

# Engineering and Manufacturing

## 3.3.5 Systems in Engineering and Manufacturing – Pneumatics



### Systems in Engineering and Manufacturing – Pneumatics

#### Learning outcomes

Students should be able to:

identify the following pneumatic components by their symbol and physical appearance and demonstrate awareness of their basic function:

- three and five port valves;
- valve actuators (roller, push button, plunger and lever);
- flow control valves;
- cylinders (double-acting cylinder and single-acting cylinder);
- reservoirs; and
- shuttle valves.

#### Pneumatic Control Symbols



3/2 Valve



5/2 Valve



Plunger



Roller trip



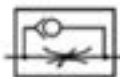
Push button



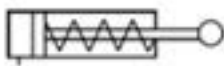
Lever



Bidirectional flow restrictor



Unidirectional flow restrictor



Single acting cylinder (SAC)



Double acting cylinder (DAC)



Reservoir



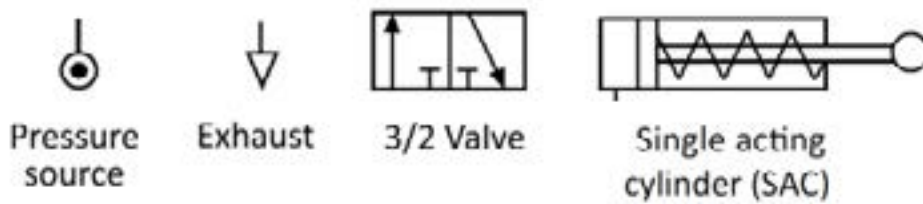
Shuttle valve

## Pneumatic symbols

Pneumatic systems use the energy stored in compressed air to do work. By controlling the flow and release of air through pneumatic components we can achieve complex sequences of motion.

Pneumatic components are arranged in circuits in a similar way to electronic circuits. Symbols for each component can be used to design and communicate the layout of a pneumatic circuit.

The symbols used in pneumatics are “functional” this means that the symbols describe the function of the component in a simple graphic.

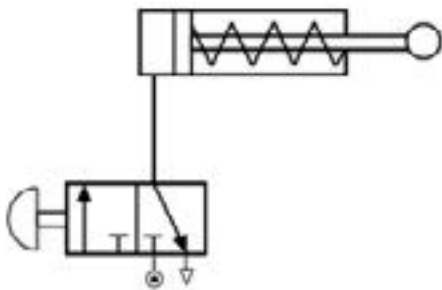


The above components can be used to represent a basic circuit.

### 3/2 Valve and single acting cylinder

The circuit is set up to extend the single acting cylinder piston when the push button on the 3/2 valve is operated.

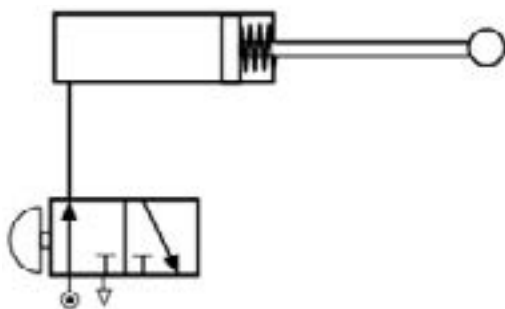
In the current state the pressure in the single acting cylinder is vented to the atmosphere allowing the spring in the cylinder to withdraw the piston. The pressure source is also closed.



When the valve is activated the pressure source is connected to the inlet port of the cylinder and the piston is extended.

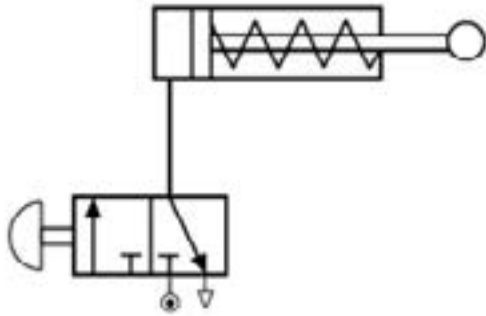
The return spring is compressed by the working pressure inside the cylinder.

The valve can be operated by a range of manual and automatic actuators. The example opposite shows a push button actuator.

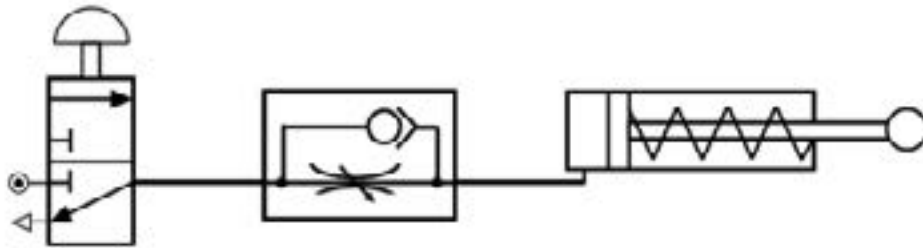


This simple circuit will operate a cylinder but the full force of the pressure source may cause the piston to extend at very high speed. In order to control the speed of the piston we can add a flow restrictor valve.

In this case the return force is by return spring so we can only restrict the flow on the outstroke of the piston.



### Flow restrictor valves

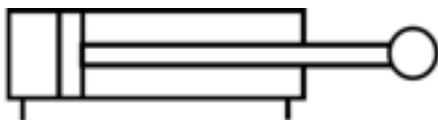


In the circuit above the air flow to power the outstroke of the cylinder must pass through the adjustable flow restrictor thus reducing the speed of the piston on the outstroke.

Upon release of the valve the cylinder pressure will vent freely by flowing past the restrictor through a one way ball valve.

### Double acting cylinders

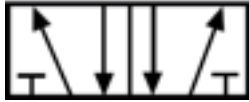
A double acting cylinder can produce a powered stroke in both directions so it requires a valve that can supply pressure and vent simultaneously. One side of the cylinder will receive pressure (inlet) therefore the other side must be allowed to vent (outlet).



Double acting  
cylinder (DAC)

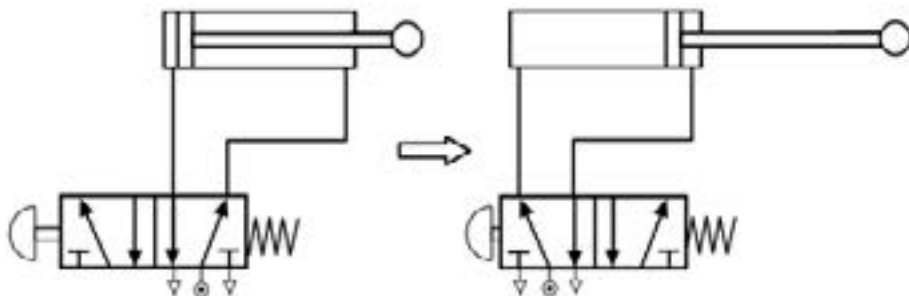
## 5/2 Valve

5/2 Valve



The 5/2 valve can be used to control the pneumatic flow for the double acting cylinder.

## 5/2 Valve and double acting cylinder

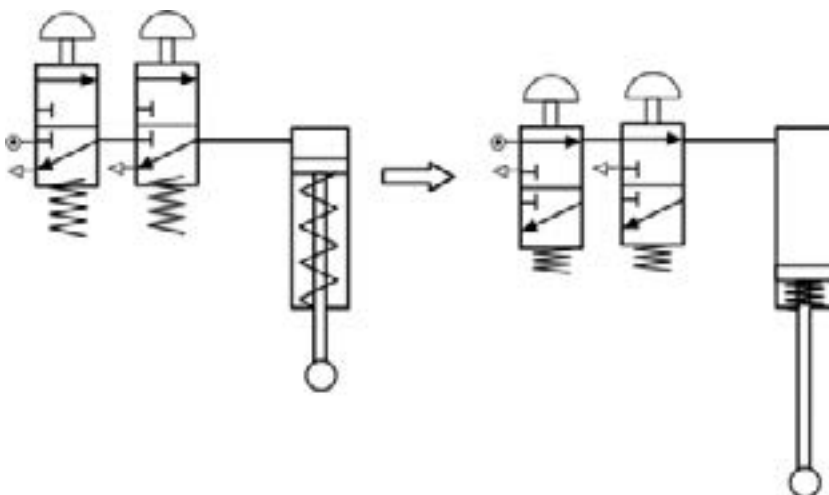


The 5/2 valve is so called because it has 5 ports on each of its two positions. As you can see from the circuit diagrams above the 5/2 valve will reverse the pneumatic pressure when it is activated. The 5/2 valves shown above have a spring return which will reset the valve when the operator releases the push button actuator and make the retracted piston the default state for the circuit.

Valves can be activated in a variety of ways. Moving objects can touch a roller actuator as they move on a production line. A plunger can be activated by an object reaching a particular position in the production line. A lever can be activated by an operator to start or stop the process for safety or other reasons. They all activate the pneumatic system and are connected in the same way. They just use a different mechanical action to activate them.

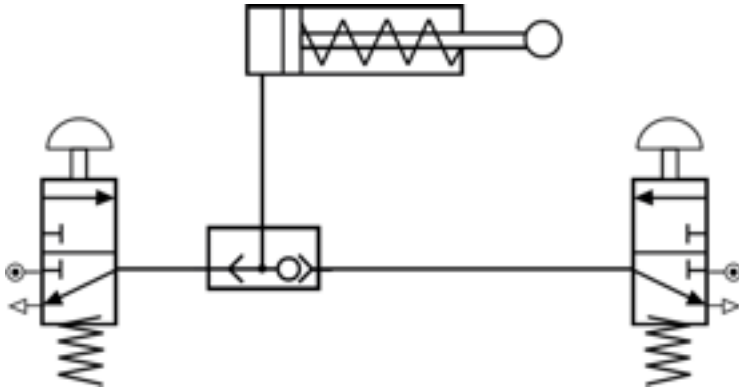
## AND circuit

The “AND” circuit requires both valves to be operated simultaneously before the cylinder will outstroke. If only one of the push button actuators is pressed then the piston will remain in or return to the retracted position.



The “AND” circuit is commonly used as a safety feature where the push buttons are arranged so that a worker can only operate a machine if both hands are away from the moving parts of a press.

### OR Circuit



The “OR” circuit can be activated by operating either one of the push button actuators. This arrangement uses a shuttle valve to direct the flow of air from either valve to the cylinder. This circuit is commonly used to open doors where a valve is placed in either side of the door.

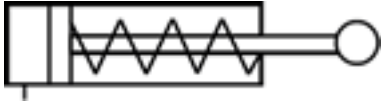











### Time delays



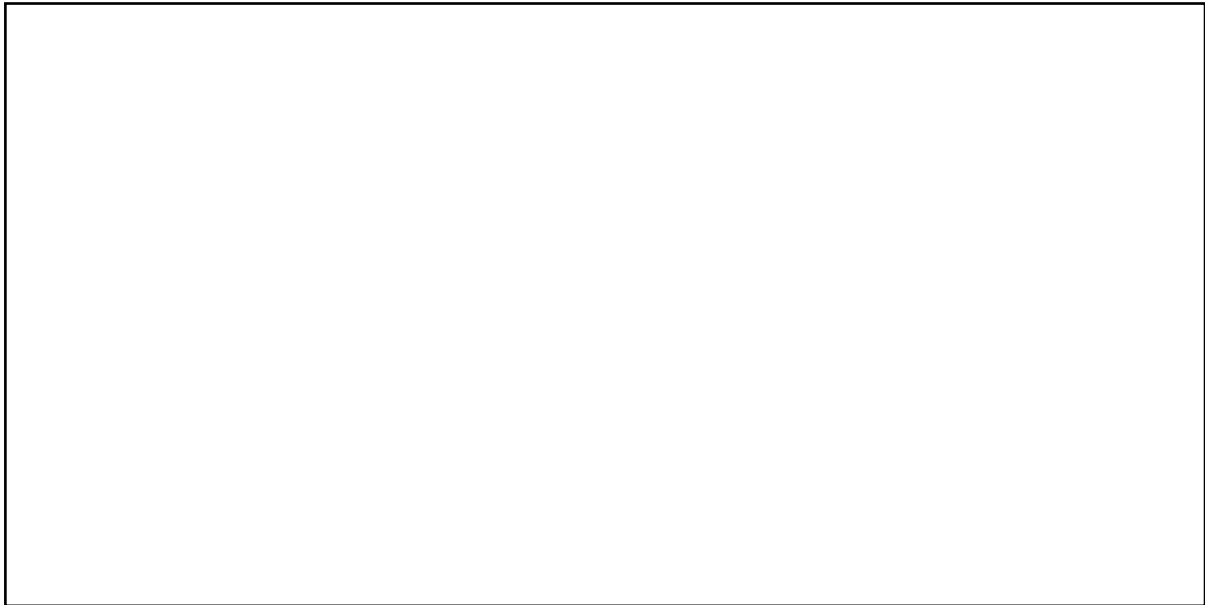
A time delay is created by using a unidirectional flow control valve in series with a reservoir. A reservoir is an empty pressure vessel. The reservoir is fed by restricted air flow and has the effect of slowing down the build-up of pressure in the circuit. The duration of the time delay depends on the rate of flow of the restricted air and the volume of the reservoir. Time delays using this method are generally of a short duration (less than 1 minute).

## Revision questions

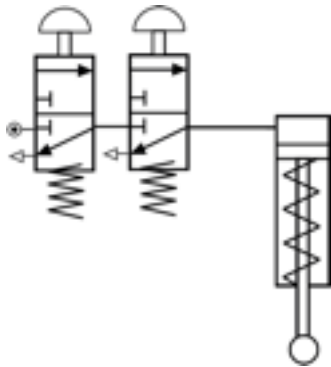
1. Complete the table below.

Component Symbol	Component name and function
	
	
	
	
	
	
	
	
	
	
	
	

2. Draw a diagram in the space below showing a basic circuit to operate a single acting cylinder using a 3/2 valve.



3. Identify the circuit below and explain its function.



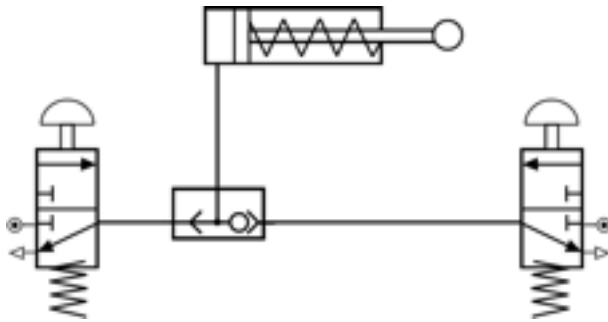
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4. Name the type of pneumatic circuit below and explain how it can be activated.




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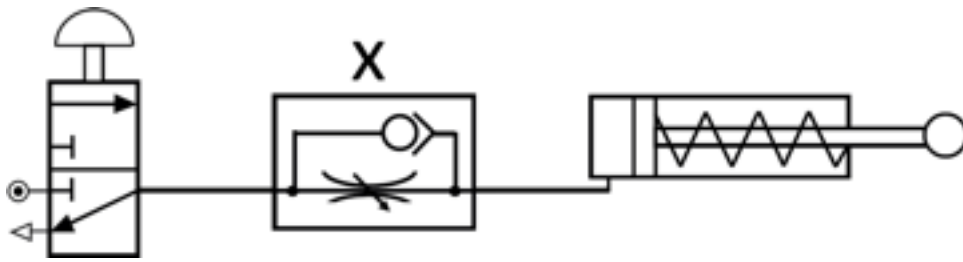


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5. Name the component labelled "X" and describe its function in the circuit.




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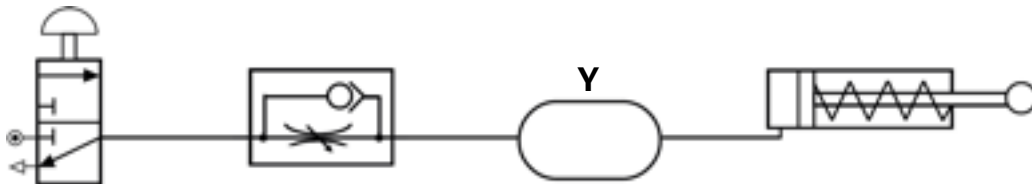


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6. Name the component labelled "Y" and the operation of the circuit shown below.




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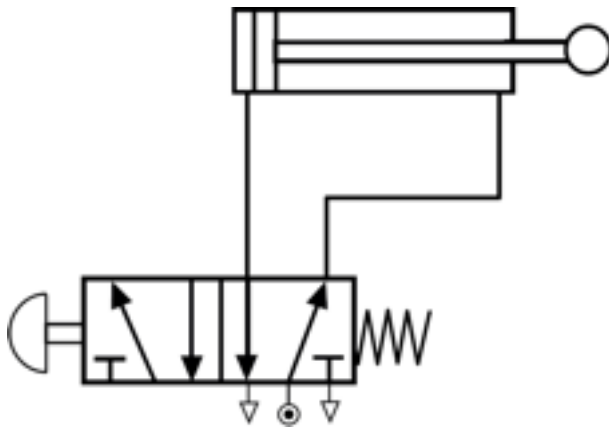
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7. Explain why the circuit shown below will always return to the position shown in the diagram when the push button is released.



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### Additional resources

[https://www.automationdirect.com/adc/Shopping/Catalog/Pneumatic\\_Components](https://www.automationdirect.com/adc/Shopping/Catalog/Pneumatic_Components)

<https://www.youtube.com/watch?v=cYBIq74IikE>

<https://www.youtube.com/watch?v=wKsNQpfRJU>

<https://www.youtube.com/watch?v=6sct2K-l8Dk>

