Pneumatic Trainer Kit

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Function & identification of Pneumatic components & their symbols.

Functional diagrams.

To empower students to design their own circuits.

Study of pneumatic actuator & reciprocating cylinder trainer kit

Abstract:-

Electro pneumatics is successfully used in many areas of industrial automation. Production, assembly and packaging systems worldwide are driven by electro pneumatic control systems. The change in requirements together with technical advances has had a considerable impact on the appearance of controls. In the signal control section, the relay has increasingly been replaced by the programmable logic controller in order to meet the growing demand for more flexibility. Modern electro pneumatic controls also implement new concepts in the power section to meet the needs of modern industrial practice. Examples of this are the valve terminal, bus networking and proportional pneumatics. In introducing this topic, this project first looks at the structure and mode of operation of the components used for setting up an electro pneumatic control. The following chapters then look at the approach to project planning and the implementation of electro pneumatic controls using fully worked examples. Finally, we had a positive approach towards our project and by looking towards the trends and developments in electro pneumatics this work was completed which would be a path shown by us towards the development of electro pneumatics trainer kits. Our work was based on controllers and relays but not on P.L.C, but we would rather say that if neglecting the cost of P.L.C, this kit could also be controlled from remote places also and better controlled signals could also be delivered if we had used P.L.C. Our circuits are based on 24 V D.C and working pressure was 0.15 MPa to 0.8Mpa.we had found that by considering this very working pressure the valves/cylinders behave in a good manner rather than creating a hammering effect by using more air pressure.
1. Introduction

Pneumatics is successfully used in many areas of industrial automation. **Pneumatic Trainer** facilitates the students and the industrial professionals to explore the fundamental of “pneumatics”. It tells how one device can be used to manage, command, direct or regulate the behavior of other system.

Pneumatics is a branch of science that is related with *Air*. In pneumatics the working medium is “Compressed Air”. Now-a-days this working medium is becoming very popular in industries like chemical, petroleum, gases, food & beverage, robotics, machineries etc. The reason for being so popular is that it is fire free and nonhazardous to our environment. And it is abundantly available in nature. It is very easy, simple and safe to operate. Pneumatic Trainer assist user to understand the principle performance of the pneumatic components as well as different actuators. Another additional feature of Pneumatic Trainer, it has both manual and automatic based control.

![Pneumatic Trainer Kit](image)

**Fig.1- Pneumatic Trainer Kit**

Pneumatic Trainer Kits are known for their accuracy and precision. The Pneumatic Trainer Kits are well tested on the stringent industry parameters by the team of experts which assures the quality of the final product. Pneumatic systems are used in controlling train doors, automatic production lines, mechanical clamps, etc Fig. 1.

Pneumatic Trainer provides different types of valves such as electronic and mechanical. This helps to understand the user about manual and automatic process. There are wide range of experiments provided on the trainer that can be performed.
2. Components of Pneumatic Trainer Kit

2.1. Compressor :-

A compressor can compress air to the required pressures. It can convert the mechanical energy from motors and engines into the potential energy in compressed air (Fig. 2). A single central compressor can supply various pneumatic components with compressed air, which is transported through pipes from the cylinder to the pneumatic components. Compressors can be divided into two classes: reciprocator and rotary.

![Air Compressor Image](image)

Fig.2.1- Air Compressor

The reason for using pneumatics, or any other type of energy Transmission on a machine, is to perform work. The accomplishment of work requires the application of kinetic energy to a resisting object resulting in the object moving through a distance. In a pneumatic system, energy is stored in a potential state under the form of compressed air. Working energy (kinetic energy and pressure) results in a pneumatic system when the compressed air is allowed to expand.

Pneumatic symbol of compressor:-

![Pneumatic Symbol](symbol)
2.2. FRL (Filter Regulator Lubricator):-

As from the name it can be understood that it is the combination of three important individual components (Filter, Regulator and Lubricator) which are necessary for a pneumatic circuit as shown in figure. The working of these three components were individually explain below along with the figure.4.2

(i) Filter – can remove impurities from compressed air before it is fed to the pneumatic Components.

(ii) Pressure regulator – to stabilize the pressure and regulate the operation of pneumatic Components

(iii) Lubricator – To provide lubrication for pneumatic components

Fig.2.2. FRL Unit

Pneumatic symbol of FRL Unit:-
2.3. The consumption of compressed air :-

Examples of components that consume compressed air include execution components (cylinders), directional control valves and assistant valves.

a) Execution component:-

Pneumatic execution components provide rectilinear or rotary movement. Examples of pneumatic execution components include cylinder pistons, pneumatic motors, etc. Rectilinear motion is produced by cylinder pistons, while pneumatic motors provide continuous rotations. There are many kinds of cylinders, such as single acting cylinders and double acting cylinders.

(i) Single acting cylinder:-

A single acting cylinder has only one entrance that allows compressed air to flow through. Therefore, it can only produce thrust in one direction (Fig. 4). The piston rod is propelled in the opposite direction by an internal spring, or by the external force provided by mechanical movement or weight of a load (Fig. 2.3.1).

The thrust from the piston rod is greatly lowered because it has to overcome the force from the spring. Therefore, in order to provide the driving force for machines, the diameter of the cylinder should be increased. In order to match the length of the spring, the length of the cylinder should also be increased, thus limiting the length of the path. Single acting cylinders are used in stamping, printing, moving materials, etc.

![Single acting cylinder](image)

Fig. 2.3.1- Single acting cylinder

Pneumatic symbol of Single acting cylinder:-

![Pneumatic symbol](image)
(ii). **Double acting cylinder:-**

In a double acting cylinder, air pressure is applied alternately to the relative surface of the piston, producing a propelling force and a retracting force (Fig. 6). As the effective area of the piston is small, the thrust produced during retraction is relatively weak. The impeccable tubes of double acting cylinders are usually made of steel. The working surfaces are also polished and coated with chromium to reduce friction.

Double-acting cylinders contain two fluid chambers so that pressure can be used to both extend and retract the rod. Sealing devices work in both directions. This type of cylinder is by far the most common, and can be used in nearly all types of applications. Effective working area of the rod side of the piston is less than that of the other side, so double-acting cylinders retract faster than they extend, and exert less force on the retraction stroke.

Fig.2.3.2. Double acting cylinder

Pneumatic symbol of Double acting cylinder:-
b) Directional control valve:-

Directional control valves ensure the flow of air between air ports by opening, closing and switching their internal connections. Their classification is determined by the number of ports, the number of switching positions, the normal position of the valve and its method of operation. Common types of directional control valves include 2/2, 3/2, 5/2, etc. The first number represents the number of ports; the second number represents the number of positions. A directional control valve that has two ports and five positions can be represented by the drawing in Fig.2.3.3, as well as its own unique pneumatic symbol.

![Diagram](image1.png)

**Fig.2.3.3. directional Control Valve**

(i) **2/2 Directional control valve:-**

The structure of a 2/2 directional control valve is very simple. It uses the thrust from the spring to open and close the valve, stopping compressed air from flowing towards working tube ‘A’ from air inlet ‘P’. When a force is applied to the control axis, the valve will be pushed open, connecting ‘P’ with ‘A’ (Fig. 9). The force applied to the control axis has to overcome both air pressure and the repulsive force of the spring. The control valve can be driven manually or mechanically, and restored to its original position by the spring.

![Diagram](image2.png)

**Fig.2.3.4. 2/2 Directional control valve**
(ii) 3/2 Directional control valve:

A 3/2 directional control valve can be used to control a single acting cylinder. The open valves in the middle will close until ‘P’ and ‘A’ are connected together. Then another valve will open the sealed base between ‘A’ and ‘R’ (exhaust). The valves can be driven manually, mechanically, electrically or pneumatically. 3/2 directional control valves can further be divided into two classes: Normally open type (N.O.) and normally closed type (N.C.)

(a) 3/2 directional control valve  
(b) Cross section

Pneumatic symbol of 3/2 Direction control valve:-

(a) Normally closed type  
(b) Normally open type
c) **Control valve:**

i) **Push button (mechanical valve):**

This Micro-switch style mechanical valve is designed as a 3/2 -Push Button valve figure (a). Its normal mode of operation is explained below: An actuated - Pressure port P closed and port A vented to R, which is inside the case and used as a vent only as shown in figure (b).

![3/2 Push button valve](image)

Actuated - Pressure from P is opened to A and R is closed as shown in figure (c) However, if pressure is applied to P it vents to R until the button is presser shown by arrow thus switching to port A. This is shown in the figure (c) and is the mode used for the inflation valve for the simple air muscle operation scheme we suggested - the deflation valve being as normal.
ii) **Flow control valve:**

It allows the flow of fluid to be regulated from zero to the maximum possible through the particular aperture size. However, it differs from a water tap in that it contains a one way bypass valve which allows uncontrolled back flow if the normal output side pressure rises above the supply side pressure. This can be used to prevent the output side being damaged by over pressuring due to excessive or shock loads on the actuator.

![Flow control valve diagram](image)

(a) Flow control valve

(b) Symbol with flow direction (one-way flow)

In flow control valve, one thing must be keep in mind that the input and output connection should be as shown in figure (b). Otherwise it will not going to function at all.
Shuttle valves are also known as double control or single control non-return valves. A shuttle valve has two air inlets ‘P1’ and ‘P2’ and one air outlet ‘A’. When compressed air enters through ‘P1’, the sphere will seal and block the other inlet ‘P2’. Air can then flow from ‘P1’ to ‘A’. When the contrary happens, the sphere will block inlet ‘P1’, allowing air to flow from ‘P2’ to ‘A’ only.
d) Manifold:-

Manifolds are fluid distribution devices. They range from simple supply chambers with several outlets to multi-chambered flow control units including integral valves and interfaces to electronic networks. Manifolds are generally configured for several outlets sharing one inlet or supply chamber; exhaust manifolds can have several inlets sharing one exhaust port. They may have one or more shared supply chambers and any number of outlets. Complex pneumatic and hydraulic circuits can utilize manifolds with interfaces to sophisticated electronic networks. Applications, port specifications, flow and pressure specifications, manifold circuit style, and valve specifications are all important parameters to consider when searching for manifolds. Additional specifications to consider for manifolds include communication network, body materials, features, and operating temperature.

![8-Port manifold (1/4" connection)](image)

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e) Pressure Gauge:-

Pressure gauge is an instrument used to measure and indicate “Pressure” of a specific instrument or a process as shown in figure. Here, it is provided in order to check pressure in the working circuit. It has two scales lower is 0 – 10 Kg/cm² and upper is 0 – 150 psi. It is not compulsory to use but you can use it to see the pressure difference in the circuit.

![Pressure Gauge](image)
3. Principles of pneumatic control

a) Pneumatic circuit:-

Pneumatic control systems can be designed in the form of pneumatic circuits. A pneumatic circuit is formed by various pneumatic components, such as cylinders, directional control valves, flow control valves, etc. Pneumatic circuits have the following functions:

i) To control the injection and release of compressed air in the cylinders.
ii) To use one valve to control another valve.

b) Pneumatic circuit diagram:-

A pneumatic circuit diagram uses pneumatic symbols to describe its design. Some basic rules must be followed when drawing pneumatic diagrams.

i) Basic rules:-

1. A pneumatic circuit diagram represents the circuit in static form and assumes there is no Supply of pressure. The placement of the pneumatic components on the circuit also follows this assumption.

2. The pneumatic symbol of a directional control valve is formed by one or more squares. The Inlet and exhaust are drawn underneath the square, while the outlet is drawn on the top. Each function of the valve (the position of the valve) shall be represented by a square. If there are two or more functions, the squares should be arranged horizontally.

3. Arrows "→" and "↓" are used to indicate the flow direction of air current. If the external port is not connected to the internal parts, the symbol “Ο” is used. The symbol “Ο” underneath the square represents the air input, while the symbol “∇” represents the exhaust. Fig. 3.2 shows an example of a typical pneumatic valve.

4. The pneumatic symbols of operational components should be drawn on the outside of the squares. They can be divided into two classes: mechanical and manual (Fig. 3.3 & Fig. 3.4).
ii) **Basic principles:**

Fig. 3.6 shows some of the basic principles of drawing pneumatic circuit diagrams, the numbers in the diagram correspond to the following points:

1. When the manual switch is not operated, the spring will restore the valve to its original position.
2. From the position of the spring, one can deduce that the block is operating. The other block will not operate until the switch is pushed.
3. Air pressure exists along this line because it is connected to the source of compressed air.
4. As this cylinder cavity and piston rod are under the influence of pressure, the piston rod is in its restored position.
5. The rear cylinder cavity and this line are connected to the exhaust, where air is released.
4. PRECAUTIONS

1. Follow the instructions as it mentioned in manual or given by lab instructor.

2. Connection of components must be according to the symbols as mentioned above.

3. Be sure about the connections whether they are correctly and tightly connected.

4. While connecting any components or connector in the circuit use Teflon tape for air tight fitting. So, that air losses can be minimized for better result.

5. Handle FRL with care and keep it in vertical position always (filter and lubricator section should be in downward direction), because the lubricator is filled with oil.

6. Don’t cross the maximum range of pressure (100 psi) as indicated by the pressure gauge of compressor’s cylinder.

7. Don’t disturb the setting of safety valve of compressor, it can be dangerous.

8. Check the oil level indicator regularly whether oil level is in center or not. If the level is not in Centre then pour oil through the oil inlet.

9. Switch on the compressor and raise the pressure upto20 to 30 psi and switch it ‘Off’. Now, open the pressure relief valve alternate days to pump out the water get condensed at the bottom of the compressor’s cylinder.

10. Do not touch the “Don’t Touch” zone, when the compressor is ‘On’ or suddenly after switch it ‘Off’, because it gets heated up to high temperature that can injured you.

11. Keep yourself away from the electric motor and its connection. Otherwise, it may cause accident.
5. PNEUMATIC APPLICATIONS

Few applications of pneumatics in different fields were as explained below:

1. Applications in the field of Railway as Solenoid Valves Brake Systems as shown in figure,

Solenoid Valves for Brake Systems

2. Application in Railway Door control system as shown in figure

Door control system
3. Applications in *Agriculture machineries* for harvesting, seeding and other operations

4. *Air powered cars* run on compressed air instead of gasoline. Since the car is working on air there is no pollution. A two cylinder, compressed air engine, powers the car as shown in *figure*
5. Pneumatic also play a vital role in the field of Robotics as shown in figure
6. CONCLUSIONS
This paper successfully made an introduction to read and understand pneumatic circuit diagrams and to recognize international standards. This system is more reliable to recognize pneumatic components and to understand their functions. This system plays an important role in reading and understanding circuit diagrams for pneumatic controls. This system is also used to design circuits that are used to control multi-actuator systems. Plan, design and manufacture components are useful for practical training and hence this system is highly reliable.

7. REFERENCES

