

# **DIESEL MECHANIC**



**MINING QUALIFICATIONS AUTHORITY**

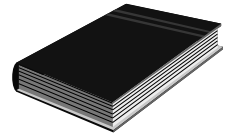
## **CODE: PN - 2**

# **CONSTRUCT A CIRCUIT WITH SINGLE ACTING CYLINDERS**

## INDEX

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## SOURCE REFERENCES

Demonstration by a competent person, e.g. a Training Officer.

FESTO – Pneumatics Basic Level Textbook

## OBJECTIVE

You will be learning towards the outcome “Construct a circuit with single acting cylinders”.

Whilst learning towards the outcome you will be required to achieve the following:

- Know the function of a single acting cylinder.
- Know the function of a 3/2 way directional control valve, normally open.
- Know the function of a 3/2 way directional control valve, normally closed.

On completion of this module, the learner must be able to:

- State the function of a single acting cylinder.
- State the function of a 3/2 way directional control valve, normally open.
- State the function of a 3/2 way directional control valve, normally closed.

During this process you must adhere to certain specified requirements as listed in the Module.

## ASSESSMENT AND EVALUATION CRITERIA

You will be assessed, when you are confident that you may achieve the outcomes as listed, to determine your competence as measured against the required criteria. This assessment will be in line with accepted best practices regarding assessment.

- Theoretical and practical assessments will be set during the module and must be completed without using reference.
- The learner will be required to answer all the questions without any reference.

**HAZARD IDENTIFICATION AND CONTROL (HIAC) FORM****PN - 2****CONSTRUCT A CIRCUIT WITH  
SINGLE ACTING CYLINDERS**

<b>STEPS IN OPERATION / PROCESS</b>	<b>POTENTIAL ACCIDENT / INCIDENT</b>	<b>CONTROLS (BY RESPONSIBLE PERSON)</b>
1. Construct a pneumatic circuit.	<ul style="list-style-type: none"> <li>Improper or careless handling of pneumatic components and pipes can lead to damage of equipment.</li> </ul>	<ul style="list-style-type: none"> <li>Always handle components and pipes correctly, and with great care.</li> </ul>
2. Use of compressed air in a pressurised circuit.	<ul style="list-style-type: none"> <li>Circuit under pressure.</li> </ul>	<ul style="list-style-type: none"> <li>Wipe components and panel clean after use and store components.</li> <li>Ensure circuit is depressurised before removing components or pipes</li> </ul>
3. Insure work area is safe.	<ul style="list-style-type: none"> <li>Dirt particles in eyes and laceration of skin.</li> </ul>	<ul style="list-style-type: none"> <li>Wear correct PPE.</li> </ul>

**NOTE:** Before doing the practical work contained in this module, the learner must study the content of the above HIAC form again and then sign the statement below.

The above risks, which will be encountered in this module, are fully understood and will be controlled during the practical work.

Signature of learner:

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Signature of Training Officer:

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Date:

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# 1. SINGLE ACTING CYLINDERS

**ITEM / TASK:** Introduction.

**DESCRIPTION:**

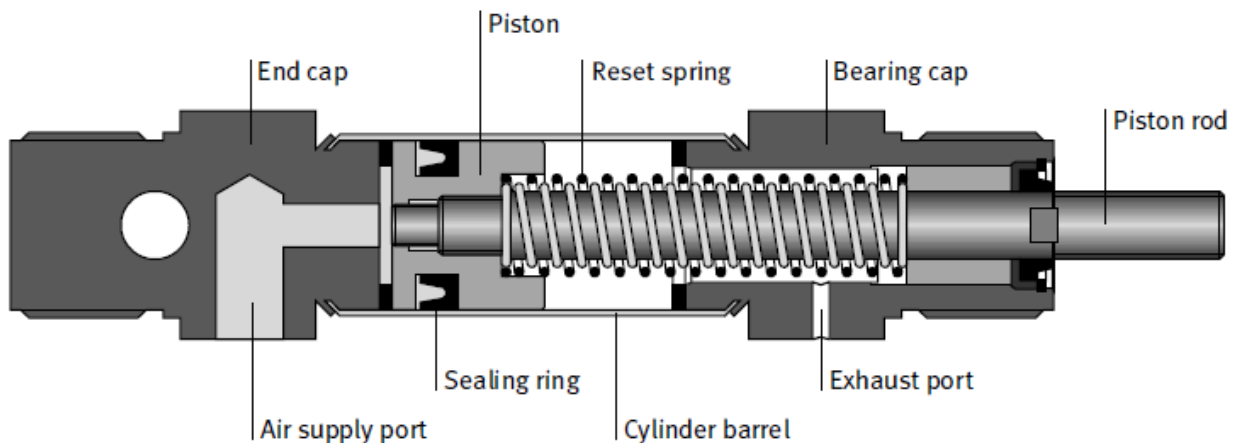
A. The purpose of a single-acting cylinder is to convert the pressure and the movement of compressed air into mechanical force. This can only be applied in one direction and in a straight line.

**ITEM / TASK:** Components of a single acting cylinder.

**DESCRIPTION:**

The main components of the single acting cylinder are: (Fig 1)

- a. Cylinder barrel.
- b. Bearing cap.
- c. End cap.
- d. Piston
- e. Piston rod.
- f. Sealing ring.
- g. Return / reset spring.



**FIG 1.**

A. Principle of operation:

- With single-acting cylinders compressed air is applied on only one side of the piston face. The other side is open to atmosphere. The return movement of the piston is effected by a built-in spring or by the application of an external force. The spring force of the built-in spring is designed to return the piston to its start position with a reasonably high speed under no load conditions.

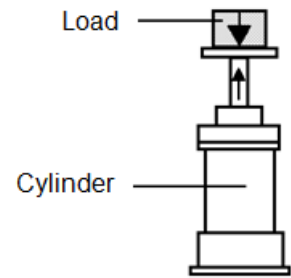
B. Single-acting cylinders can only perform work in one direction.

If gravitational force is used, the cylinder must be mounted in an upright position. (Fig 2)

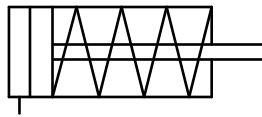
C. Single-acting cylinders are used for:

- Clamping
- Lifting
- Ejecting
- Allocating etc.

D. The symbol for a single acting cylinder with a return spring is shown in Fig 3.



**FIG 2.**



**FIG 3.**

**DO THE SELF TEST AND PRACTICE ON THE NEXT PAGES  
BEFORE CONTINUING WITH THE REST OF THE MODULE.**



## SELF TEST 1

1. What is the purpose of a single acting cylinder?

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2. Give two practical examples where a single acting cylinder may be used?

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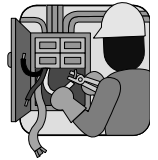
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Refer to your notes to check your answers.

Ask your Training Officer to check your work and if it is correct, to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :





## PRACTICE

1. Practice drawing the symbol for a single acting cylinder.

2. Identify the single acting cylinder from the training panel / equipment.

Ask your Training Officer to check your work and if it is correct, to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

## 2. DIRECTIONAL CONTROL VALVE





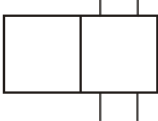
### **ITEM / TASK:** Introduction.

### **DESCRIPTION:**

A. Directional control valves are devices which influence the path taken by an air stream.

Normally this involves one or all of the following: opening the passage of air and directing it to particular air lines, cancelling air signals as required by blocking their passage and/or relieving the air to atmosphere via an exhaust port.

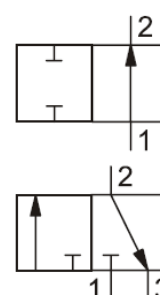
B. Symbol development:

<i>Valve switching positions are represented as squares.</i>	
<i>The number of squares shows how many switching positions the valve has.</i>	
<i>Flow path and direction of flow is indicated by arrows.</i>	
<i>Shut off positions are identified in the boxes by lines drawn at right angles.</i>	
<i>The connections (inlet and outlet ports) are shown by lines on the outside of the box, representing the normal control position of the valve.</i>	

C. The directional control valve is represented by the number of controlled connections, the number of positions and the flow path. In order to avoid faulty connections, all the inputs and outputs of a valve are identified.

<b>No of ports</b>		<b>No of switching positions</b>	
2	/	2	- way directional control valve, normally open.
3	/	2	- way directional control valve, normally closed.

### **Symbol**

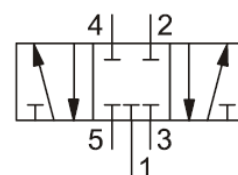
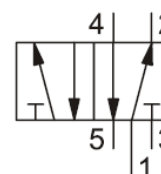
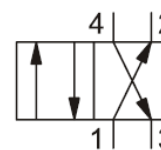
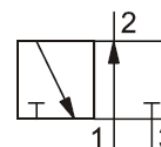


3 / 2 - way directional control valve, normally open.

4 / 2 - way directional control valve. (Flow from 1 → 2 and from 4 → 3)

5 / 2 - way directional control valve. (Flow from 1 → 2 and from 4 → 5)

5 / 3 - way directional control valve. (Mid position closed)



D. A numbering system is used to designate directional control valves and is in accordance with DIN ISO 5599-3. Prior to this, a lettering system was utilised and both systems of designation are presented here:

<b><u>Working Lines.</u></b>		
<b><u>ISO 5599 – 3</u></b>	<b><u>Lettering System</u></b>	<b><u>Port or Connection</u></b>
1	P	Pressure port / compressed air supply
2, 4	A, B	Working lines / outlets
3, 5	R, S	Outlet / Exhaust ports / Venting lines

<b><u>Pilot Lines.</u></b>		
<b><u>ISO 5599 – 3</u></b>	<b><u>Lettering System</u></b>	<b><u>Port or Connection</u></b>
10	Z	Applied signal inhibits flow from port 1 to port 2
12	X	Applied signal connects port 1 to port 2
14	Y	Applied signal connects port 1 to port 4

E. Outlet port on the valve is drawn as described below:

- If the valve has a threaded outlet port it is indicated by a line with an attached triangle. (Fig 4)
- If the outlet port is not threaded the attached triangle is drawn onto the square. (Fig 5)

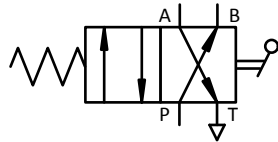


FIG 4.

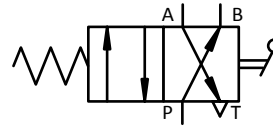


FIG 5.

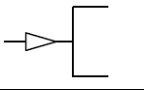
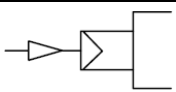
F. The methods of actuation of pneumatic directional control valves are dependent upon the requirements of the task. The types of actuation vary,

- Manually actuated.
- Mechanically actuated and
- Pneumatically actuated.

G. The symbols for the methods of actuation are detailed in DIN ISO 1219. When applied to a directional control valve, consideration must be given to the method of **initial actuation** of the valve and also the **method of return actuation**. Normally these are two separate methods. They are both shown on the symbol either side of the position boxes. There may also be additional methods of actuation such as manual overrides, which are separately indicated.

H. Actuating methods:

<b>Manual</b>	General	
	Pushbutton	
	Lever operated	
	Detent lever operated	
	Foot Pedal	
<b>Mechanical</b>	Plunger	
	Roller operated	
	Idle return, roller	
	Spring return	
	Spring centred	

<b>Pneumatic</b>	Direct pneumatic actuation	
	Indirect pneumatic actuation (piloted)	

- I. The directional control valve is characterised by its number of controlled connections or ways, the number of switching positions and the method of actuation. However, these symbols do not provide any information about the constructional design, but merely indicate the function of the valve.
- The **normal position** on valves with existing reset, e.g. spring, refers to the switching position assumed by the moving parts of the valve, if the valve is not connected.
  - The **initial position** is the switching position assumed by the moving parts of a valve after the valve has been installed in a system and the system pressure has been switched on and possibly also the electrical voltage, and with which the designated switching program starts.
- J. Designs are categorised as follows:

**Poppet valves:**

- ✓ Ball seat valve
- ✓ Disc seat valve

**Slide valves:**

- ✓ Longitudinal slide valve (spool valve)
- ✓ Longitudinal flat slide valve
- ✓ Plate slide valve

***Poppet valves:***

With poppet valves the connections are opened and closed by means of balls, discs, plates or cones. The valve seats are usually sealed simply using flexible seals. Seat valves have few parts which are subject to wear and hence they have a long service life. They are insensitive to dirt and are robust. The actuating force, however, is relatively high as it is necessary to overcome the force of the built-in reset spring and the air pressure.

***Slide valves:***

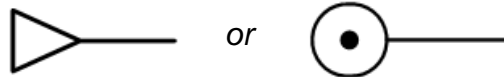
In slide valves, the individual connections are linked together or closed by means of spools, flat slide or plate slide valves.

### 3. SYMBOLS FOR LINES AND CONNECTIONS

**ITEM / TASK:** Symbols.

**DESCRIPTION:**

A. The energy source which, in most cases a compressor, is indicated as shown in Fig 6.



**FIG 6.**

B. A working line is one in which the pressure energy is transmitted. It is drawn as a solid line. (Fig 7)



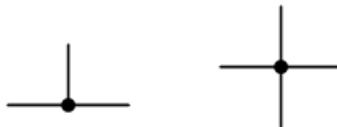
**FIG 7.**

C. A control line is a line which supplies air to a pneumatically operated valve. It is indicated by a dashed line. (Fig 8)



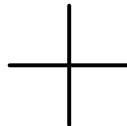
**FIG 8.**

D. When a line is connected with a fitting, it will be shown by means of a dot. (Fig 9)



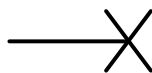
**FIG 9.**

E. When lines cross over and are not connected together they are indicated as shown in Fig 10.



**FIG 10.**

F. A pressure connection point is a point from which air under pressure can be tapped. It is indicated by the symbol shown in Fig 11.



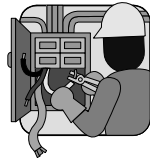
**FIG 11.**

G. A pressure connection with a connection line is indicated by the symbol shown in Fig12.



**FIG 12.**

**DO THE PRACTICE ON THE NEXT PAGE  
BEFORE CONTINUING WITH THE REST OF THE MODULE.**



## PRACTICE

1. Practice drawing the symbols for the following:

• Energy source.	
• Working line.	
• Control line.	
• Connected lines.	
• Lines crossing	
• Pressure connection point.	

Ask your Training Officer to check your work and if it is correct, to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :



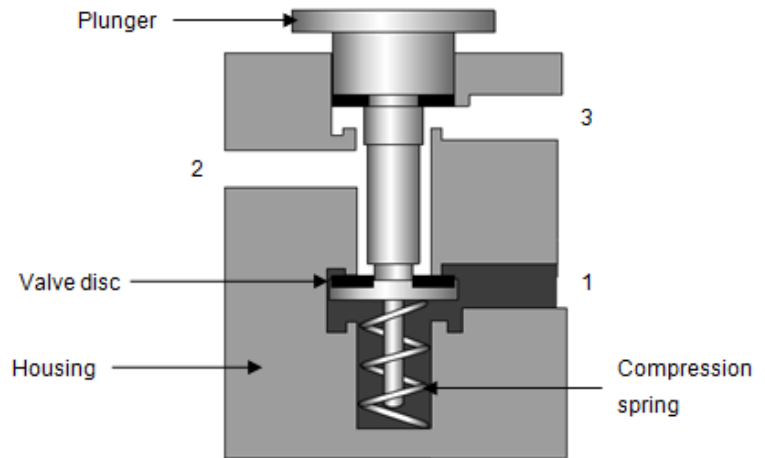
## 4. 3/2 WAY DIRECTIONAL CONTROL VALVES

**ITEM / TASK:** 3/2 way directional control valve, normally closed (Plunger type).

### **DESCRIPTION:**

A. The valve consists of the following parts: (Fig 13)

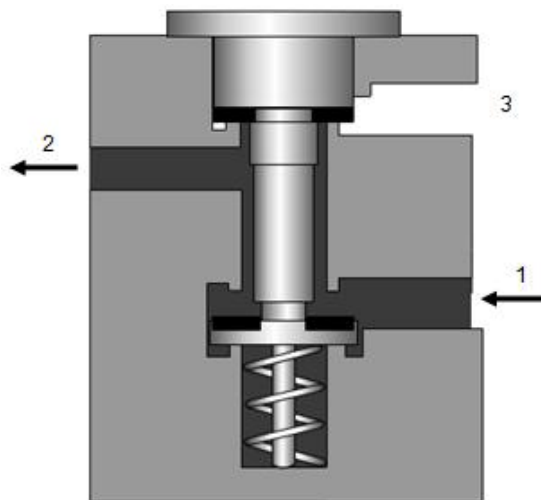
- a. Housing.
- b. Plunger.
- c. Valve disc.
- d. Compression spring.



**FIG 13.**

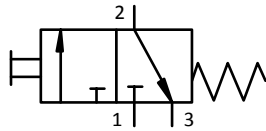
B. Principle of operation.

- In its normal position, the supply port 1 (P) is shut off. The working line from the cylinder connected to port 2 (A) is opened to the exhaust port 3 (R). Refer to Fig 13.
- When the plunger is depressed the supply port 1 (P) is connected to port 2 (A) and supplies air to the cylinder. In this position the exhaust port 3 (R) is blocked off. (Fig 14)

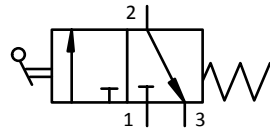


**FIG 14.**

- C. A 3/2-way directional control valve, normally closed is used to control the flow of air to and from a single-acting cylinder when the piston is to be moved out momentarily.
- D. The symbols for a 3/2-way directional control valve, normally closed, manual (Fig 15 a) or lever control (Fig 15b), spring reset, are shown below.



**FIG 15a.**



**FIG 15b.**

**DO THE SELF TEST AND PRACTICE ON THE NEXT PAGES  
BEFORE CONTINUING WITH THE REST OF THE MODULE.**



## SELF TEST 2

1. What is the function of a directional control valve?

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2. What is the 3/2 way directional control valve, normally closed, used for?

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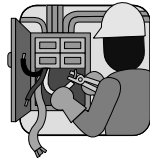
3. Fill in all the new designations for:

<u>Old</u>	<u>Designation</u>	<u>New</u>
P		
A		
B		
R		
S		
X		
Y		
Z		

Refer to your notes to check your answers.

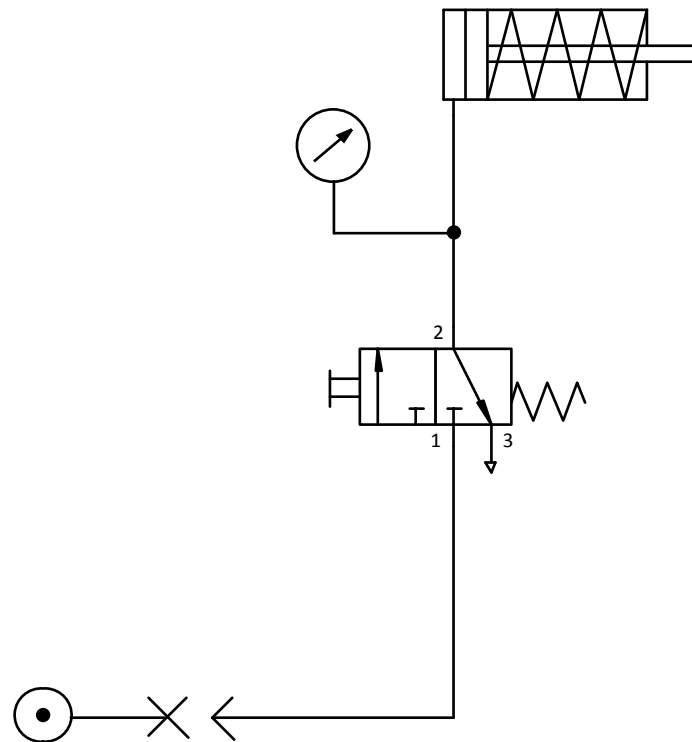
Ask your Training Officer to check your work and if it is correct, to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :



## PRACTICE

1. Practice drawing the symbols for a 3/2 way directional control valve, normally closed, manual control, spring reset.
2. Identify a 3/2 way directional control valve, normally closed, manual control, spring reset from the training panel / equipment.
3. Connect up the circuit below on the training panel.



4. Indicate the flow of air for both positions of the control valve on the drawing with different colour highlighters.

## **SAFETY.**

1. Plug in all the pneumatic connectors securely. If the connecting tubes become disconnected when the compressed air is applied, accidents can occur.

2. Keep the piston rod free to travel.

After you have connected the circuit, open the compressed air supply and operate the control valve.

If the cylinder remains in its retracted position when the air supply is opened, and moves outwards when the control valve is operated, your circuit is connected correctly.

Ask your Training Officer to check your work and if it is correct, to sign below.

<b>LEARNER</b>	<b>TRAINING OFFICER</b>
DATE :	DATE :
SIGNATURE :	SIGNATURE :

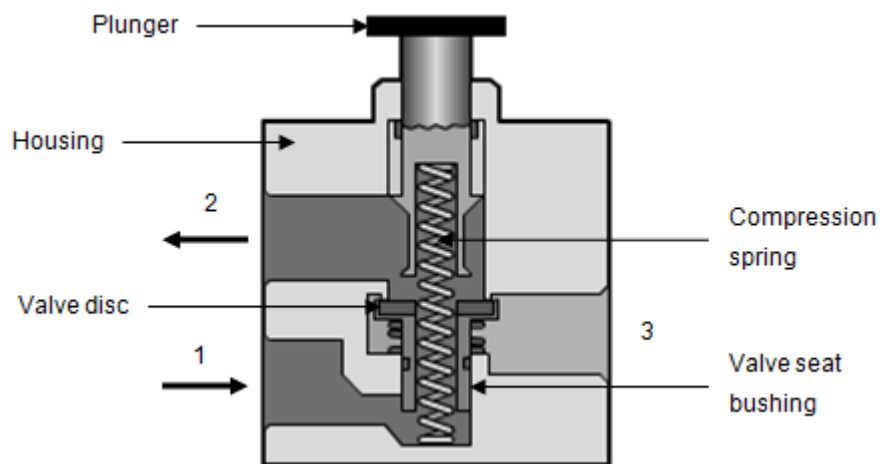
**ITEM / TASK:** 3/2 way directional control valve, normally open (Poppet type).

**DESCRIPTION:**

A. This valve allows the air to flow to the cylinder in its normal position.

B. The valve consists of the following parts: (Fig 16)

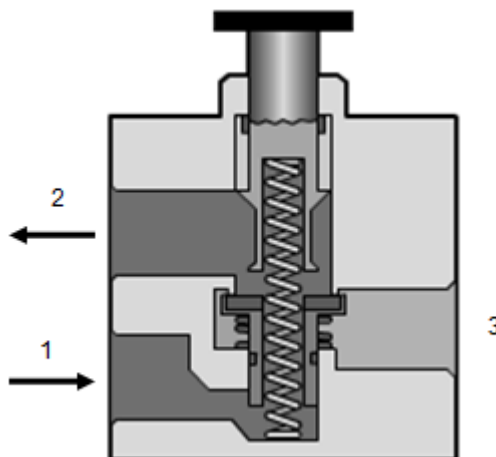
- a. Housing.
- b. Plunger.
- c. Valve disc.
- d. Compression spring.
- e. Valve seat bushing.



**FIG 16.**

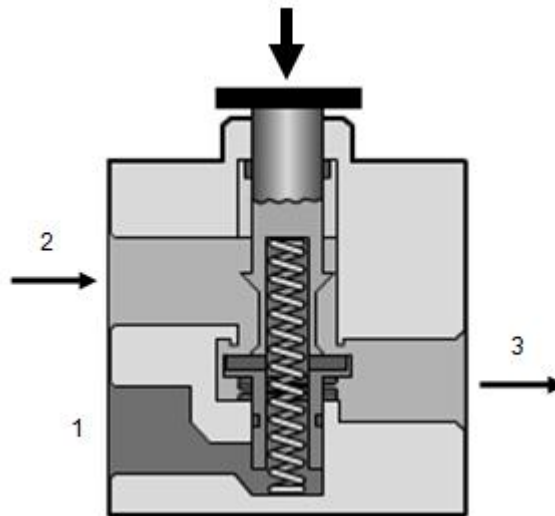
C. Principle of operation.

- In its normal position, the supply port 1 (P) is connected to port 2 (A) which is connected to the cylinder. The exhaust port 3 (R) is blocked off in this position. (Fig 17)



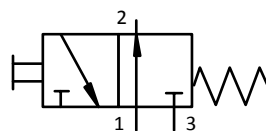
**FIG 17.**

- When the plunger is depressed the supply port 1 (P) is closed off. The working line from the cylinder to port 2 (A) is opened to the exhaust port 3 (R). This allows the cylinder to retract. (Fig 18)

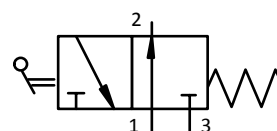


**FIG 18.**

- D. A 3/2-way directional control valve, normally open is used to control single acting cylinders if the piston rod has to remain in the "travelled out" position for a long period of time.
- E. The symbols for a 3/2-way directional control valve, normally open, manual (Fig 19a) or lever control (Fig 19b), spring reset, are shown below.



**FIG 19a.**



**FIG 19b.**

**DO THE SELF TEST AND PRACTICE ON THE NEXT PAGES  
BEFORE ATTEMPTING THE ASSESSMENT.**



## SELF TEST 3

1. What is the 3/2 way directional control valve, normally open, used for?

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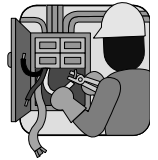
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Refer to your notes to check your answers.

Ask your Training Officer to check your work and if it is correct, to sign below.

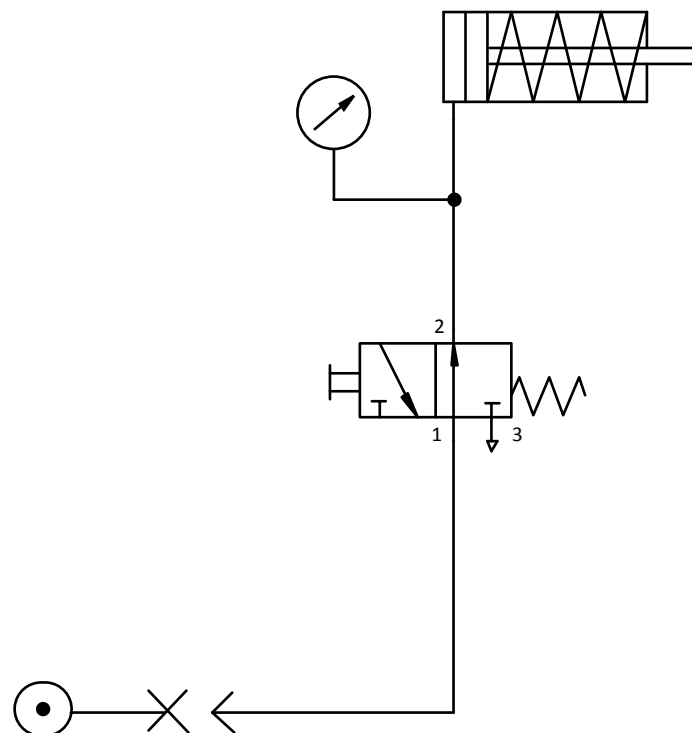
LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :





## PRACTICE

1. Practice drawing the symbols for a 3/2 way directional control valve, normally open, manual control, spring reset.
2. Identify a 3/2 way directional control valve, normally open, manual control, spring reset from the training panel / equipment.
3. Connect up the circuit below on the training panel.



4. Indicate the flow of air for both positions of the control valve on the drawing with different colour highlighters.

## **SAFETY.**

1. Plug in all the pneumatic connectors securely. If the connecting tubes become disconnected when the compressed air is applied, accidents can occur.

2. Keep the piston rod free to travel.

After you have connected the circuit, open the compressed air supply and operate the control valve.

If the cylinder moves outwards when the air supply is opened, and retracts to its initial position when the control valve is operated, your circuit is connected correctly.

Ask your Training Officer to check your work and if it is correct, to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :



## **REMEMBER ALWAYS WORK SAFE**

**Once you have passed the entire practices, you are now at liberty to request a Formative Assessment from your Assessor.**