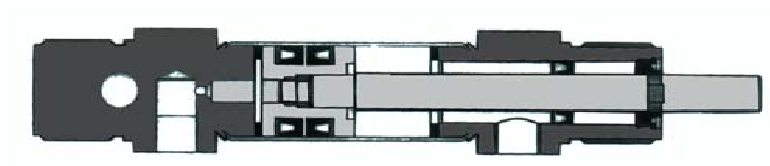


FIG. 9

DOUBLE ACTING CYLINDER :

The construction principle of a double - acting cylinder is similarly to that of the single acting cylinder. However, there is no return spring and No ports are used alternatively as supply and exhaust ports. The double acting cylinder has the advantage that the cylinder is able to carry out of work in both direction of motion. thus the installation possibilities are universal.



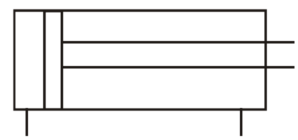
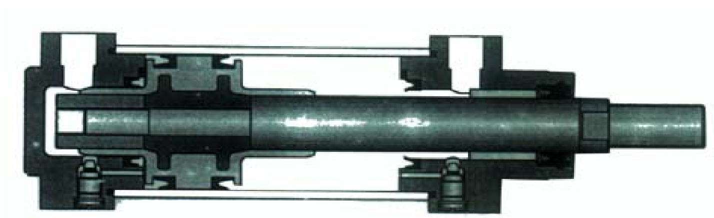


FIG.10 DOUBLE ACTING CYLINDER



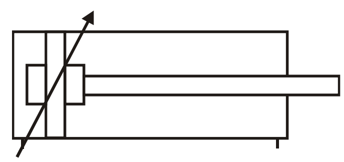


FIG.10 DOUBLE ACTING CYLINDER WITH END POSITION CUSHIONING

Cushioning arrangement on double acting cylinder. The purpose of "**cushioning**" is to absorb the momentum of energy of the piston rod assembly and the load. It is moving, by means of air cushion, there by preventing the impact of a piston on the end covers. This can only be done at the end position of the piston stroke in all intermediate position a separate externally mounted cushioning device must be provided it required.

ROTARY MOTION ACTUATORS :

Rotary actuators are divided in to continuous motion and limited angle rotation. The air motor and the rotary cylinder are the example.

In the rotary actuator force is transmitted to the drive shaft via. a vane angular displacement is infinity adjustable from 0^{o} to 180^{o} Torque should not exceed 10 Nm.

Design Feature of pneumatic rotary actuators :

1. Small and robust.
2. Adjustable with contact less sensing.
3. Adjustable for angular displacement.
4. Easy to install.

FIG.11 ROTARY ACTUATOR

AIR MOTOR :

To generate rotational motion in pneumatic system a pneumatic motor is used. Pneumatic motors have been found to provide vary high rotational speed, may go some times up to 10,000 revolutions per minute or even more. The possibility of high power transmission is accomplished at infinitely variable speeds which is an added advantage not found in other rotational systems.

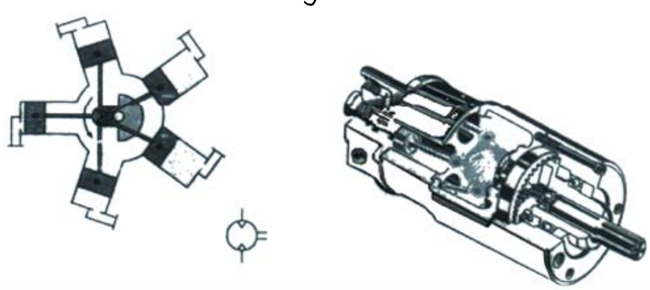


FIG.12 AIR MOTOR

PNEUMATIC VALVES :

Pneumatic applications use a "**device**" to control the repeated filling and exhausting of air under pressure into a certain volume (e.g. cylinder, clutch etc) These devices are called "valves" The control function that can be initiated with the valve its mode of actuation and the connection size. Directional control valves are classified functionally as 2/2, 3/2, 4/2, 5/2, 4/3, 5/3 etc depending upon the number of post opening and valve position. (Which also determines the flow capacity of the valves) are important parameters in valve selection the control for actuation of valve could be manual, Mechanical, Pneumatic, or by electrical.

1. Directional Control Valve.
2. Now Return Valve.
3. Flow Control Valve.
4. Pressure Control Valve.

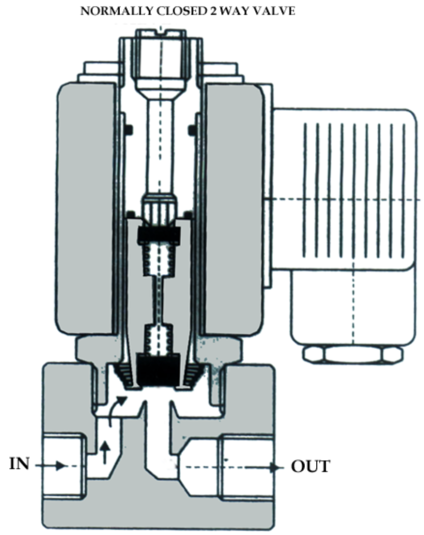
1. DIRECTIONAL CONTROL VALVE :

Directional control valve as the name suggests, are used for controlling the directional of air - flow. These come under two classification.

a. CLASSIFICATION BASED ON NUMBER OF PATHS.

Depending on the air number of paths the air is allowed to take, direction control valves are termed as two way, three way, or four way or five way valves. The terms de - note the number of controlled connections or number of ports ports on the valve namely inlet connection for the compressed air, outlet connection to the air consumer and exhaust connection to the atmosphere. Even when valve has several exhaust ports, these are counted as only one way.

2 Way valve have one inlet port and one outlet port they can be either normally open or normally closed. Two way valve are only to be found in pneumatic controls were a simple straight way pneumatic path is required, that is when the down stream air does not need exhausting to the atmosphere via this valve.



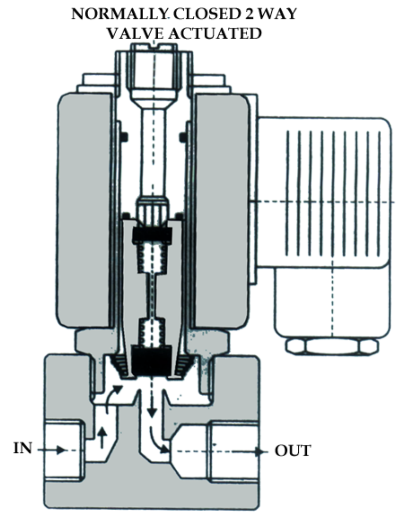
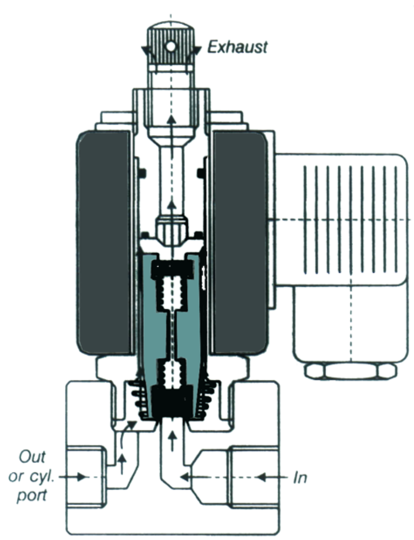
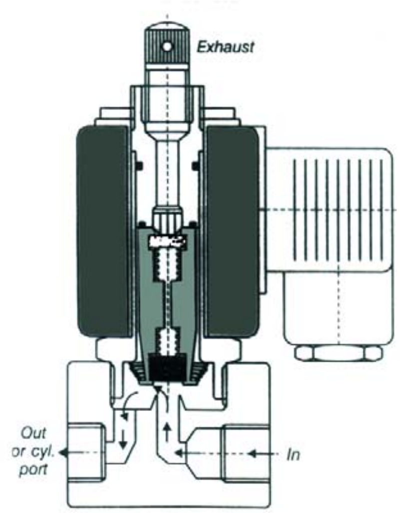


FIG.13

3 Way valve can also be either normally open or normally closed. After performing an operating stroke, every air cylinder to be exhausted before a new cycle can commence. This means that it needs at least a 3 way valve. 3 way valve have the facility of exhausting the trapped air inside the cylinder which has already passed though the cylinder port. These valves are available in two version namely direct acting plunger type and spool type. These valves are normally used with single acting cylinder.



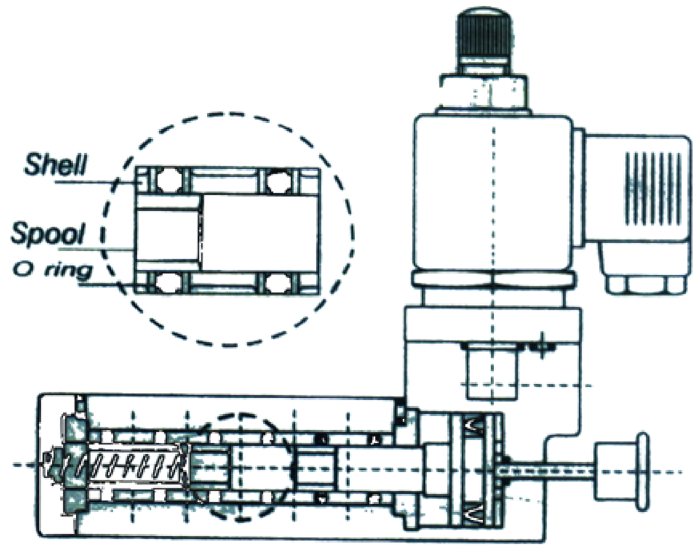
NORMALLY CLOSED 3 WAY VALVE
DIRECT ACTING TYPE



Normally closed 3 way valve, Actuated
Direct acting type

FIG.14

4 Way valve have 2 outlet ports. One normally open and one closed. The position reverse when the valve is actuated. Air which has already passed through the outlet port is exhausted bake through the valve when the valve changes it's position.



5/2 Modular spool valve

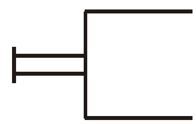
FIG.15

The direction control valve is represented by the number of controlled connections. The number of position and the flow – path in order to avoid faulty connections all the inputs and output of a valve are identified.

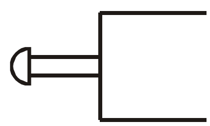
METHODS OF ACTUATION :

MANUAL :

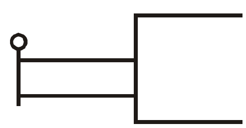
4 General :



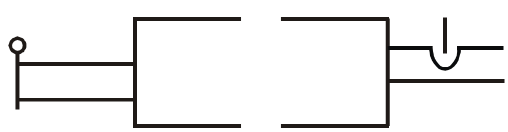
4 Push Button :



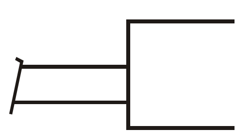
4 Lever Operated :



4 Detend Lever Operated :

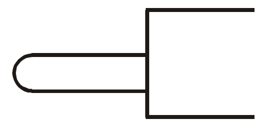


4 Foot Pedal :

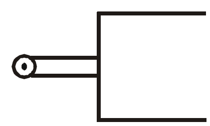


MECHANICAL :

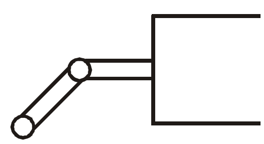
4 Plunger :



4 Roller Operated :

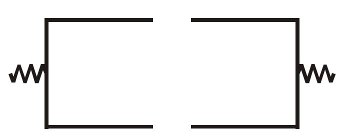


4 Idle Return, Roller :



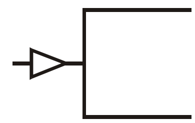
4 Spring return :

4 Spring Centered :

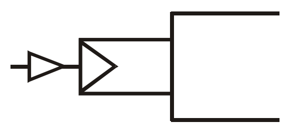


PNEUMATIC :

4 Direct Pneumatic Actuation :

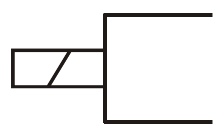


4 Indirect Pneumatic Actuation (Piloted) :

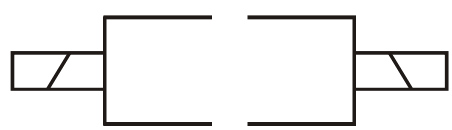


ELECTRICAL :

4 Single Solenoid Operation :



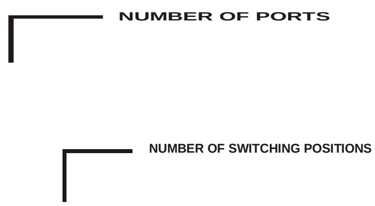
4 Double Solenoid Operation :



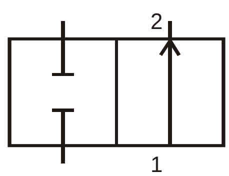
COMBINED :

4 Double Solenoid and pilot operation with manual override.

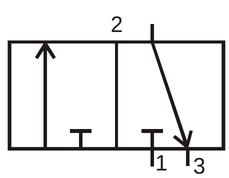
4 Directional Control Valves Port and Position :



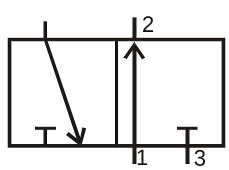
1. 2/2 - Way direction control valve, normally open :



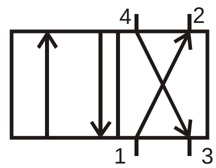
2. 3/2 - Way direction control valve, normally closed :



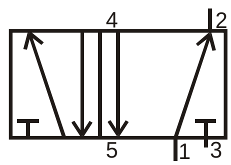
3. 3/2 - Way direction control valve, normally open :



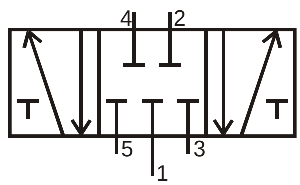
4. 4/2 Way direction control valve flow from 1 - 2 and from 4 - 5 :



5. 5/2 Way direction control valve flow from 1 - 2 and from 4 - 5 :

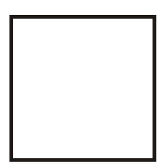


6. 5/3 Way direction control valve mid position closed :

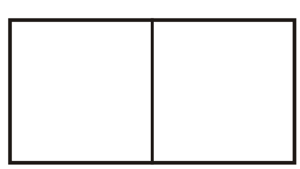


1. <u>DIRECTIONAL CONTROL VALVES SYMBOL DEVELOPMENT :</u>

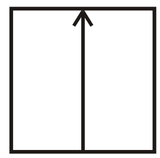
4 Valve switching positions are represented as squares :



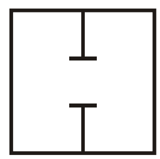
4 The number of squares shows how many switching positions the valve has :



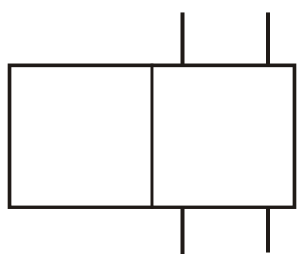
4 Lines indicate flow paths, arrows shows the direction of flow :



4 Shut off positions are identified in the boxes by lines drawn at right angles :



4 The connections (inlet and outlet ports) are shown by lines on the outside of the box :



2. NON RETURN VALVES :

Non - Return valve allows the flow of air in one direction and block the flow of air in the reveres direction.

Mostly these valve are designed in a such way that pressure applied in non return direction air the blocking mechanism of the non return valve.

Following variations of non - return valves are used in pneumatic control applications.

a. Check Valve.
b. Shuttle Valve.
c. Quick Exhaust Valve.

a. CHECK VALVE :

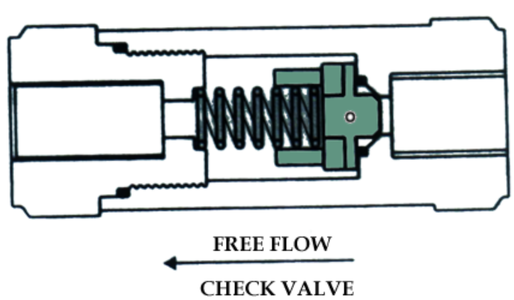


FIG.16

The simplest type of non return valve is the check valve. This valve completely blocks air flow in one direction while permitting the free flow in the other direction with minimum pressure loss across the valve. Pressure applied on free flow side over comes the spring force exerted on "check" and opens the gate thus allowing free flow in that direction. But when the pressure is applied from the other port, the "check" closes the gate and does not allow any isolated different pneumatic components from each other and to prevent mutual interface.

b. SHUTTLE VALVE :

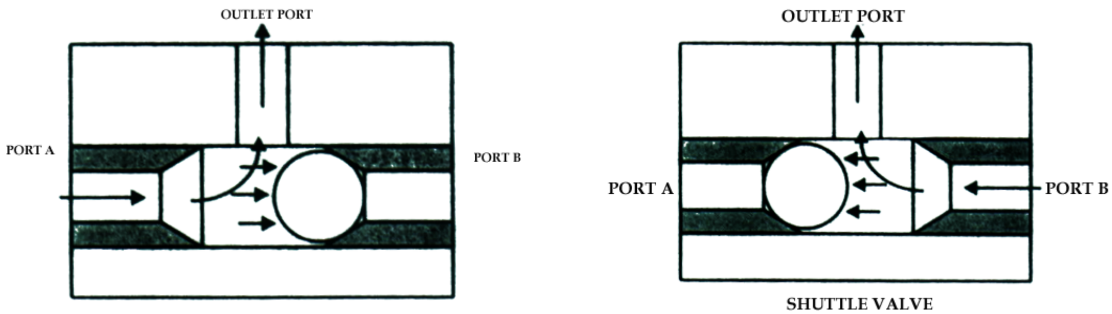


FIG.17

Shuttle valve has two inlet and one outlet when air is connected to part "A" it is get connected to outlet port and port "B" is blocked. But when air inlet is connected to port "B" it is gets connected to the outlet port and port "A" is blocked. Shuttle is normally used when one pneumatic device is required to be operated from two - different sources.

c. QUICK EXHAUST VALVE :

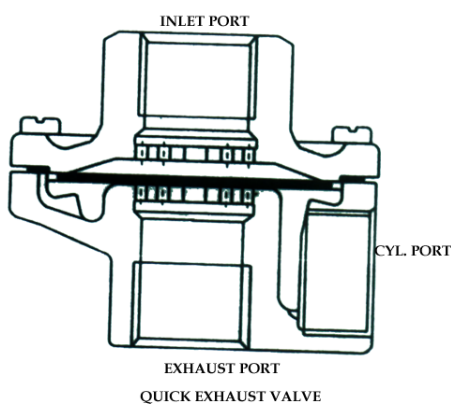
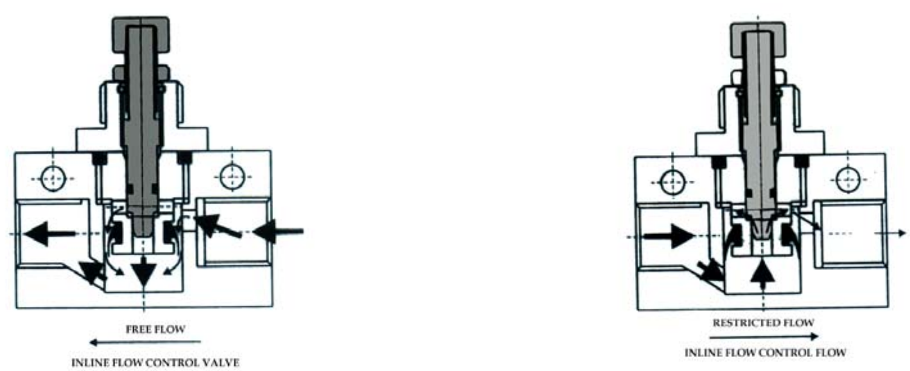


FIG.18

Quick exhaust valve rapidly exhaust air from cylinder port and thus increase the speed. The fig.18 shown the section drawing of a quick exhaust valve. The pressurized air coming from the direction control valve enters the inlet port of the quick exhaust valve and force the diaphragm against the seat of the exhaust port. The inlet air lows past the diaphragm to the cylinder port. The diaphragm keeps the exhaust port closed until the piston reverses in the cylinder. As soon as the directional control valve changes over the exhaust air, now coming from the cylinder port forces the diaphragm against the Intel port there by blocking it. The exhaust air then flow from the cylinder port to exhaust port of quick exhaust valve, gaining rapid direct access to the atmosphere instead of having to take the path back through the control valve. This drastically reduces the exhaust air back pressure on the piston there by increasing the piston velocity.

3. <u>FLOW CONTROL VALVE :</u>

Flow control valve control the flow of air. This is achieved by restricting the passage of air inside the flow control valve.



<u>FIG.19</u>

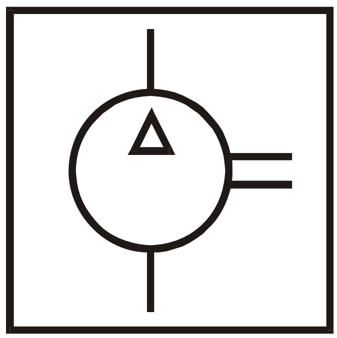
Normally the throttling or restricting air passage in flow control valve is adjustable by manual control.

The typical flow control valve combines the feature of check valve and a needle valve and this valve is widely used for controlling speed of the piston movement in pneumatic cylinder. This valve is allows free flow of air in one direction and controlled flow in another. Making it possible to regulated the speed of cylinder by controlling the exhaust air flow.

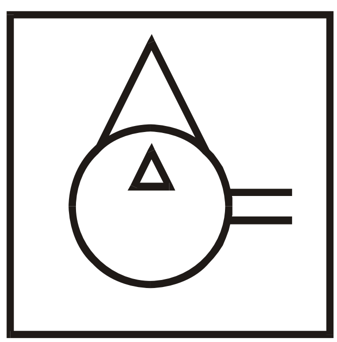
SYMBOL USED IN PNEUMATICS (DIN / ISO 1219)

ENERGY CONVERSION :

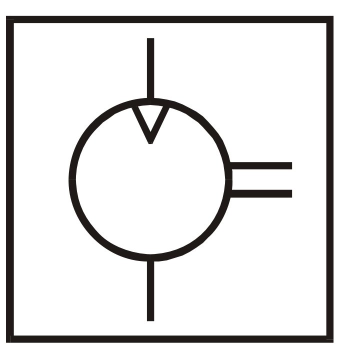
1. Compressor :



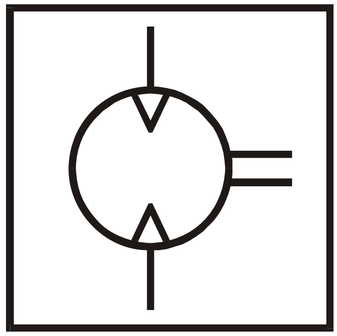
2. Vacuum Pump :



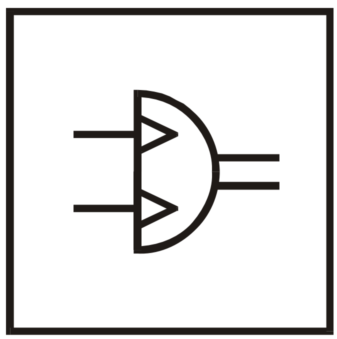
3. Pneumatic Constant rate motor with one direction of flow :



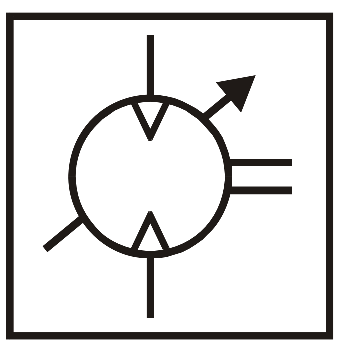
4. **Pneumatic Constant rate motor with two direction of flow :**



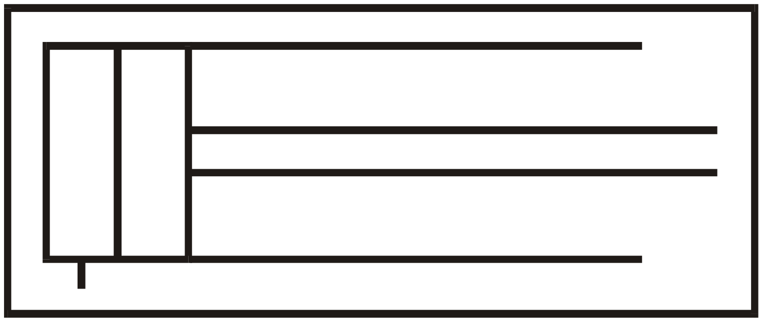
5. **Pneumatic Constant with limited range of swivel :**



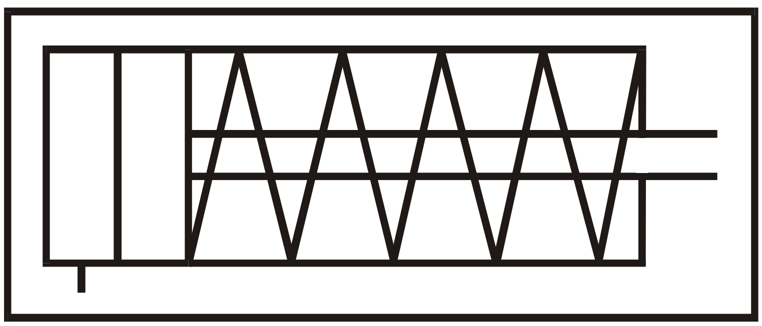
6. **Pneumatic motor with adjustable displacement volume, 2 directions :**



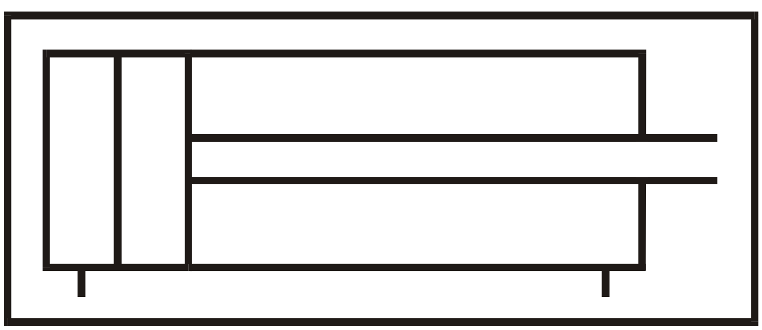
7. <u>Single acting cylinder, return movement by external force :</u>



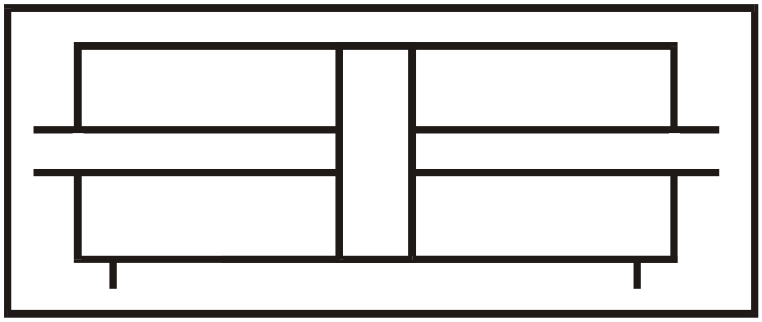
8. <u>Single acting cylinder, return movement by spring :</u>



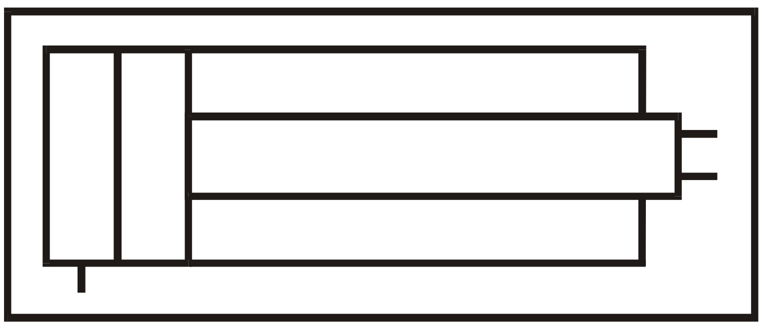
9. <u>Double acting cylinder with single - ended piston Rod :</u>



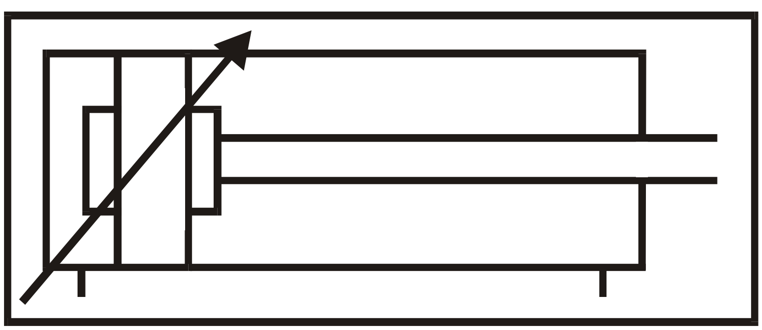
10. <u>Double acting cylinder with double - ended piston Rod :</u>



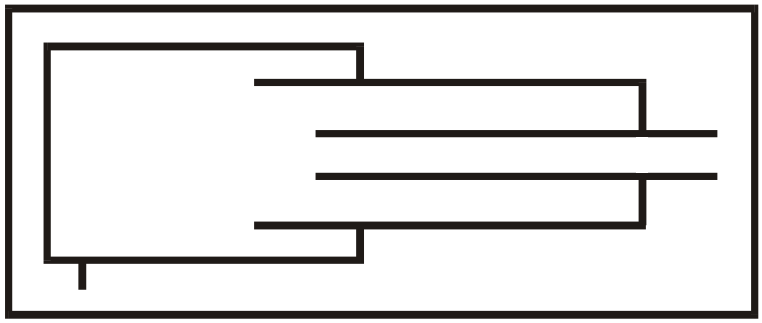
11. <u>Differential Cylinder with single ended - ended piston Rod :</u>



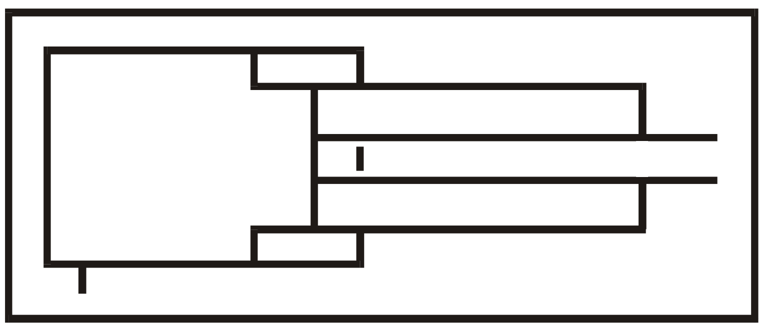
12. <u>Double acting cylinder e.g. with double ended adjustable cushioning :</u>



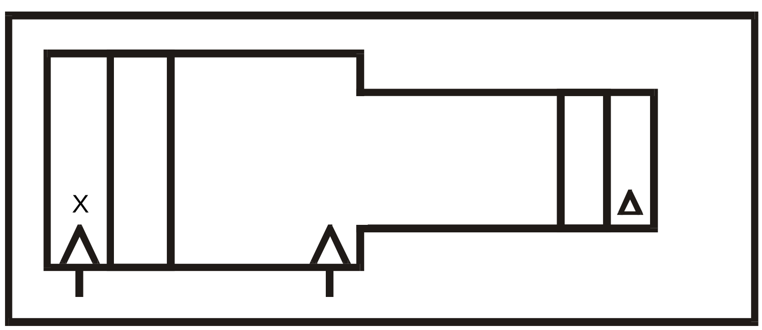
13. Single acting telescopic cylinder return movement by external force :



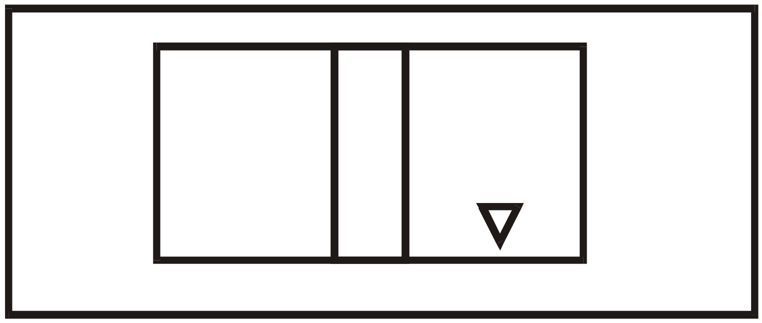
14. Double acting telescopic cylinder :



15. Pressure Intensifier :

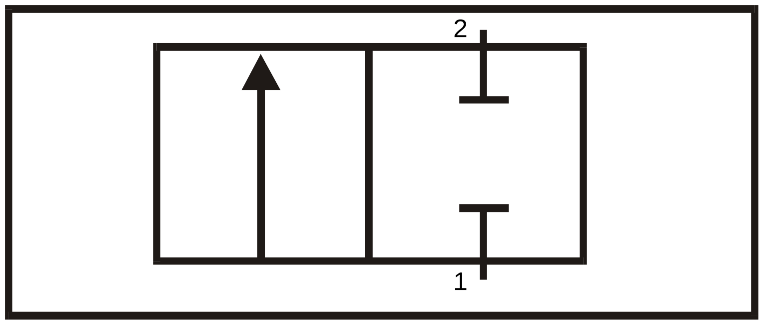


16. <u>Pressure Converter :</u>

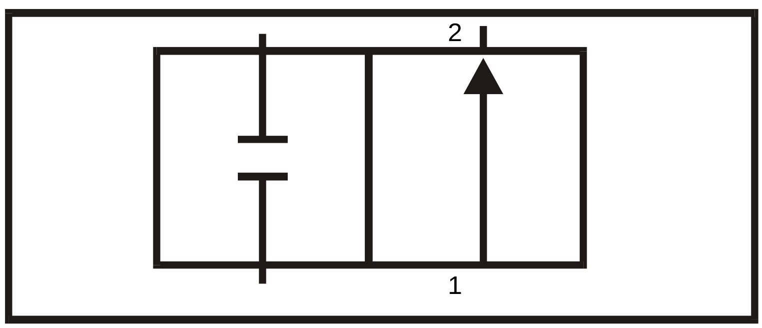


ENERGY CONTROL & REGULATION DIRECTIONAL VALVES

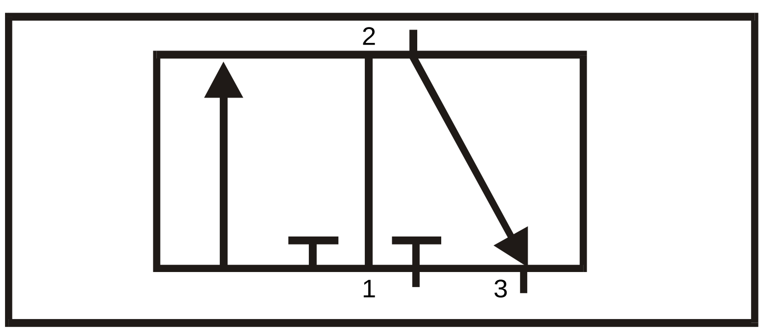
1. 2/2 – way valve neutral position closed :



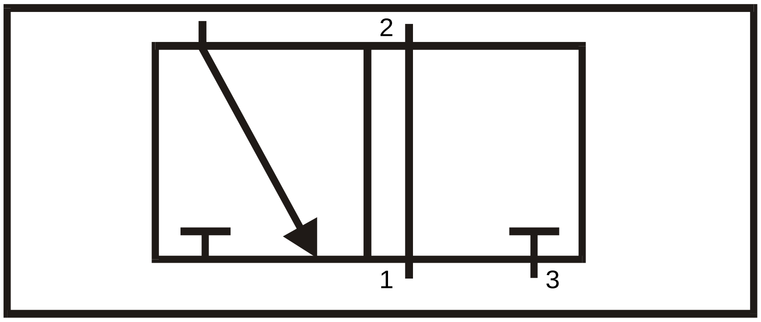
2. 2/2 – way valve neutral position open :



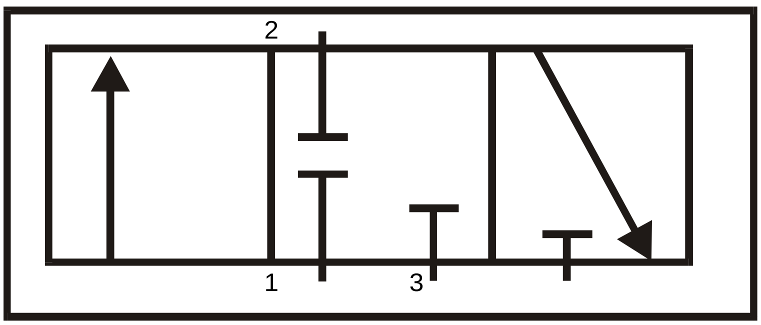
3. 3/2 – way valve neutral position closed :



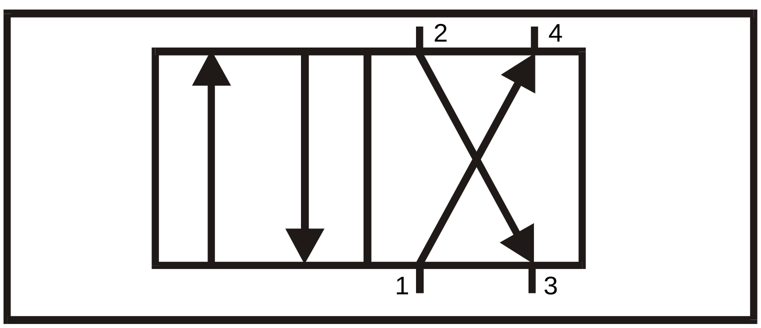
4. 3/2 - way valve neutral position open :



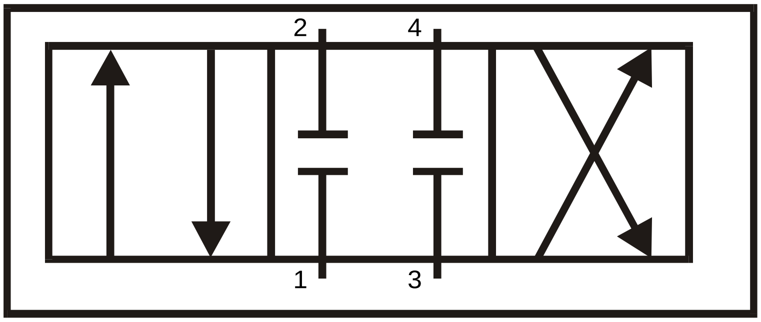
5. 3/3 - way valve mid - position closed :



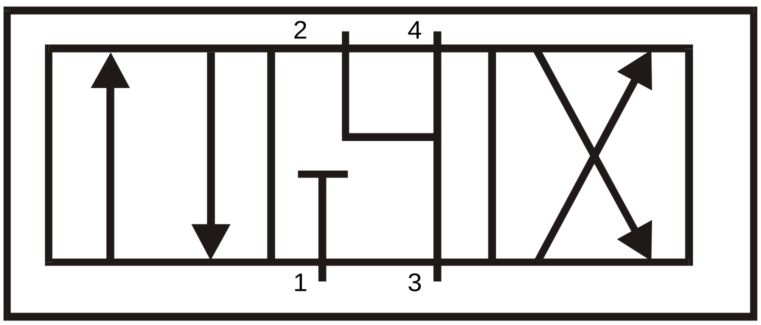
6. 4/2 - way valve :



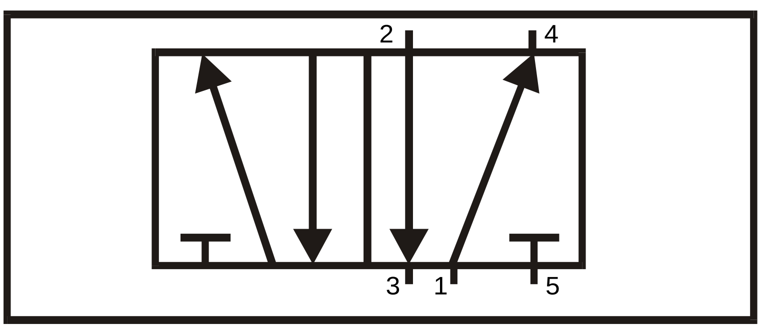
7. <u>4/3 - way valve mid - position closed :</u>



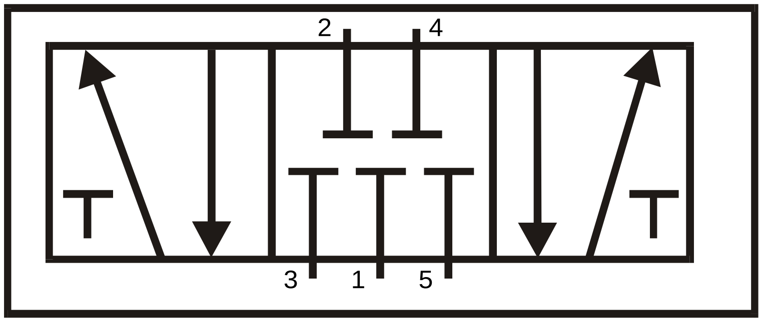
8. <u>4/3 - way valve floating mid - position :</u>



9. <u>5/2 - way valve :</u>

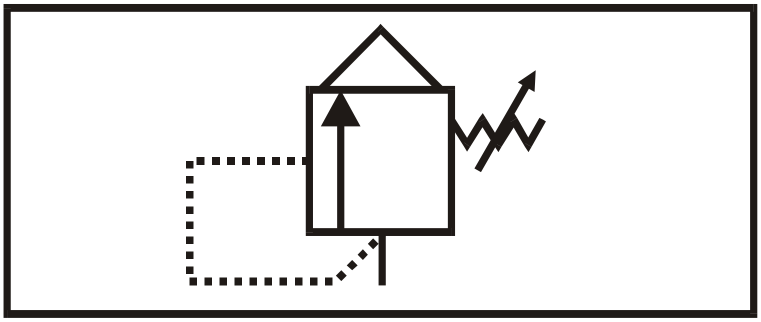


10. <u>5/3 - way valve mid - position closed :</u>

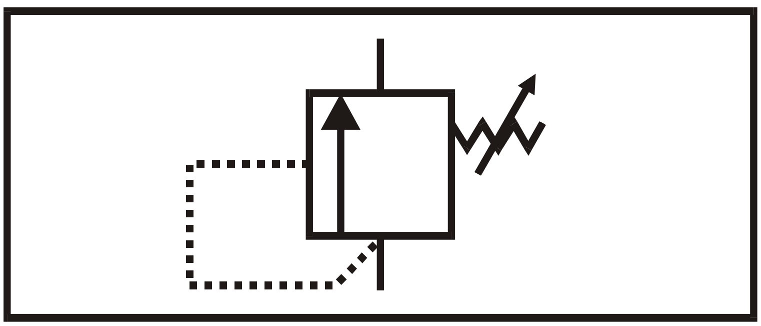


PRESSURE CONTROL VALVES

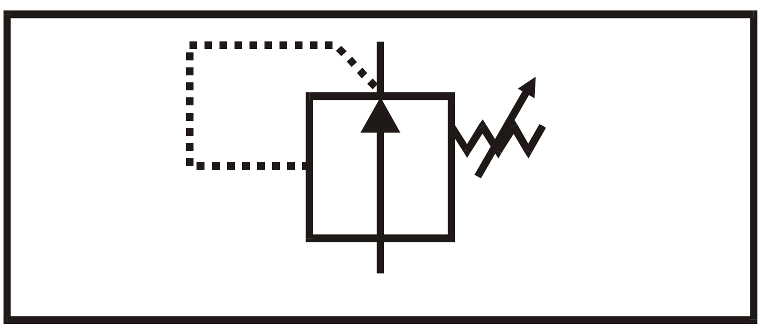
1. Pressure limiting valve, adjustable :



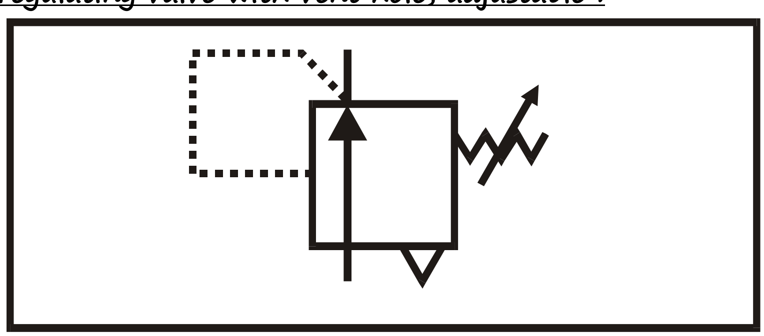
2. Sequence valve, adjustable with exhaust :



3. Pressure regulating valve without vent hole, adjustable :

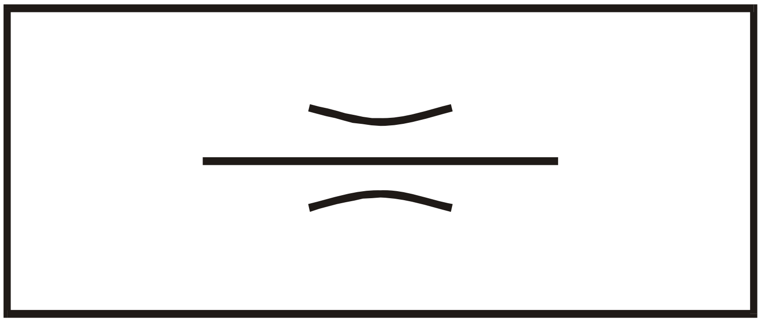


4. Pressure regulating valve with vent hole, adjustable :

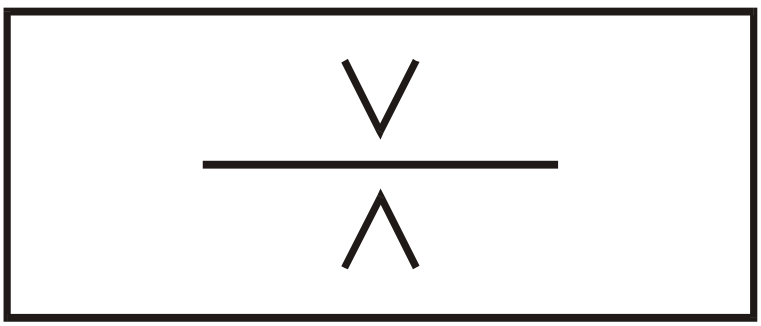


FLOW CONTROL VALVES

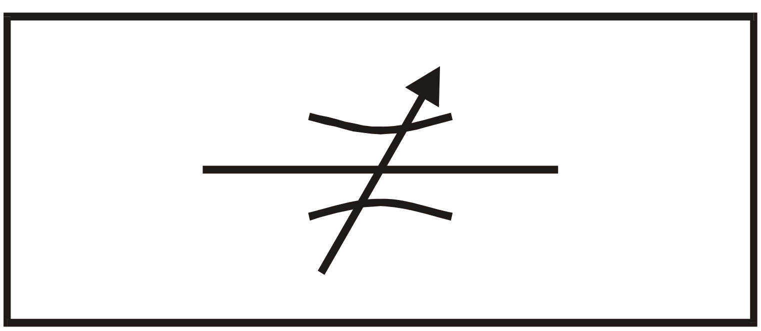
1. Throttic valve with constant restriction :



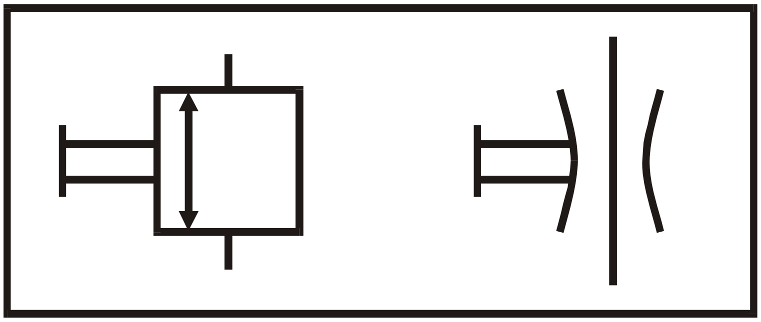
2. Diaphragm valve with constant restriction :



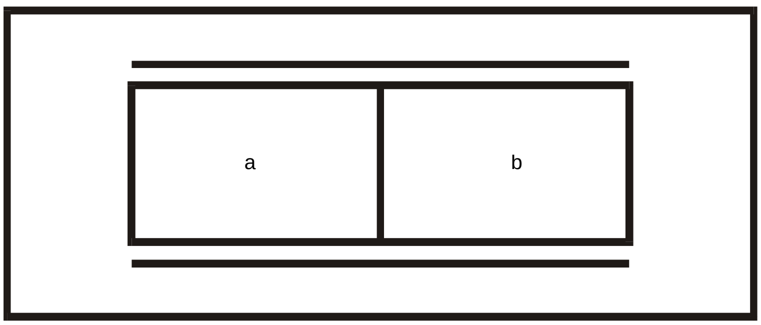
3. Throttic valve, adjustable any actuation :



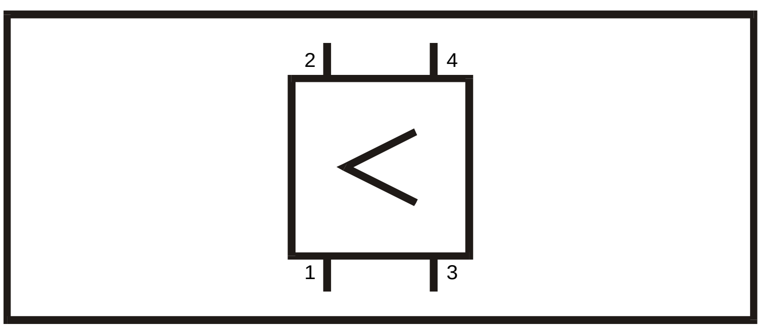
4. Throttle valve, adjustable, mechanical actuation against reset spring :



5. Directional valve with intermediate switching position and two and position :

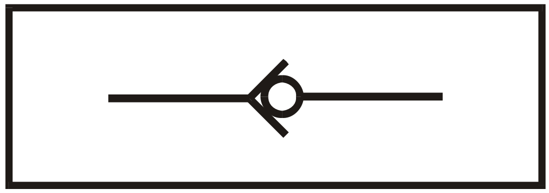


6. Simplified representation of directional valve with for example, 4 connections :

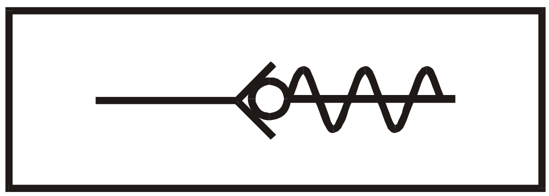


NON RETURN VALVES

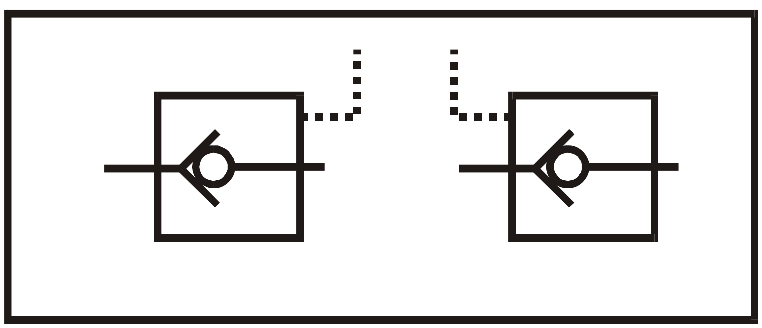
1. **Check valve without spring :**



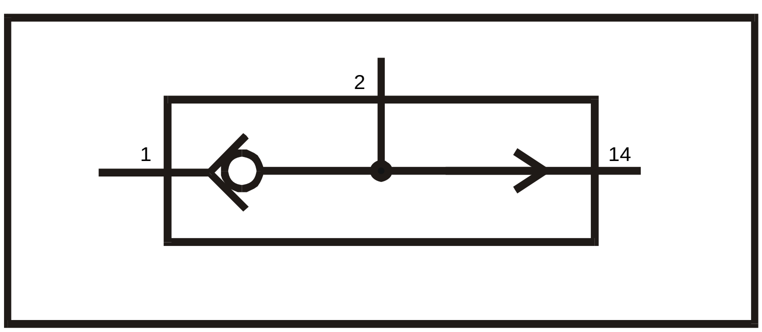
2. **Check valve with spring :**



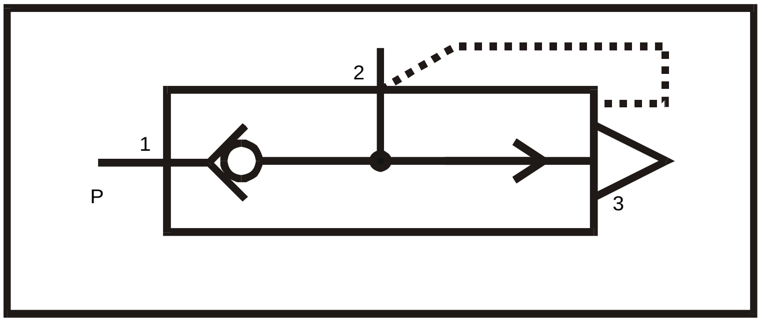
3. **Piloted check valve :**



4. **Shuttle valve :**

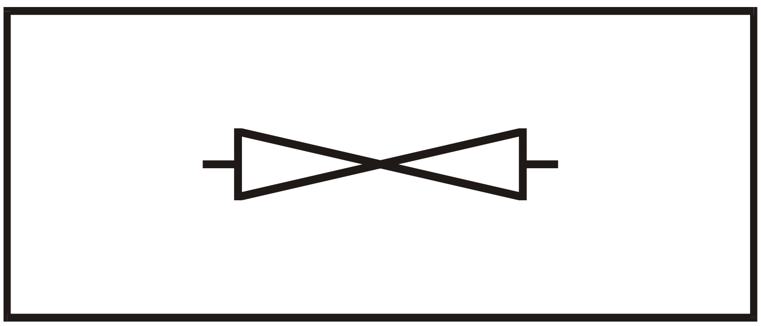


5. Quick exhaust valve :



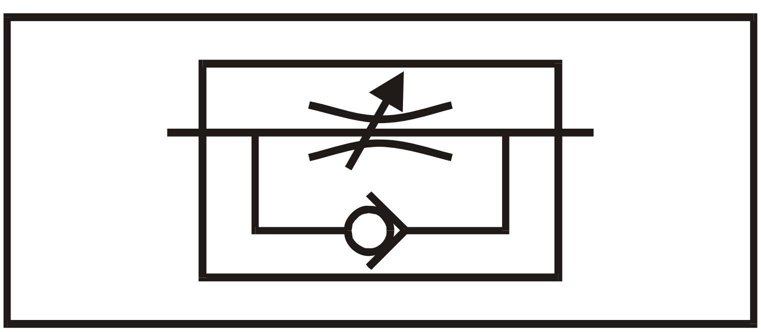
SHUT – OFF VALVES

1. Shut - off valve, simplified representation :



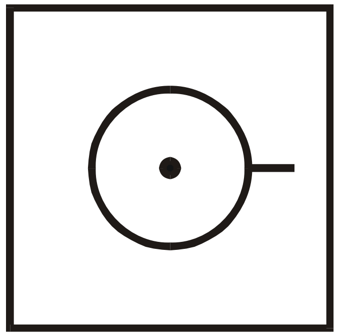
FLOW CONTROL VALVE WITH CHECK VALVE (IN PARALLEL)

1. Throttic relief valve, adjustable :

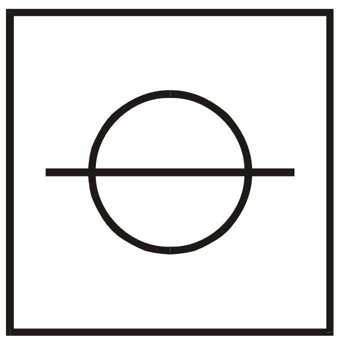


ENERGY TRANSMISSION

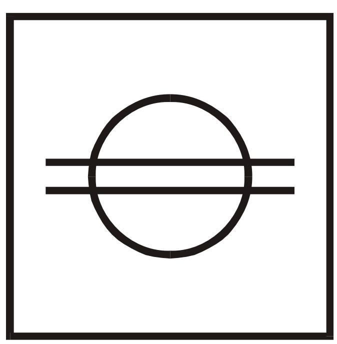
1. **Pressure source :**



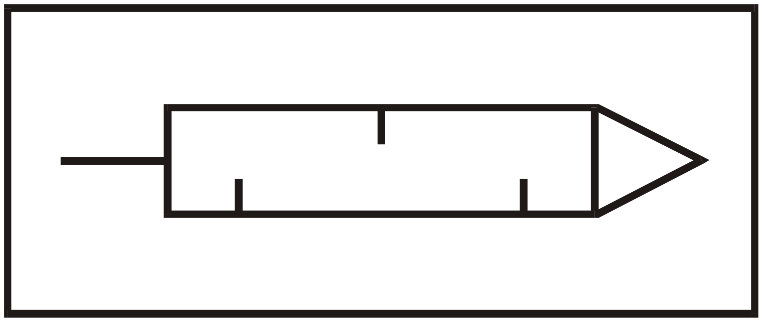
2. **Rotary connection with 1 path :**



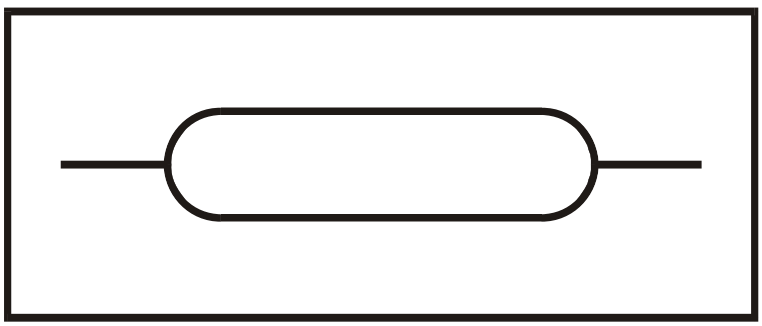
3. **Rotary connection with e.g. 2 paths :**



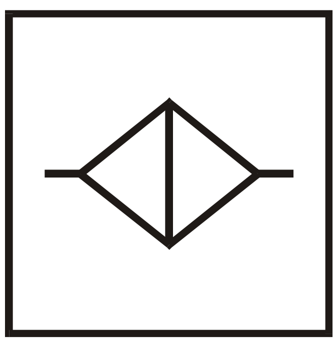
4. <u>Silencer :</u>



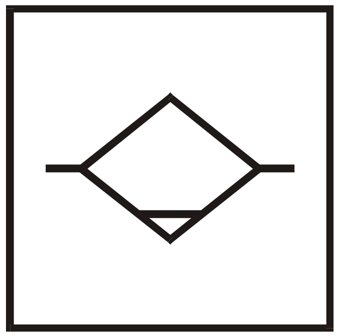
5. <u>Pneumatic reservoir :</u>



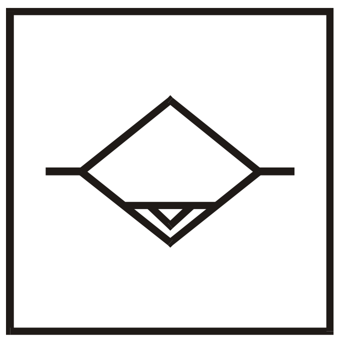
6. <u>Filter :</u>



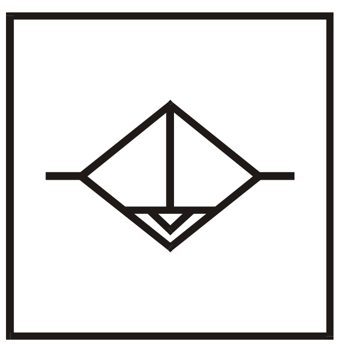
7. <u>Water separator, manually operated :</u>



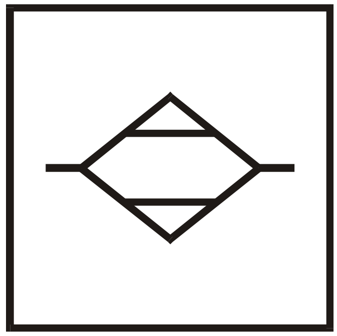
8. <u>Water separator with automatic draining :</u>



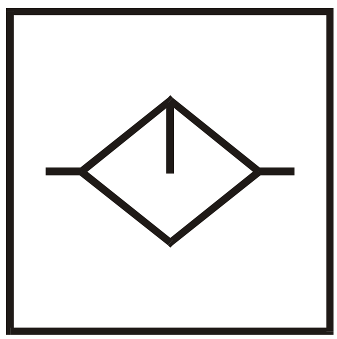
9. <u>Filter with automatic water separator :</u>



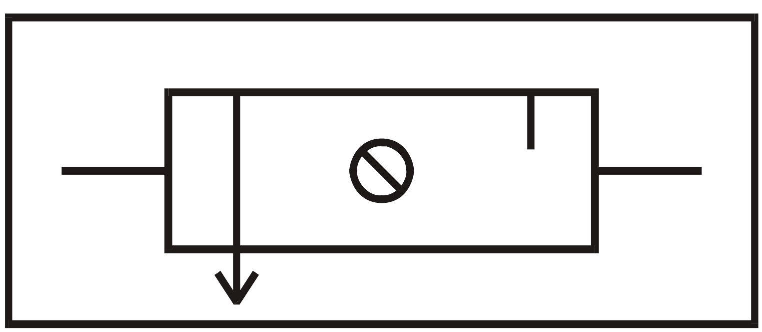
10. Drier :



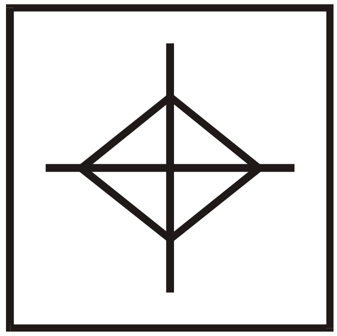
11. Lubricator :



12. Service unit (filter, pressure regulating valve, lubricator and pressure gauge), simplified representation :

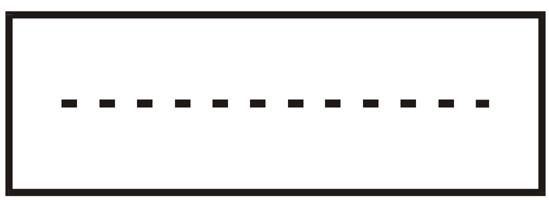


13. <u>Cooler :</u>

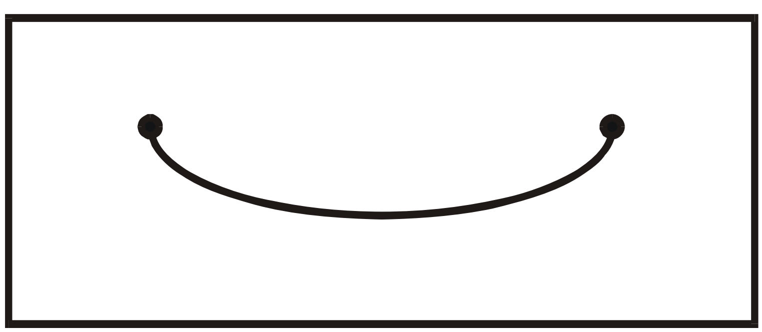


14. <u>Control line (pilot line) :</u>

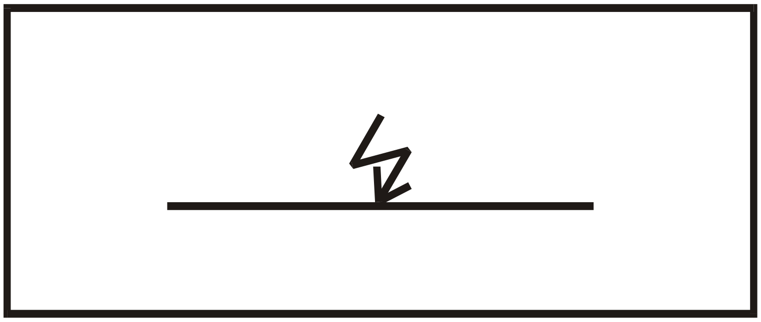
15. <u>Exhaust line :</u>



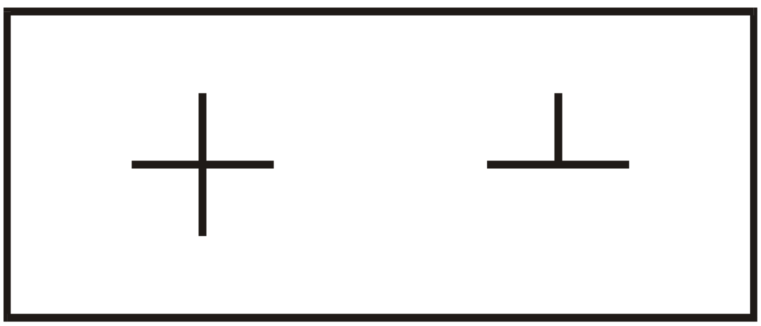
16. <u>Flexible pipeline :</u>



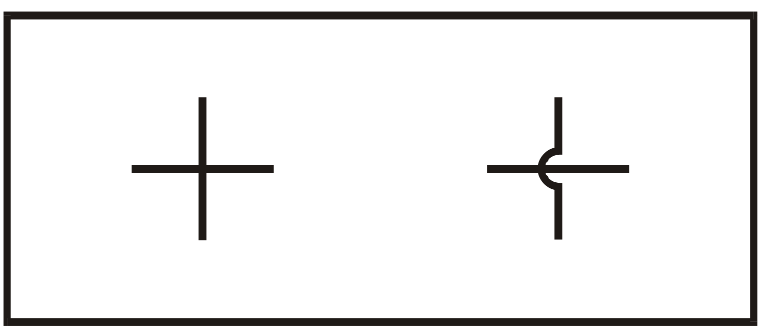
17. Electrical line :



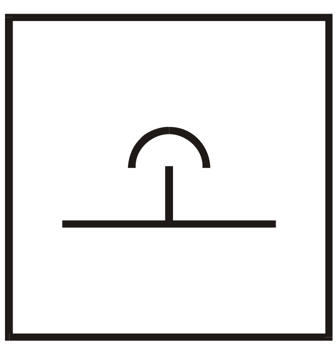
18. Line connection (fixed) :



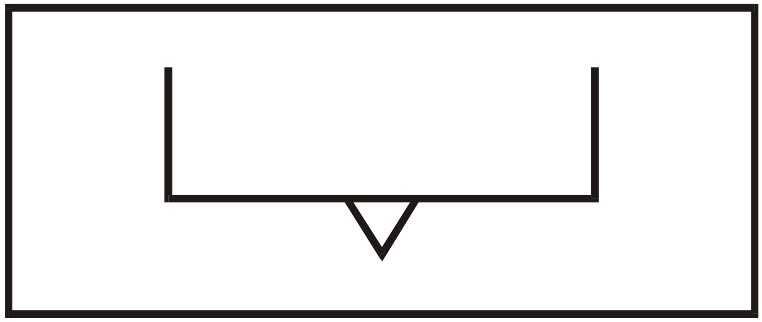
19. Line crossing :



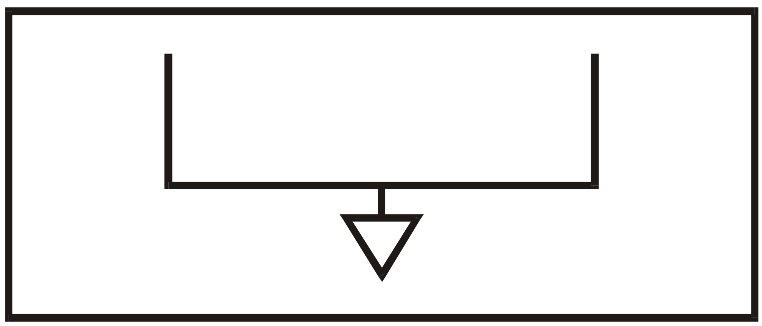
20. Exhaust point :



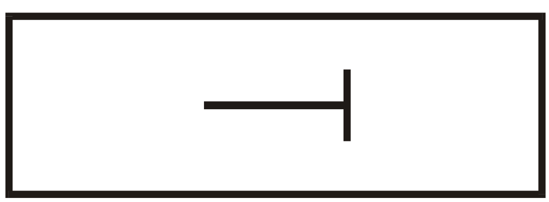
21. Outlet without pipe connection :



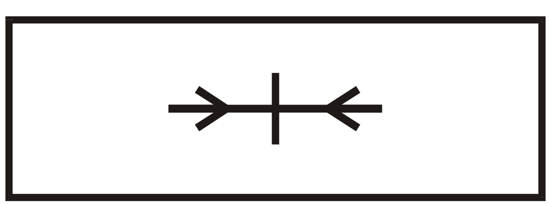
22. Outlet with pipe connection :



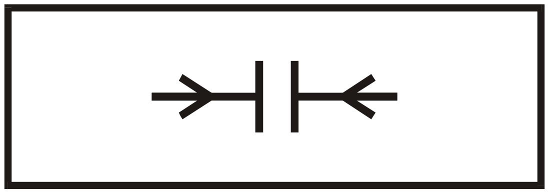
23. Pressure connecting point closed :



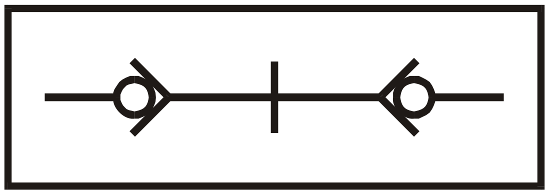
24. Pressure connection point with connecting line :



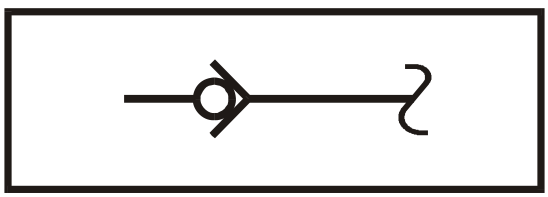
25. <u>Quick release coupling, no mechanically, opened shut off valves connected :</u>



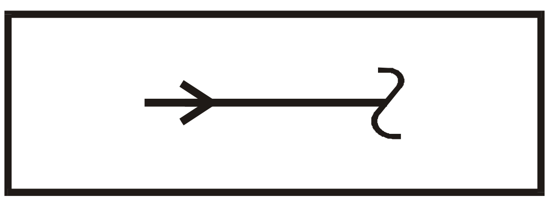
26. <u>Quick release coupling, with mechanically, opened shut off valves connected :</u>



27. <u>Quick release coupling, disconnected line closed :</u>

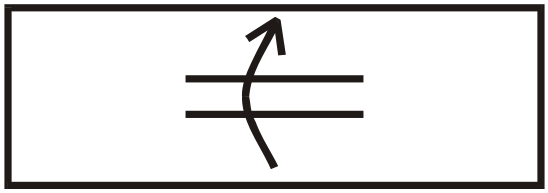


28. <u>Quick release coupling, disconnected line open :</u>

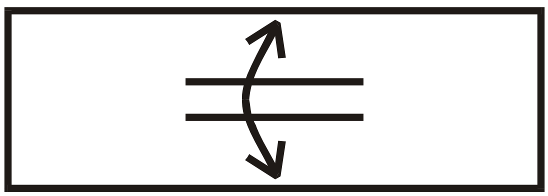


ACTUATION MECHANICAL COMPONENTS

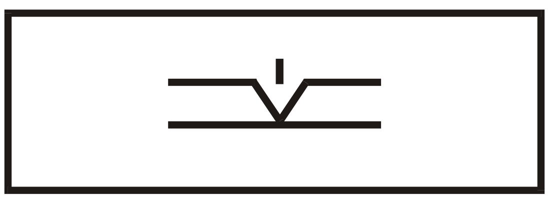
1. Shaft rotary movement in 1 direction :



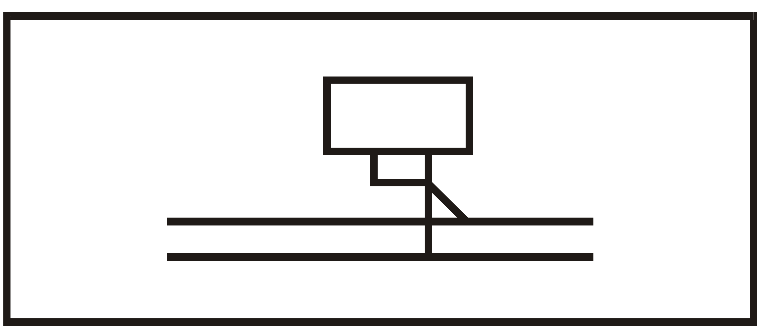
2. Shaft, rotary movement in 2 directions :



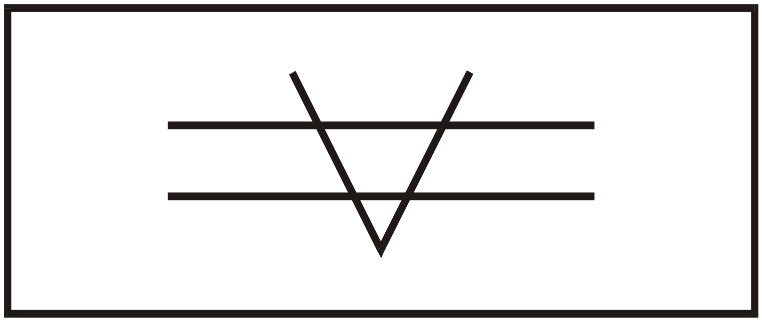
3. Detent :



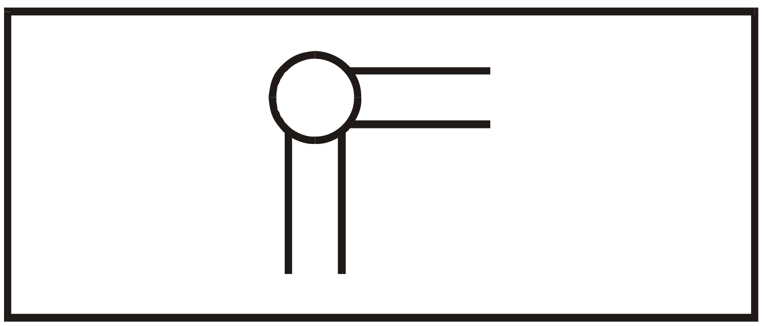
4. Latch (* symbol for the actuating device used to release the latch) :



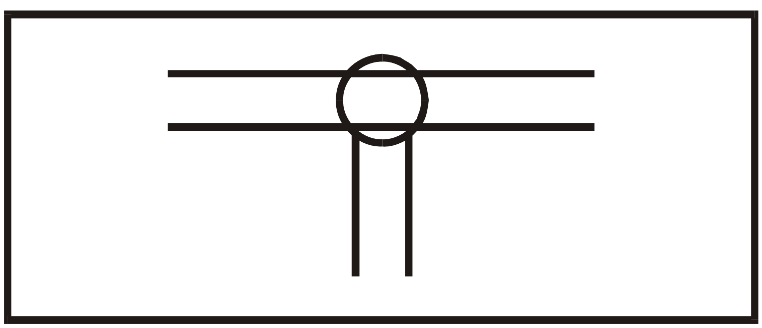
5. Jump Mechanism :



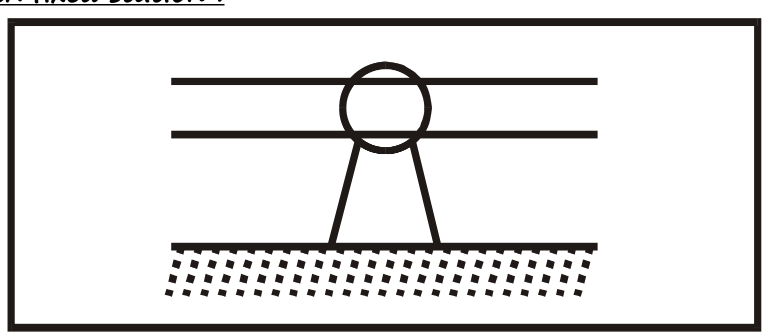
6. Hinge joint, simple :



7. Hinge joint extended lever :



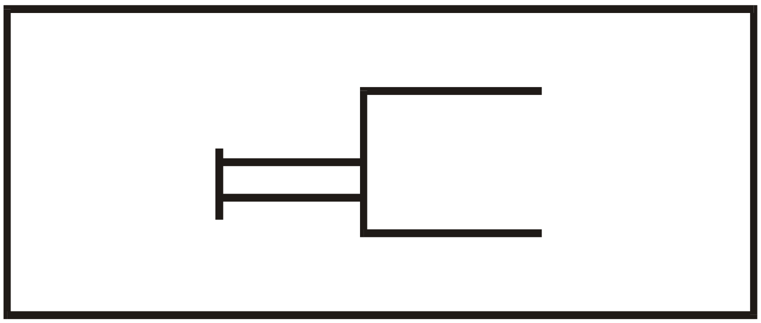
8. Hinge with fixed station :



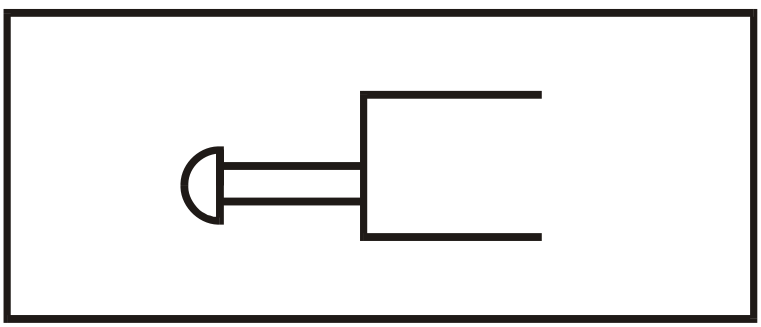
ACTUATING MEANS

OPERATOR ACTUATION :

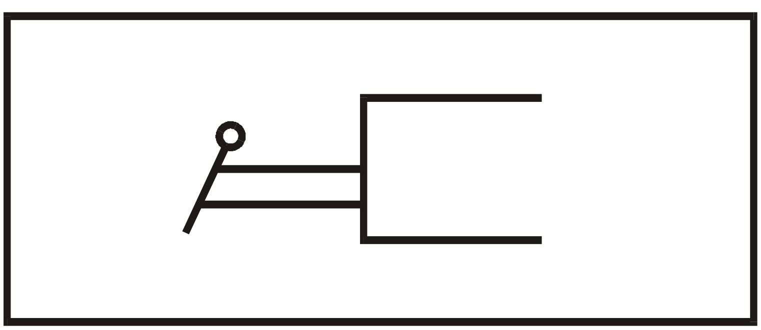
1. General :



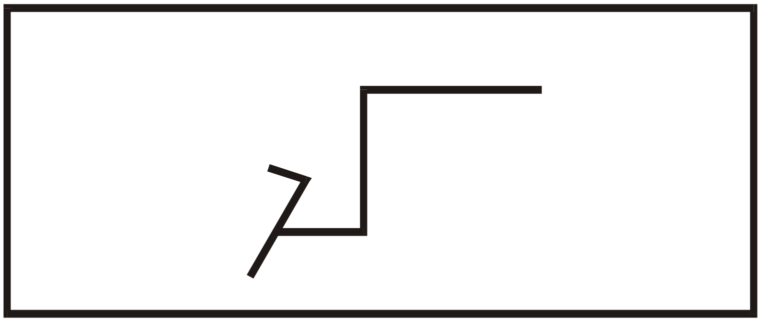
2. Push button :



3. Lever :

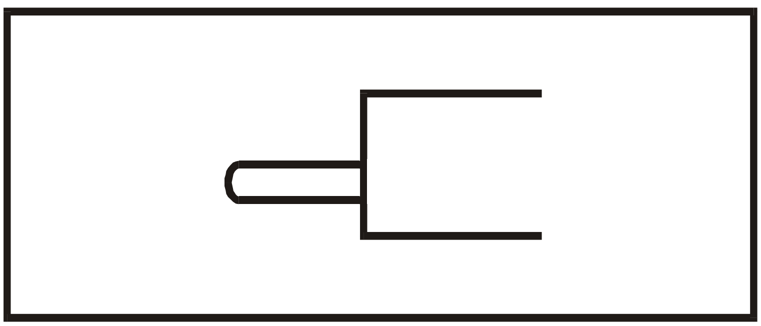


4. **Pedal :**

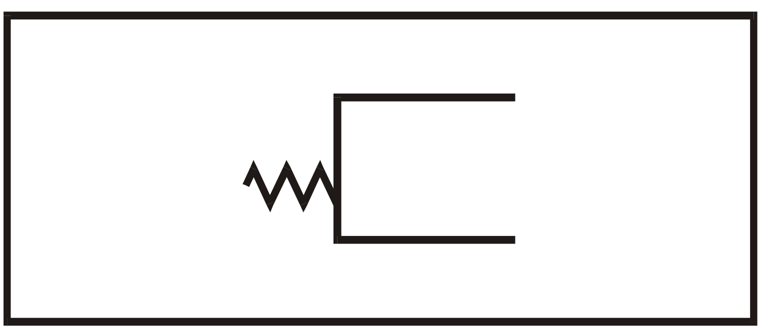


MECHANICAL ACTUATION :

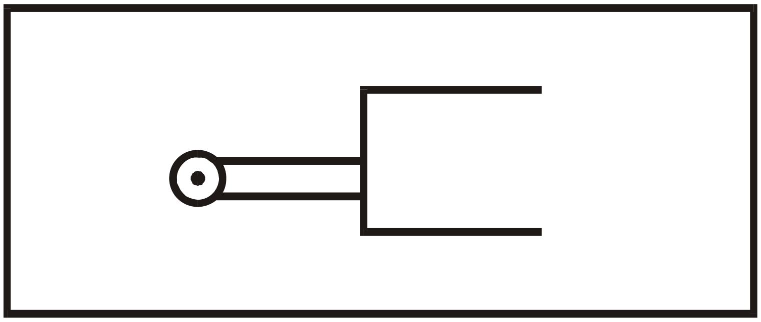
1. **Plunger :**



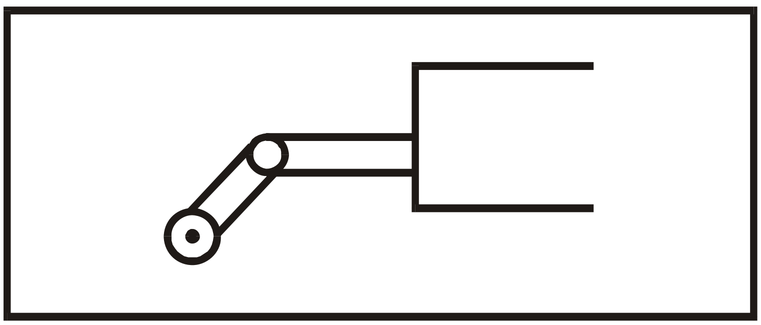
2. **Spring :**



3. Roller lever :

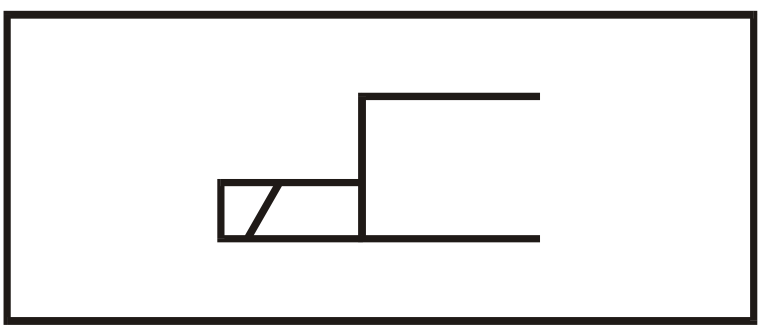


4. Roller lever with idle return :

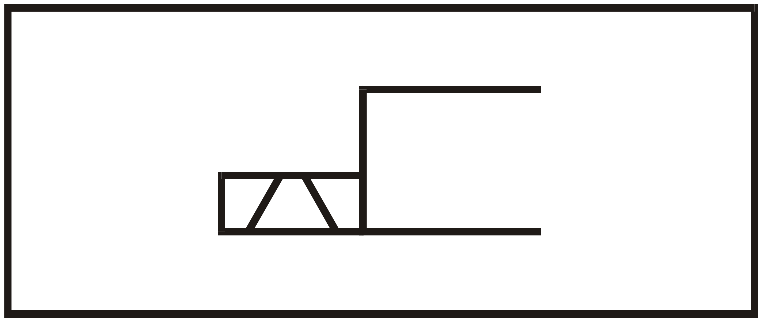


ELECTRICAL ACTUATION :

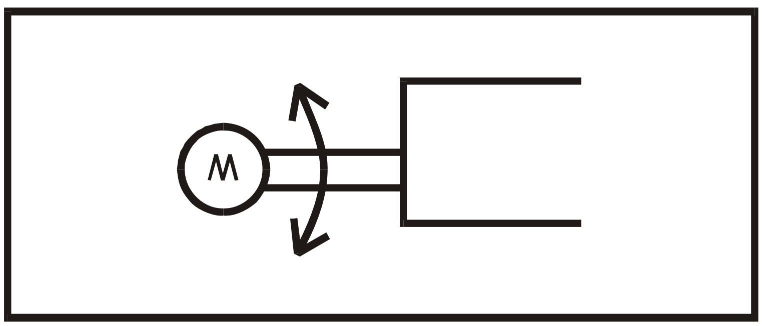
1. Solenoid with 1 effective winding :



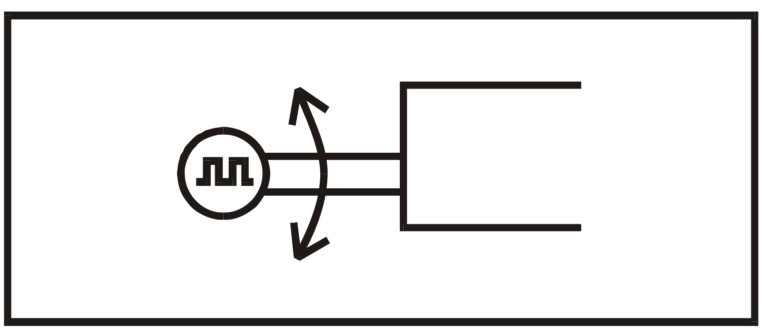
2. Solenoid e.g. with two opposing effective windings :



3. Electric motor with continuous rotary motion :

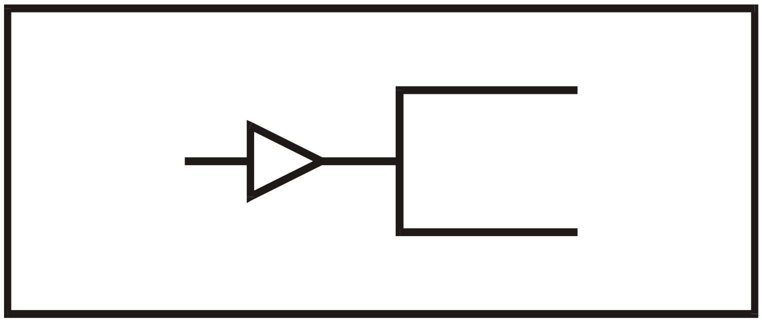


4. Electric stepping motor :

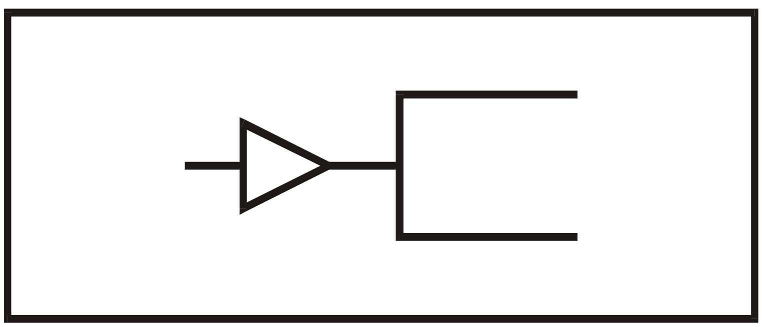


PNEUMATIC ACTUATION :

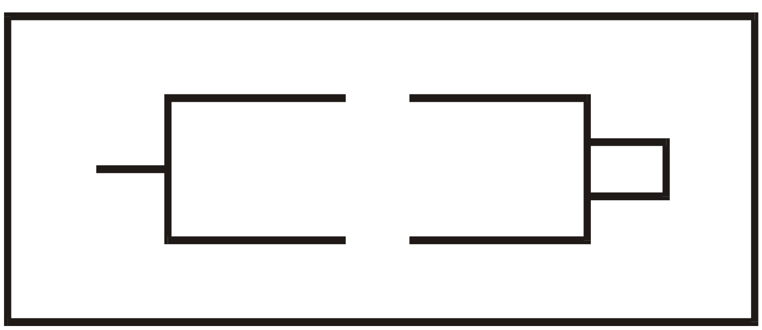
1. Direct by application of pressure :



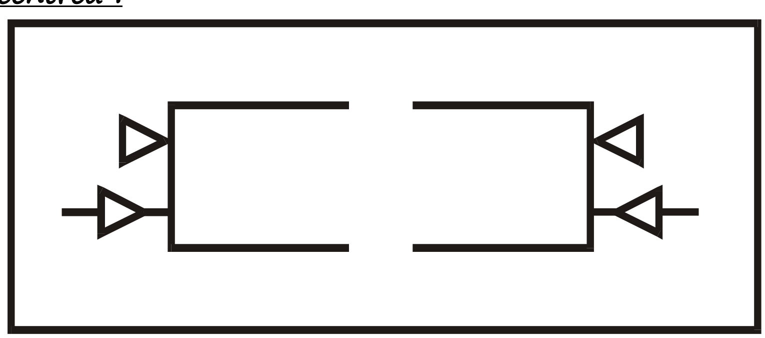
2. Direct by pressure relief :



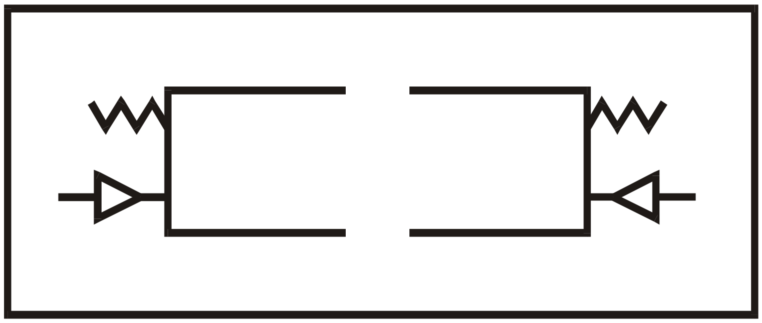
3. Differential pressure actuation :



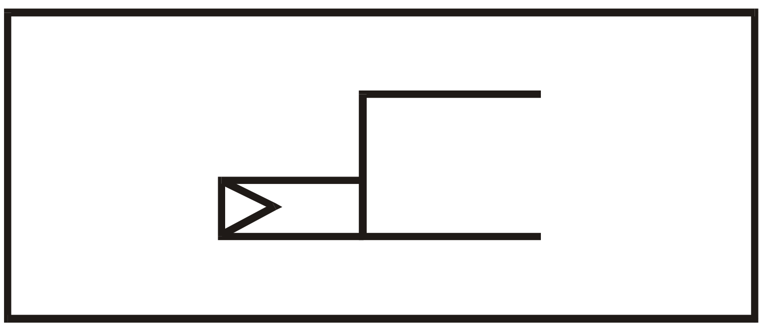
4. Pressure centred :



5. Spring centred :

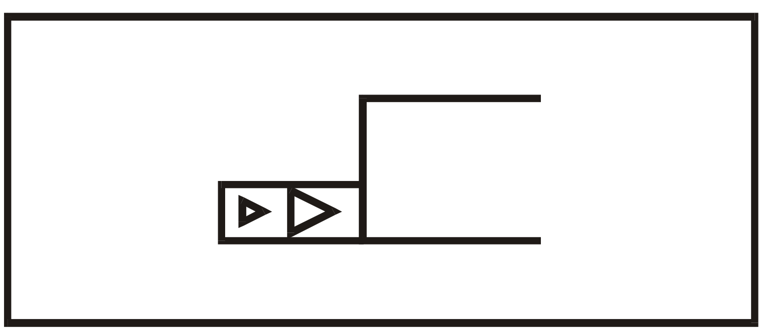


6. Indirect by application of pressure relief :

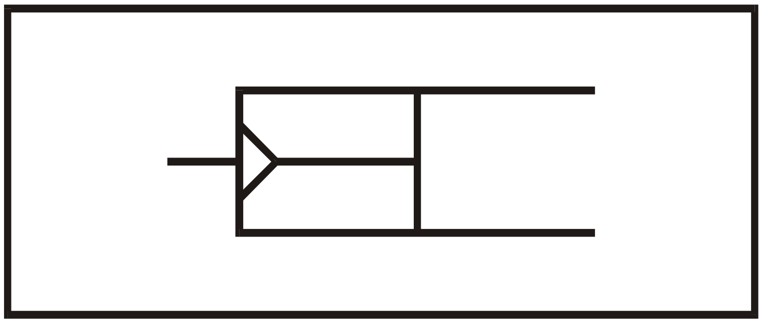


SPECIAL ACTUATION (NON STANDARDISED) :

1. Application of pressure from charged amplifier :

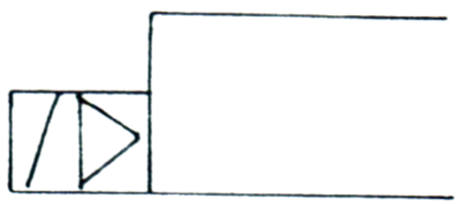


2. Application of pressure type of actuation produces alternating behaviour :

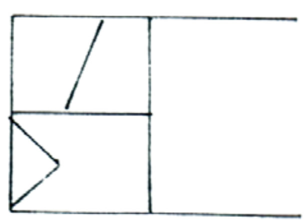


COMBINED ACTUATION :

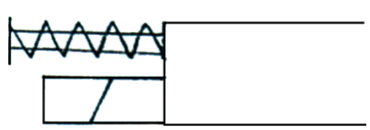
1. Solenoid & pilot valve :



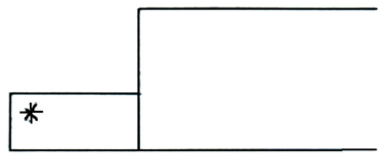
2. Solenoid or pilot valve :



3. Solenoid or manual actuation with preset :



4. General * : Explanatory symbol :

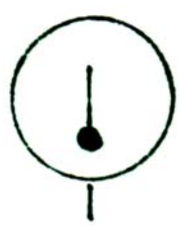


OTHER EQUIPMENT :

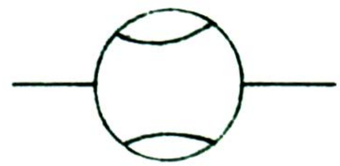
1. Pressure measuring instrument :

2. Differential pressure measuring instrument :

3. Temperature measuring instrument :

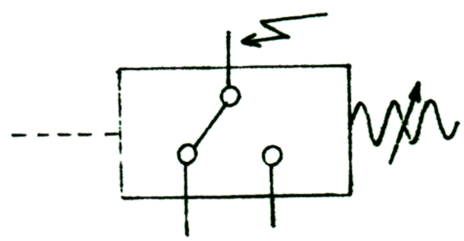


4. **Flow meter :**

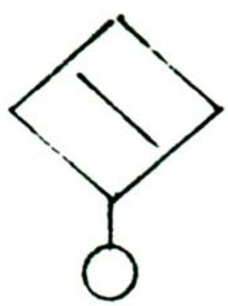


5. **Volumetric flow meter :**

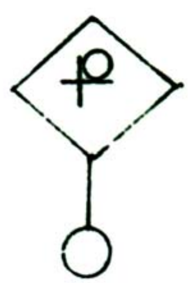
6. **Pressure switch :**



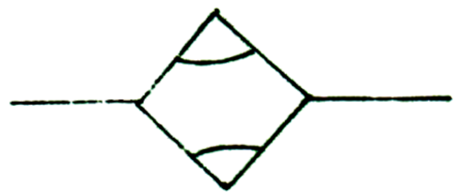
7. **Pressure probe :**



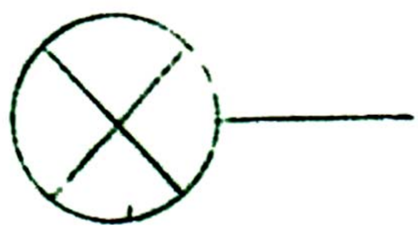
8. **Temperature probe :**



9. Flow probes :

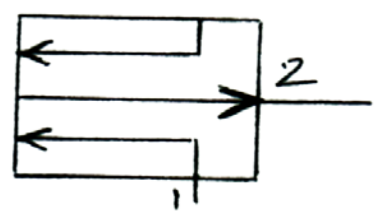


10. Optical indicator :

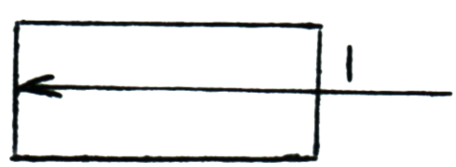


SPECIAL SYMBOLS (NOT STANDARDISED) :

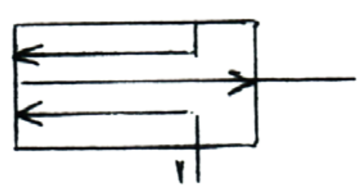
1. Reflex sensor :



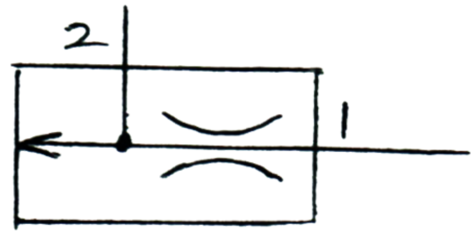
2. Nozzle, general, sender nozzle for air barrier :



3. Charged receiver nozzle for air barrier :



4. **Bade pressure sensor :**



LETTER SYMBOLS OF CONNECTIONS :

2, 4 / A, B, C	:	Working lines
I/P	:	Supply air, compressed air connection.
3, 5, 7 / R, S, T	:	Drain exhaust points.
L	:	Leakage liquid.
(10), 12, 14 / Z, Y, X	:	Control lines.

EXPERIMENT 1

AIM : To study 5/3 Way Hand Lever Valve.

EQUIPMENT USED :

1. FRL.
2. Manifold.
3. 5/3 way Hand Lever valve.
4. Double acting cylinder.

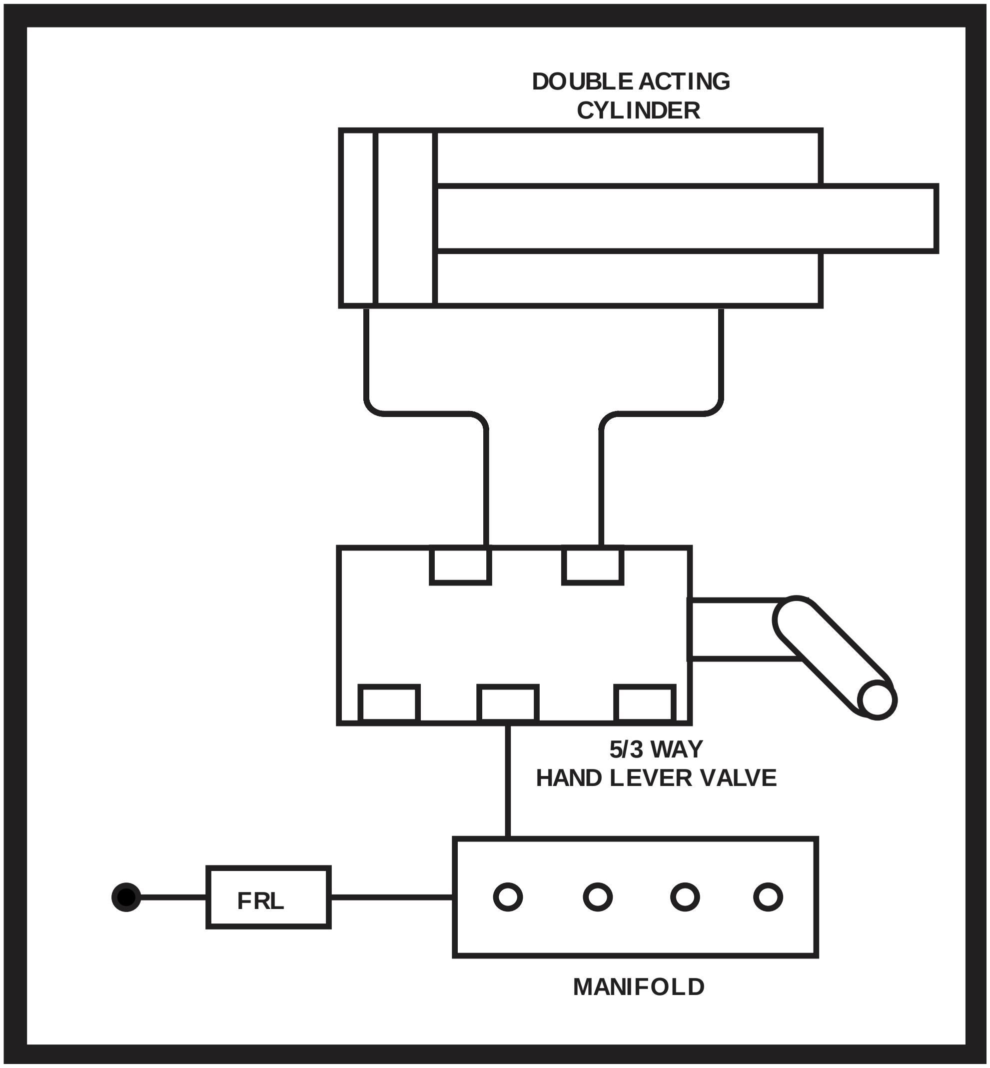
PROCEDURE :

1. Make the connection as shown.

2. Observe the motion of the cylinder piston after pressing the handle of hand lever valve in one direction. The cylinder piston extends.

3. Move the handle of the hand lever valve in other direction. The piston moves back to its original position.

4. Keep the handle of hand lever in middle position. no any action takes place.


DOUBLE ACTING
CYLINDER
5/3 WAY
HAND LEVER VALVE
FRL
MANIFOLD

EXPERIMENT 2

AIM : To study the 5/2 way Push Button Valve.

EQUIPMENT USED :

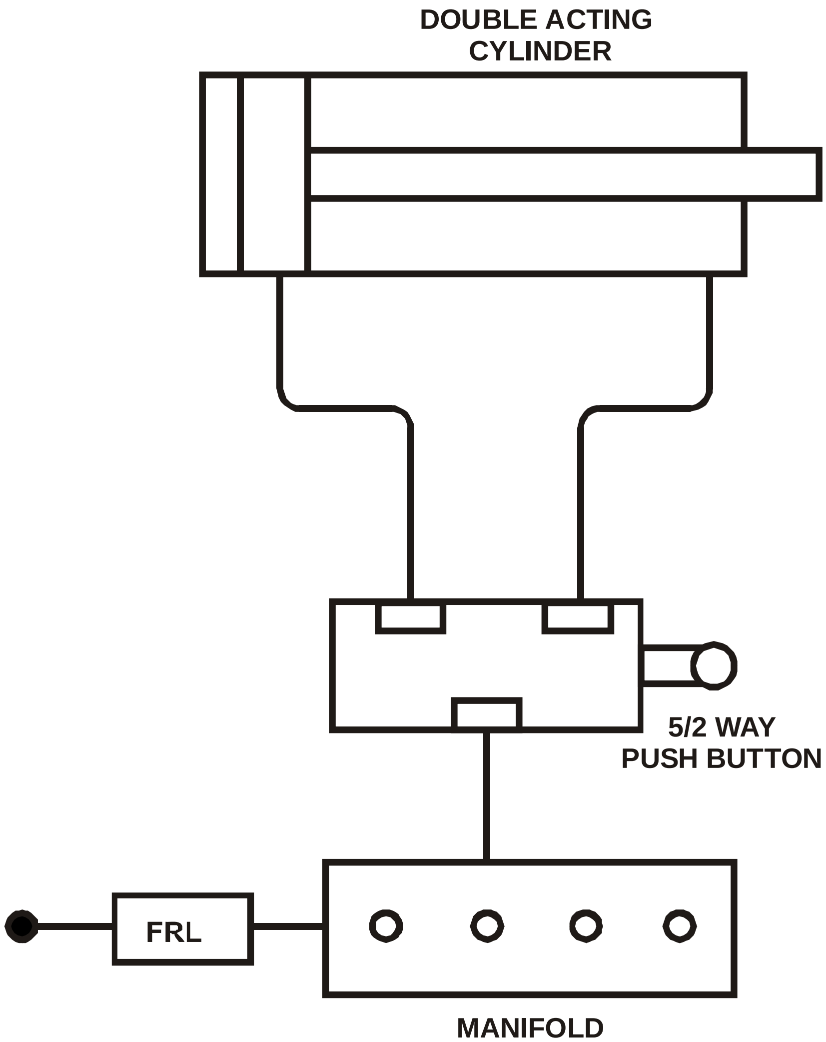
1. FRL Unit.
2. Manifold.
3. 5/2 way Push Button Valve.
4. Double Acting Cylinder.

PROCEDURE :

1. Make the connection as shown.

2. To actuate the 5/2 way push button valve either can push the knob or pull the knob.

3. If push the knob cylinder piston extend and if pull the knob, cylinder piston back in original position.


DOUBLE ACTING
CYLINDER
5/2 WAY
PUSH BUTTON
FRL
MANIFOLD

EXPERIMENT 3

AIM : To study 5/2 way single solenoid valve.

EQUIPMENT USED :

1. FRL Unit.
2. Manifold.
3. 5/2 way single solenoid valve.
4. Double acting cylinder.

PROCEDURE :

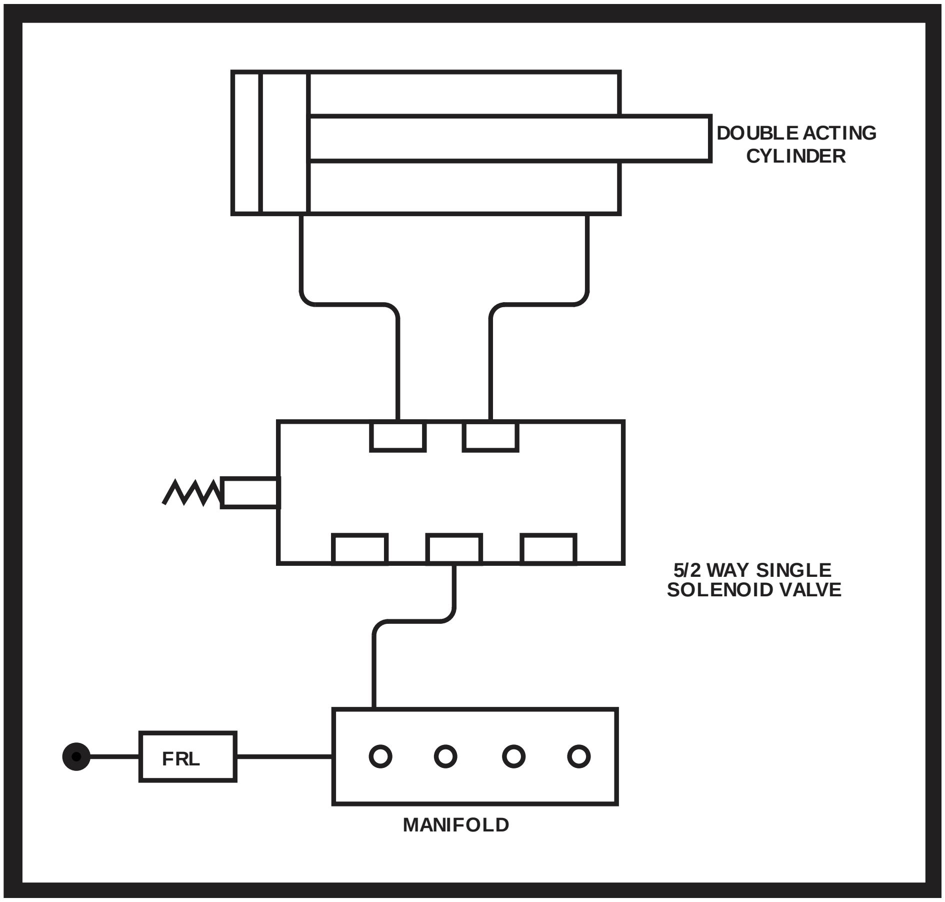
1. Make the connection as shown.

2. 5/2 way single solenoid valve is electrical operated valve.

   Beside the solenoid valve push button is provided. To actuate the valve press the button and observe the motion of double acting cylinder the cylinder piston extends.

3. After realising the button cylinder piston retracts.

4. While pressing the electrical button electro magnet creates in the coil and the valve change its position after realizing the button de – magnet the coil.


DOUBLE ACTING
CYLINDER
5/2 WAY SINGLE
SOLENOID VALVE
FRL
MANIFOLD

EXPERIMENT 4

AIM : To study 5/2 way Double solenoid valve.

EQUIPMENT USED :

1. FRL Unit.
2. Manifold.
3. 5/2 way double solenoid valve.
4. Double acting cylinder.

PROCEDURE :

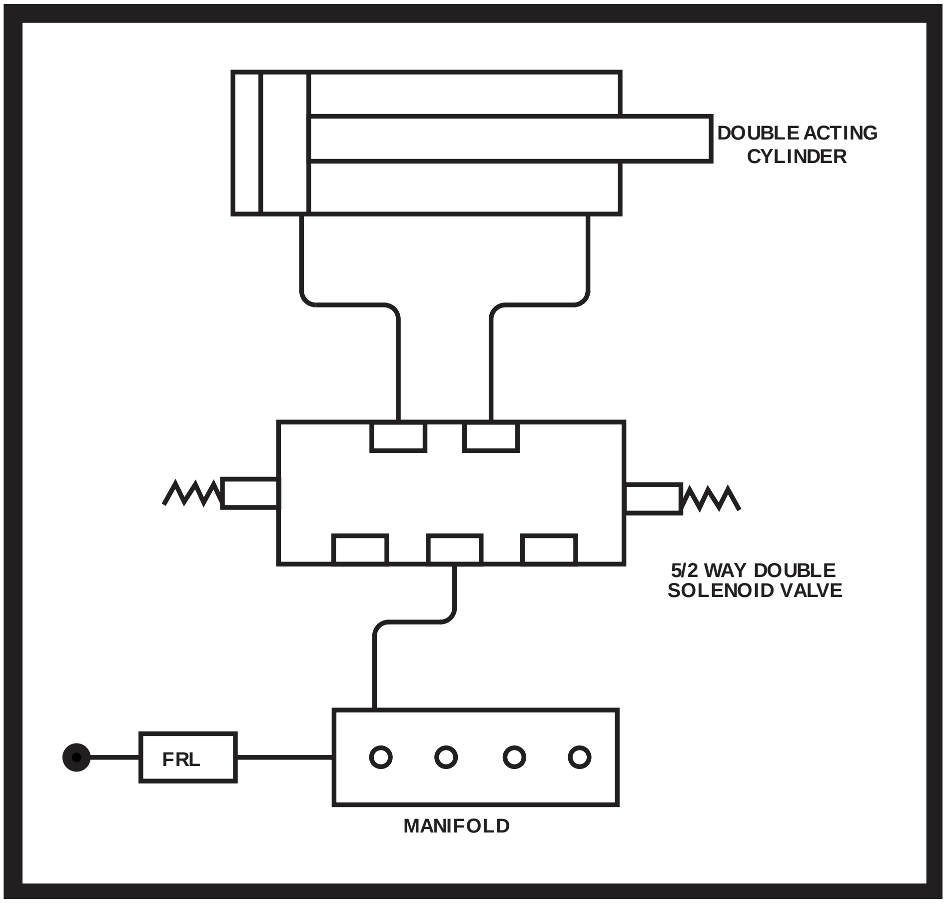
1. Make the connection as shown.

2. 5/2 way double solenoid valve is also electrical operated valve as the experiment is with double solenoid valve. Two individual press button is provided beside the solenoid valve.

   Beside the solenoid valve push button is provided. To actuate the valve press the button and observe the motion of double acting cylinder the cylinder piston extends.

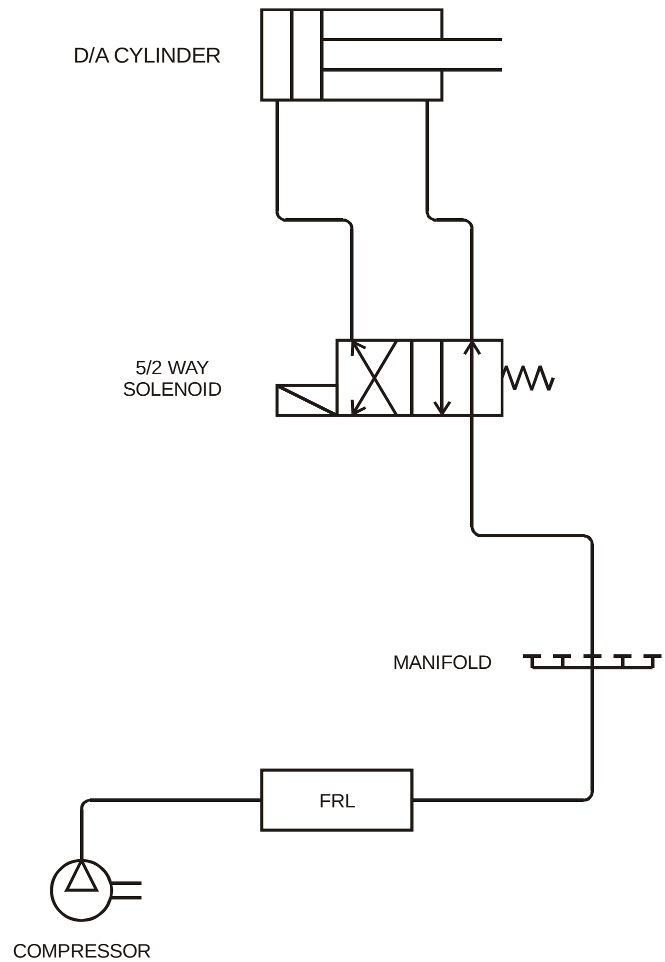
3. After realising the button cylinder piston retracts.

4. While pressing the electrical button electro magnet creates in the coil and the valve change its position after realizing the button de – magnet the coil.


DOUBLE ACTING
CYLINDER
5/2 WAY DOUBLE
SOLENOID VALVE
FRL
MANIFOLD

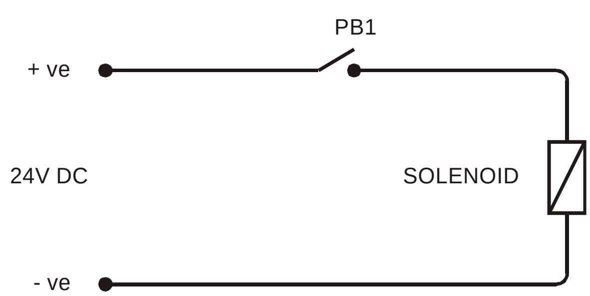
EXPERIMENT 5

OPERATION OF D/A CYLINDER 5/2 WAY DIRECTION CONTROL VALVE



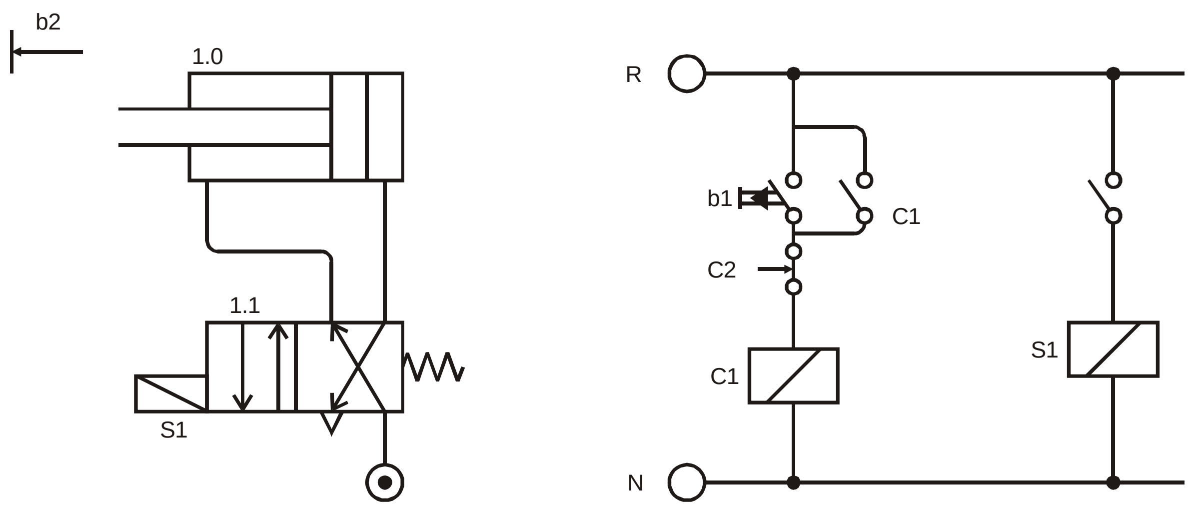
1. Connect the components as shown in circuit pneumatically / electrically.
2. Start the air supply cylinder motion starts in the one direction.
3. Energize the coil, it starts movement in another direction.

ELECTRICAL DIAGRAM :



EXPERIMENT 6

STUDY OF CONNECTION OF CONTACTORS WITH SELF HOLDING

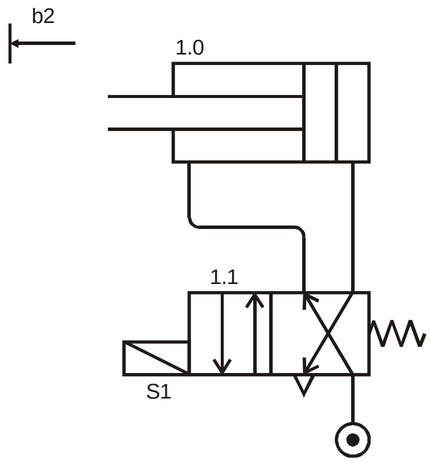


(a) (b)

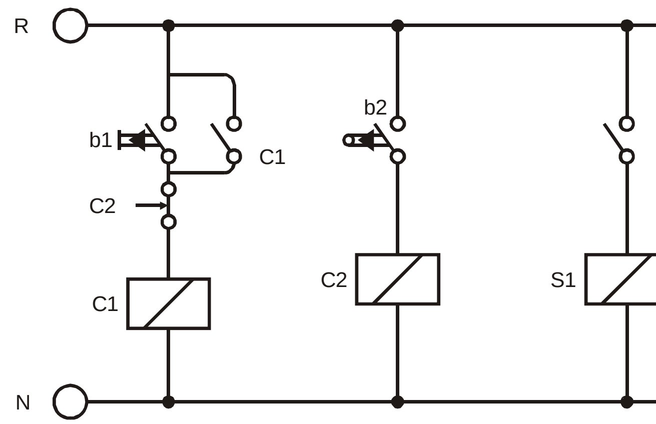
It may be necessary to introduce some sort of time dependent '**holding**' characteristics into the electrical circuit designed to operated the solenoid valves. This '**holding**' behavior may be imparted either to the '**off**' or '**on**' signal to the circuit, for this purpose auxiliary contactors in combinations with the switches are used. The above figure shows the pneumatic and electrical circuit diagrams for the above problem. Here the cylinder moves out with the momentary switching function of manual switch B1. Even when B1 is released the NC contactors C2 will allow energy through C1 till the cylinder at the end of its stroke.

EXPERIMENT 7

AUTOMATIC RETURN CONTROL OF A DOUBLE ACTING CYLINDER



(a)



(b)

It may be necessary to introduce some sort of time dependent '**holding**' characteristics into the electrical circuit designed to operated the solenoid valves. This '**holding**' behavior may be imparted either to the '**off**' or '**on**' signal to the circuit, for this purpose auxiliary contactors in combinations with the switches are used. The above figure shows the pneumatic and electrical circuit diagrams for the above problem. Here the cylinder moves out with the momentary switching function of manual switch B1. Even when B1 is released the NC contactors C2 will allow energy through C1 till the cylinder at the end of its stroke, contacts the limit switch B2. Transformer hence it return to its initial position.

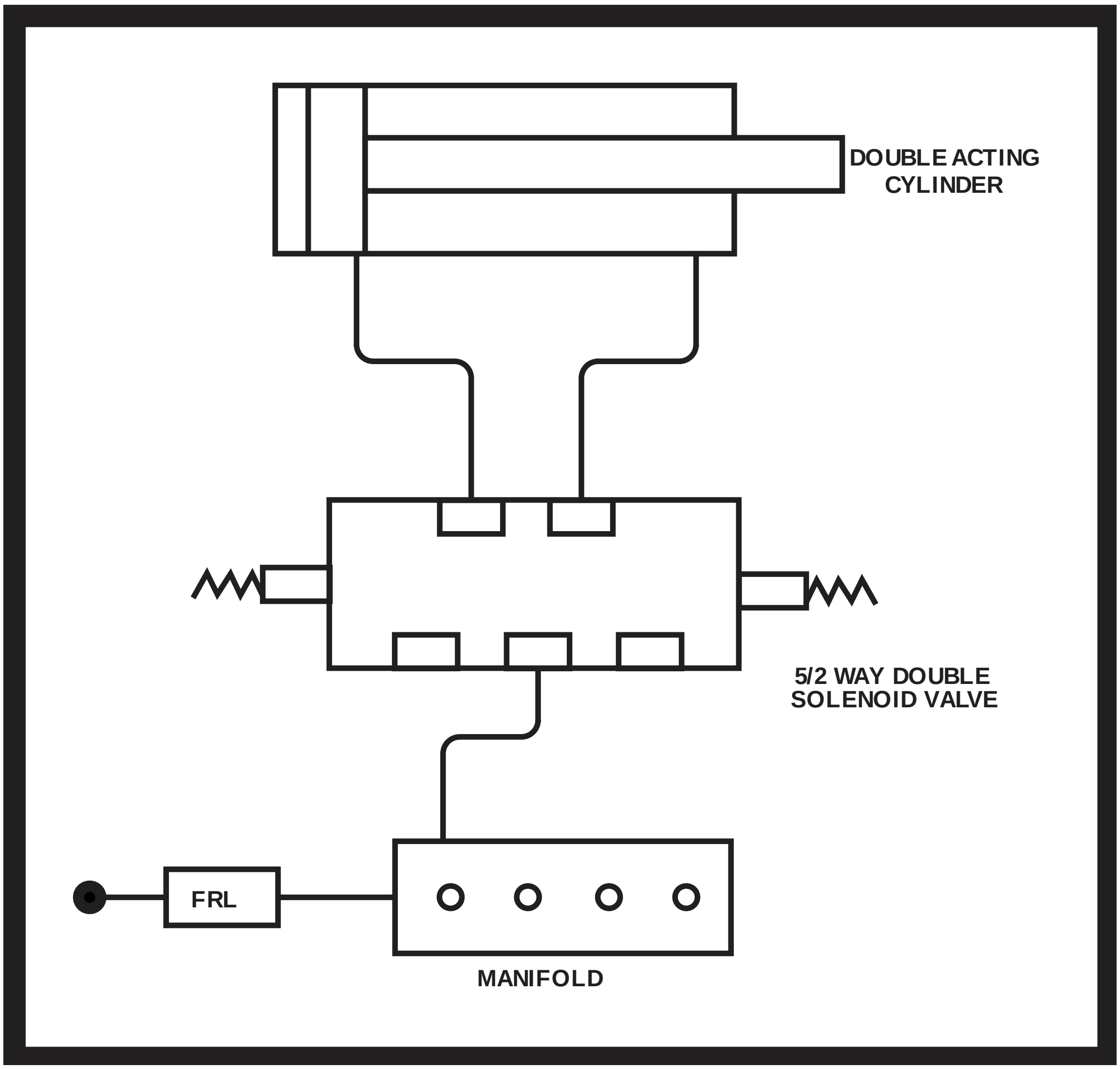
PLC

EXPERIMENTS

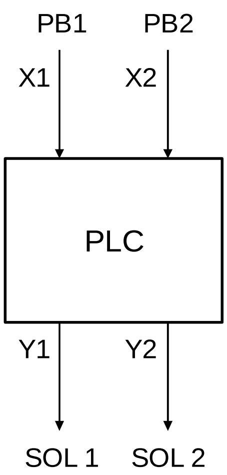
EXPERIMENT NO. 1

1. Operated Double Acting Cylinder Using 5/2 Double Solenoid Valve Using Push Button.

PNEUMATIC CIRCUIT :



ELECTRICAL CIRCUIT :



OPERATION :

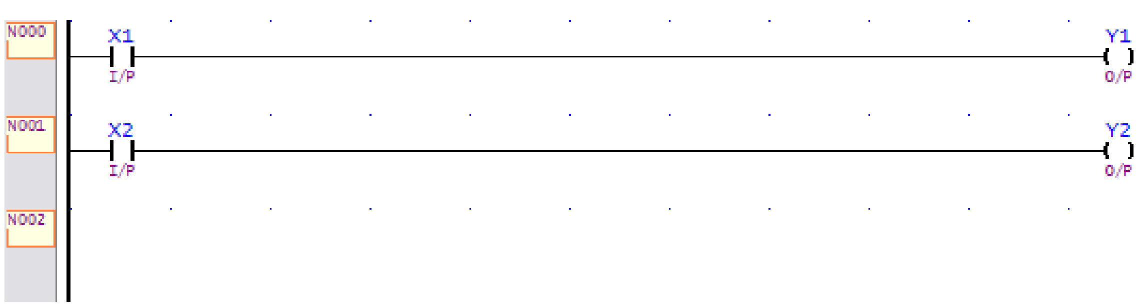
1. Make connections as shown in Pneumatic Circuit.
2. Connect the electrical connections as per electrical circuit diagram.
3. Push Button PB1 and observe the movement of cylinder.

   When push button PB1 is energized the solenoid coil 1 on D.A. Cylinder is energized and the plunger moves forward.

4. Now release PB1 and push button PB2 and observe the movement of cylinder.

You will see that solenoid 2 on D.A. Cylinder is energized and the plunger of D.A. Cylinder moves backward.

PLC LADDER DIAGRAM :



INPUTS

4 X1 - Push Button PB1

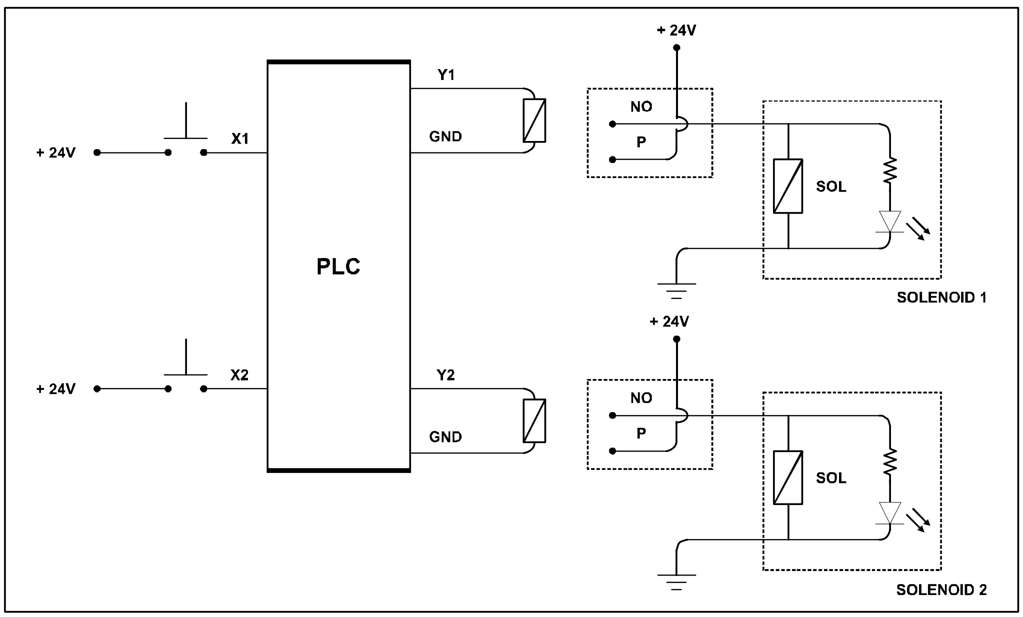
4 X2 - Push Button PB2

OUTPUTS

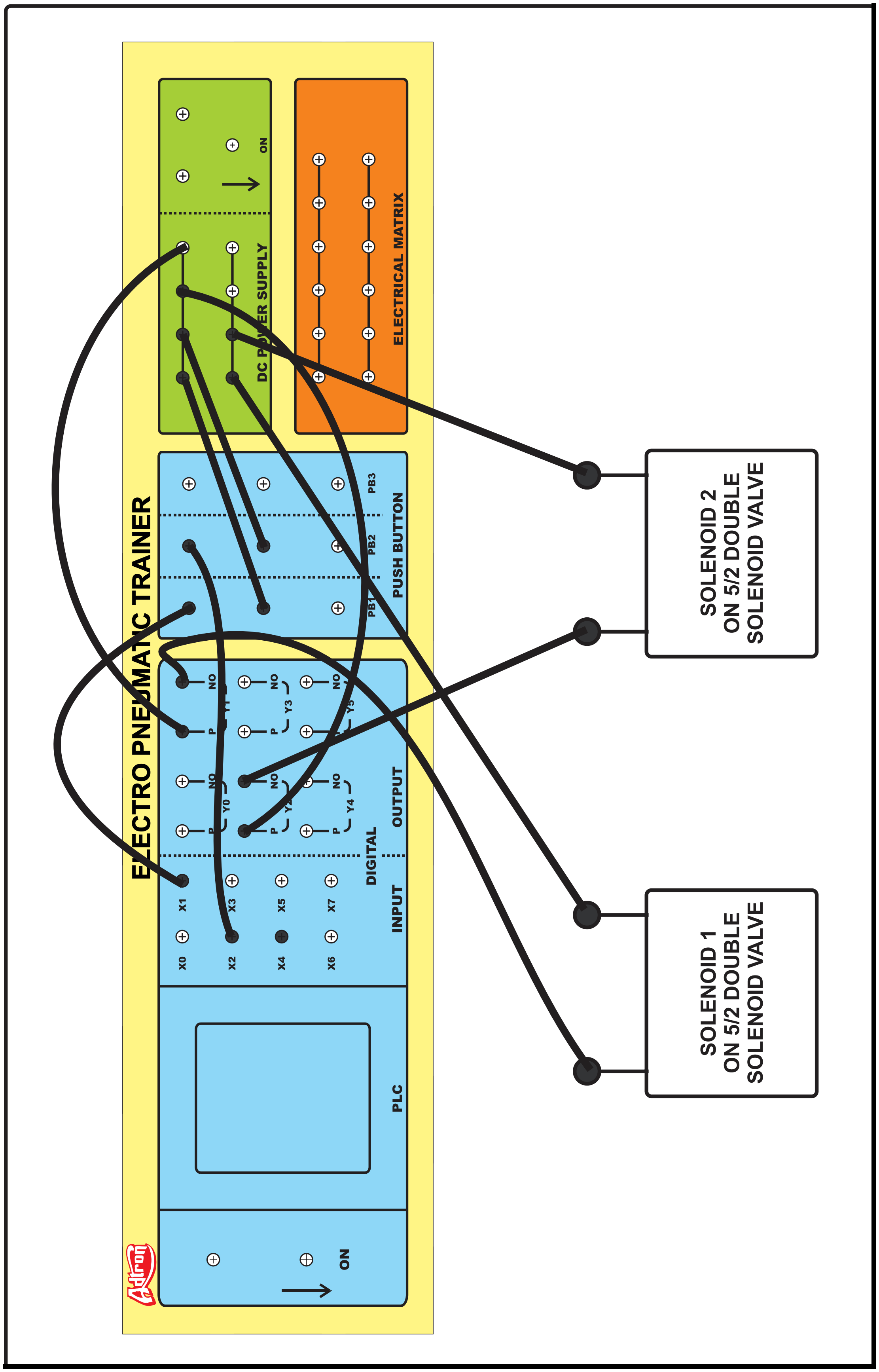
4 Y1 - Solenoid 1 of 5/2 D.S. Valve

4 Y2 - Solenoid 2 of 5/2 D.S. Valve

ELECTRICAL CIRCUIT :



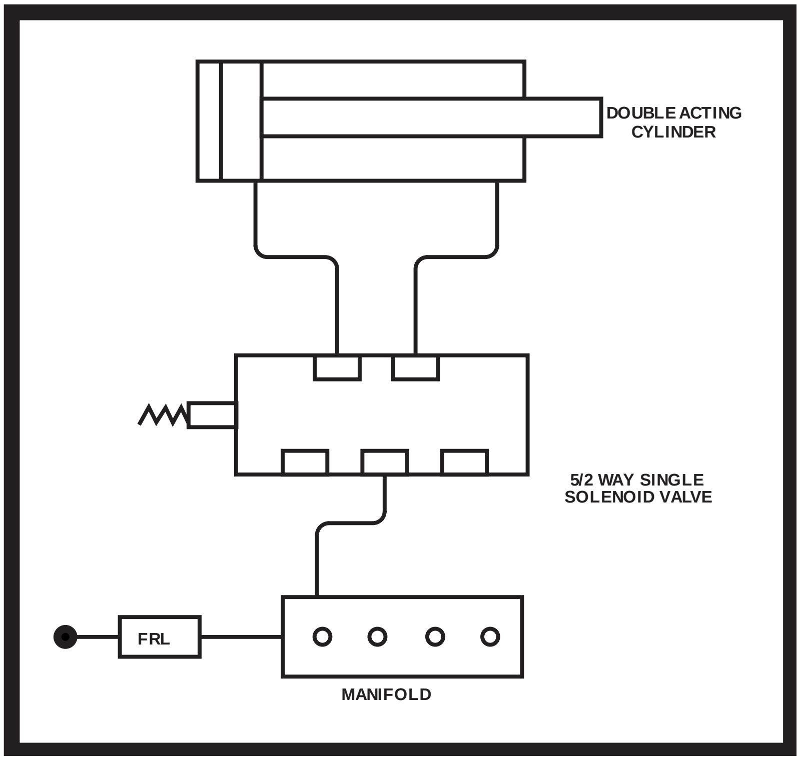
CONNECTION DIAGRAM :



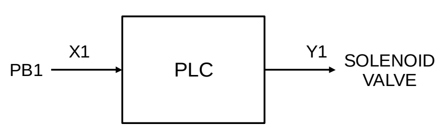
EXPERIMENTS NO. 2

1. Operated Single Acting Cylinder Using 5/2 Single Solenoid Valve Using Push Button.

PNEUMATIC CIRCUIT :



ELECTRICAL CIRCUIT :



OPERATION :

1. Make connections as shown in Pneumatic Circuit.
2. Connect the electrical connections as per electrical circuit diagram.
3. Start the power pack and observe the operation of D.A. Cylinder.

You will observe that the plunger moves out and remains there. This is the normal position of 5/2 Single Solenoid Valve.

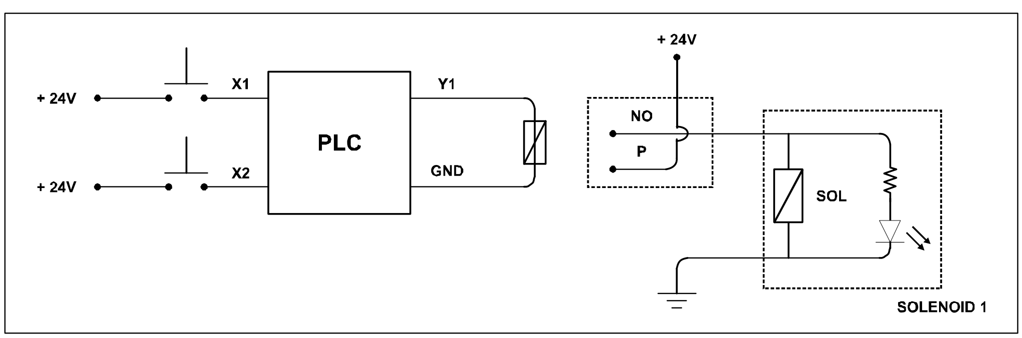
4. Now push PB1 and observe the operation of D.A. Cylinder.

   You will observe that the plunger moves in and stays there as long as PB1 is pressed. It gives back to normal position when PB1 is released.

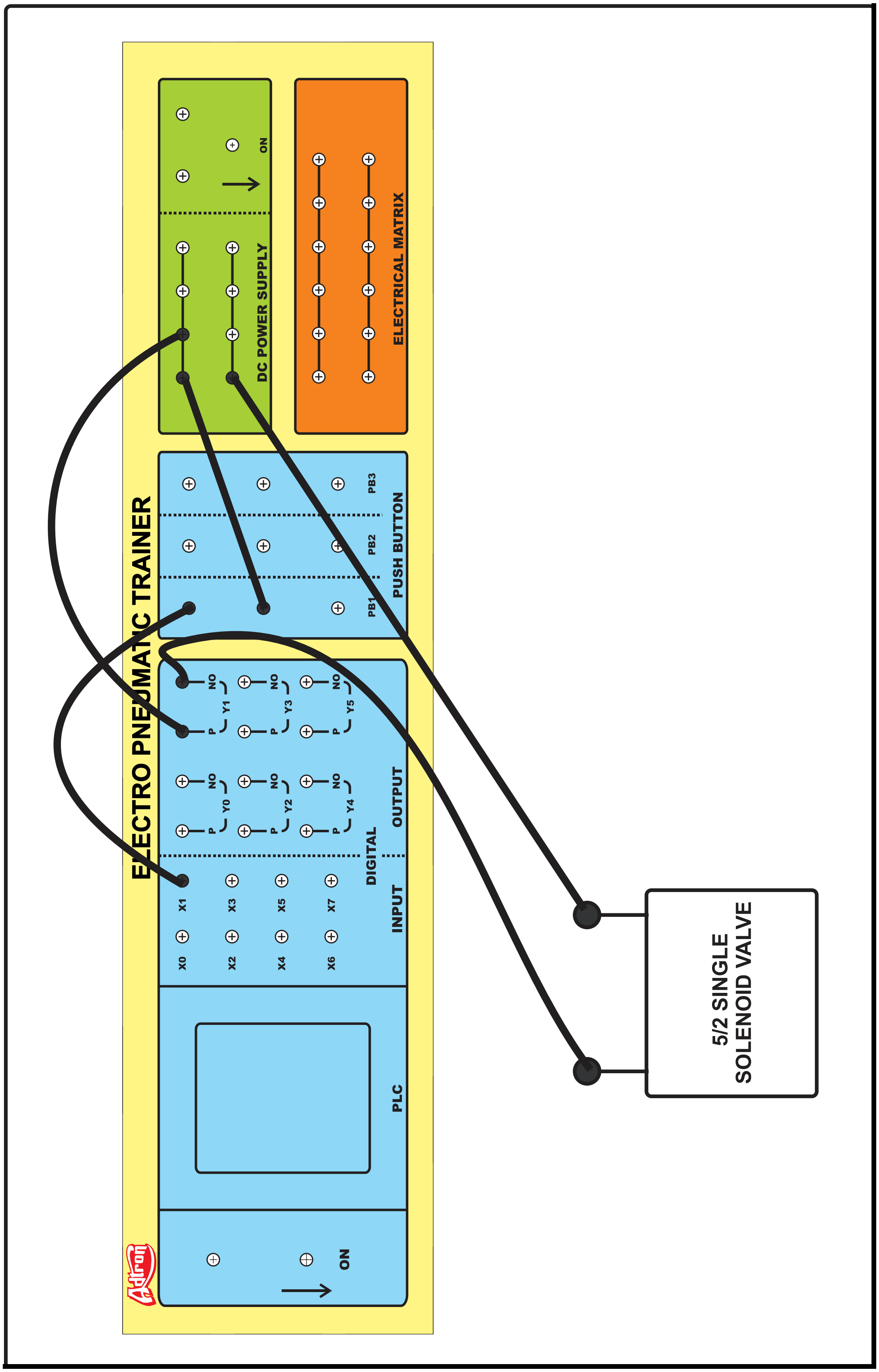
LADDER DIAGRAM :

INPUTS	**OUTPUTS**
4 X1 - Push Button PB1	4 Y1 - Solenoid 1 of 5/2 D.S. Valve

ELECTRICAL CIRCUIT :



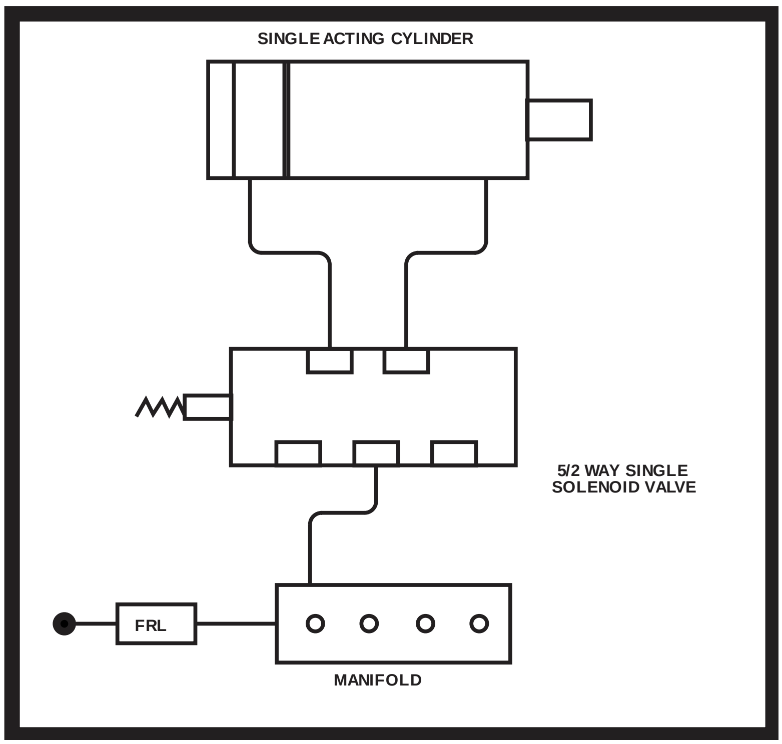
CONNECTION DIAGRAM :



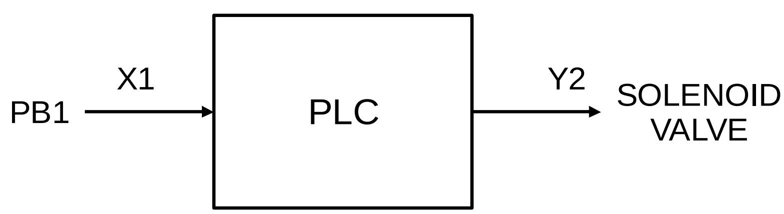
EXPERIMENTS NO. 3

1. Operated Single Acting Cylinder With 5/2 Single Solenoid Valve With Timer Base.

PNEUMATIC CIRCUIT :



ELECTRICAL CIRCUIT :



OPERATION :

1. Make connections as shown in Pneumatic Circuit.
2. Connect the electrical connections as per electrical circuit diagram.
3. Start the power pack and observe the operation of D.A. Cylinder.

You will observe that the plunger moves out and remains there. This is the normal position of 5/2 Single Solenoid Valve.

4. Now press PB1 momentarily and observe the operations of D.A.

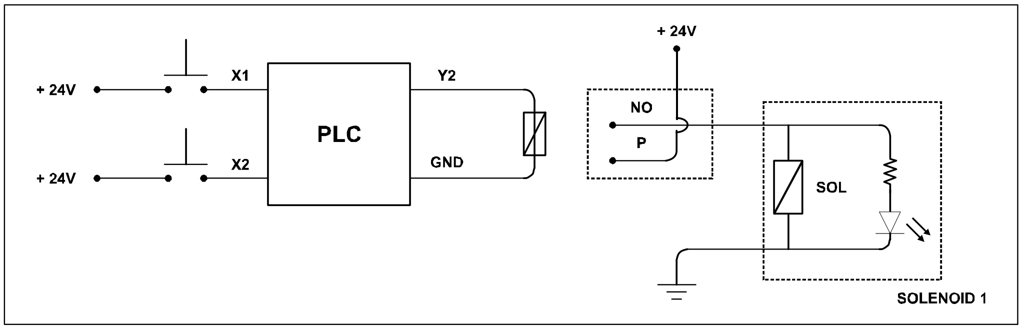
You will observe that when PB1 is pressed momentarily, it initiation a timer is PLC which energized output Y2 and keep Y2 energized for time set in the timer.

Since Y2 is energized, the solenoid coil on 5/2 single solenoid valve is energized and the plunger of D.A cylinder goes back, when timer goes to zero, it de - energized Y2 and hence solenoid is de - energized and 5/2 single solenoid valve comes back to normal positions. This process goes on indefinitely.

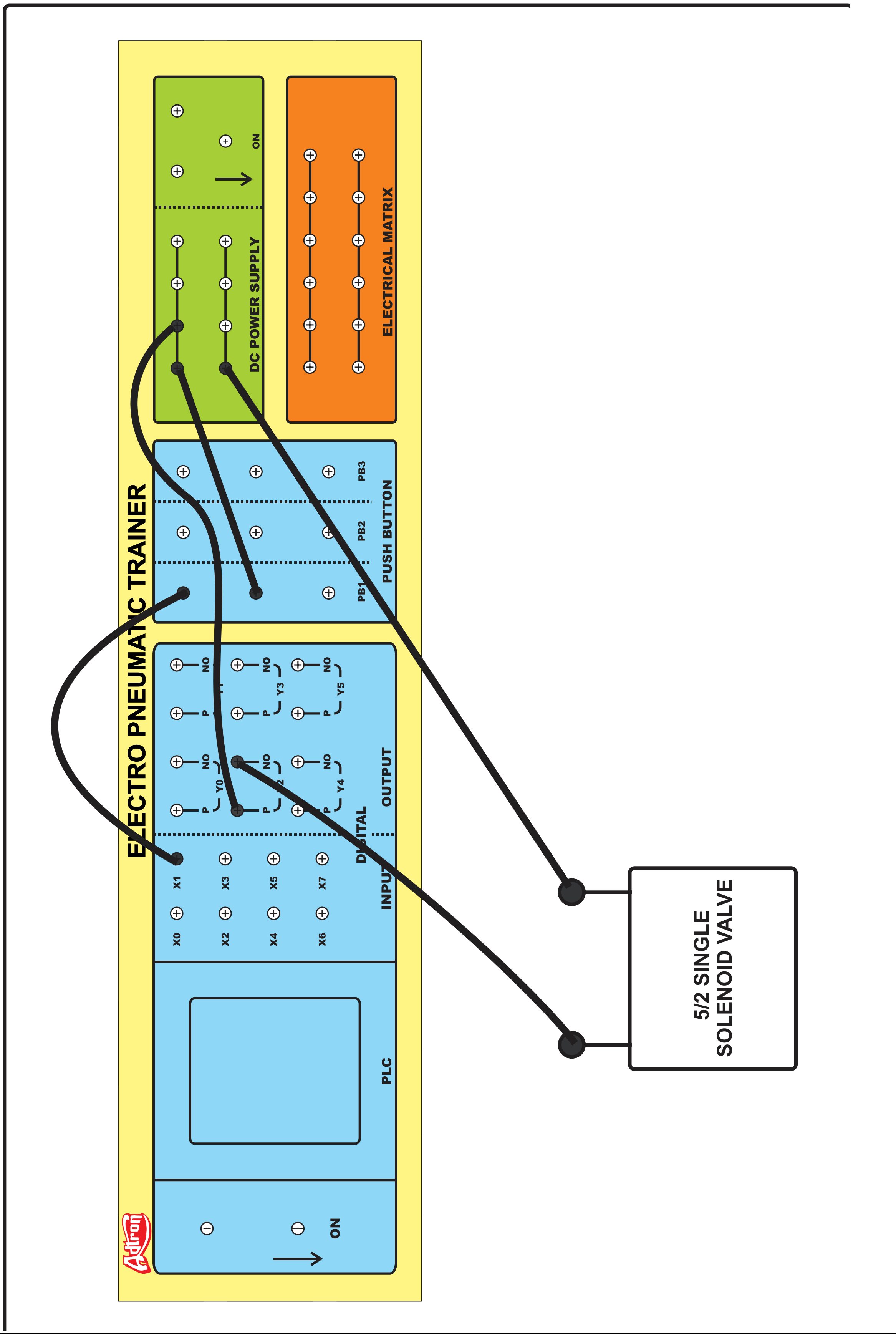
LADDER DIAGRAM :

INPUTS		**OUTPUTS**	
4	X1 - Push Button PB1	4	Y2 - Solenoid 2 of 5/2 S.S. Valve

ELECTRICAL CIRCUIT :



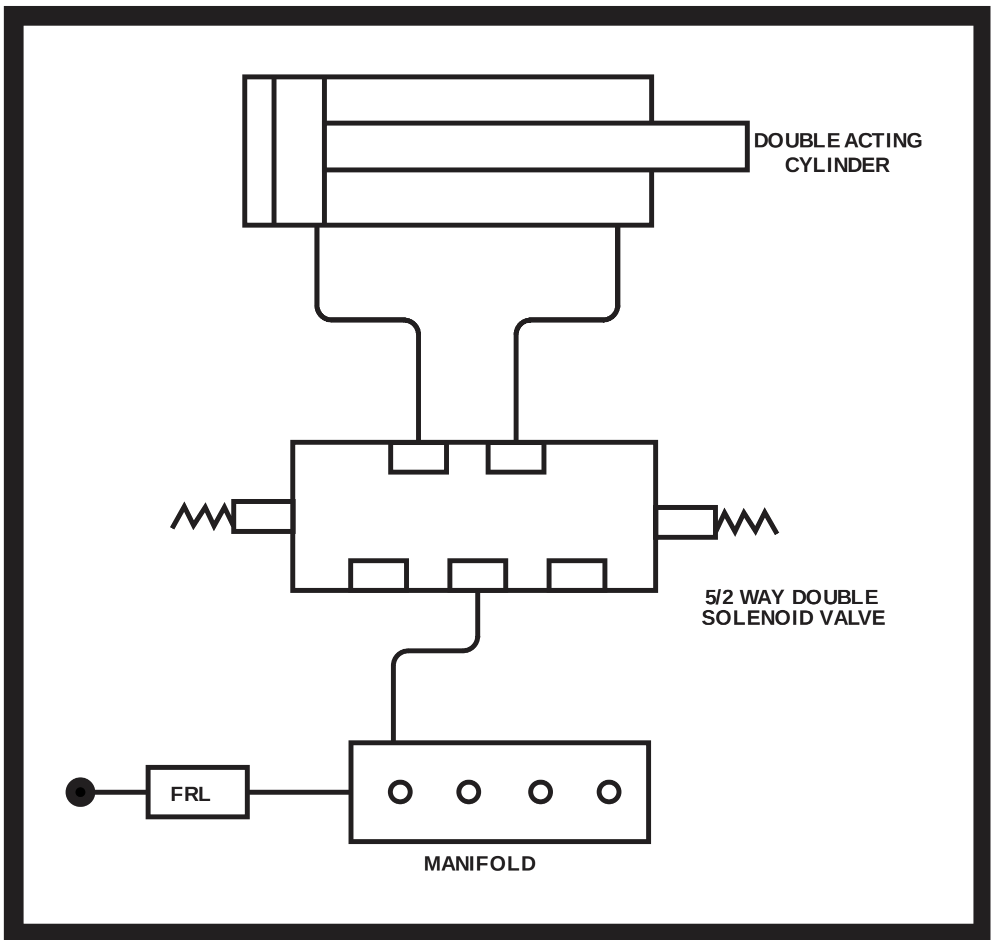
CONNECTION DIAGRAM :



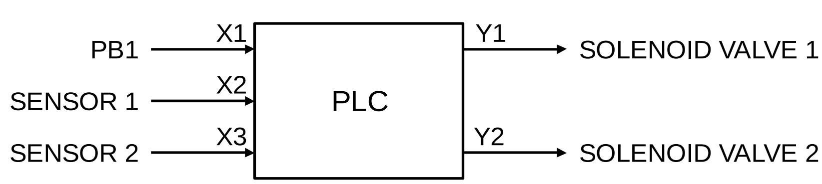
EXPERIMENTS NO. 4

1. Operate Double Acting Cylinder Using 5/2 Way Double Solenoid Valve Using Sensors.

PNEUMATIC CIRCUIT :



ELECTRICAL CIRCUIT :



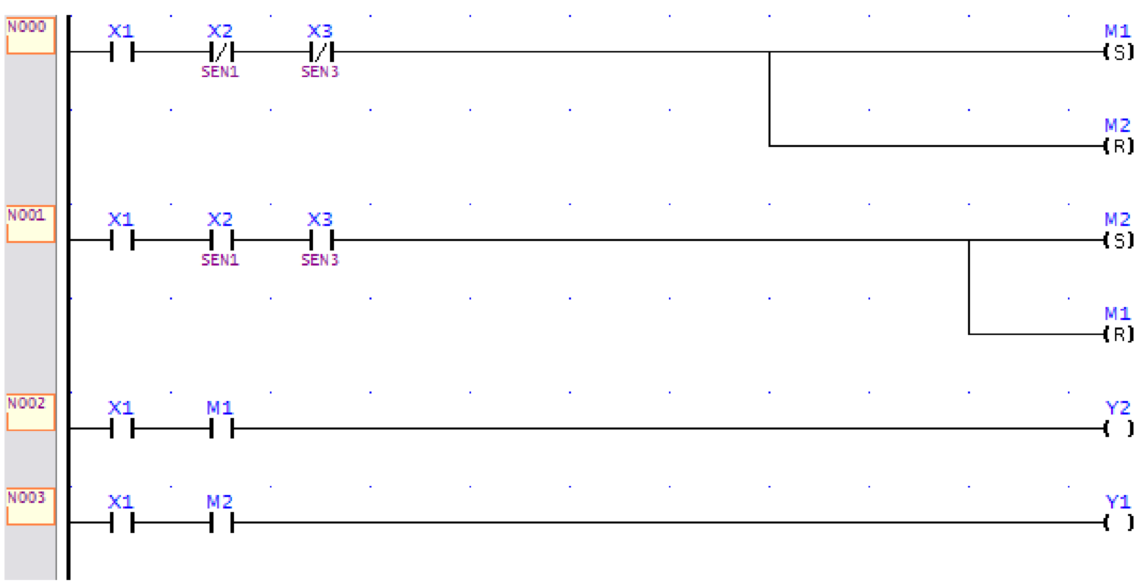
OPERATION :

1. Make connections as shown in Hydraulic Circuit.
2. Connect the electrical connections as per electrical circuit diagram.
3. Push Button PB1 and observe the movement of cylinder.

   When push button PB1 is energized the solenoid coil 1 on D.A. Cylinder is energized and the plunger moves forward.
4. Now release PB1 and push button PB2 and observe the movement of cylinder.

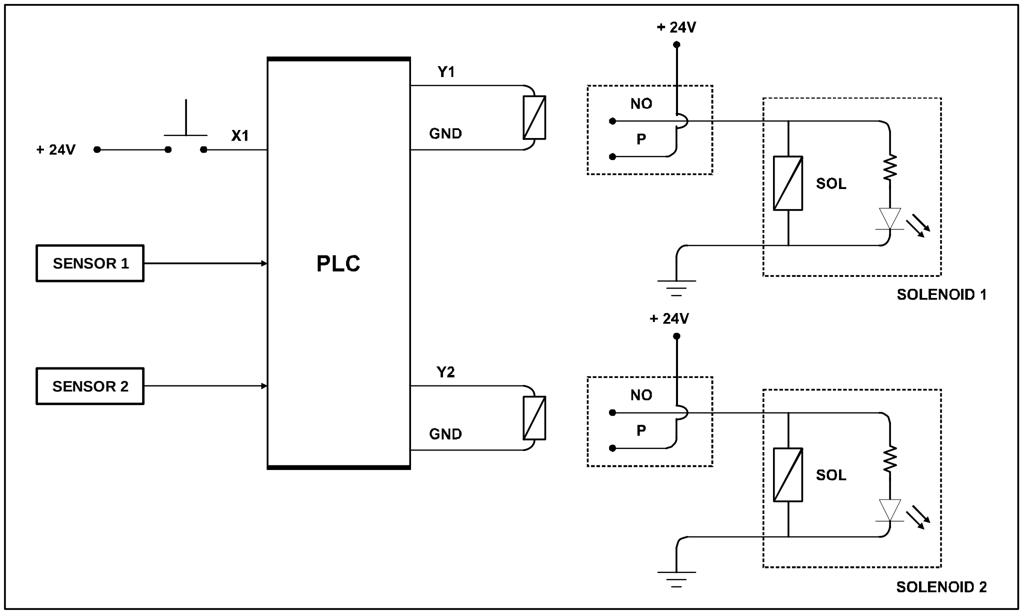
You will see that solenoid 2 on D.A. Cylinder is energized and the plunger of D.A. Cylinder moves backward.

PLC LADDER DIAGRAM :



INPUTS	OUTPUTS
X1 - Push Button PB1	Y1 - Solenoid 1 of 5/2 D.S. Valve
X2 – Reed Switch 1	Y2 - Solenoid 2 of 5/2 D.S. Valve
X3 - Reed Switch 2	

ELECTRICAL CIRCUIT :



CONNECTION DIAGRAM :