Introduction to Pneumatic Basics

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Pneumatic Basics

After viewing this document, the student should be able to:

1. Identify the main components that will supply air to the lab equipment in the fluid power lab.
2. Identify the components used on a fluid power training board
3. Explain what the different colored air lines represent.
4. Explain the purpose, and how a flow control valve works.
5. Explain what a check valve is, and what direction air will flow through the valve
6. Determine what connects to the port numbers on a Festo valve.
7. Identify the symbols for the exhaust, power supply, cylinder and valve.
8. Calculate PSI from BARs, and BARs from PSI.

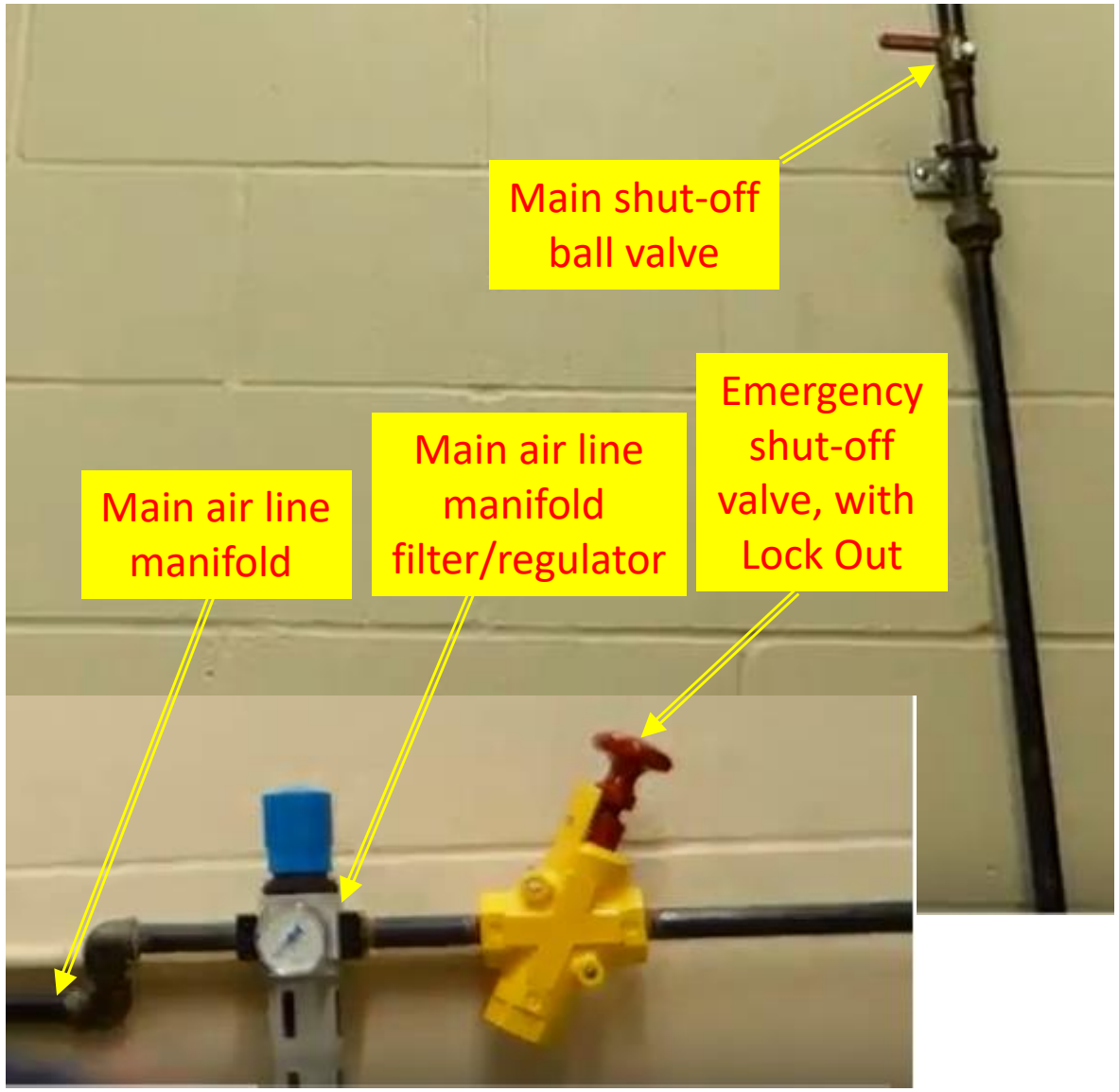
Please Read This

This document is to overview the operation of a pneumatic system, based on the hardware the student will use in the fluid power lab.

The intent of the document is the student to get a good understanding of the hardware used in the course, as well as some basic pneumatic circuits.

The valves in the IND 134 HOA’s will be primarily Festo brands.

The main air supply for the lab:



This is the basic hardware of air supply that feeds the main air manifold in the fluid power lab. The main shut-off valve is also called a ball valve.

The emergency shut-off valve will shut off the air to the whole room, with one hit on the air knob. This valve also bleeds off the main manifold when pressed.

The pressure on the manifold is set with the main airline regulator. This is typically around 120-140 lbs/sq. in. (PSI). The air gauge is read in PSI or BAR. 1 BAR is equal to 14.5-15 PSI.

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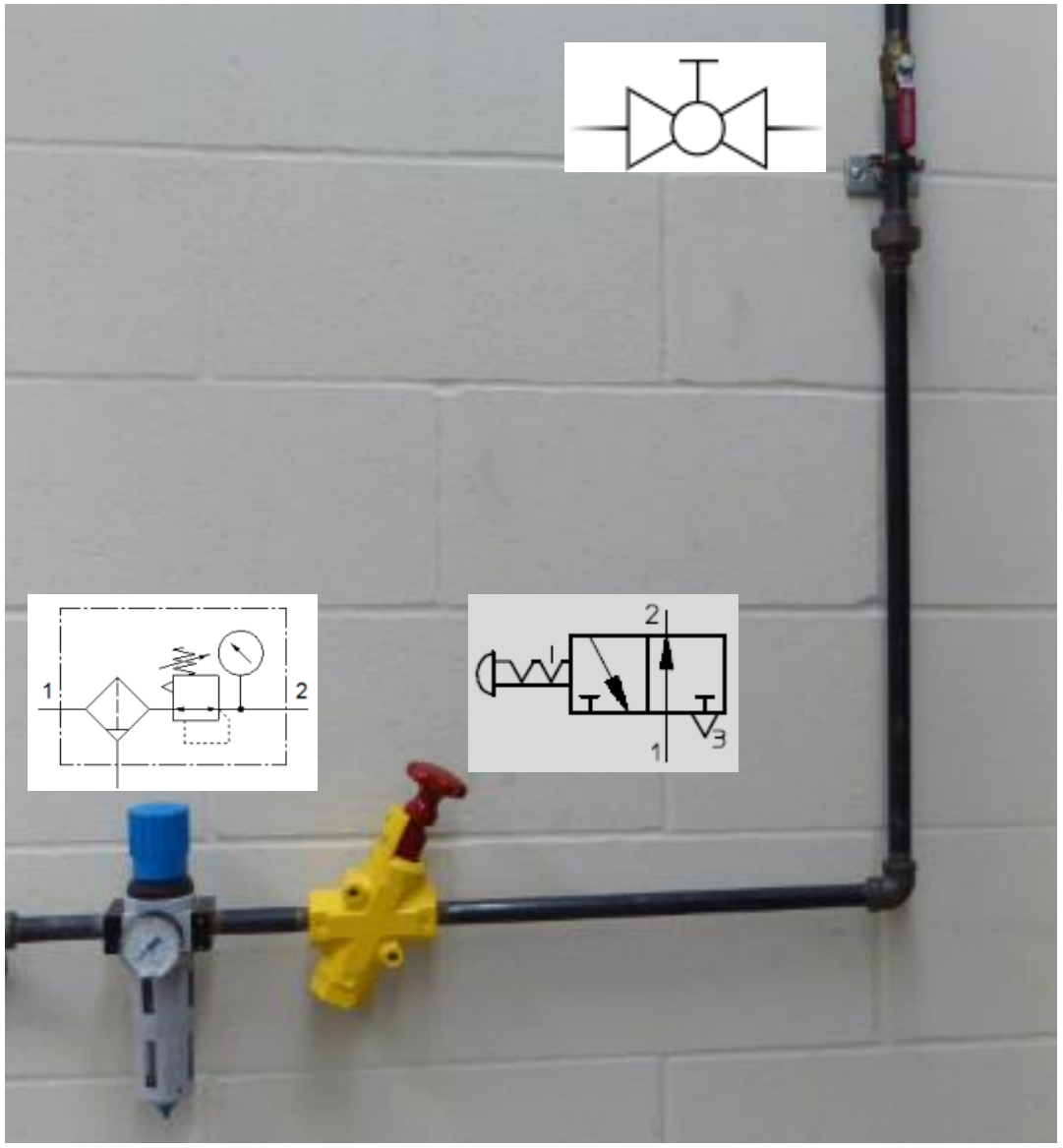

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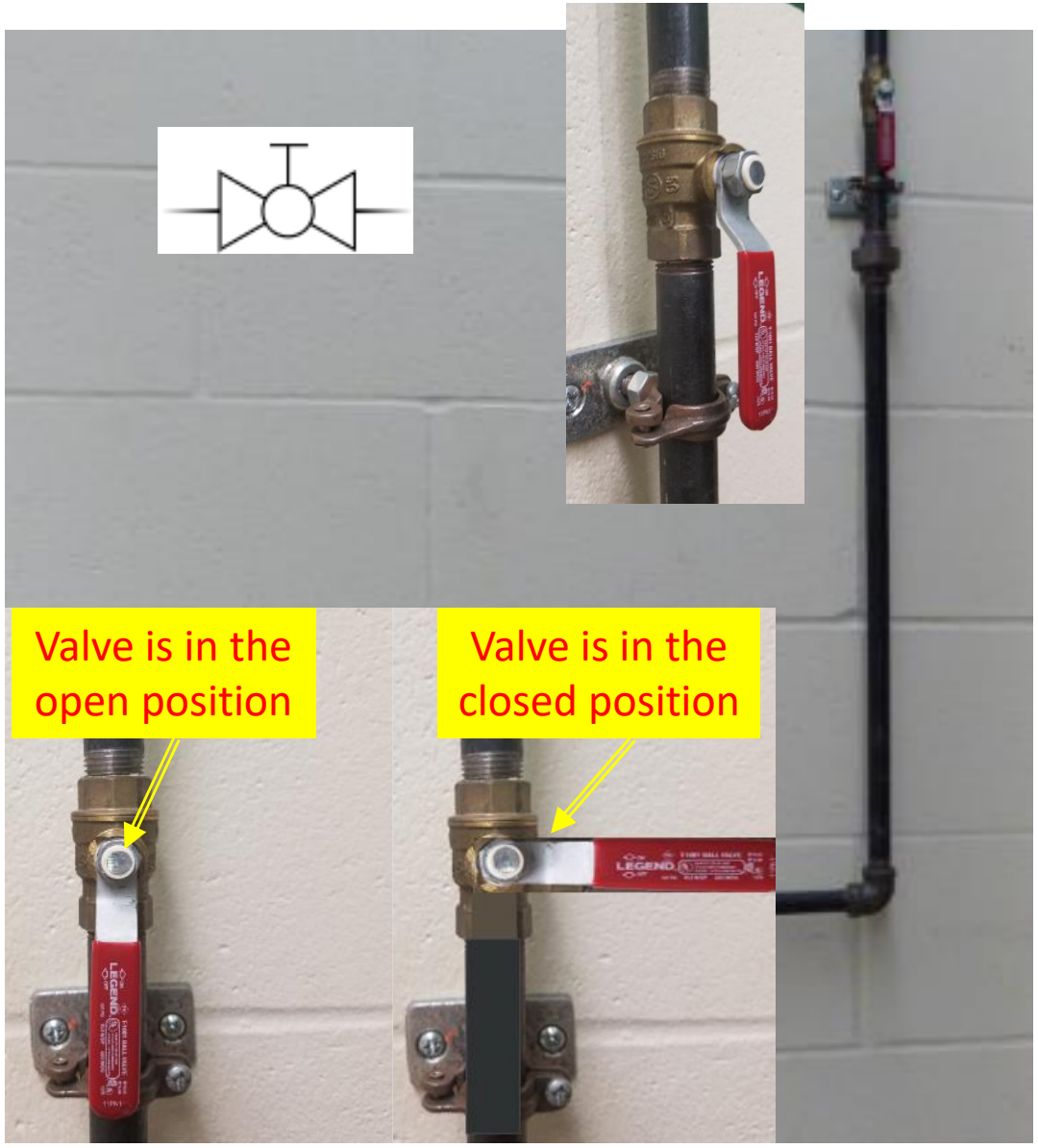
This graphic shows the symbols for the devices that will be used on a pneumatic circuit print.

Main shut-off Ball Valve:



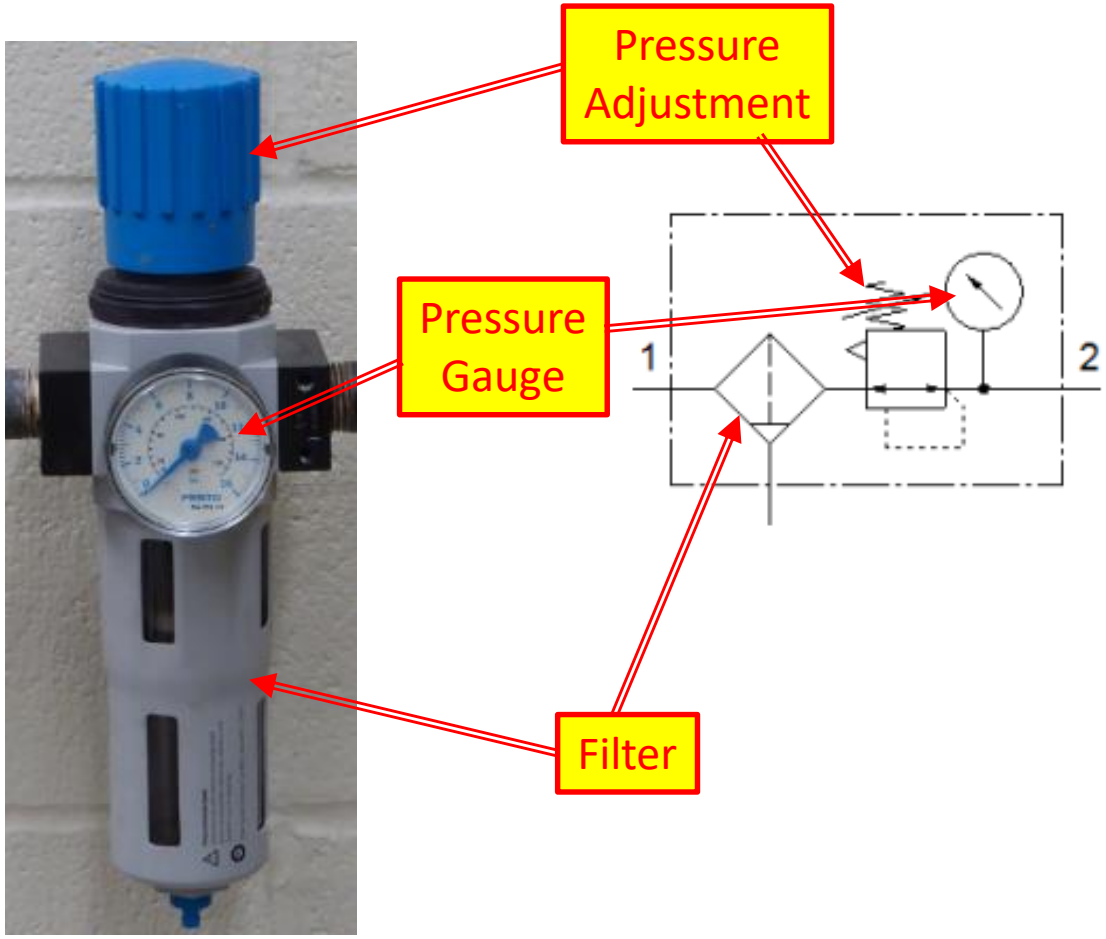
The main shut-off valve is a manual, ball-valve.

The illustrations in the lower part of the graphic shows the valve handle in the open position (left graphic), which means that pressure is applied to the circuit, and fluid will flow downstream if a valve actuates.

The lower right graphic shows the valve handle in the closed position, which will shut off all pressure and flow to any downstream components.

It is important to understand, that when turning the valve on to a discharged circuit, the valve should be turned on very slowly. The user will hear the air going into the components downstream. When the hissing stops, the user can go ahead and turn the valve on, all the way.

Filter Pressure Regulator:



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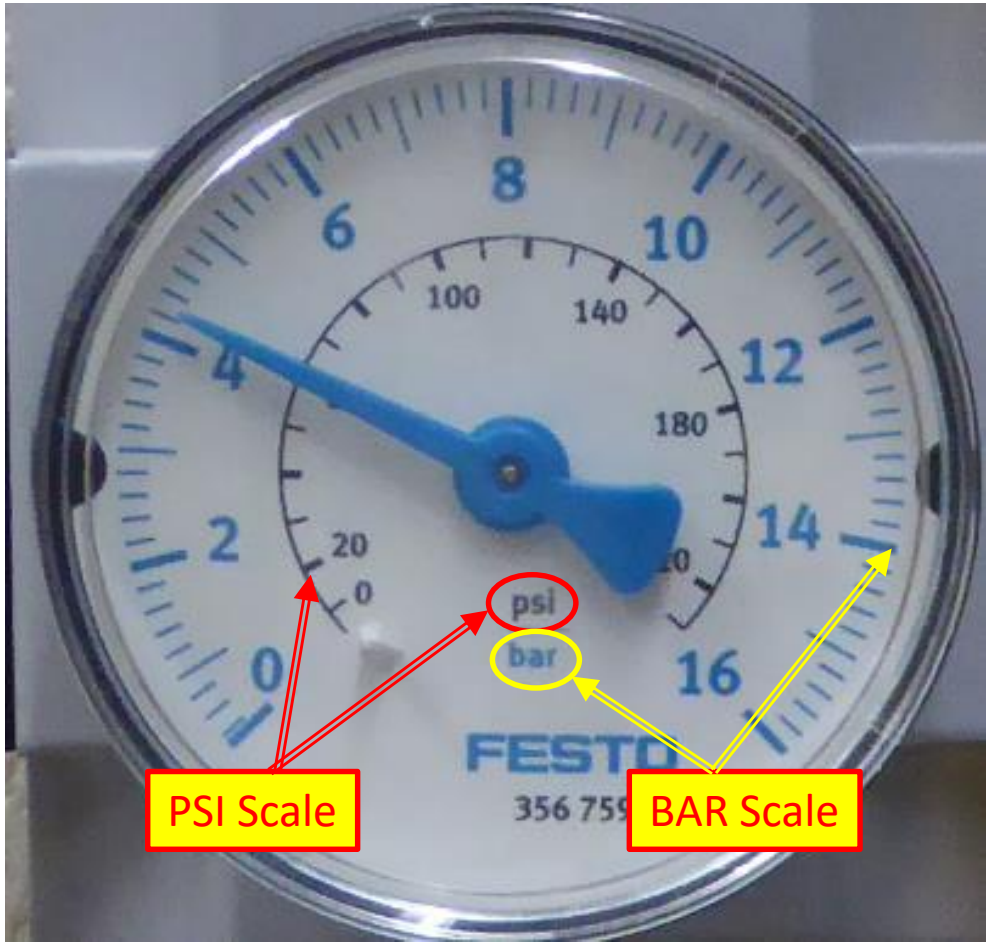


It is important to be able to read the pressure gauge on the pressure regulator. There are two scales on the gauge: PSI (pounds per square inch), and BAR.

PSI is the common unit of pressure measurement used in the US.

BAR is a metric unit of pressure measurement.

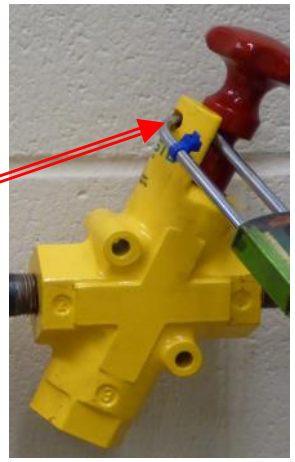
At sea level, atmospheric pressure would be 1 BAR, or 14.7 PSI. Equipment manufacturers will typically use 14.5 PSI to 15 PSI to equal 1 BAR. Realize that elevation has a lot to do with this. Currently in Maumee, Ohio, I am 200 meters above sea level. The atmospheric pressure should be 14.35 PSI. Bottom line, when converting from PSI to BARs or vice versa, use approximations. The easiest way is to equate 1 BAR to 15 PSI, so a 6 BAR air line will be approximately 90 PSI.

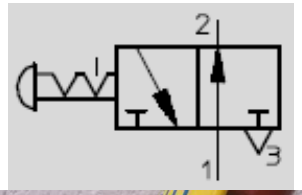
Website to calculate atmospheric pressure based on elevation: https://www.mide.com/pages/air-pressure-at-altitude-calculator

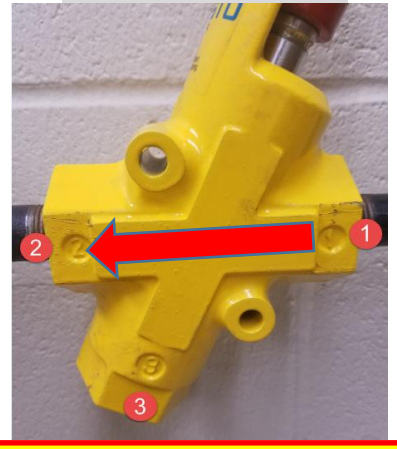
Shut off valve with lockout (and bleed off):

Actuating Knob

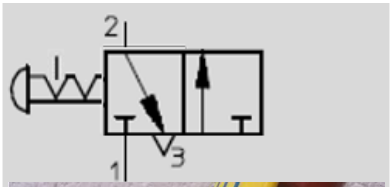
Actuating Knob Locked Out

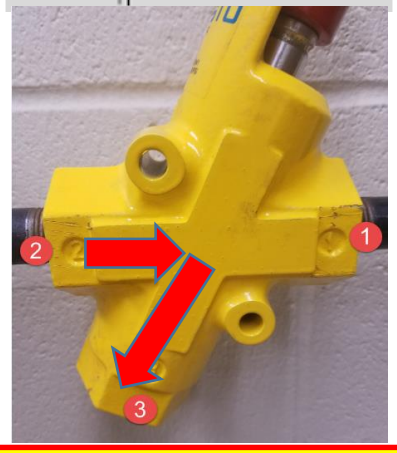






Knob is Not Actuated (pulled out)





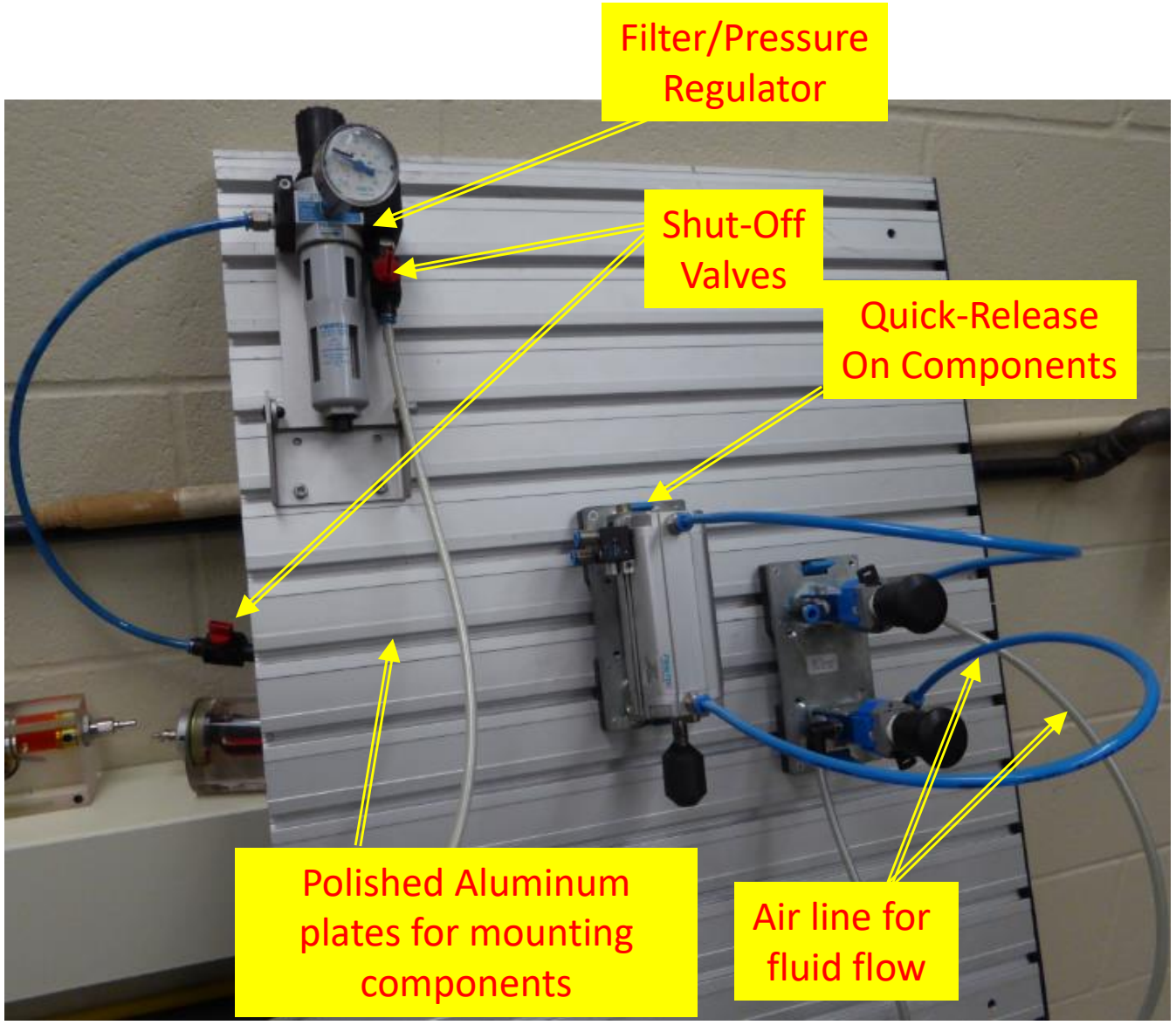
Knob is Actuated (pushed in)

This graphic shows the Air Shut-off valve on the main supply line. If the knob is pulled out (up position), the air will flow (have pressure) from ports 1 to port 2. This is for normal operation.

If the knob is pushed in (down position), port 1 is blocked, shutting off the main air feed, and there is flow from port 2 to port 3. This will allow the compressed air from the manifold to exhaust out (through port 3) to atmosphere. You will hear a loud hissing noise when this occurs.

It is important that the valve be locked out if a maintenance person is working on a pneumatic circuit that this valve is feeding.

A pneumatic training board:



This graphic shows an example of the lab components used in the fluid power lab.

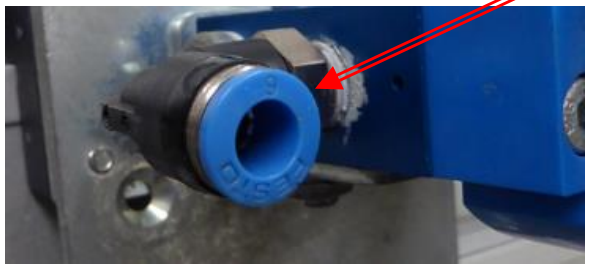
The components (valves, cylinders, etc.) are mounted on the tracks of the board, and can be quickly removed or moved by pressing the quick-release tab on the components.

The pressure regulator can be adjusted to a lower pressure than the manifold pressure. The black knob at the top of the regulator must be pulled up to engage the mechanism. Turning to the right will increase the pressure. The pressure regulator will not be able to put out more pressure than what is on the main manifold.

Notice the small inline shut-off valves on the primary and secondary side of the pressure regulator.

The color coding of air lines:

To connect an air line, press in on the compression sleeve, then insert the hose and release



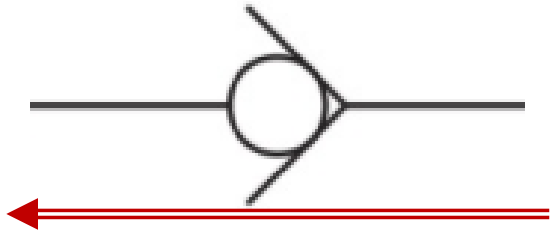
In the IND134 course, it is important to use proper color coding for the air lines.
Use the **clear (off white)** lines for the main air supply into the circuit.

Use the **blue colored** air lines for air that is ran from the valves to the actuators.

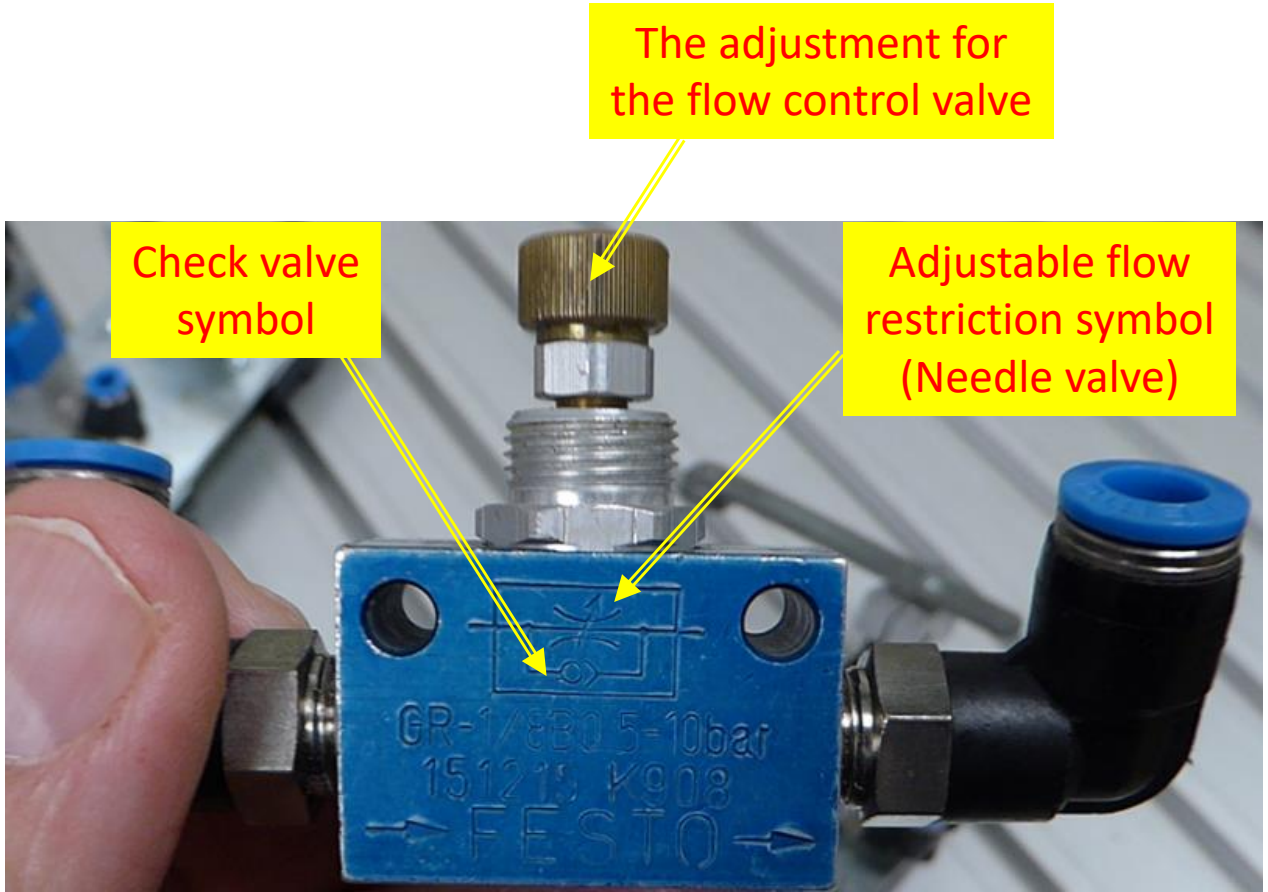
Use the **green colored** air lines for pilot air (the air that is used to actuate a valve.

The FESTO pneumatic components use a simple compression sleeve that when pressed-in, will open just a small amount so an air line can be inserted. When release, the sleeve will hold the air hose securely.

An flow control valve:



Fluid will flow through the check valve in this direction



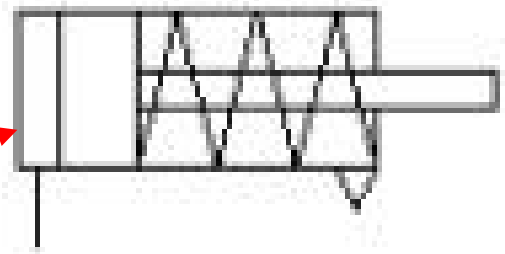
This illustration shows a flow control valve. This valve is adjusted to control the flow of fluid (in this case, it is air), which will control the speed of extension or retraction of a pneumatic cylinder.

Notice that the unit has a check valve in parallel with the needle valve. The check valve allows fluid to flow through the needle valve (restriction) in only one direction (opposite the direction of the arrow). If the fluid flows in one direction, it will go through the check valve. If it flows in the other direction, it will go through the needle valve (controlling the flow). This is called a unidirectional flow control valve.

So depending on how the unit is connected, it will allow the user to control the time for extension or retraction of the cylinder. A little later, we will discuss the terms “meter-in”, and “meter-out”.

A single acting cylinder:

Intake and exhaust port on the cylinder

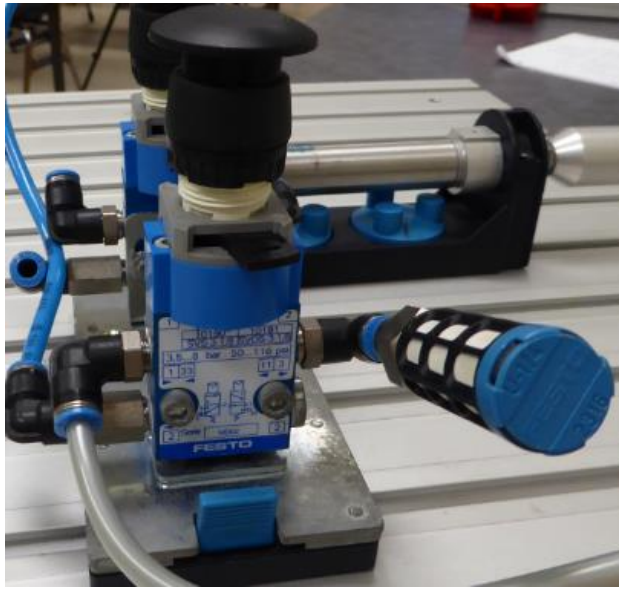


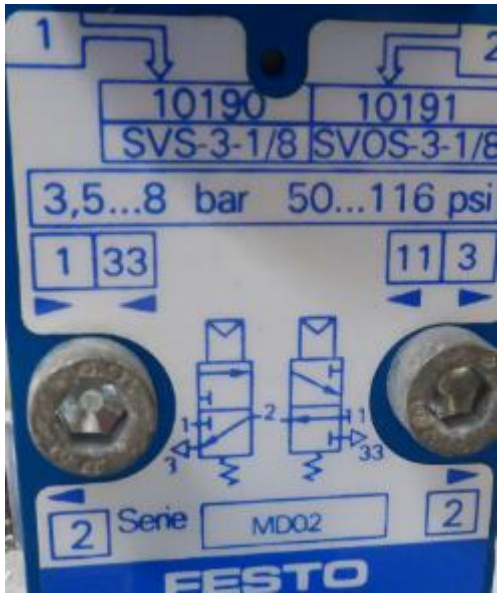
Pneumatic diagram symbol for a single -acting cylinder

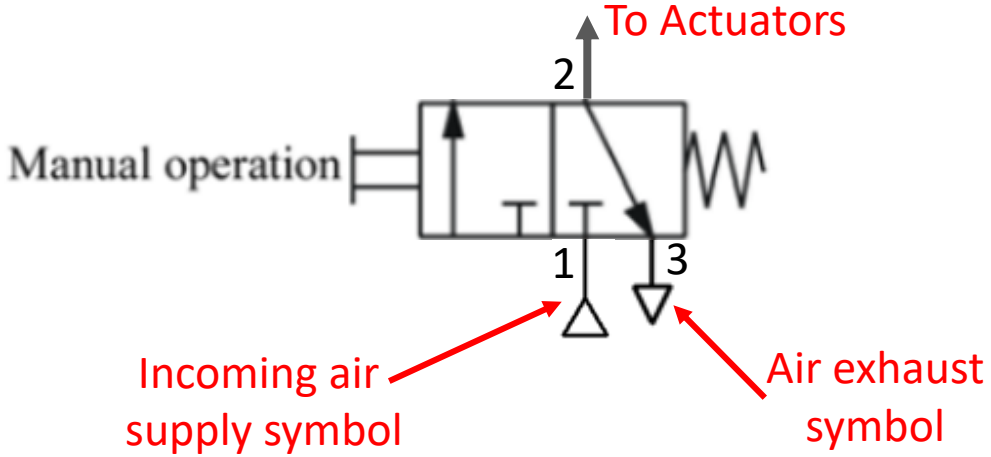
The exterior of the single acting spring return cylinder is identified by having only one port. The symbology is drawn as a horizontal cylinder shape with a rod down the middle with a spring object on one end.

Notice that there is only one port on this valve. When this port is pressurized, fluid will flow into the cylinder, extending the rod. When the port is connected to an exhaust, the spring will return the rod to the retracted position.

A few basics on pneumatic valves:







Just a few simple things on the directional control valves used in pneumatic circuits. The first is that the one shown in this graphic has a manual pushbutton on it, that has a spring return. When pressed, it shifts the position of the valve, and when it is released, the spring returns the valve to the normal position.

Port numbers are important. Typically:

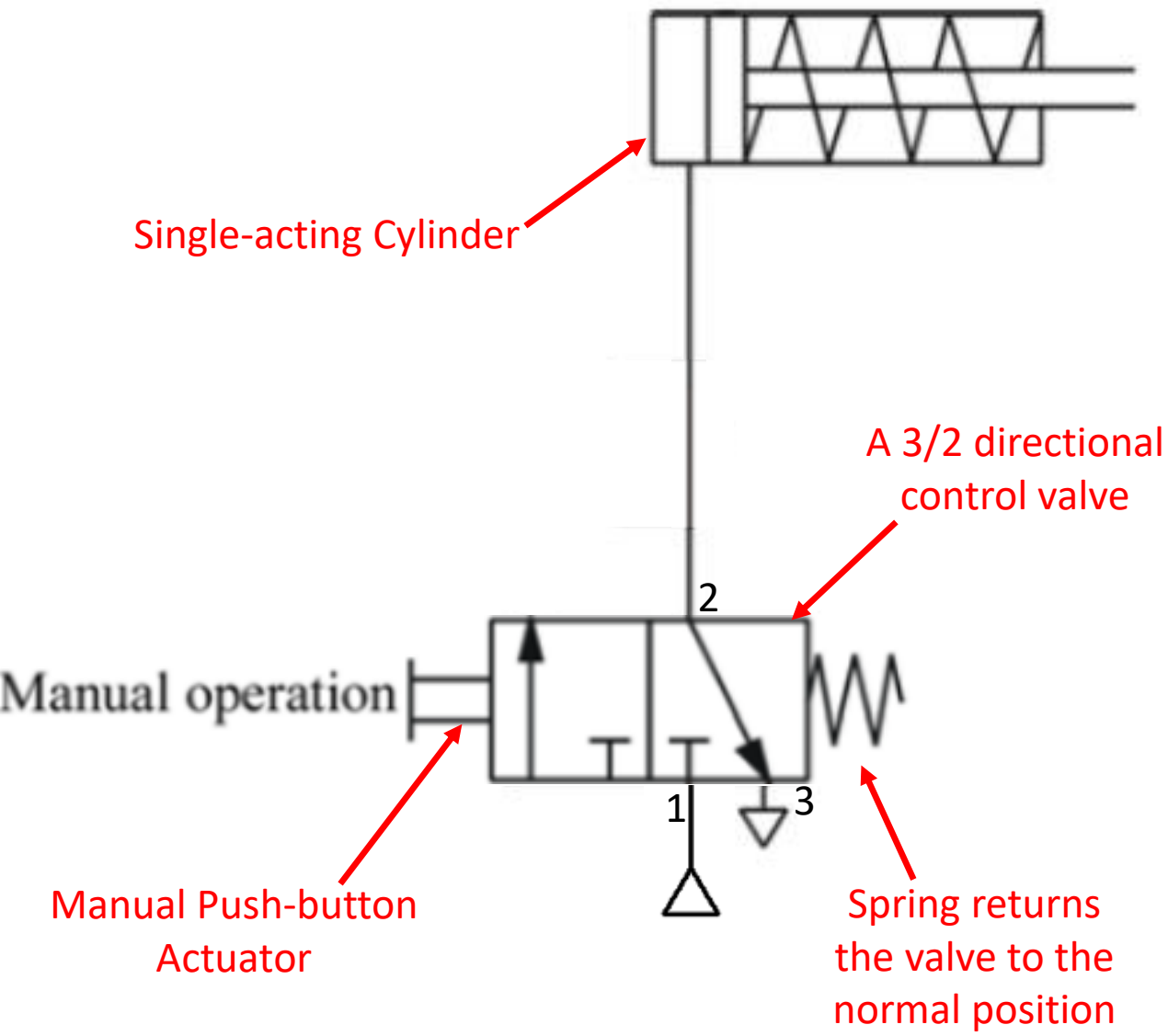
Ports 1 and P will be the power in source.

Ports 2 and 4 will be power out source.

Ports 3 and 5 will be the exhaust.

Ports 12 and 14 will be the pilot ports.

A few pneumatic basics:



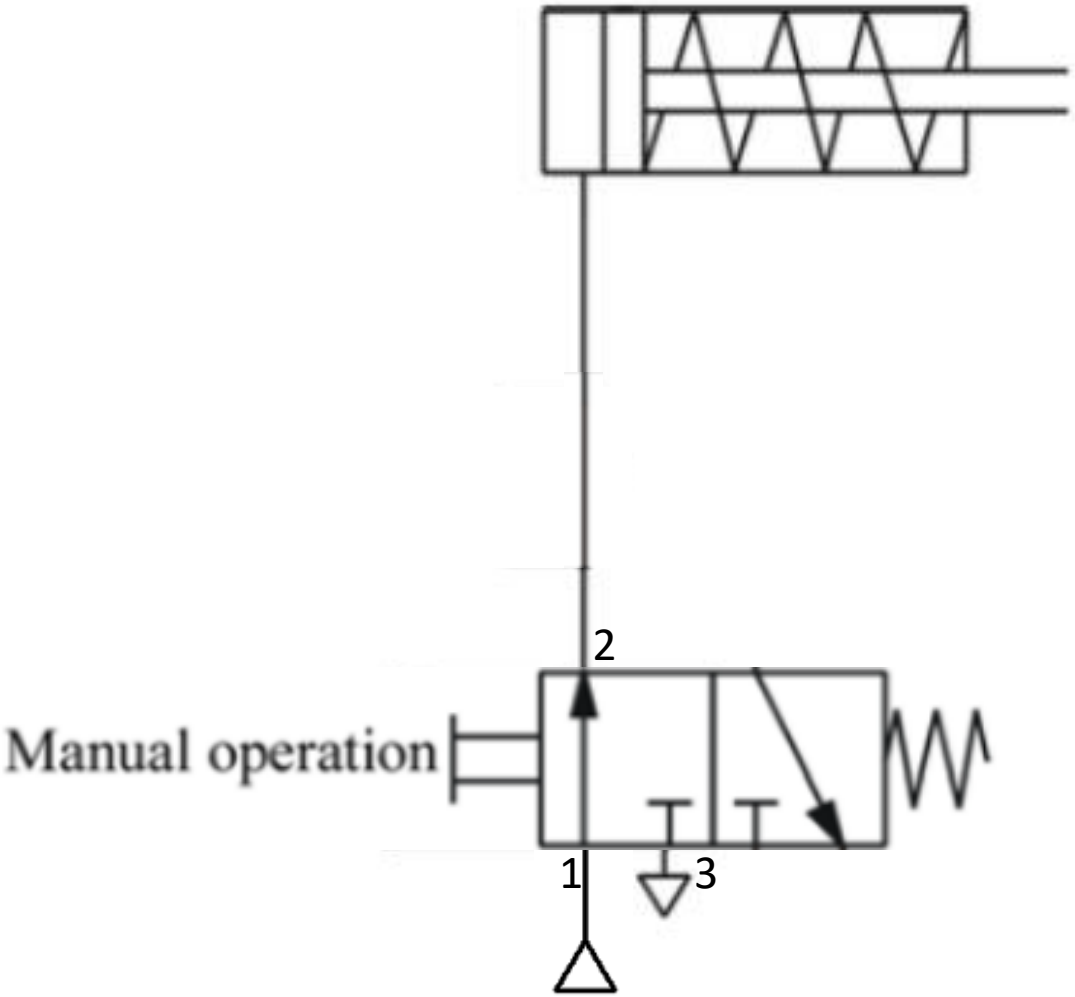
This diagram shows a very simple pneumatic circuit. It is made up of a single-acting cylinder, a directional control valve, and a power source and an exhaust.

The directional control valve has 3 ports. Port 1 connects to the incoming air supply. Port 2 connects to the cylinder (the output), and Port 3 connects to the exhaust. The valve is manually actuated with a pushbutton that shifts the position of the valve. A spring returns the valve to it's normal position (as shown on this diagram).

This would be termed a Normally Closed valve, since it does not connect the power source directly to the actuator (cylinder).

When the pushbutton is actuated, it shifts the position of the valve, and sends air flow to the cylinder extending it.

A few pneumatic basics:



The manual normally closed valve in this position is in the open position non at rest position.

This illustration shows the pushbutton is actuated, the valve has shifted to the open position (Port 1 connects to Port 2). The valve should extend

Practice Question #1

- What color should the air line be that will be used to supply air to a pneumatic circuit ?
  - a. Blue
  - b. Red
  - c. Green
  - d. Clear

Answer to Practice Question #1

- What color should the air line be that will be used to supply air to a pneumatic circuit ?
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  - b. Red
  - c. Green
  - **d. Clear**

- Explanation: In the IND134 course, it is important to use proper color coding for the air lines.
- Use the **clear (off white)** lines for the main air supply into the circuit.
- Use the **blue colored** air lines for air that is ran from the valves to the actuators.
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Practice Question #2

- What will be the pressure in PSI, for a pneumatic air circuit that is rated at 6 BAR?
  - a. 30 PSI
  - b. 60 PSI
  - c. 90 PSI
  - d. 105 PSI

Answer to Practice Question #2

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  - b. 60 PSI
  - c. **90 PSI**
  - d. 105 PSI

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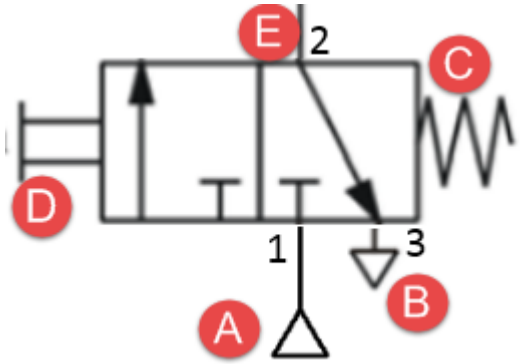
Practice Question #3

- Explain what each device is that has a letter assigned to it on this directional control valve.
  - A -
  - B -
  - C -
  - D -
  - E -



Answer to Practice Question #3

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  - D -
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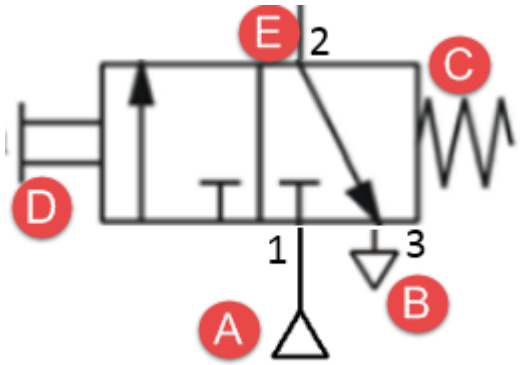


A – is the air supply feeding the pneumatic circuit. This should connect to Port 1 of the valve. B – is the exhaust. In this case the air is exhausted to the atmosphere. This can also create a lot of noise. Sometimes a Silencer is connected to the exhaust port.

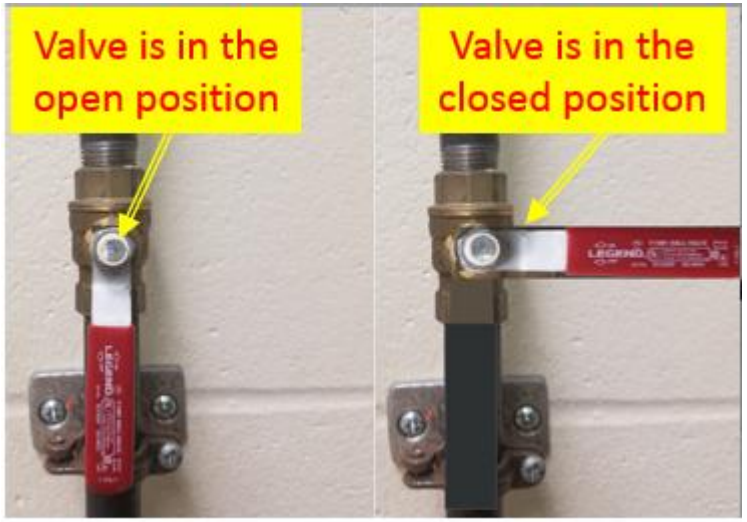
C – is the spring return for the valve. D – is the pushbutton that will actuate the valve. When the pushbutton is pushed, the valve shifts to the second position. When the pushbutton is released, the spring will return the valve to the normal position. E – is the output port of the valve. This port will primarily connect to the actuator, which in many times a cylinder.

Practice Question #4

T F This shut-off valve is in the open position, allowing air to flow downstream.

Answer to Practice Question #4

T (F) This shut-off valve is in the open position, allowing air to flow downstream.



This completes this Instructional Document