Higher Pneumatics

Safety

- Wear safety goggles
- Don't blow air at anyone, not even yourself
- Don't let compressed air come in contact with your skin
- Check all connections are secure before turning on the air
- Don't leave pipes trailing along the floor

Advantages of Pneumatic System

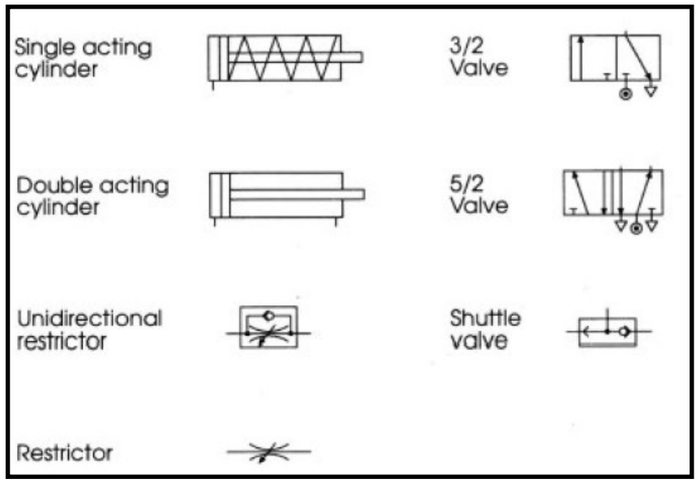
Clean - Pneumatic systems are clean because they use compressed air. If a pneumatic system develops a leak, it will be air that escapes and not oil.

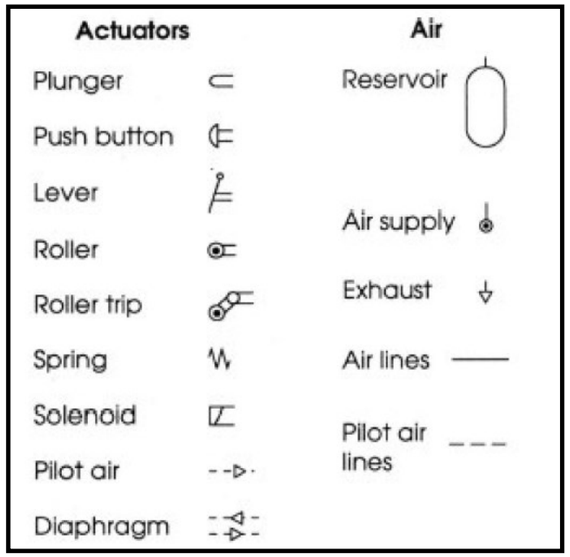
Safe - Pneumatic systems are very safe compared to other systems. We cannot, for example, use electronics for paint spraying because many electronic components produce sparks.

Reliable - Pneumatic systems are very reliable and can keep working for a long time.

Economical - If we compare pneumatic systems to other systems, we find that they are cheaper to run. This is because the components last for a long time.

Flexible - Once you have bought the basic components, you can set them up to carry out different tasks.

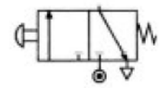




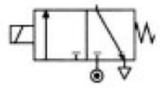
Valves should be named to give a clear indication of the type of valve and the method of operation.

For example

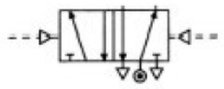
3/2 valve Push button Spring return



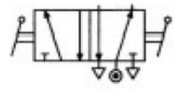
3/2 valve Solenoid Spring return



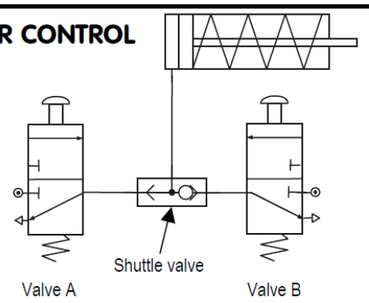
5/2 valve Pilot Pilot



5/2 valve Lever Lever

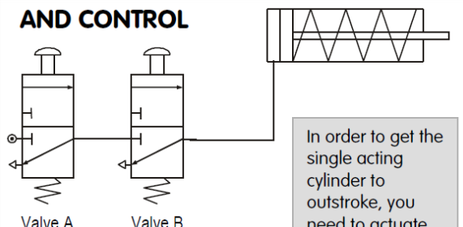


OR CONTROL

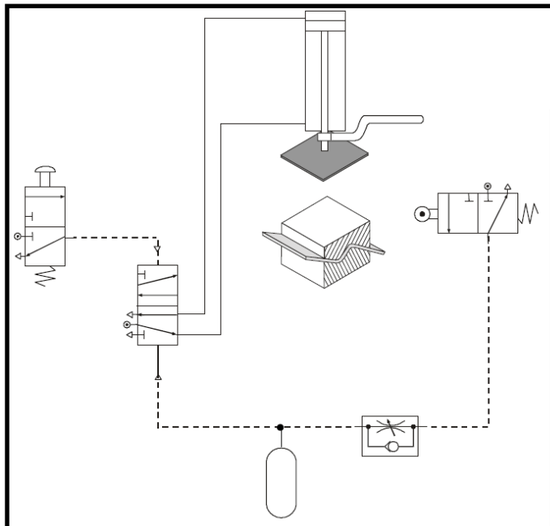


The cylinder will outstroke if valve A OR valve B is actuated.

AND CONTROL



In order to get the single acting cylinder to outstroke, you need to actuate valve A AND valve B.



Could you describe how this circuit works?

ANSWER

When the push button is pressed, the 5/2 valve changes state and the cylinder outstrokes. As it outstrokes, it pushes the former together and the hot plastic sheet is pressed into shape. As this happens it also actuates the roller. Air now flows through the restrictor and starts to fill up the reservoir. Once the reservoir is full, the 5/2 valve changes state and the cylinder instrokes, ready for the process to begin again.

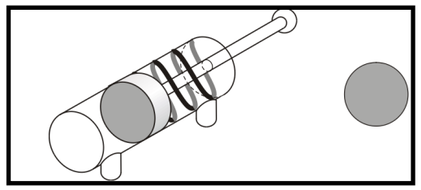
Force, Pressure, Area Calculations

$$Area = \pi r^2 = \pi \frac{d^2}{4}$$

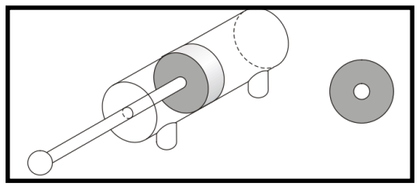
$$Force = Pressure \times Area$$

where force is measured in newtons (N), pressure is measured in Nmm^{-2} and area is measured in mm^2

Outstroke area of a piston



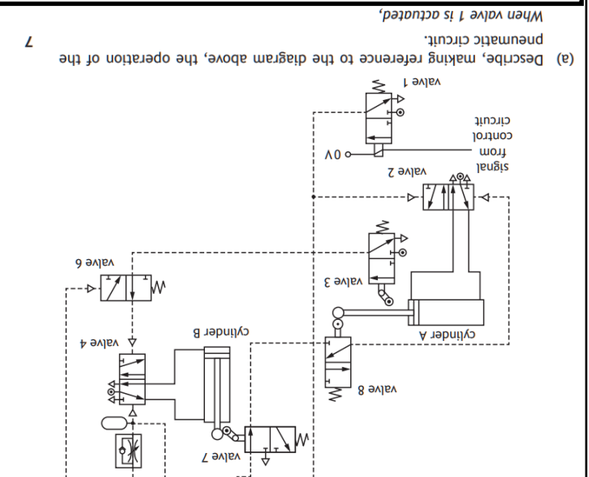
Instroke area of a piston



Effective area = piston area – piston rod area

Describing circuits

A further part of the system controls the motion of two cylinders.



Describe, with reference to the components, the full operation of the pneumatic circuit when the button on V_1 is pressed. **5**

When V_1 is actuated a pilot signal actuates V_2 causing C_A to outstroke.

As C_A outstrokes there is a delay then V_4 is actuated.

V_4 causes C_B to outstroke and actuates V_3.

V_3 cuts of the pilot signal to V_4.

After a delay V_4 and V_2 are actuated causing both cylinders to instroke.

Both cylinders will instroke anytime V_5 is actuated.

(a) Describe, making reference to the diagram above, the operation of the pneumatic circuit. **7**

When valve 1 is actuated,

When Valve 1 is actuated, pilot air flows to V_9 causing the main air through V_9 to be cut off. It also sends pilot air to V_2, causing cylinder A to instroke.

This actuates V_3 which causes pilot air to flow through V_6 which actuates V_4 and causes cylinder B to outstroke.

V_5 is actuated which sends a pilot signal through V_6 to actuate V_4 and outstroke cylinder B. V_5 also sends a pilot signal to a time delay circuit which will eventually actuate V_4 and V_9.

When V_4 is actuated, cylinder B instrokes and actuates V_7.

V_7 will send a pilot signal through V_8 to V_2 causing cylinder A to outstroke. When cylinder A outstrokes it actuates V_8 and cuts off the signal to V_2 allowing the process to begin again.

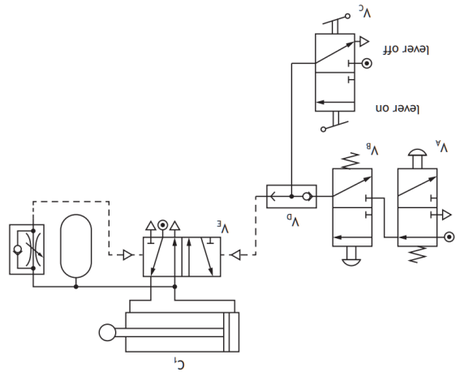
Valves 6 and 9 cut off the air supply to prevent cylinders instroking before the required conditions are met.

Fault finding

A mechanical engineer must design a pneumatic circuit to meet the following criteria:

- when push buttons on V_A and V_B are **not** pressed, or when the lever on V_C is thrown to the on state, a double-acting cylinder must outstroke $\left(\text{Outstroke} = \overline{A}.B + C\right)$
- a short time after the cylinder outstrokes, it must instroke automatically
- the cylinder must instroke slowly.

An initial design for the circuit, shown below, is known to have faults.



(a) Describe four faults with the circuit design shown

V_B lets air through when pressed.

V_B has no exhaust.

V_C is connected to the output of V_D.

The restrictor and reservoir are connected in the wrong sequence.

There is no restrictor to slow the instroke of the cylinder.

The ball and valve in the UDR are upside down.

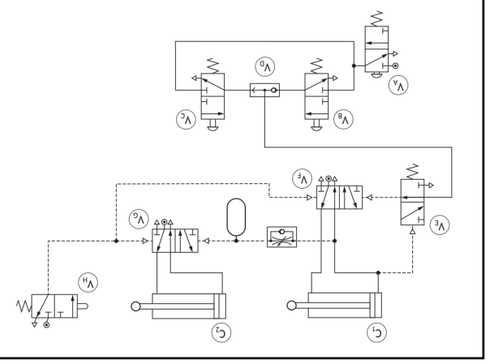
The engineering team are considering changing the circuit shown opposite to one that is operated by a microcontroller.

(ii) Describe two reasons why using a microcontroller-based system is preferred to a fully pneumatic system.

Significantly fewer components would be required so the system would be smaller/cheaper/quicker to manufacture.

Would allow for changes to be made to the function of the system as it can be reprogrammed more easily than constructing a replacement pneumatic circuit.

(a) Describe, making reference to the diagram above, the operation of the pneumatic circuit.



V_A must be released for mains air to flow to V_B and V_C.

If V_B or V_C is actuated then air flows to V_F which changes state.

When V_F is actuated C_1 will outstroke and V_E will be actuated.

After a time delay, C_2 will outstroke.

When V_H is actuated a pilot signal will be sent to V_G and V_F causing both cylinders to instroke.

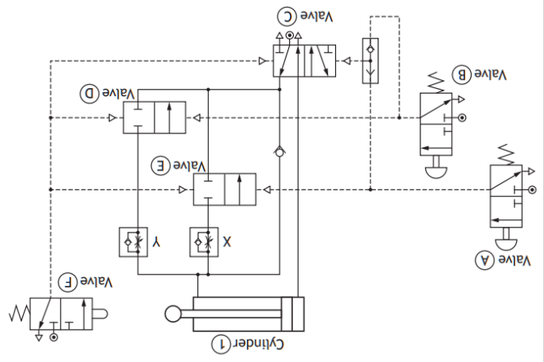
When V_F has been actuated V_E will return to its original state.

V_E's function is to prevent both sides of V_F being actuated at the same time.

9. A pneumatic circuit is used to compress two different types of material in the production of children's car seats. An operator actuates either valve (A) or (B) when the material is in position.

Components X and Y are set at different levels.

Valves (D) and (E) are 2/2 valves. They allow air to flow through when actuated in one state but not when they are in the other state.



(a) Describe, with reference to **all** of the components in the pneumatic circuit, the operation of the system when valve (A) is pressed and released then valve (B) is pressed and released. **7**

The cylinder will outstroke more quickly than if only one valve was pressed.

This is because air can exhaust through both V_D and V_E simultaneously.

9. **(continued)**

(b) Explain the effect that pressing **both** valves (A) and (B) together would have on the outstroking speed of the cylinder. **2**

When V_A is pressed, V_C is actuated causing C_1 to outstroke.

V_A also actuates V_E allowing air to exhaust through it but causing the outstroke speed to be slow.

Air must escape through a UDR due to the one-way valve.

Air cannot exhaust through V_D as it has not been actuated.

When C_1 is fully outstroked it actuated V_F which resets V_C and V_E.

C_1 will instroke quickly as air is able to go through the one-way valve unrestricted.

When V_B is actuated it actuates V_C causing C_1 to outstroke.

V_B also actuates V_D which allows air to exhaust causing C_1 to outstroke slowly.

When C_1 is fully outstroked it actuates V_F which resets V_C and V_D. C_1 will instroke as air is able to go through the one-way valve unrestricted.