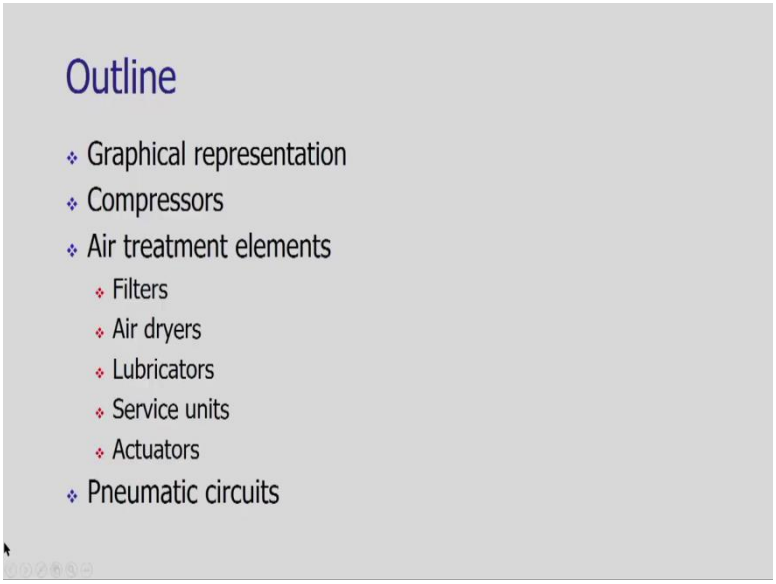
Automation in Manufacturing
Dr. Shrikrishna N. Joshi
Department of Mechanical Engineering
Indian Institute of Technology, Guwahati

Week – 11
Pneumatic systems
Lecture – 35
Graphical representation and pneumatic circuits

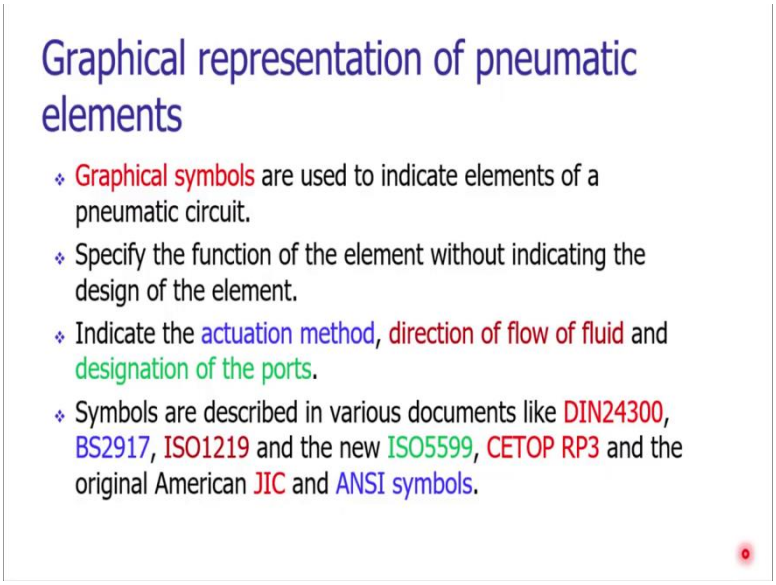
Hello everybody. I welcome you all to the third lecture of week 11. And, in the last lecture of this week, we will be studying how to graphically represent various pneumatic system elements and how to comprehend pneumatic circuits, how to prepare pneumatic circuits.

(Refer Slide Time: 00:47)



The outline of the lecture is on the screen. At the start of the lecture we will see how to graphically represent various pneumatic system elements. We will see how to represent compressors, various air treatment elements such as filters, air dryers, lubricators and service units. At the end of the lecture we will have a discussion on how to comprehend a pneumatic circuit and how to prepare a pneumatic circuit.

(Refer Slide Time: 01:23)



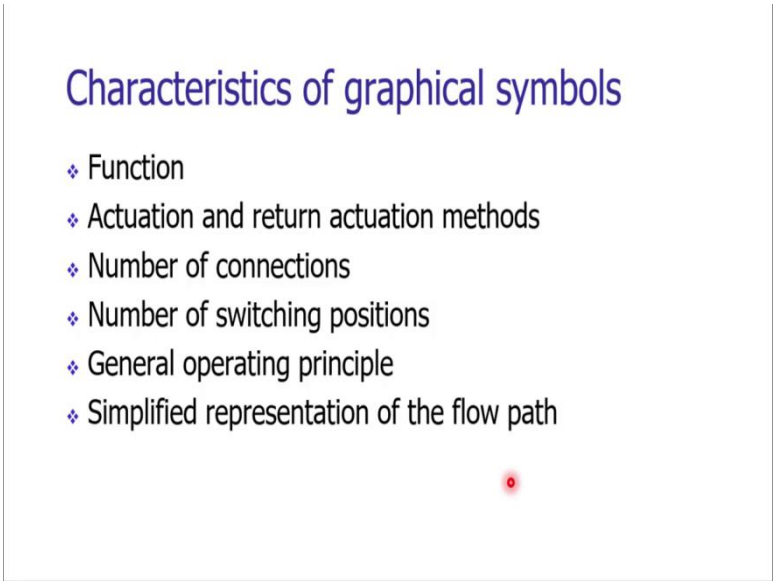
There are various mechanical elements which are used in pneumatic system. And, these elements are having very complex construction. We have seen the actuators and the valves which have very complicated construction.

Now, when we want to integrate and assemble all these pneumatic elements together and use them for our application, we need lot of number of such element. And, to communicate the drawing of this assembly to the shop floor, or the process planner, or the purchase engineer, it is a huge task.

Communicating with them in a proper way is very essential and important. For that purpose we are using graphical symbols to indicate these elements in pneumatic circuits as well. In the previous week we have seen that, such kind of graphical language or representation is very helpful to designate the hydraulic elements. In a similar way for pneumatics as well we are using the graphical representation.

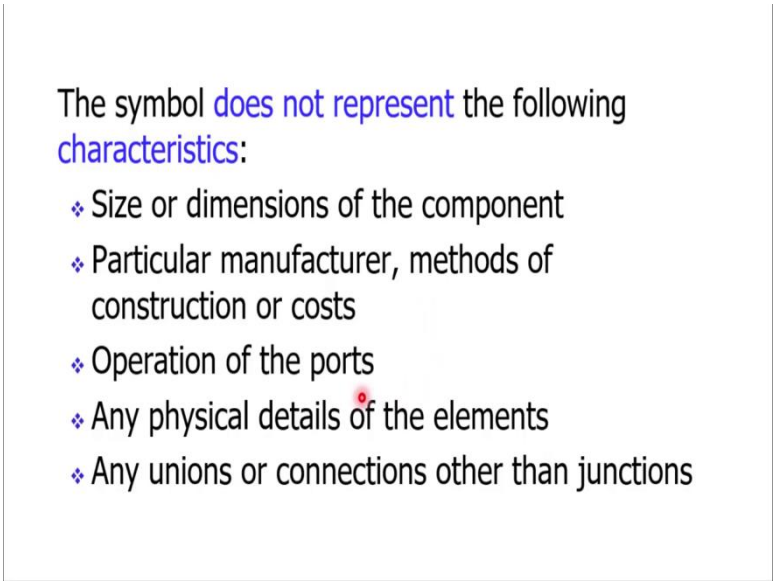
This graphical representation is basically used to indicate the actuation method, the direction of flow of fluid, the compressed air and designation of various ports. And, basically we are following the various standards, which are available such as DIN24300, BS2917, ISO1219 and the new ISO that is 5599, and many other standards which are available, the industry people are following them and they are designing the various pneumatic circuits.

(Refer Slide Time: 03:27)



Basically, the graphical symbols are giving us the information about the function of that element, how to actuate or how to return the actuation method, how many number of connections are there to that particular device, maybe a valve or a actuator device, how many number of switching positions of that particular valve, what is the general operating principle; so these information will be communicated through the graphical symbol.

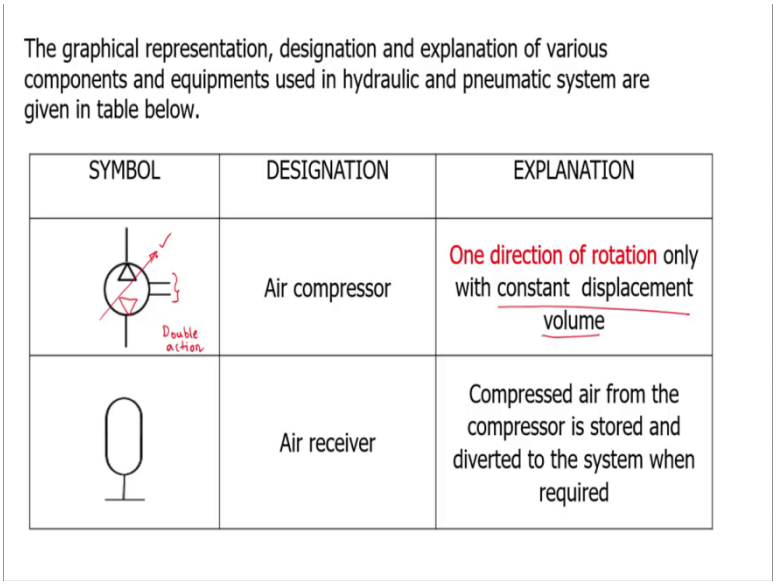
(Refer Slide Time: 04:01)



But, what is not being presented, what is not being represented in these characteristics? We are not communicating about the size and the dimension of the component, no information

about the manufacturer or the cost of the construction there is no information about the operation of the ports, exact operation of the ports. We are not communicating any information about the physical details of the elements though material specifications are also provided.

(Refer Slide Time: 04:37)

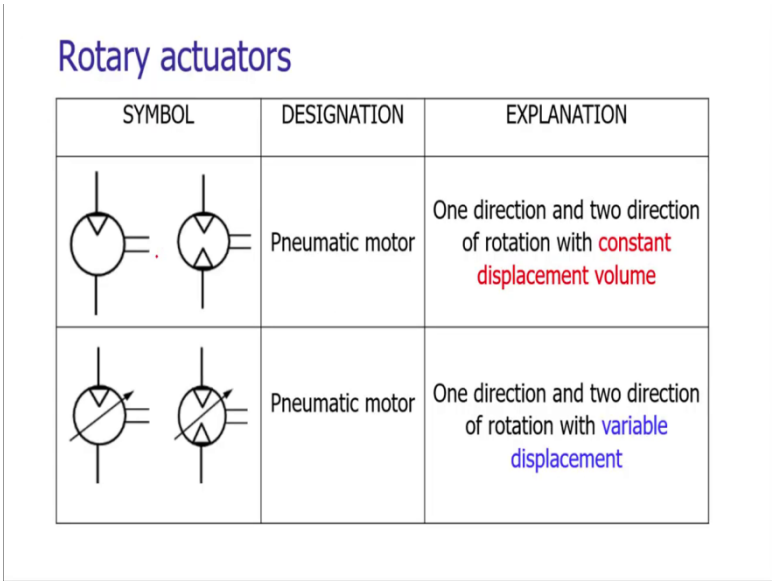


We are using a circle to designate the air compressor with a triangle. The triangle is not filled in hydraulic circuit we are using hydraulic pump with filled in triangle. There are two parallel lines, which are indicating the constant displacement volume.

Then for the air receiver we are using an obround shaped representation, compressed air from the compressor is stored inside the air receiver or the tank. To have the double direction of rotation we are adding one more triangle over here. If we add one more triangle in a downward direction that is providing the double action.

Now, these two parallel lines are indicating the constant displacement volume. If, I put an inclined arrow as shown here, then we can interpret this symbol as the compressor is providing variable displacement. That inclined arrow is the indication of variable displacement, if the arrow is not there it is giving the constant displacement.

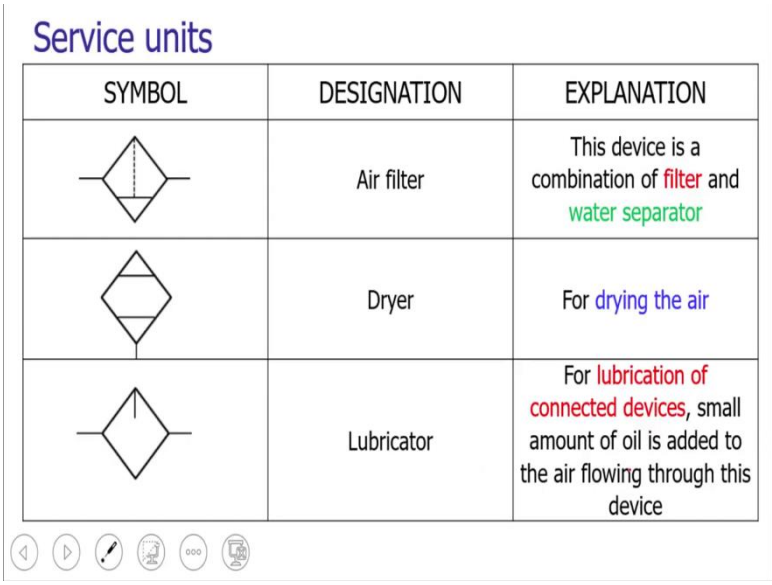
(Refer Slide Time: 06:07)



Now, the rotary actuators can be designated by using the symbols which you can see on your screen, we are using a circle with a triangle and the direction of the triangle is opposite to the direction of the triangle for the compressor; the it is an actuator which is being run or it is being driven by the compressed air.

By using the pneumatic energy, the rotary motion is generated which is why the circle has been provided. When the constant displacement volume based motor is operated, two parallel lines are used for that purpose. An arrow will designate the variable displacement.

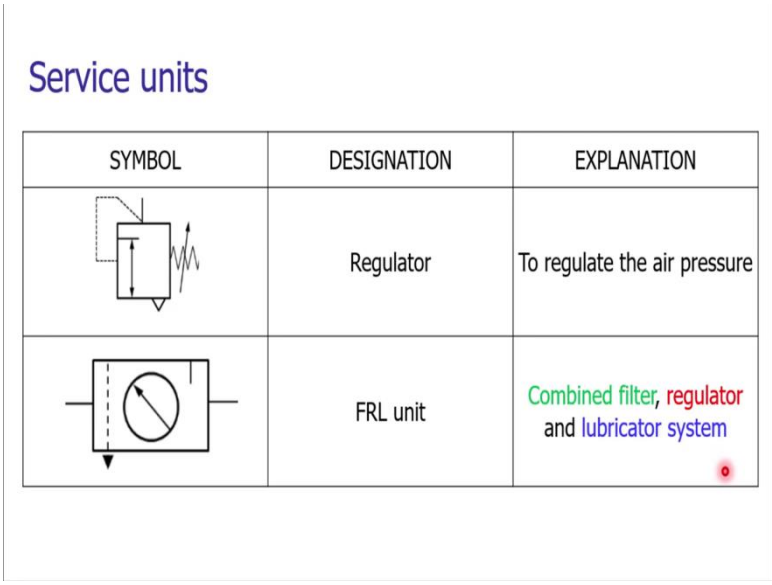
(Refer Slide Time: 07:01)



The air filter has been shown in this way. We have already discussed about the representation of the air filter in our previous class, when we have seen the meaning of the service unit.

The dryer has been shown by using this symbol; the lubricator device can be shown by using the symbol as there on your screen. As we have seen that the lubricators are used to generate the oil mist, which can be utilized to lubricate variety of mechanical elements of the pneumatic system.

(Refer Slide Time: 07:45)



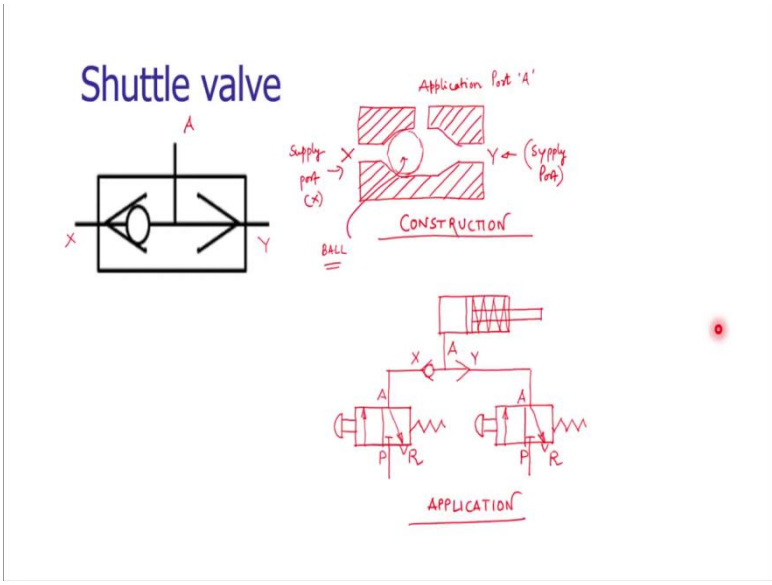
The entire FRL unit, the service unit, which is having the filtration, regulation and lubrication facility is together can be shown by using a symbol, which is there on your screen all the three functions operations are combined together. This is to enhance the convenience of using this facility.

Because, these three units are essential elements they are to be there they are compulsorily used during the pneumatic operations. The regulatory valve which is used to regulate the air pressure can be seen on your screen, this is the regulatory valve, which is the spring loaded valve, but we can change the spring force over here.

For that purpose the arrow has been mentioned and when the system pressure is getting increased beyond the critical pressure or the set pressure or the cracking pressure, then the compressed air has to be vent out to the environment.For that purpose a small triangle, open

triangle, not filled in triangle is there at the bottom side, which is giving the indication that the compressed air has to be vent out.

(Refer Slide Time: 09:21)



When we want to have the actuation of the actuators say, a single acting cylinder or double acting cylinder by using two different valves, then a shuttle valve is used. The shuttle valve is having three ports the port X, port Y, and there is the application port A. At port X the supply from one valve has been given and the port Y, there is another supply will be given by the other valve.

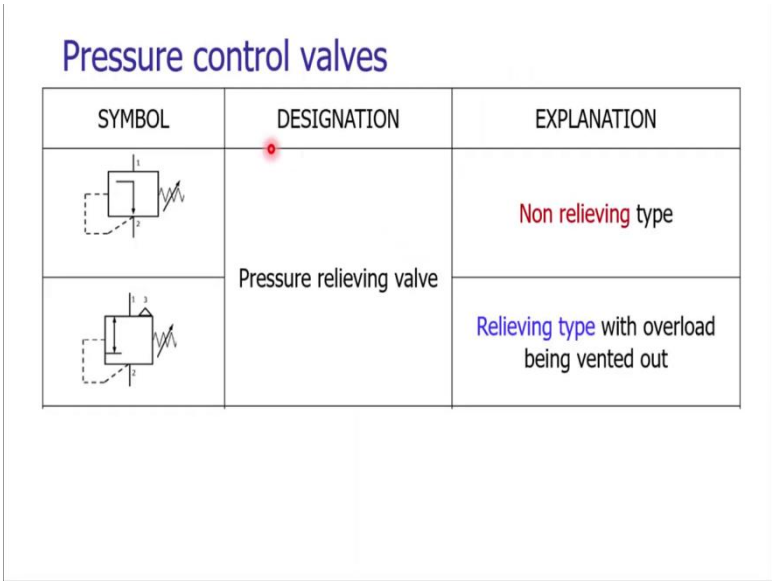
The port X and port Y are getting the input from the different valves. If, the supply port X is getting the compressed air, the ball will get displaced and it will block the passage for the port Y. And, the compressed air from port X will be given to the application port A.

When compressed air at port Y is applied provided there is no compressed air at port X, the ball will displace from right to the left and it will block the port X. And, then port Y is connected to the application port.

The shuttling of the ball from left to right, and right to left, is called as the shuttle valve. A typical application can be seen on the screen, this is a single acting cylinder and it is being controlled by using 2 valves. This is valve A and valve B and this valve A is connected to the X port of the shuttle valve and the valve B is connected to the Y port of the shuttle valve.

As the valve A is actuated we are getting the compressed fluid at X port and then through that we are actuating the cylinder, we are extending the cylinder. When valve B is operated by a pressurized fluid or a compressed air at different pressure, that will be given to the port Y and through port Y it is applied at the piston cylinder arrangement. It is to be noted that this is the single acting cylinder, the forward stroke being controlled by two different forces; the return stroke is given by the spring force itself.

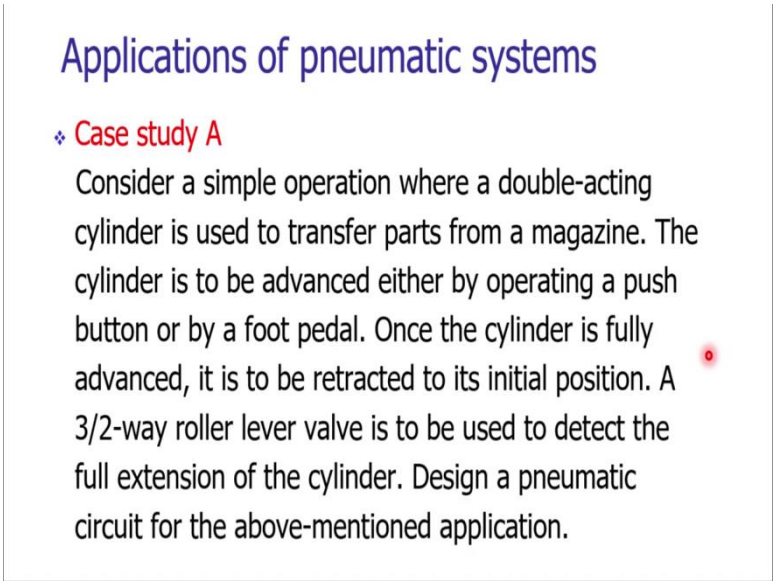
(Refer Slide Time: 12:13)



Now, the pressure control valves are designated by using the typical way, which we have seen in hydraulic circuits as well. And, the non relieving valve can be seen or can be represented by using a square with an arrow. And, there is a spring which is having an inclined arrow which is indicating we can set the spring force. When the load pressure or the output pressure is more the valve will be opened and it will be connected to the input port.

But, if the output pressure is exceeding the cracking pressure of the system, then this valve is not helping us. For that purpose we need to have a vent out or a relieve port or the exhaust port or the environment port. When the system pressure is increasing beyond the cracking pressure, the input pressure will be given to or the input pressure port will be connected to the vent port that is an environment port.

(Refer Slide Time: 13:19)

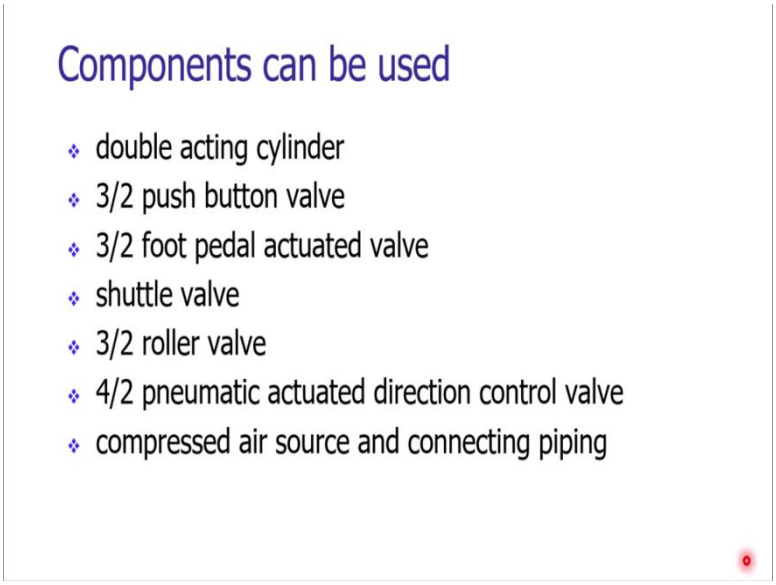


Now, let us study how we can assemble these components together and how we can draw a pneumatic circuit. Let us consider a simple operation where we need to operate a double acting cylinder, which is used to transfer the parts from a magazine. The magazine work magazine or a tool magazine is having variety of parts and we need to use a double acting cylinder, for the transfer of parts from a magazine.

The cylinder is to be advanced either by using a push button or by using a foot pedal. Here two options are given we can use a push button operated valve or we can have a foot pedal based operation as well. Once, the cylinder is fully advanced it is to be retracted to its initial position. Both the operations need to be controlled, the forward and the reverse.

A 3 by 2 roller lever valve is to be used to detect the full extension. It is given that we need to employ 3 by 2 roller lever valve; a 3 ports 2 position valve which is to be operated by using the roller lever, that is to be used to detect the full extension of the cylinder. For that purpose we have to give a conceptual system and a pneumatic circuitry for above mentioned application.

(Refer Slide Time: 14:57)

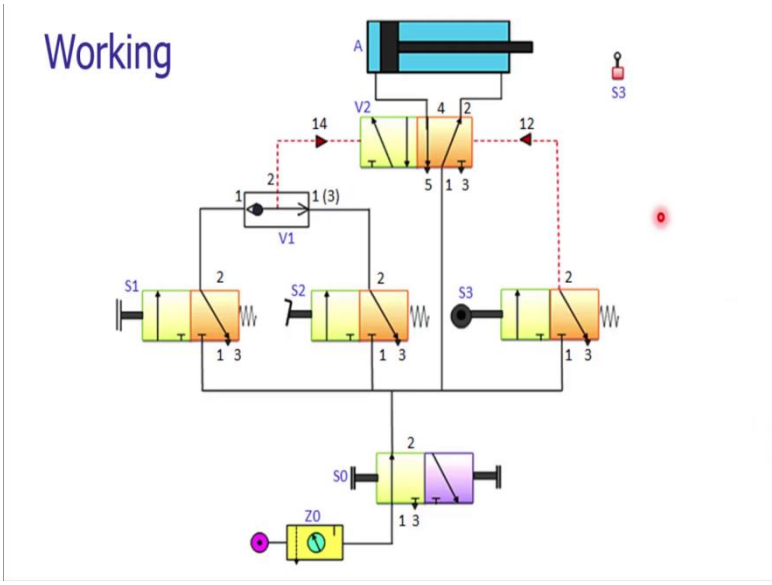


Now, let us list down the various components which can be used to develop this pneumatic circuit. As it is mentioned that we need to actuate the double acting cylinder by using two different valves, that is a 3 by 2 push button valve and the 3 by 2 foot pedal actuated valve.

To utilize the services of these two different valves, we are taking help of a shuttle valve. Then to actuate the retraction of the piston cylinder there is need to have a 3 by 2 roller valve, to control the direction of the compressed air which is applied to the double acting cylinder, we need to have a DCV that is the direction control valve.

We are using 4 by 2 pneumatic actuated DCV. A compressed air source is required and a FRL unit that is a filtration, regulation and the lubrication unit is required with the required connecting pipes. Let us look at the configuration that is developed for the given problem.

(Refer Slide Time: 16:27)



As it is mentioned that for displacement of the work parts or the components, which are there in the magazine, we need to have a double acting cylinder. A is the double acting cylinder which is to be controlled or which is to be operated by using the compressed air. We need the the compressed air which is being taken by the receiver tank and there is the FRL unit. From the FRL unit, the compressed air is taken.

This entire operation of taking the compressed air from the FRL unit is controlled by using a button switch, the button valve, button operated valve. There are two buttons are given for switching on the system and switching off the system. When the SO button is pressed then the port 1 is connected to the port 2.

Port 1 is the input port and port 2 is the application port. 3 ports and 2 position valve is being utilized to actuate to get the required compressed air inside the system. Now, after getting the compressor air we are having 2 different valves. This is the system start, but to accurate the work working or to operate the working of the double acting cylinder, it is mentioned that we need to utilize 2 valves, push button valve, and the pedal operated valve.

We got the 2 valves, i.e. a push button valve and pedal operated valve, to give the output from both these valves, a shuttle valve is used. We have placed a shuttle valve over here and the input from the shuttle valve is given to the direction control valve. This is DCV, this is a 4 by 2 DCV, all the number of ports are shown here, the 5 and 3 are the vent port and the exhaust port respectively.

We are considering 5 and 3 as a single port only, 2 positions are given for the DCV, when the cylinder is extending in the forward stroke it will hit the roller and that roller is actuating its retraction movement. For that purpose we need a 3 by 2 roller lever valve that is placed over here.

And, this roller lever valve is actuating the retraction movement by using the pilot pressure given to the DCV. The DCV is operated by the pilot pressure which is supplied by the shuttle valve for forward stroke and for the return stroke; it is working based upon the pilot pressure given by the roller operated valve. Now, let us start looking at the working of this pneumatic circuit.

Let us consider the push button is actuated. The default position of the push button valve is this here the port to the application port is connected to the vent and the input port or the power port is shut off, there is no input at this stage, this is the spring loaded. When we apply the energy at the push button, the push button will displace the position and the second position will be actuated.

What is this second position? The input port will connected to the application port. We are getting the compressed fluid at the application port. This application port is applying the compressed air to the shuttle valve. Here the ball will get displaced and it will block the foot pedal operated valve.

Now, the pressurized fluid will come from the power port to the port 1 of the shuttle valve and the pressurized air further will be given to operate the DCV. This is a pilot pressure which will actuate the DCV. Now, let us look at the position which will be actuated by the pilot pressure given by the shuttle valve.

Now, as the left side or the green position is actuated, the input port or the pressure port will be connected to the port 4. As it is being connected to port 4, there is extension of the double acting cylinder.

When the piston is moving from left to right, the fluid which is on the other side of the piston cylinder arrangement will be taken back for the vent. Here it will be taken back for the vent porting. Now, if somebody wants to utilize foot operated pedal valve to utilize that valve, the mechanical energy needs to be applied here. Instead of using the push button the foot pedal valve will be operated.

When the valve is actuated by pressing the foot pedal then the same operation would be carried out. Thus, instead of blocking the foot pedal valve now there would be blockage of the push button valve.

The ball will move from right to left direction and the push button valve will be blocked and the compressed air will be given to the DCV via shuttle valve. When the piston rod is getting ramp on the roller, that roller lever valve will be actuated as you can see here the roller lever valve we be actuated.

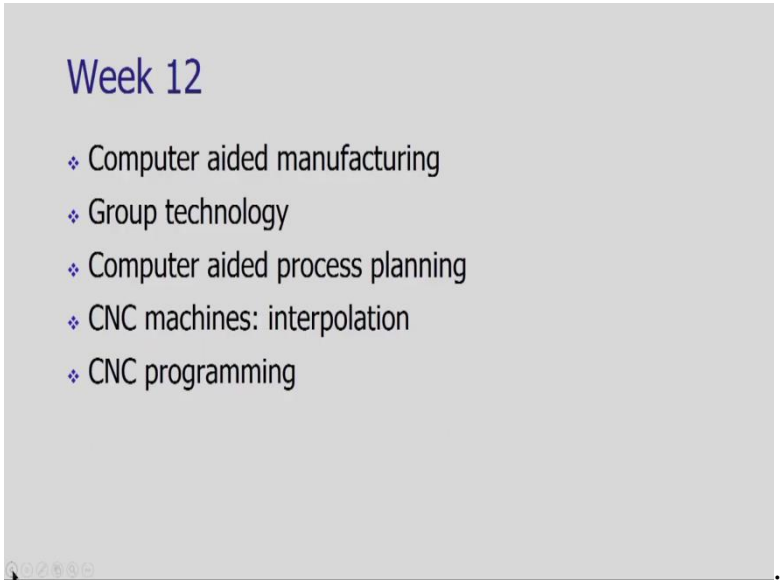
The port number 1 will be connected to the input port here. Port number 1 will be connected to the input port and that is giving the pilot pressure for the retraction. The pilot pressure will be given for the retraction, which is operating the valve and it is opening up and connecting the input port 1 to the retraction port 2.

This is input port 1 and retraction port 2 as the pressurized fluid has been applied on the other side of the piston rod, the piston rod will be displaced from right to the left direction. In this way there is a retraction or the contraction of the piston cylinder arrangement will be carried out.

Thus, we have seen that how this variety of pneumatic elements are helping to have an efficient and systematic operation of the pneumatic based circuitry for the desired application, in this case it is displacing the components from the magazine.

Well, let me summarize the last lecture of week 11. In this lecture we have seen how to graphically represent various pneumatic system elements such as, compressors, filters, air dryers, lubricators, service units and actuators. We have also seen how to comprehend the pneumatic circuits, how to prepare the pneumatic circuits.

(Refer Slide Time: 24:59)



In the last week of this course, we will be studying the computer aided manufacturing and CNC technology. We will see, what is the meaning of the GT that is a group technology, what is the philosophy of computer aided process planning, what are the various CNC machine configurations being utilized in automated industry, what is the meaning of interpolation and how to develop a simple CNC program, what is the structure of a CNC program, and what are the various important functions that to be incorporated in a CNC machining program.

Thank you.