FLUID POWER

FLUID POWER EQUIPMENT

TUTORIAL – OTHER FLUID POWER VALVES

This work covers part of outcome 2 of the Edexcel standard module:

UNIT 21746P APPLIED PNEUMATICS AND HYDRAULICS

The material needed for outcome 2 is very extensive so the tutorial is presented as a series.

OUTCOME 2 Investigate the construction and operation of pneumatic and hydraulic components, equipment and plant.	• Identify and describe the features of pneumatic and hydraulic equipment. • Analyse the performance characteristics of pneumatic and hydraulic equipment.

The series of tutorials provides an extensive overview of fluid power for students at all levels seeking a good knowledge of fluid power equipment.

Directional control valves are covered in a separate tutorial. On completion of this tutorial you should be able to do the following.

- Explain the principles and symbols of pressure relief valves.
- Explain the principles and symbols of pressure reducing valves and pressure regulators.
- Explain the principles and symbols of non return valves.
- Explain the principles and symbols of restrictor valves.
- Explain the purpose of pneumatic logic valves.
- Explain the purpose of pneumatic time delay valves.
- Explain the purpose of pneumatic counters.

FLUID POWER VALVES

1. INTRODUCTION

Directional control valves were described in the previous tutorial. There are many other valves used in fluid power to control the pressure and flow of the fluid. This tutorial is about them.

2. NON RETURN VALVE

These allow the fluid to flow only in one direction. They are typically used to stop the reverse flow of fluid through a pump when it is switched off and to lock an actuator in position by preventing the fluid leaving it.

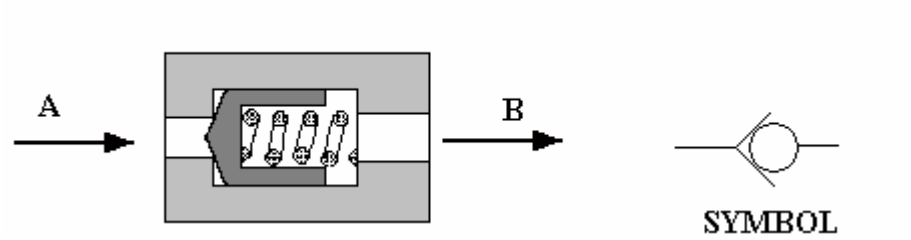

Figure 1

3. VARIABLE RESTRICTOR VALVES

These restrict the flow of the fluid producing a drop in pressure. They are often used to control the speed of cylinders and motors. Often they have a one way valve in parallel with it so that restriction only occurs in one direction. The diagram below shows a one way restrictor with restricted flow from A to B.

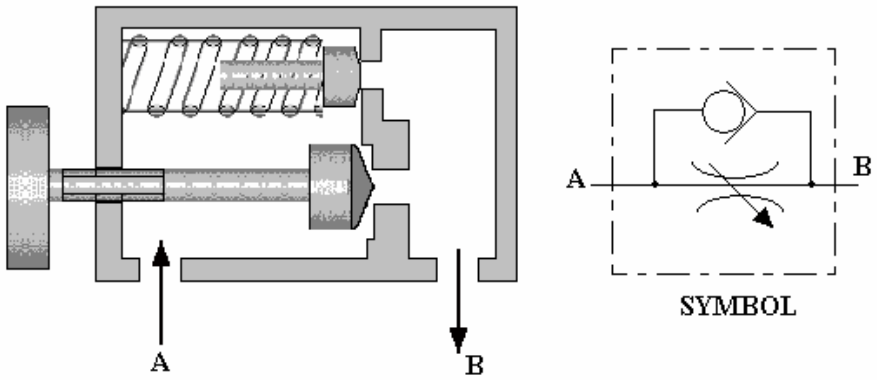

Figure 2

The pneumatic version is much simpler as it works at lower pressures. Fie control is produced by the needle shape of the poppet. The reverse flow is allowed by the flexible washer under the popper lifting up.

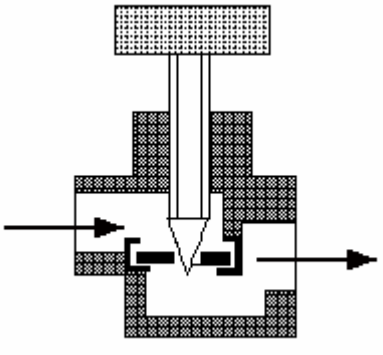

Figure 3

4. PRESSURE RELIEF VALVE

The purpose of a pressure relief valve is to protect a system from too much pressure. This will occur if the actuator is overloaded or if the flow of fluid is blocked. For example when a cylinder reaches the end of its stroke, the pump will still try to pump oil into it but it has nowhere to go. Similarly if a closed centre valve is used, the pump becomes blocked off. In such cases the pump or the system will become damaged.

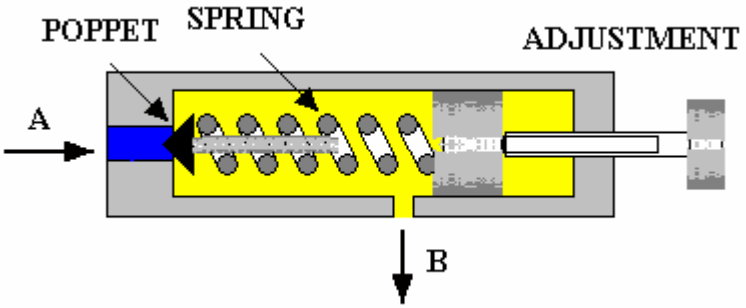

Figure 4

The relief valve is normally kept closed by the spring. Port (A) is connected to the system to be protected. If the pressure acting on the poppet overcomes the force of the spring, the poppet opens and lets the oil through to the tank (port B) thus limiting the pressure. Usually the spring is adjusted in order to set the pressure. The symbol is shown below.

In order to cope with large flow rates efficiently, a two stage valve is used. The diagram shows a 2-stage valve. The first stage contains the spring loaded poppet which lifts and passes oil from port A (pressure) to port B (Tank). The pressure is set by adjusting the spring force. The flow of oil is through a restrictor and this produces a pressure difference between the bottom and top of the second stage piston. The piston rises as a result and port A is opened directly to port B. The pilot port is normally closed but if it is opened, the second stage is opened fully without the operation of the first stage. This is often used in connection with an emergency stop valve to quickly depressurise a system. The drainage port copes with any fluid leaking past the adjuster. The valve is designed to fit on a standard base.

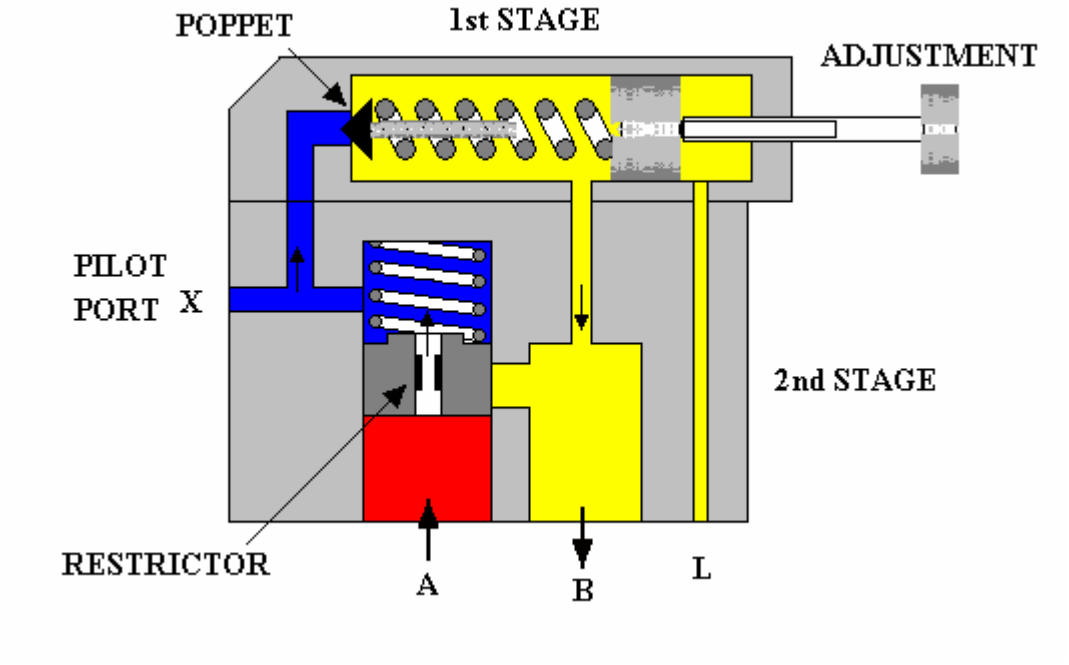

Figure 5

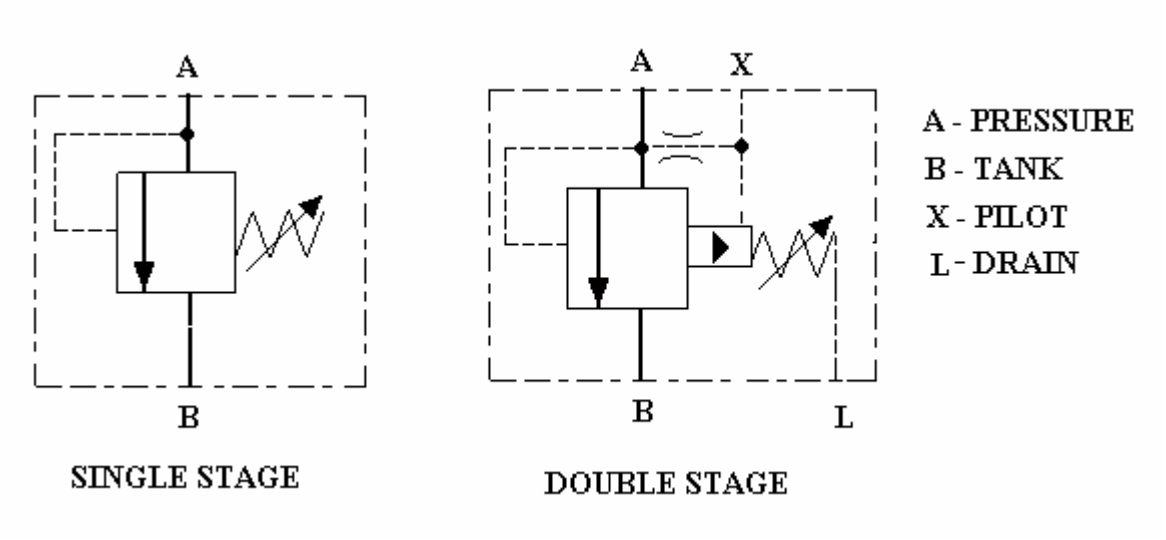
A
B
SINGLE STAGE
A
X
B
L
DOUBLE STAGE
A - PRESSURE
B - TANK
X - PILOT
L - DRAIN

Figure 7

5. PRESSURE REDUCING VALVES

These are used to provide a constant pressure to part of a system that is lower than the pressure in the rest of the system. The design is very similar to the two stage pressure relief valve but the motion of the piston is controlled by the outlet pressure, not the system pressure. The high pressure oil leaks through the restrictor and lifts the poppet. The pressure is set by adjusting the spring behind the poppet. The oil passing through is wasted to drain. The pressure drop through the restrictor produces a force imbalance on the spool and it moves to partially block port B and so reduce the pressure at port B. If the pressure on port B rises, the leakage through the restrictor increases and the pressure drop increases so the spool moves further close port B. If the pressure on port B drops, the leakage drops and the pressure difference drops so the spool moves to open port B and let more oil through.

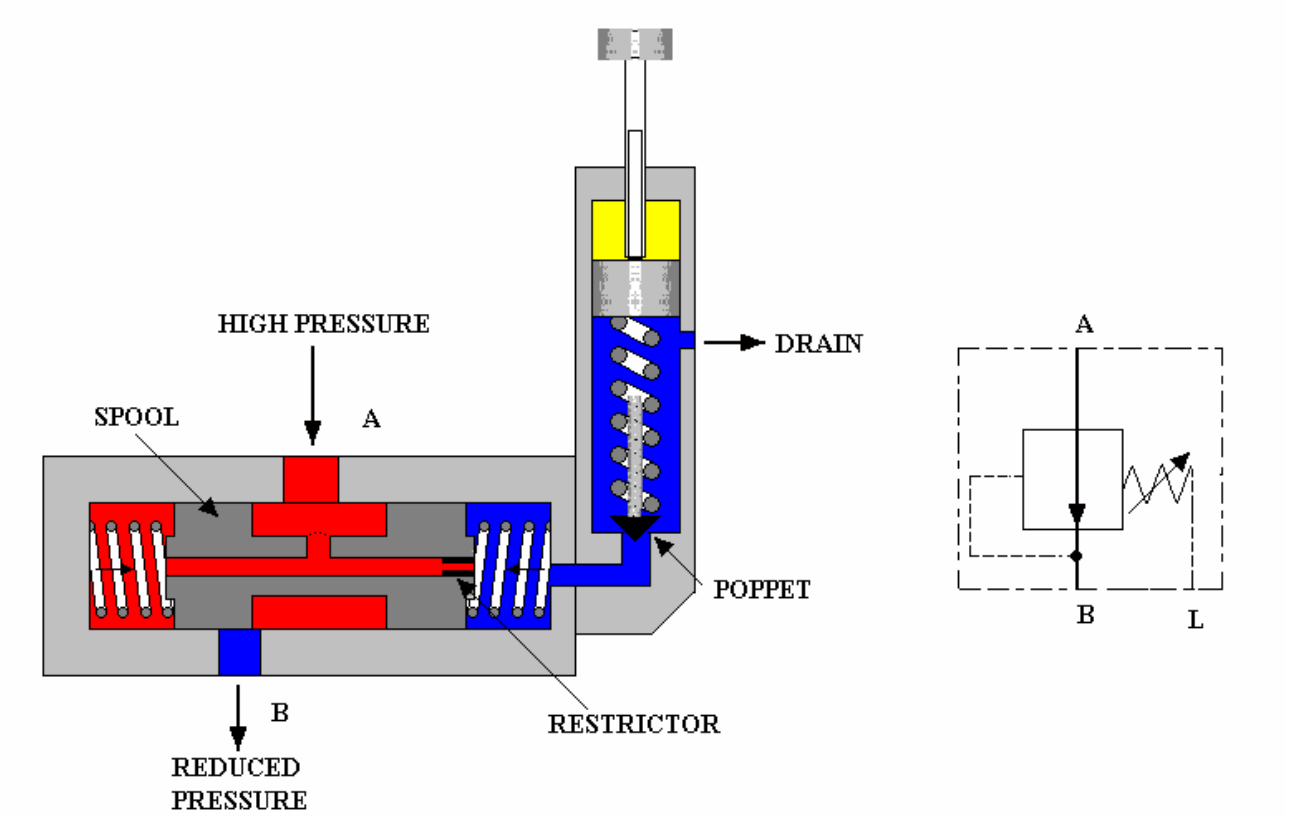

Figure 8

Pneumatic systems are low pressure systems and are supplied with air at a typical pressure of 8 bar and this is reduced to supply the system typically at 3 bar. The air is supplied to the system through a regulator which is a form of reducing valve. The pressure is reduced through the poppet valve (2). The valve is set by the spring and adjuster 4. Variations in the outlet pressure make the diaphragm (3) move up or down to open and close the valve as required to keep the pressure constant.

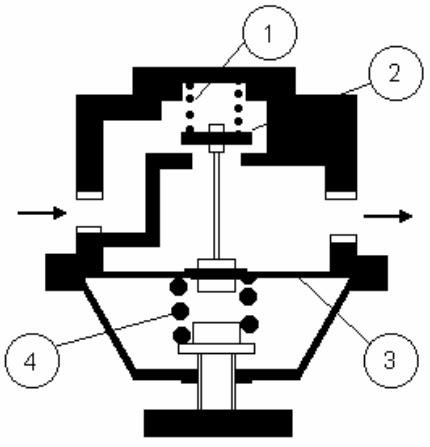

Figure 9

6. CARTRIDGE VALVES

A fuller description of cartridge valves is given in the tutorial on directional control valves. These are forms of poppet valve designed to fit into a block. Just about all valve types can be designed as a cartridge to fit into a block specially machined to accept it. In this way a bank of valves may be built into one block. The block might contain directional valves, relief valves, flow dividers, one way valves and so on. The diagram below shows a cartridge type pressure relief valve.

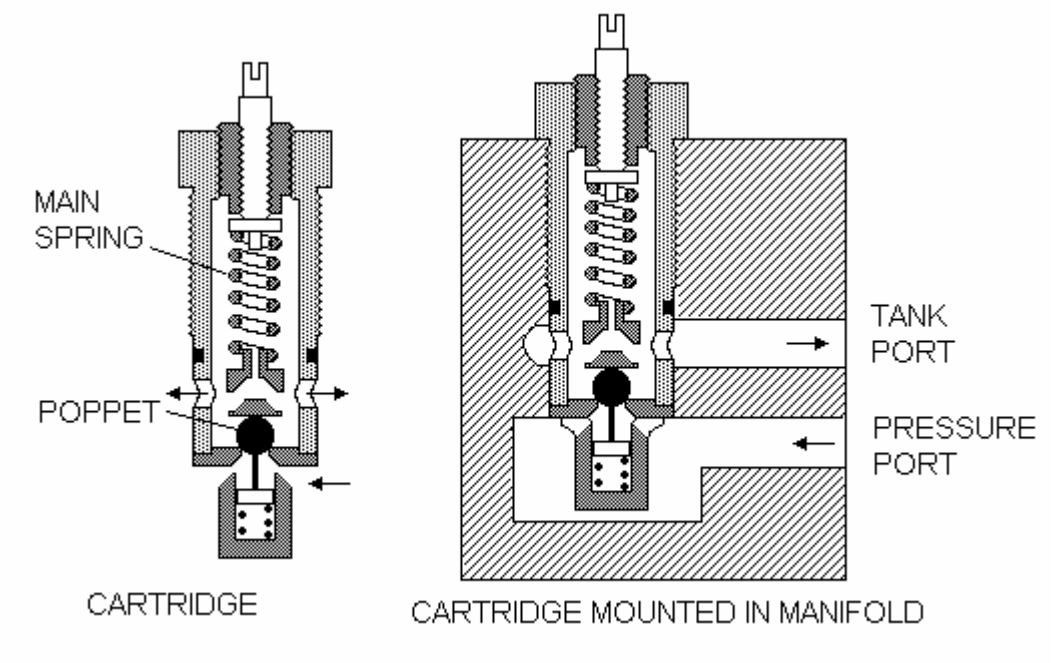

Figure 10

7. PNEUMATIC LOGIC VALVES

The two main logic valves are OR valves and AND valves. The OR valve is also called a SHUTTLE VALVE. The air always comes out of port C when air is applied to port A OR port B.

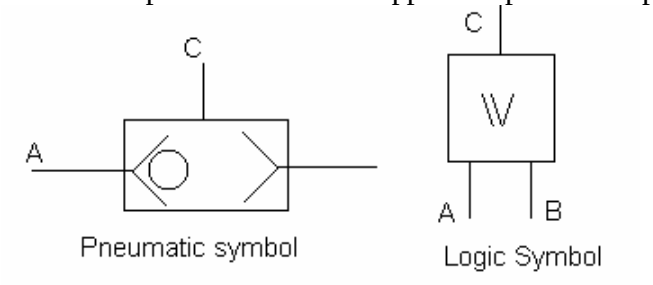

Figure 11

The AND valve only gets air from port C when air is applied to ports A AND B.

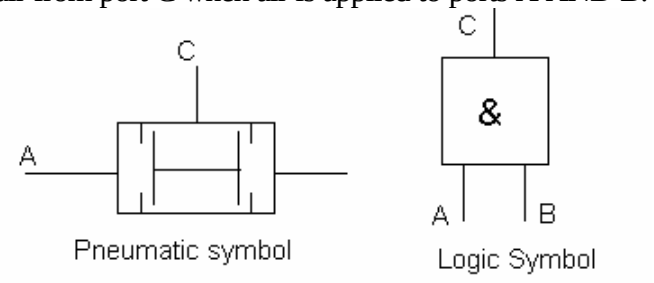

Figure 12

A NOT valve reverses a signal so if air is supplied at A, no air comes out of B and if no air is supplied at A, air is obtained from B. If a small circle is placed on the symbol as shown, it inverts the action at that connection. Hence a NOR valve is really an OR valve with an inverting output. The NOR valve supplies no pressure at C when no pressure is supplied to A nor B.

The NAND valve supplies pressure at C when pressure is supplied to A and not B.

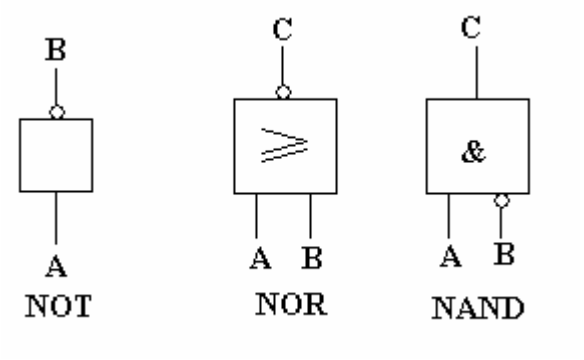

Figure 13

8. QUICK EXHAUST VALVE

This valve is used to enable the air exhausting from a cylinder to go straight to atmosphere without passing back down the tubes to the directional valve. This enables quicker operation of the cylinder as no back pressure builds up in the return tubes.

The air comes in through the inlet and pushes the flapper back blocking the exhaust and letting air through the holes around the edge and out through the cylinder port.

When air enters from the cylinder port, the rush throws the flapper against the flat surface and blocks the holes in it so preventing air going back to the inlet. This action opens the exhaust port and the air leaves that way.

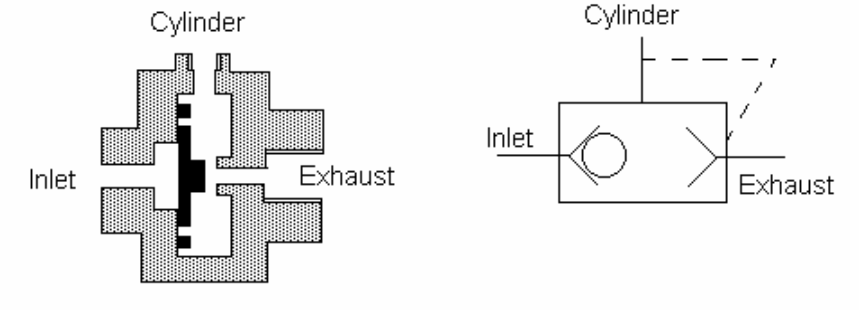

Figure 14

9. TIME DELAY VALVES

Time delay valves are pilot operated valves in which the pilot air is supplied through a variable restrictor so that it takes time for the operating pressure to build up. The time delay is adjusted by adjusting the variable restrictor.

Time delays are used a lot in industrial equipment. For example, a time delay may be used to give a tool time to clear the piece area before moving the work it.
The symbol is shown below. When a pressure is applied to port 1 a time delay occurs and then pressure is obtained from port 3. A permanent pressure source is connected to port 2.

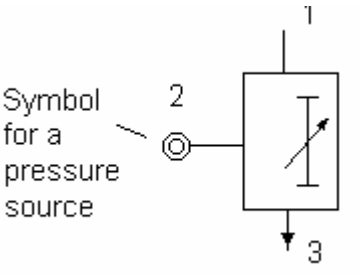

Figure 15

10. COUNTERS

Counters are used count a set number of pressure pulses and then switch on an air supply.

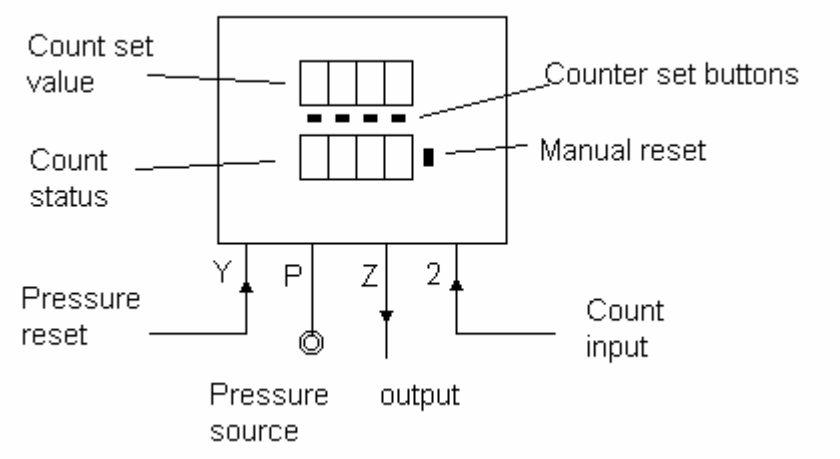

Figure 16

The diagram shows one type of pneumatic counter.

The number of counts required is set. The pulses to be counted are connected to port 2. The present count value is also displayed on a mechanical counter. When the two values are the same pressure is obtained from port Z. Port P is connected to a permanent pressure source. The unit may be reset by either applying a pulse to port Y or by pressing the reset button.

SELF ASSESSMENT EXERCISE No.1

1. Identify the component on the pneumatic circuit below represented by symbols V1, V2, V3 and A1.

   Explain the purpose of V3

   Explain the purpose of component V1

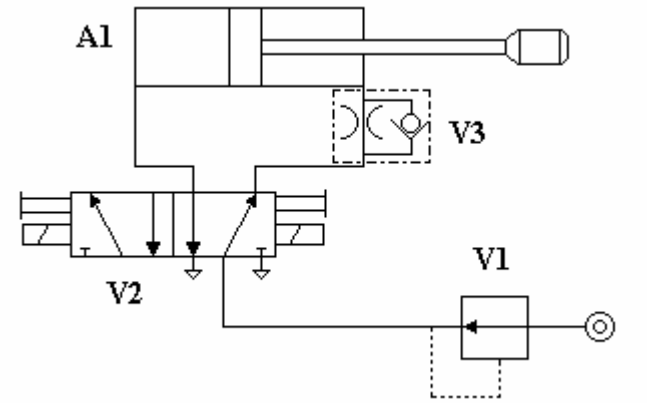

Figure 17

ANSWERS

V1 is a pressure regulating valve.
V2 is a 5/2 DCV solenoid operated in both directions with a manual override on each.
V3 is a one way restrictor valve.
A1 is a double acting cylinder.

V3 controls the speed of the cylinder outstroke by restricting the flow coming out but not going in.

V1 reduces the pressure from the supply and keeps the system pressure constant.

2. Identify the purpose of the components on the pneumatic circuit below.

Identify component V6
Explain the purpose of the OR valve V9.
Explain the purpose of valve V7.
Explain the sequence of events that occur after valve V1 or V2 is operated.

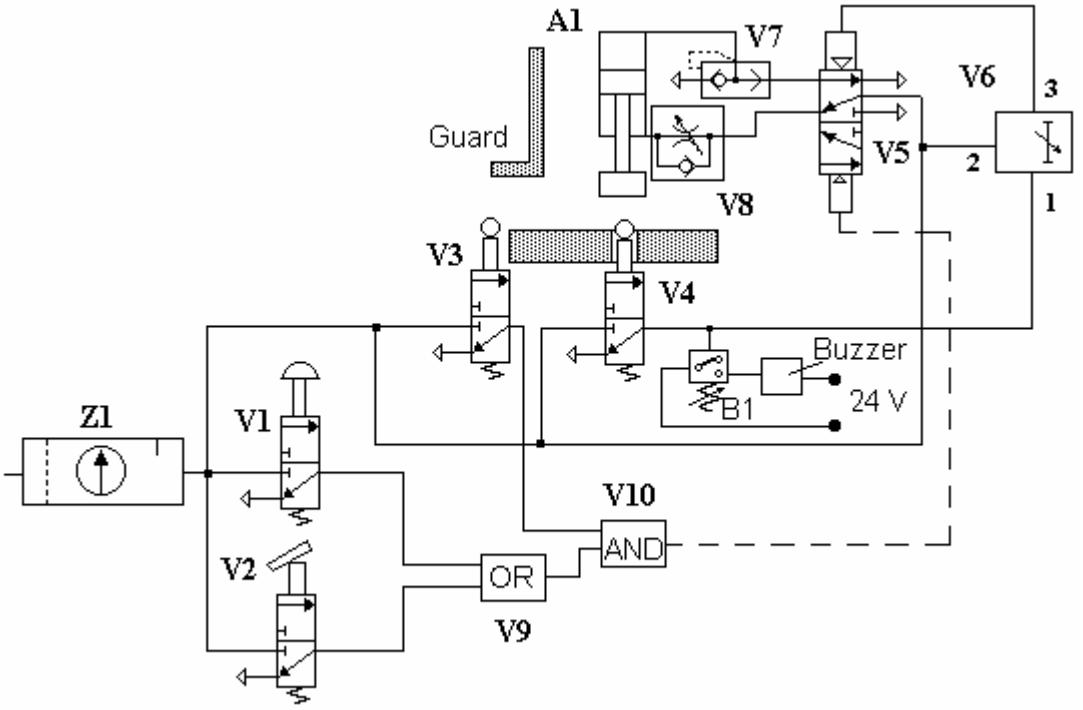

Figure 18

ANSWERS

Component V6 is time delay valve.

Component V7 is a quick exhaust valve which allows air to escape direct to the atmosphere instead of through the system thus speeding up the return stroke of cylinder A1.

The OR valve allows the system to be actuated by either the hand operated valve V1 or the foot operated valve V2.

The AND valve ensures that the system will not operate unless the guard is down operating valve V3 and the system is activated by V1 or V2.

If V1 or V2 is operated and the guard is down, air is supplied to DCV V5 making the cylinder A1 go down. The speed is regulated by the restrictor valve V8. When down, valve V4 is operated supplying air to port 1 of the timer valve and at the same time the pressure activates a pressure switch B1 and sets off a buzzer. After a time delay air pressure appears at port 3 of the timer valve and the DCV operates the other way forcing the cylinder to rise. The exhaust air escapes through the quick exhaust valve.

3. Explain the sequence of events that occur when valve V1 is operated.

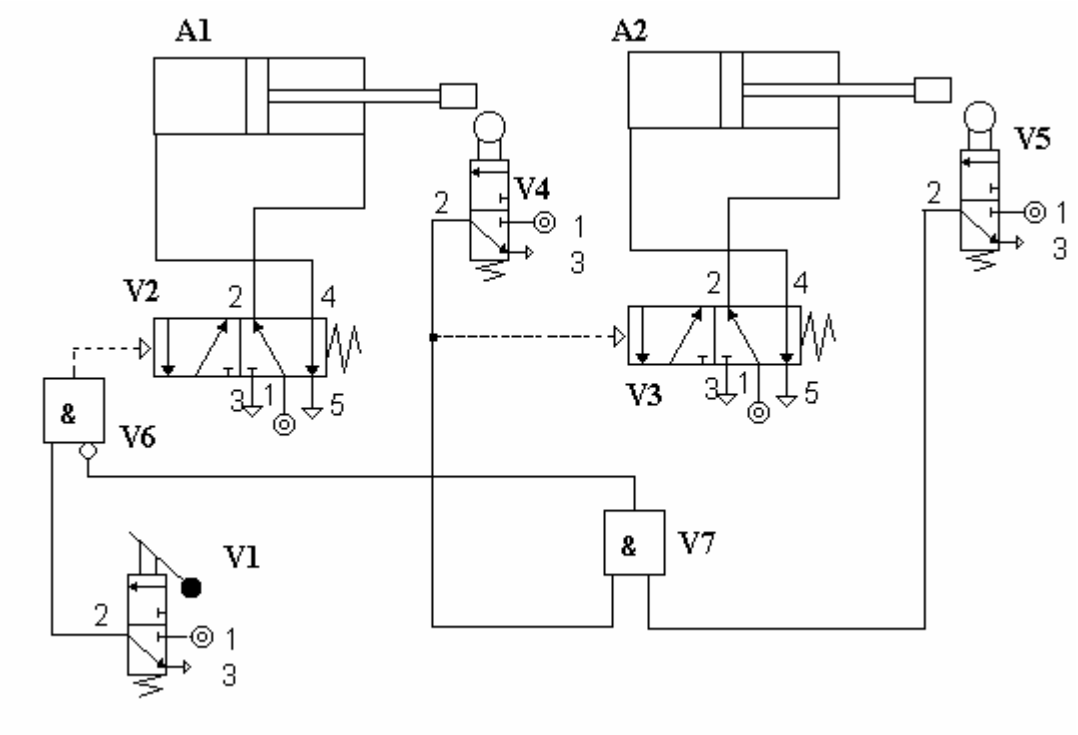

Figure 19

ANSWER

When V1 is operated air is sent from port 1 to port 2 and on to the NAND valve V6. Since no air pressure is applied to inverting port air is supplied to the pilot port of V2 and this switches sending air from port 4 to the cylinder A1 making it extend. At full extension the valve V4 is depressed and air is sent to from port 1 to ort 2 and on to the AND valve V7. At te same time air is supplied to the pilot port of V3 making it switch. Air is sent from port 1 to port 4 and on to cylinder A2 making it extend. At full extension valve V3 is depressed and air is sent from it to V7. Since air is supplied to both inputs of the AND valve V7 air comes out of the exit to the inverting port of V6. Since air is supplied to both inputs of the NAND valve V6, air is NOT sent from the output and V2 switches back making A1 retract. This cuts the supply from V4 and V3 switches back making A2 retract. This cuts the supply from V5 to V7. The AND valve V7 stops the air to V6.

So long as V1 is operated the cycle will continue with A1 operating. Then A2, then A1 retracting, then A2 and so on.