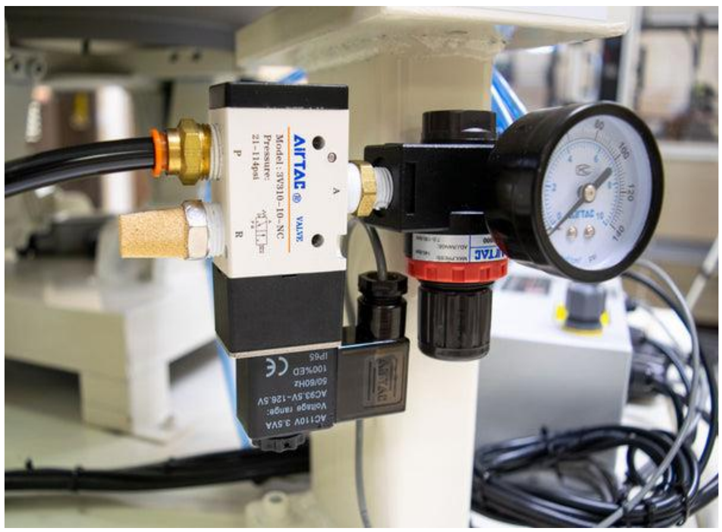
Automotive Mechanics

Level V

Based on December, 2024 Curriculum Version II



Module Title: - Developing and Applying Vehicle's Vehicle Pneumatic System Modifications

Module code: EIS AUM5 M03 1224

Nominal duration: 50 Hour

Prepared by: Ministry of Labor and Skill

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Addis Ababa, Ethiopia

Table of Contents

Acknowledgment

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVT instructors and respective industry experts who donated their time and expertise to the development of this Training Materials (TM).

Acronym

NBIC	National Board Inspection Code
ICC	International Code Council
API	American Petroleum Institute
CGA	Compressed Gas Association
CAN	Computer area network
LPM	Liters per minute
CFM	Cubic feet per minute
Lap-Test	Learning activity performance
DVC	Directional control valves
TTLM	Teaching, Training and Learning Materials

Introduction to module

In the modern automotive industry, the performance, efficiency, and reliability of vehicles are greatly influenced by the quality and functionality of their pneumatic systems. pneumatic systems are integral to many key components of a vehicle, from braking and steering to suspension and lifting systems. As vehicle technology continues to evolve, the need for effective modifications to hydraulic systems has become increasingly important. These modifications are necessary to optimize vehicle performance, enhance safety, and adapt to new operational demands.

This training module, "Developing and Applying Vehicle's pneumatic System Modifications," is designed to provide a comprehensive understanding Developing and applying modifications to a vehicle's pneumatic system can lead to significant enhancements in performance, safety, and efficiency. By following a structured approach that includes understanding the existing system, thorough design and testing, and careful implementation, vehicle engineers and modifiers can optimize pneumatic systems to meet the evolving demands of the automotive landscape. Keeping abreast of technological advancements and regulatory changes will ensure that modifications are both innovative and compliant with industry standards.

The primary objective of this training module is to equip automotive professionals and technicians with the knowledge and skills required to develop, modify, and apply Pneumatic system modifications can improve vehicle handling, acceleration, and braking performance, enhance comfort, reduce weight, improve durability and reliability, optimize fuel efficiency, adapt to different conditions, and enhance safety. These modifications can involve refining air suspension systems, improving brake responsiveness, and integrating with advanced technologies like electronic control systems. These improvements can lead to longer lifespans, lower maintenance costs, and improved vehicle dynamics.

This module covers the units:

- Basic Principles of Pneumatic Systems:
- Key components of a Pneumatic system:
- The role of Pneumatic systems in vehicle subsystems such as steering, suspension, and braking.
- Evaluating the Need for Pneumatic System Modifications:

- Designing Pneumatic System Modifications:
- Application of Pneumatic Modifications in Vehicle Systems:
- Testing and Troubleshooting Modified Pneumatic Systems:
- Safety Considerations and Best Practices:

Learning Objective of the Module

By the end of this training module, participants will be able to:

- Understanding Pneumatic Systems Gain a comprehensive understanding of the fundamental principles of pneumatic systems used in vehicles, including components such as compressors, valves, actuators, and air reservoirs.
- Develop skills for analysing and diagnosing existing pneumatic systems in vehicles, identifying inefficiencies, and recognizing opportunities for improvement or modification
- Learn different modification techniques that can be applied to enhance the performance, efficiency, and reliability of pneumatic systems, including retrofitting and upgrading components
- Acquire knowledge in designing pneumatic system modifications tailored to specific vehicle requirements, including calculations for air pressure, flow rates, and system capacities.
- Develop skills in testing and evaluating the performance of modified pneumatic systems, employing appropriate metrics and methodologies to assess improvements.
- Apply theoretical knowledge to practical scenarios by developing and implementing an actual pneumatic system modification project, from concept through to execution and evaluation.
- Gain experience in documenting the modification process, creating technical reports, and presenting findings, including challenges encountered and solutions implemented.
- Understand relevant regulatory requirements and ensure that modifications comply with safety and environmental standards.
- Apply modifications to improve the efficiency, energy consumption, and performance of hydraulic systems in vehicles.

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit one: Introduction to Vehicle Pneumatic Systems

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Introduction to Vehicle Pneumatic Systems
- Pneumatic Systems in Vehicles
- Fundamentals of Pneumatic Systems
- Components of Pneumatic Systems
- Operation Pneumatic System Components
- Interpretation of schematic diagrams
- Applications of Pneumatic Systems modification in Vehicles
- OHS requirement

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Fundamental and Principles of Pneumatics
- Compressor
- Air Reservoir
- Valves
- Actuators
- Pneumatic Lines
- Applications in Vehicles
- Advantages of Pneumatic Systems
- Challenges and Limitations

1.1 Introduction to Vehicle Pneumatic Systems

1.1.1 Pneumatic systems

Pneumatic systems play an essential role in modern vehicles, serving numerous functions from actuating brakes to operating suspension systems and powering various components that enhance vehicle performance and safety. The development and application of modifications to a vehicle's pneumatic system can lead to improvements in efficiency, capability, and responsiveness. This guide provides an overview of key concepts, steps for developing modifications, and considerations for application.

Pneumatic systems in vehicles use compressed air to perform various functions, ranging from power assistance to control mechanisms. These systems are integral to enhancing vehicle performance, improving safety, and providing comfort and convenience to the driver and passengers.

Advantages and Disadvantages of Compressed Air

Pneumatic systems have numerous advantages, the most important of which are:

- The medium, compressed air, can be easily extracted from our environment. There is no lack or shortage of it.
- After usage the compressed air goes back to its original condition. It can be released into the environment.
- Air can be compressed flexibly. Therefore, it is ideal for absorbing shocks and vibrations.
- The distribution of compressed air can be easily handled with pipes and hoses.
- Compressed air can be used in fire- and explosion-hazardous environment.
- Both its pressure level and volume can be regulated quite easily. Therefore, the energy brought to the actuator can also be controlled quite easily and within broad parameters.
- The usage of pneumatic components is easy as well as their maintenance. Their functionality is generally very reliable.
- Inexpensive: Pneumatic systems are relatively inexpensive compared to other systems such as hydraulic systems

- Clean: Pneumatic systems are clean because they use air as the working fluid. This makes them ideal for applications where cleanliness is important, such as in the food industry .
- Safe and easy to operate: Pneumatic systems are safe and easy to operate. They do not require any special training to operate and are not hazardous to the environment
- Low maintenance: Pneumatic systems require low maintenance and have long operating lives .
- Compressible gases are easy to store and safer: Compressible gases are easy to store and safer than other types of fluids. They do not present a fire hazard and machines can be made to be overload safe .

Besides these advantages there are some typical disadvantages:

- Compressed air depending on its application – needs some preparation, especially filtration and drying.
- Because of pricy electric energy and the limited efficiency of compressors, compressed air is a relatively expensive means of energy.
- Because of air's compressibility, the precise and load-independent positioning of the actuator(s) is not possible.

1.1.2 Fundamentals of Pneumatics

Pneumatics is the branch of engineering that deals with the study and use of pressurized gas to produce mechanical motion. Here are some fundamental principles of pneumatics.

Pressure: The force per unit area exerted by a fluid (gas) in a contained space. Measured in units such as psi (pounds per square inch) or bar.

Flow Rate: The volume of gas moving through a system per unit of time, typically measured in liters per minute (LPM) or cubic feet per minute (CFM).

Volume: The amount of space that a gas occupies, which can be affected by temperature and pressure changes.

Ideal Gas Law

The behavior of gases can be described by the Ideal Gas Law: ($PV = nRT$)

(P) = Pressure

(V) = Volume

(n) = Number of moles of gas

(R) = Ideal gas constant

(T) = Temperature (in Kelvin)

This produces a uniform pressure at every point within the fluid, which acts with equal force per unit area on the walls of the system. Liquid properties enable large objects (rudder, planes, etc) to be moved smoothly. According to Pascal's principle Magnitude of force transferred is indirectly proportional to the surface area (F α A), hence proportionality coefficient (pressure is constant).

$$P = \frac{F}{A}$$

Where, P = Pressure

F = Force

A = Area

Pressure

Pressure is force applied to a specific area. When a confined fluid is subject to pressure, the force applied to the area of confinement will be uniform throughout (Pascal’s law). When a liquid confined in a vessel is pushed on, the pressure that results acts evenly on all of the walls of the vessel. This characteristic makes it possible to transmit force or ‘‘push’’ through pipes. In hydraulics, we use liquids rather than gases as hydraulic fluids, because liquids are not easily compressed. Because of this incompressibility, we can relay action almost instantaneously, so long as the circuit is full of liquid and contains no air.

Pressure measurement

The actual pressure at a given position is the absolute pressure, and it is measured relative to absolute vacuum (i.e., absolute zero pressure). However, most pressure measuring devices calibrated to read zero in the atmosphere, and so they indicate the difference between the absolute pressure and the local atmospheric pressure. This difference is the gage pressure.

$$F = P \times A$$

Pressure is usually expressed in pounds per square inch or kilopascals. Additionally, there are a number of different pressure scales whereas all based on atmospheric pressure. One unit of atmosphere is the equivalent of atmospheric pressure and it can be expressed in all these ways:

- 1atm = 1 bar (European) =14.7psia = 29.92'' Hg (inches of mercury) = 101.3kPa (metric)

However, each of the above values is not precisely equivalent to the others:

- 1atm = 1.0192 bar
- 1bar = 29.53'' Hg = 14.503psia
- 1'' Hg = 13.6'' H_2O @ 60° F

Work and energy

Work occurs when effort or force produces an observable result. In a hydraulic circuit, this means moving a load. To produce work in a hydraulic circuit, we must have flow. Work is measured in units of force multiplied by distance, for example, in pound-feet.

- Work = Force × Distance

Physical Fundamentals and Units of Measurement (metric system)

The SI-system of units is based on numerous basic and derived units of measurement. We do not cover that in detail. [**International System of Units**, short **SI** (french): *Système international d'unités*]

Units of measurement that are relevant in pneumatics:

- Meter – **m** (length / distance)
- Kilogram – **kg** (weight / mass)
- Second – **s** (time)
- Kelvin – **K** (temperature)

Derived units that are used:

- Newton – **N** (force)
- Pascal – **Pa** (pressure)

Force

Force is any interaction that, when unopposed, will change the motion of an object. In other words, a force can cause an object with mass to change its velocity (acceleration, change of shape). Force can also be described as a push or pull. It is a vector quantity consisting of magnitude and direction.

- Symbol: **F**
- Unit: **Newton**
- Unit symbol: **N**
- In SI-based units: $\frac{kg \cdot m}{s^2}$

Pressure

Pressure is the force applied perpendicular to the surface of an object per unit area over which the force is distributed.

$$p = \frac{F}{A}$$

- Symbol: **P**
- Unit: **Pascal**
- Unit symbol: **Pa**
- In SI-based units: $\frac{N}{m^2}$

For measuring pressure, the following multipliers are common:

1 **kPa** (Kilopascal) = 1,000 Pa

1 **MPa** (megapascal) = 1,000,000 Pa

In pneumatics we normally use the unit **bar.**

1 **bar** = 100,000 Pa = 0.1 MPa = 0.1 N/mm^2

1 **mbar** = 0.001 bar

1 **nbar** = 0.000000001 bar

In some countries such as the USA or Great Britain the unit **psi** (pounds per square inch) is also still in use.

1 **psi** = 0.07 bar (rounded)

Standard atmospheric pressure is the pressure of the air on sea-level, which equals 1 atm (atmosphere).

1 **atm** = 101,325 Pa = 1013.25 mbar (*Millibar*) or hPa (*Hektopascal*)

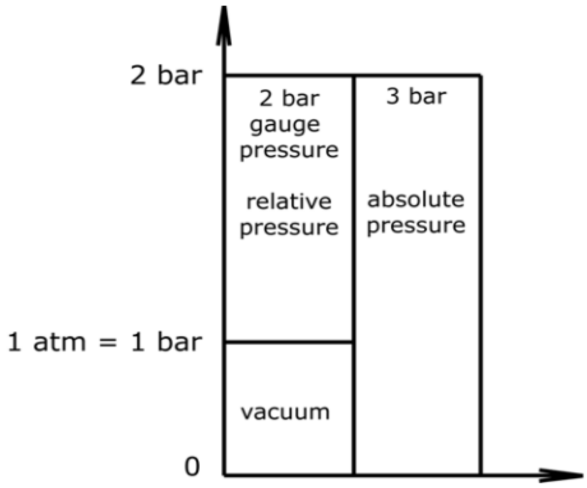
This unit is normally used in meteorology. Rounded and precise enough for most applications:

1 atm = 1 bar

Excess pressure or gauge pressure is the value of pressure above standard atmospheric pressure. It is also called **relative pressure.**

In case **absolute pressure** is measured, standard atmospheric pressure is included. The scale starts at 0 Pa = total vacuum.

Absolute pressure = standard atmospheric pressure + gauge pressure (relative pressure)



Expressions:

- $\mathbf{P_{(a)}}$: Absolute pressure
- $\mathbf{P_{(t)}}$: Excess/Gauge pressure
- $\mathbf{-P_{(t)}}$: Vacuum

Examples:

- 6 bar excess pressure = 6 $bar_{(t)}$
- 7 bar absolute pressure = 7 $bar_{(a)}$
- 0.7 bar absolute pressure = 0.7 $bar_{(a)}$ or -0.3 $bar_{(t)}$

The expressions „excess pressure“ and „vacuum“ refer to a value larger or smaller than standard atmospheric pressure.

There are different **levels of vacuum**:

Standard atmospheric pressure	101325 Pa	= 1.01325 bar = 1 bar
Low vacuum (rough vacuum)	100 kPa ... 3 kPa	= 1 bar ... 0.03 bar
Medium vacuum	3 kPa ... 100 mPa	= 0.03 bar ... 0.001 mbar
High vacuum	100 mPa ... 1 µPa	= 0.001 mbar ... 0.01 nbar
Ultra-high vacuum	100 nPa ... 100 pPa	
Extremely high vacuum	< 100 pPa	
Outer space	100 µPa ... < 3 fPa	
Perfect vacuum	0 Pa	

In pneumatics we use the unit **bar** for vacuum as well as for excess pressure.

Unless there is any further indication, we normally work with **excess pressure** = **relative pressure**.

1.1.3 Components of a Pneumatic System

Air Actuator: Air cylinders and motors are used to obtain the required movements of mechanical elements of pneumatic system.

Air cooler: During compression operation, air temperature increases. Therefore, coolers are used to reduce the temperature of the compressed air.

Air filters: These are used to filter out the contaminants from the air.

Compressor: Compressed air is generated by using air compressors. Air compressors are either diesel or electrically operated. Based on the requirement of compressed air, suitable capacity compressors may be used.

Control Valves: Control valves are used to regulate, control and monitor for control of direction flow, pressure etc.

Dryer: The water vapor or moisture in the air is separated from the air by using a dryer.

Electric Motor: Transforms electrical energy into mechanical energy. It is used to drive the compressor.

Receiver tank: The compressed air coming from the compressor is stored in the air receiver.

Air Actuator: Pneumatic cylinders, also known as pneumatic actuators or air cylinders, are designed to convert compressed air energy into a reciprocating linear motion in automated industrial applications

i. Single acting cylinder

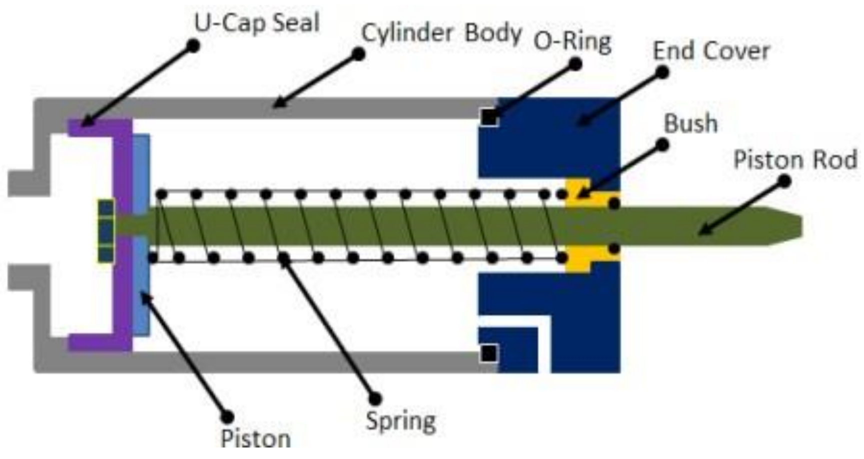


Figure 1.1 .Single acting cylinder

These cylinders produce work in one direction of motion hence they are named as single acting cylinders. The compressed air pushes the piston located in the cylindrical barrel causing the desired motion. The return stroke takes place by the action of a spring. Generally, the spring is provided on the rod side of the cylinder.

ii. Double acting cylinder

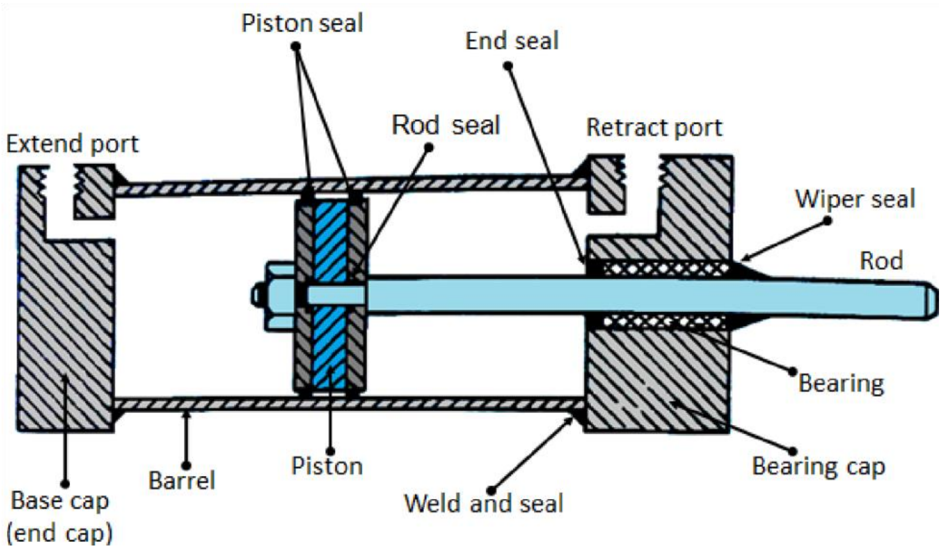


Figure 1.2 Double acting cylinder

The main parts of a hydraulic double acting cylinder are: piston, piston rod, cylinder tube, and end caps. The piston rod is connected to piston head and the other end extends out of the cylinder. The piston divides the cylinder into two chambers namely the rod end side and piston end side. The seals prevent the leakage of oil between these two chambers. The cylindrical tube is fitted with end caps.

The pressurized oil, air enters the cylinder chamber through the ports provided. In the rod end cover plate, a wiper seal is provided to prevent the leakage of oil and entry of the contaminants into the cylinder.

The combination of wiper seal, bearing and sealing ring is called as cartridge assembly. The end caps may be attached to the tube by threaded connection, welded connection or tie rod connection. The piston seal prevents metal to metal contact and wear of piston head and the tube. These seals are replaceable. End cushioning is also provided to prevent the impact with end caps.

A. Air cooler

Air temperature increases when the air is compressed in the compressor. This hot air is not suitable for further operation. Hence it is important to cool down the hot air coming out of the air compressor. The cooling of air is done by an air cooler. The main objective of an air cooler is to reduce the temperature and moisture content in the air coming out from the air compressor.

There are two types of commonly used air coolers.

i. Air-cooled air cooler.

In an air-cooled air cooler, the hot air is enclosed in pipes and cool air is forced on it with the help of a fan this cool air carries away heat from the hot air without decreasing the pressure.

ii. Water-cooled air cooler.

While in the case of a water-cooled air cooler the heat is exchanged by indirect contact between the hot air from the compressor and cold water.

Much lower temperature can be obtained by a water-cooled air cooler than the air-cooled air-cooler. As cold water is available in large quantities, water-cooled air coolers are cost-effective and quick.

B. Air filters

Air contains various impurities such as pollen grains, dust particulate, soot, etc. These impurities need to be removed from the air before it enters a pneumatic circuit.

Hence an air filter is used to restrict these impurities from entering the pneumatic circuit. The air filter is a fibrous or porous material that traps the solid particulate and allows air to move in.

It may also contain some absorbent material such as charcoal that absorbs pollutant gas particles and soot.

Figure 1.3 Twin air filter

C. Compressor

It is a mechanical device which converts mechanical energy into fluid energy. The compressor increases the air pressure by reducing its volume which also increases the temperature of the compressed air. The compressor is selected based on the pressure it needs to operate and the delivery volume.

The compressor can be classified into two main types

i. Positive displacement compressors and

ii. Dynamic displacement compressor

Positive displacement compressors include piston type, vane type, diaphragm type and screw type.

- Piston compressors

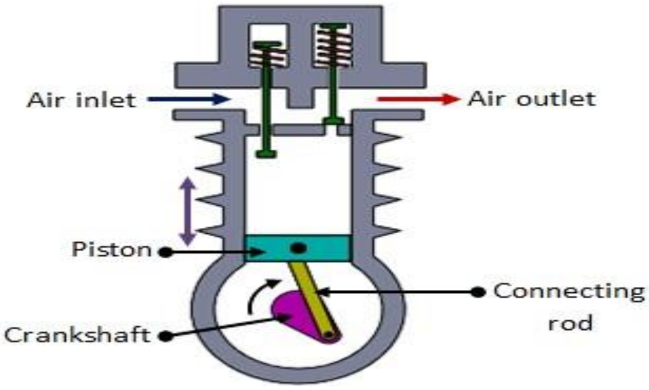


Figure 1.4 Piston compressors

Piston compressors are commonly used in pneumatic systems. The simplest form is single cylinder compressor. It produces one pulse of air per piston stroke. As the piston moves down during the inlet stroke the inlet valve opens and air is drawn into the cylinder. As the piston moves up the inlet valve closes and the exhaust valve opens which allows the air to be expelled. The valves are spring loaded. The single cylinder compressor gives significant amount of pressure pulses at the outlet port. The pressure developed is about 3-40 bar.

D. Refrigerated dryers

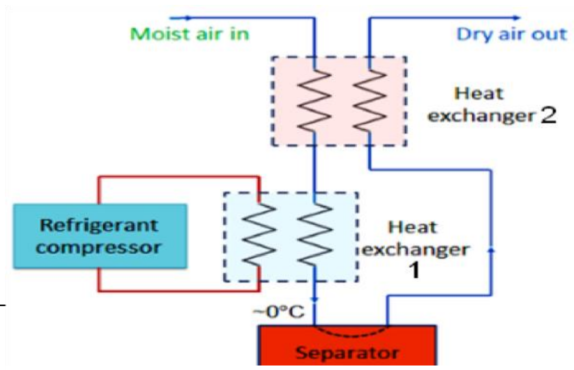


Figure 1.5 Refrigerated dryers

It consists of two heat exchangers, refrigerant compressor and a separator. The dryer chills the air just above 0 °C which condenses the water vapor. The condensate is collected by the separator. However, such low temperature air may not be needed at the application. Therefore, this chilled air is used to cool the high temperature air coming out from the compressor at heat exchanger 2. The moderate temperature dry air coming out from the heat exchanger 2 is then used for actual application; whilst the reduced temperature air from compressor will further be cooled at heat exchanger 1. Thus, the efficiency of the system is increased by employing a second heat exchanger.

E. Lubricators

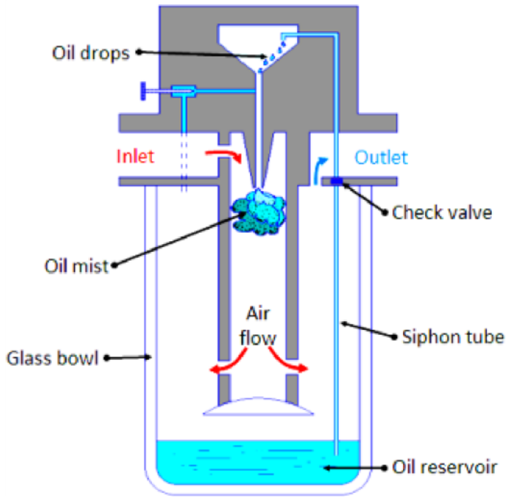


Figure 1.6 Lubricators

The compressed air is first filtered and then passed through a lubricator in order to form a mist of oil and air to provide lubrication to the mating components. The principle of working of venture meter is followed in the operation of lubricator. The compressed air from the dryer enters in the lubricator. Its velocity increases due to a pressure differential between the upper and lower changer (oil reservoir). Due to the low pressure in the upper chamber the oil is pushed into the upper chamber from the oil reservoir through a siphon tube with check valve. The main function of the valve is to control the amount of oil passing through it. The oil drops inside the throttled zone where the velocity of air is much higher and this high velocity air breaks the oil drops into tiny particles. Thus a mist of air and oil is generated. The pressure differential across chambers is adjusted by a needle valve. It is difficult to hold an oil mixed air in the air receiver as oil may settle down. Thus air is lubricated during secondary air treatment process. Low viscosity oil forms better mist than high viscosity oil and hence ensures that oil is always present in the air.

F. Pressure regulation

In pneumatic systems, during high velocity compressed air flow, there is flow dependent pressure drop between the receiver and load (application). Therefore, the pressure in the receiver is always kept higher than the system pressure. At the application site, the pressure is regulated to keep it constant. There are three ways to control the local pressure.

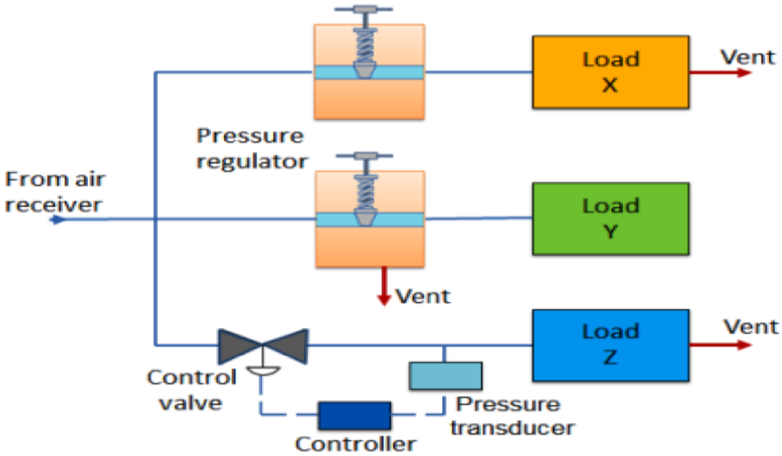


Figure 1.7 Pressure regulation

In the first method, load X vents the air into atmosphere continuously. The pressure regulator restricts the air flow to the load, thus controlling the air pressure. In this type of pressure regulation, some minimum flow is required to operate the regulator. If the load is a dead end type which draws no air, the pressure in the receiver will rise to the manifold pressure. These type of regulators are called as ‘non-relieving regulators’, since the air must pass through the load.

In the second type, load Y is a dead end load. However, the regulator vents the air into atmosphere to reduce the pressure. This type of regulator is called as ‘relieving regulator’.

The third type of regulator has a very large load Z. Therefore, its requirement of air volume is very high and can’t be fulfilled by using a simple regulator. In such cases, a control loop comprising of pressure transducer, controller and vent valve is used. Due to large load the system pressure may rise above its critical value. It is detected by a transducer. Then the signal will be processed by the controller which will direct the valve to be opened to vent out the air. This technique can be also be used when it is difficult to mount the pressure regulating valve close to the point where pressure regulation is needed.

G. Relief valve

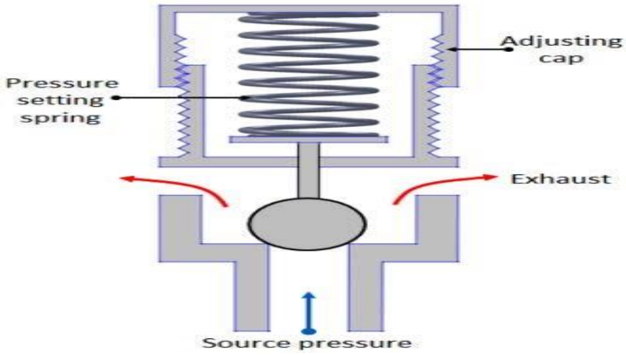


Figure 1.8 Relief valve

Relief valve is the simplest type of pressure regulating device. It is used as a backup device if the main pressure control fails. It consists of ball type valve held on to the valve seat by a spring in tension. The spring tension can be adjusted by using the adjusting cap. When the air pressure exceeds the spring tension pressure the ball is displaced from its seat, thus releasing the air and reducing the pressure. A relief is specified by its span of pressure between the cracking and full flow, pressure range and flow rate. Once the valve opens (cracking pressure), flow rate depends on the excess pressure. Once the pressure falls below the cracking pressure, the valve seals itself.

Service units

During the preparation of compressed air, various processes such as filtration, regulation and lubrication are carried out by individual components. The individual components are: separator/filter, pressure regulator and lubricator.

Preparatory functions can be combined into one unit which is called as 'service unit'. Figure below shows symbolic representation of various processes involved in air preparation and the service unit.

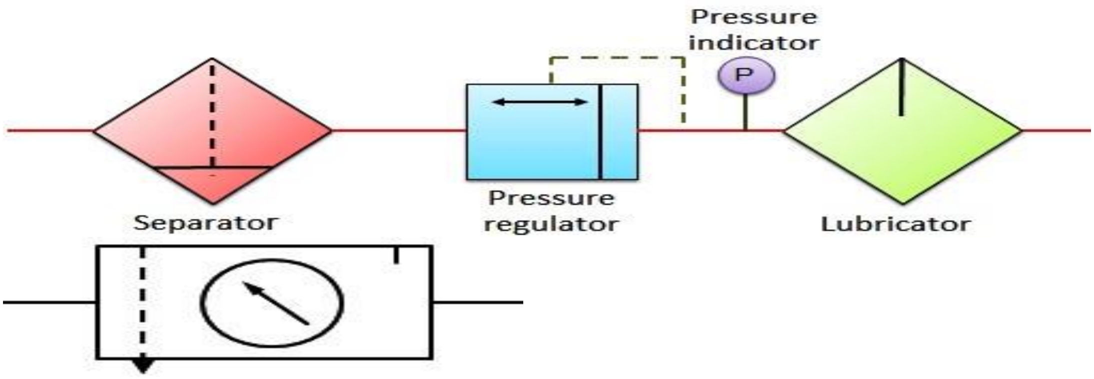


Figure 1.9 Service units

The construction of hydraulic and pneumatic linear actuators is similar. However, they differ at their operating pressure ranges. Typical pressure of hydraulic cylinders is about 100 bar and of pneumatic system is around 10 bar.

H. Control Valves

Directional control valves are the most important device used in a pneumatic system. The directional control valves or DVCs are used to control the direction and the amount of air entering the actuators.

The valves transfer the pressure energy of air to the actuators as per the command given by the operator. The generally used valve in a pneumatic system is a solenoid valve, also sometimes known as a spool valve.

These valves are operated by the action of a solenoid coil coupled with an electromagnet.

Figure 1.10 Directional control valves

I. Dryer

An air dryer is a system or piece of equipment that is used to remove moisture present in the air, particularly compressed air. Ambient air typically has a relative humidity of around 30 to 50%, but compressing air packs higher quantities of moisture in a small volume. humidity. When air is compressed it loses its ability to hold water. Therefore, water remains when air is compressed. As this water, the condensate, would be disturbing the following processes, it needs to be removed from the pneumatic system. In a so called refrigeration dryer the water condensates and can be removed. There are also absorption dryers in which the water is absorbed by special materials.

Figure 1.11 air dryer

J. Electric Motor

A suitable motor is used to run the compressor in a pneumatic system. The capacity of the motor depends on the size of the compressor and the power required to run the compressor. The motor is directly connected to the power supply.

K. Receiver tank

The air is compressed slowly in the compressor. But since the pneumatic system needs continuous supply of air, this compressed air has to be stored. The compressed air is stored in an air receiver as shown in Figure below The air receiver smoothens the pulsating flow from the compressor. It also helps the air to cool and condense the moisture present. The air receiver should be large enough to hold all the air delivered by the compressor. The pressure in the receiver is held higher than the system operating pressure to compensate pressure loss in the pipes. Also the large surface area of the receiver helps in dissipating the heat from the compressed air. Generally, the size of receiver depends on, • Delivery volume of compressor.

- Air consumption.
- Pipeline network
- Type and nature of on-off regulation
- Permissible pressure difference in the pipelines

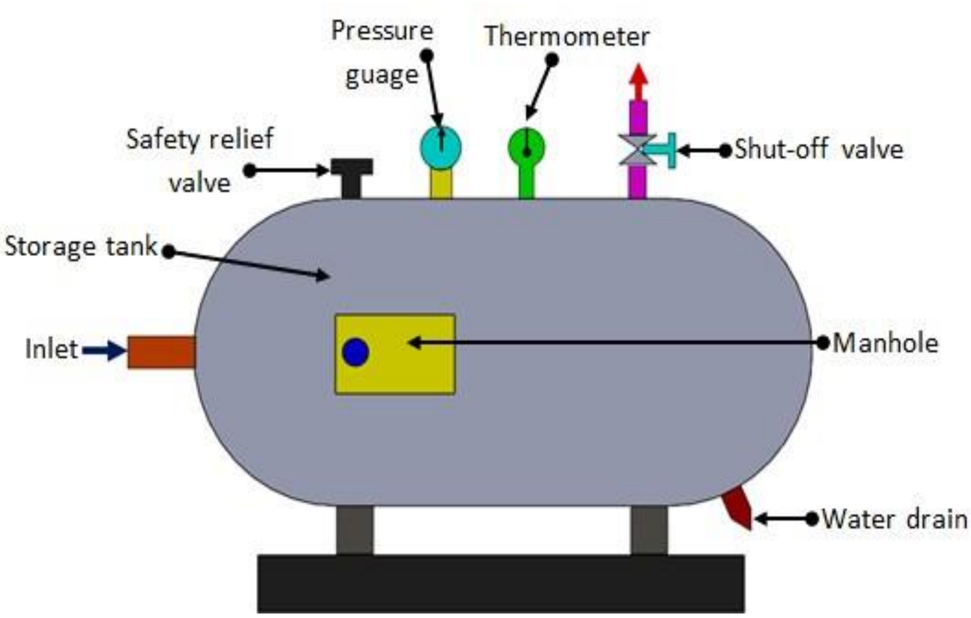


Figure 1.12 Receiver tank

1.1.4 Operation of pneumatic systems

Pneumatic systems are used in many applications. New uses for pneumatics are constantly being discovered. In construction, it is indispensable source of power for such tools as air drills, hammers, wrenches, and even air cushion supported structures, not to mention the many vehicles using air suspension, braking and pneumatic tires. In manufacturing, air is used to power high speed clamping, drilling, grinding, and assembly using pneumatic wrenches and riveting machines. Plant air is also used to power hoists and cushion support to transport loads through the plant. Many recent advances in air – cushion support are used in the military and commercial marine transport industry. Some of the Industrial applications of pneumatics are listed in the Table

Table 1.1: applications of pneumatics

Material Handling	**Manufacturing**	**Other applications**
Clamping Shifting positioning Orienting Feeding Ejection Braking Bonding Locking Packaging Feeding Sorting stacking	Drilling Turning Milling Sawing Finishing Forming Quality Control Stamping Embossing Filling	Aircraft Cement plants chemical plants Coal mines Cotton mills Dairies Forge shops Machine tools Door or chute control Turning and inverting parts

The sketch exemplifies a pneumatic system at the machine-level:

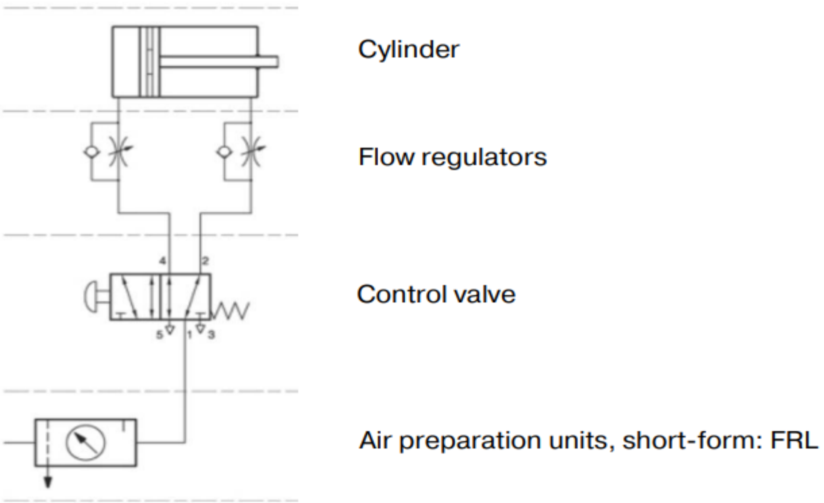


Figure 1.13 pneumatic system at the machine-level

The individual elements are represented by ISO-symbols, which are connected with lines. They display the route of the compressed air. In order to get a better overview, we position the air preparation on the bottom and the actuators on the top of the drawing.

i. We can form logic groups of the elements as you can see in the drawing above:
   - Air preparation
   - Filter
   - Pressure regulator
   - Lubricator
   - Switch-on valve
   - Soft start

ii. Control valves
   - Directional control valves
   - Other types of control valves
   - Logic elements

iii. Flow control valves, check-valves
   - Flow control valves, uni- or bidirectional
   - Exhaust flow-regulators
   - Non-return valves = check valves
   - Function fittings

iv. Actuators, cylinders

- Cylinders
- Roadless cylinders
- Rotary actuators

v. Tubes and fittings

- To distribute compressed air and to connect different components

1.1.5 Interpretation of schematic diagrams

Circles: Circles are widely used in pneumatic circuit drawings. Size is one factor used to signify different components. Large circles are used to indicate motors and compressors. A triangle within the circle is used to indicate whether the unit is a compressor (air pump) with the flow leaving the component or a motor (flow entering the component). A prime mover that drives a compressor (electric motor) has the letter ‘M’ in the circle. The symbols for these three components are illustrated below.

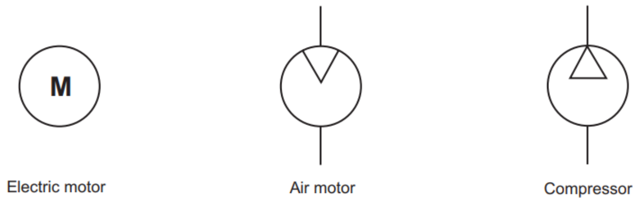


Figure 1.14 Circles pneumatic circuit drawings

If the component is uni-directional (operates one way), the symbol has only one triangle. A reversible or bi-directional motor is indicated by a triangle drawn at both of the main connection ports, as illustrated below.

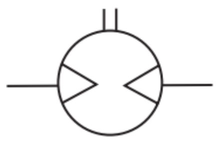


Figure 1.15 bi-directional motor

Squares: A single square (or envelope) indicates a circuit control valve for controlling the air flow or pressure. The valve’s construction will allow it a number of possible positions between its two extremes of fully closed and fully open. This provides for variable control across one or more of its fluid ports, to ensure delivery of the required pressure and/or flow for the circuit.

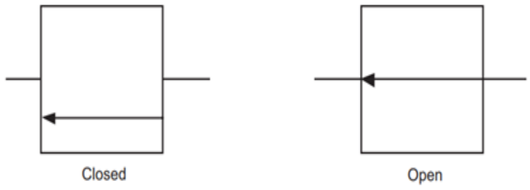


Figure 1.16 single square Circuit control symbol

Two or more squares (envelopes) indicate a directional control valve having as many finite positions as there are squares. In the circuit drawing, the pipes are normally shown connected to the box representing the valve's non-activated position. When describing a valve, it is standard practice to identify the number of ports first, followed by the number of valve positions and then configuration type.

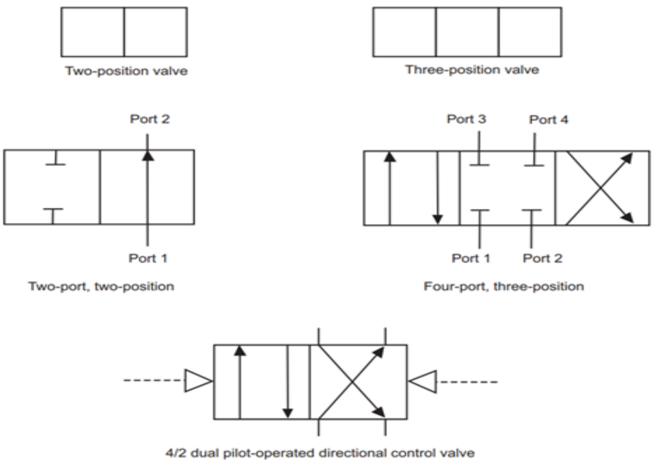


Figure 1.17 Two or more squares directional control valve

Rectangles in circuit drawings, rectangles represent pneumatic cylinders, which are used to convert fluid energy into linear energy. These cylinders may be divided into three major classes – single-acting, double-acting and telescopic. Symbols for an example of each are illustrated below.

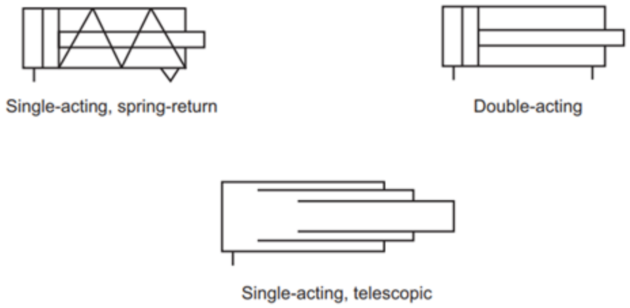


Figure 1.18 Rectangles represent pneumatic cylinders

Diamonds Circuit components represented by diamond-shaped figures can be generally classified as conditioning apparatus. They include filters, lubricators, driers, water separators and air coolers (heat exchangers). Symbols for these components are illustrated below.

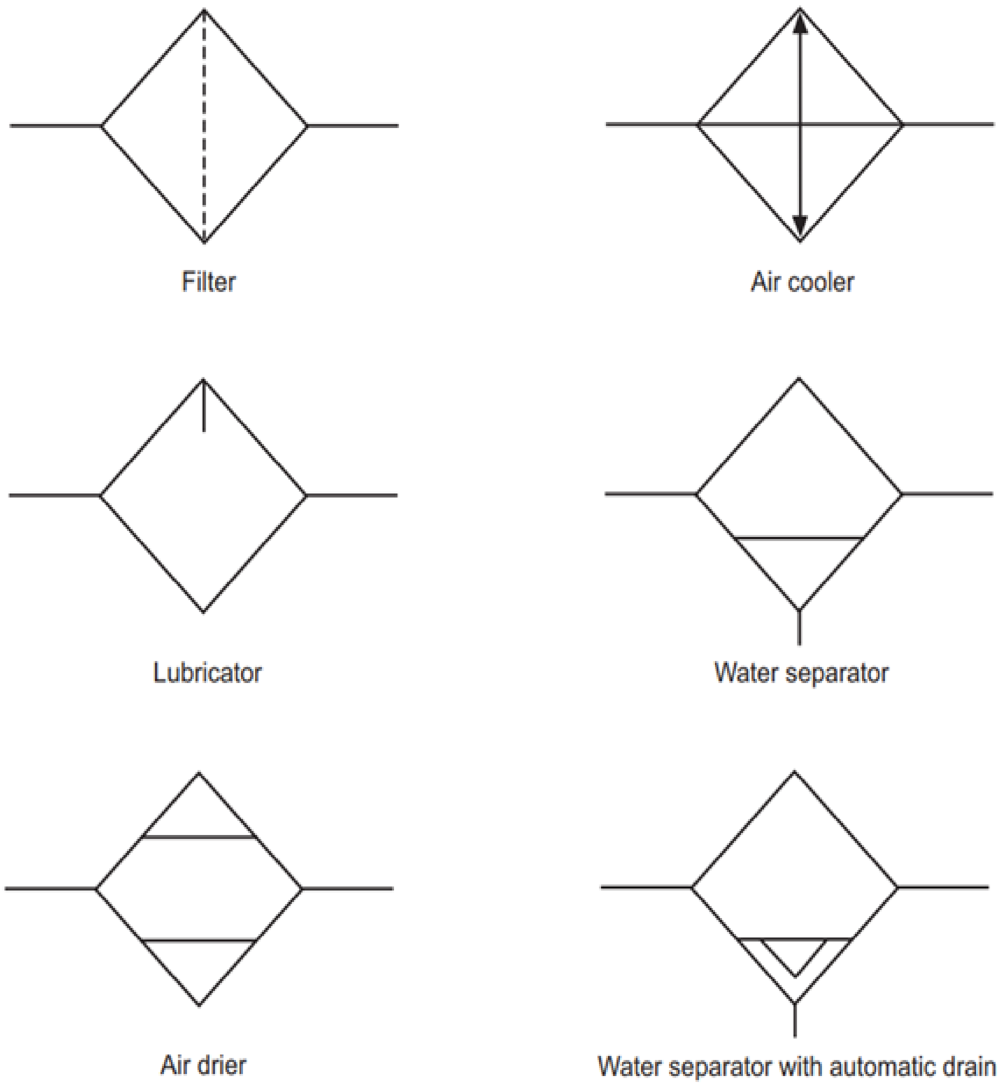


Figure 1.19 Diamonds Circuit components

Miscellaneous symbols A variety of other particular symbols are commonly used in pneumatic circuit drawings. The main ones are illustrated below.

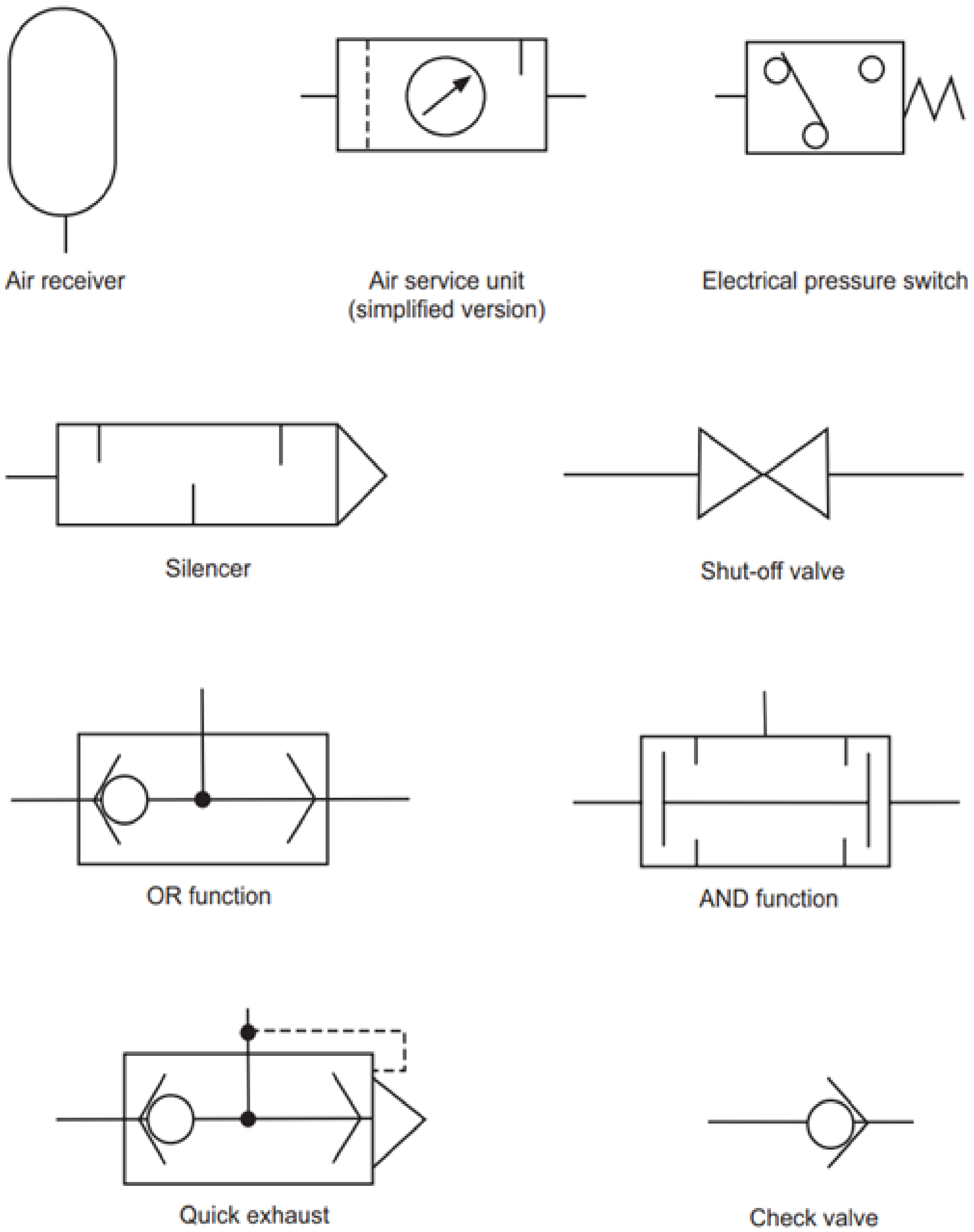


Figure 1.20 Miscellaneous symbols

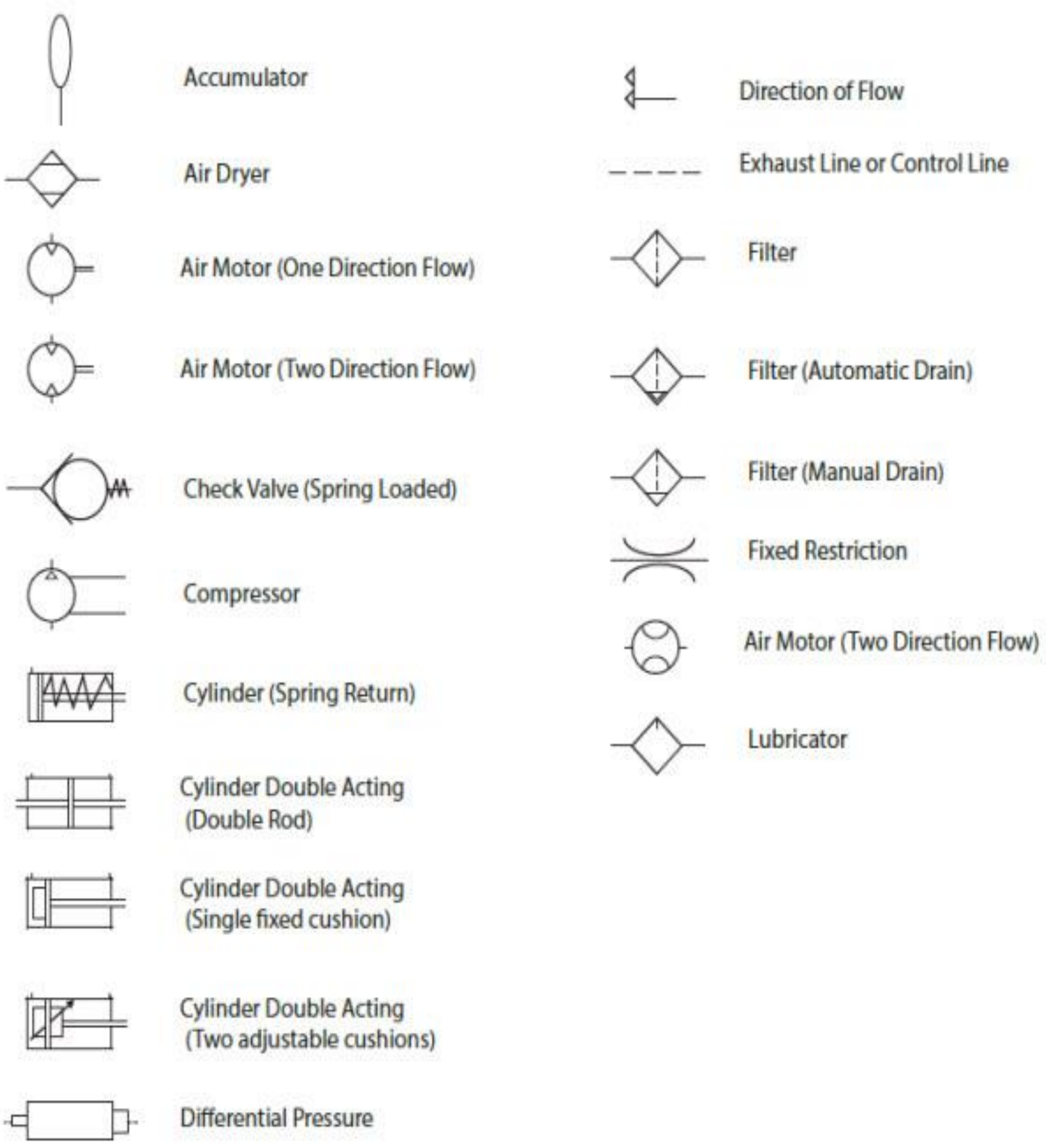


Figure 1.21 Miscellaneous symbols

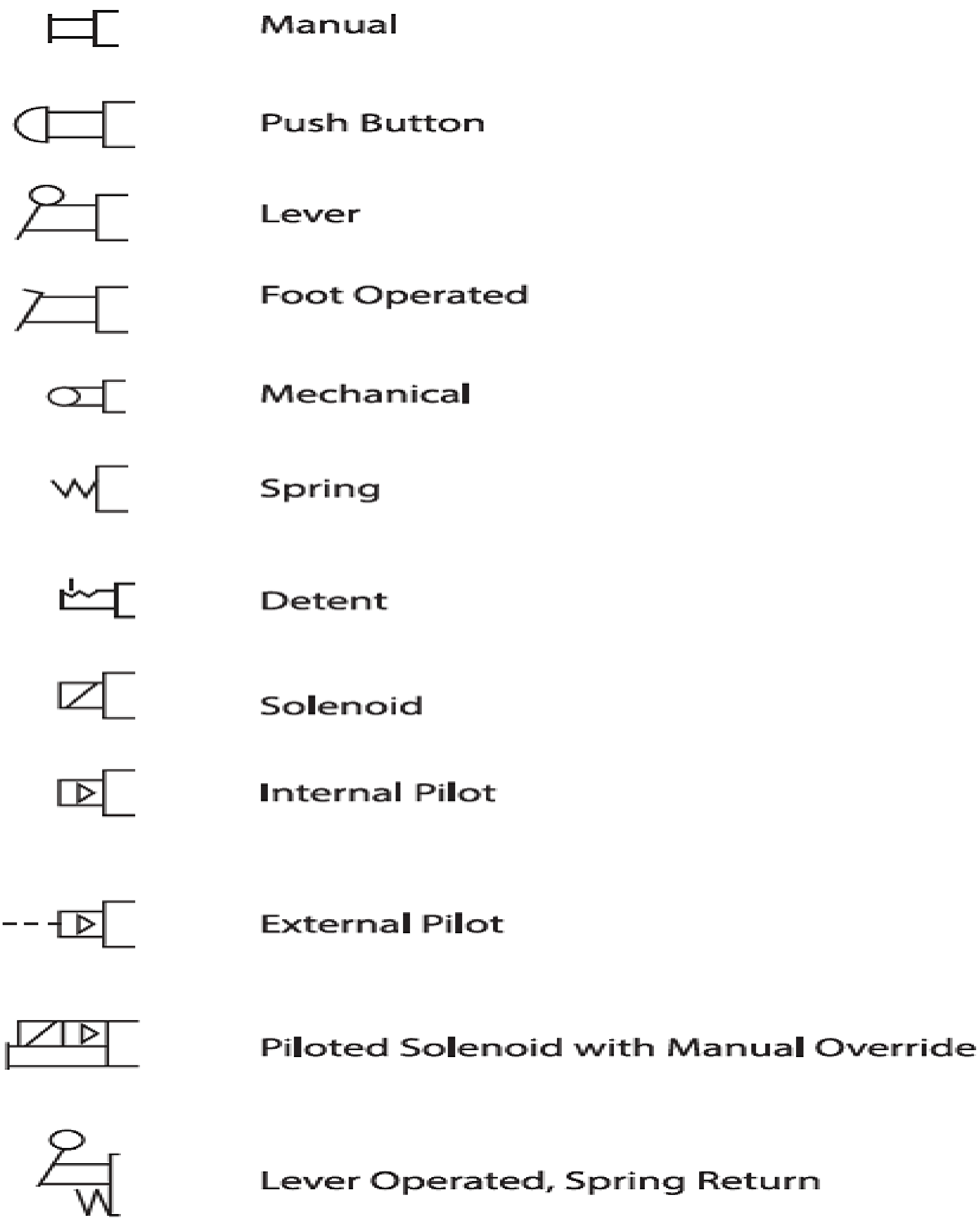


Figure 1.22 Miscellaneous symbols

1.1.6 Applications of Pneumatic Systems modification in Vehicles

- **Braking Systems:** Pneumatic brakes, particularly in heavy vehicles, utilize compressed air to apply braking force. The air pressure is used to engage brake pads against the rotor, providing powerful stopping capabilities.
- **Suspension Systems**: Air suspension systems use compressed air to adjust the ride height and firmness. By changing the amount of air in the suspension, vehicles can achieve better stability and comfort.
- **Gates and Doors**: Pneumatic systems are used in vehicle access mechanisms, such as automatic doors and hatches, enabling them to open and close smoothly.
- **Control Systems**: Various vehicle controls, such as steering assist, utilize pneumatic power to reduce the effort required by the driver and enhance vehicle responsiveness.
- **Clutch Systems**: In some vehicles, pneumatic systems may assist in engaging and disengaging the clutch, improving drive ability and reducing driver fatigue.

Advantages of Pneumatic Systems modification

- ✓ **Speed and Efficiency**: Pneumatic systems can operate quickly and are generally easier to control than hydraulic systems.
- ✓ **Weight:** They tend to be lighter than hydraulic systems, contributing to overall vehicle weight savings.
- ✓ **Simplicity**: Pneumatic systems often have fewer components than their hydraulic counterparts, which can simplify maintenance and reduce points of failure.
- ✓ **Environmental Impact:** Pneumatic systems do not rely on hydraulic fluid, reducing the risk of leaks and environmental contamination.

Challenges and Limitations of modification

- ✓ **Power Loss**: Compressed air can dissipate quickly, leading to a decrease in performance over time if not managed properly.
- ✓ **Temperature Sensitivity**: The performance of pneumatic systems can be affected by temperature changes, necessitating careful design and material selection.
- ✓ **Complexity of Maintenance**: While simpler than hydraulics, pneumatic systems still require regular maintenance to ensure proper operation and to prevent air leaks.

1.1.7 OHS and PPE requirements

OHS requirement

- Safety precaution for pneumatic system include
  - Never blow compressed air at anyone.
  - Don't turn the main air supply on until the circuit is connected up. Disconnected pipes can whip round and cause injury.
  - If air is leaking from a joint, turn the air off.
  - Always turn air off before altering the circuit.
  - Keep fingers clear of the piston rods.

When designing a pneumatic system, there are five key safety functions that must be considered: protection against unplanned start-up, exhausting, holding, blocking and stopping, reversing the movement, and reducing speed

- Pneumatic hose safety tips
  - A pneumatic hose can turn into a whipping hazard if it becomes disconnected or the coupling blows out, so it's important to take hose safety precautions.
  - Make sure all air hose connections are secured by a short wire or a positive locking device to prevent accidental disconnection.
  - Blow out the air line before connecting a tool.
  - Install a safety excess flow valve to any hose more than ½ inch in diameter. The valve will reduce pressure if the hose fails and prevent a whipping hazard.
  - Turn off the air pressure to the hose when the tool is not in use or when changing accessories.
  - Never hold the tool by its hose. This can damage the hose or cause it to become disconnected.
  - Never point the air gun at anyone.
  - Take precautions to make sure air hoses don't create a tripping hazard.
- Compressed air safety tips
  - Know how to handle the air compressor, and the compressed air, with safety in mind.
  - Keep the air compressor tank close by, with the air shutoff valve visible and within reach.

- To prevent overheating, do not place objects that could impede air flow on or against the air compressor.
- Make sure the compressed air is clean and dry to prevent tool damage.
- Never use compressed air to blow off debris. This can cause the debris to fly back at the operator or ricochet and injure someone nearby. If you need to clean a site of dust or dirt, use an industrial vacuum or broom instead.

Tools and Equipment

A service manual is absolutely necessary when performing any type of Maintaining Pneumatic Systems testing, diagnosis, calibration, servicing and repairing works. Not only does the manual clearly illustrate all components and their servicing procedure, it also lists many vital specifications.

As the result of technology variation, any type of technical product has its repair and service manual. Hence, you should identify and make ready the right manual for the type and model of the Pneumatic Systems.

Benefits of Pneumatic Tools and Equipment in Industrial Operations

- Easy to use: The simple levers and push buttons make it easy to start, accelerate, decelerate and stop.
- Accurate: The controls increase accuracy and make it easier to operate machinery, reducing the chance of human error
- Handles a huge weight range: Pneumatic systems are fluid systems and have no levers, pulleys, or gears. This means it can easily accommodate weight variations.
- Constant force and torque: The pressurized fluid system supplies consistent force and torque, and the effects are not affected by speed changes.
- Fewer moving parts: This makes the Pneumatic system simple, safe, and easier to maintain. It also makes them economical compared to electrical and mechanical systems.
- Doesn’t spark: This makes Pneumatic systems safe to use in mines and chemical plants.

1.1 Self-check

I. Choose The Best Answer from The Given Alternative

1. What is the main medium used in pneumatic systems?

A. Water
B. Compressed air
C. Hydraulic fluid
D. Electricity

2. Which of the following is NOT an advantage of pneumatic systems?

A. Inexpensive
B. Low maintenance
C. Limited efficiency
D. Safe and easy to operate

3. What is an advantage of using compressed air in pneumatic systems?

A. It is difficult to distribute
B. It is expensive to produce
C. It can be easily regulated
D. It is hazardous to the environment

4. What is a typical disadvantage of using compressed air in pneumatic systems?

A. Difficult to store
B. Prone to fire hazards
C. Limited lifespan
D. Requires filtration and drying

5. Why are pneumatic systems considered clean?

A. They use water as the working fluid
B. They use air as the working fluid
C. They use hydraulic fluid as the working fluid
D. They use electricity as the working fluid

6. Which component is used to obtain the required movements of mechanical elements in a pneumatic system?

A. Air Actuator
B. Air cooler
C. Air filters
D. Compressor

7. What is used to reduce the temperature of the compressed air during the compression operation?

A. Air Actuator
B. Air cooler
C. Control Valves
D. Electric Motor

8. What component is used to filter out contaminants from the air?
   A. Air Actuator
   B. Air cooler
   C. Air filters
   D. Dryer
9. Which equipment is used to generate compressed air in a pneumatic system?
   A. Air Actuator
   B. Electric Motor
   C. Compressor
   D. Receiver tank
10. What is used to regulate, control, and monitor the direction flow and pressure in a pneumatic system?
   A. Air Actuator
   B. Air cooler
   C. Control Valves
   D. Dryer
11. What separates water vapor or moisture from the air in a pneumatic system?
   A. Air Actuator
   B. Air cooler
   C. Dryer
   D. Receiver tank
12. What component transforms electrical energy into mechanical energy and is used to drive the compressor?
   A. Air Actuator
   B. Electric Motor
   C. Air filters
   D. Compressor
13. Which component stores the compressed air coming from the compressor?
   A. Air Actuator
   B. Air cooler
   C. Receiver tank
   D. Control Valves
14. Which component is used to reduce the temperature of the compressed air during the compression operation?
   A. Air Actuator
   B. Air cooler
   C. Control Valves
   D. Electric Motor
15. What component is used to filter out contaminants from the air?
   A. Air Actuator
   B. Air cooler
   C. Air filters
   D. Dryer

II. Say True Or False For The Given Questions

1. When designing a pneumatic system, there are five key safety functions that must be considered.
2. It is important to secure all air hose connections with a short wire or a positive locking device to prevent accidental disconnection.
3. It is recommended to blow out the air line before connecting a tool to a pneumatic hose.
4. It is advisable to install a safety excess flow valve to any hose more than 1 inch in diameter to prevent a whipping hazard.
5. It is safe to hold the tool by its hose while using a pneumatic system.
6. It is important to turn off the air pressure to the hose when the tool is not in use or when changing accessories.
7. It is safe to use compressed air to blow off debris to clean a site of dust or dirt.
8. It is necessary to keep the air compressor tank close by, with the air shutoff valve visible and within reach for safety.
9. It is recommended to keep the compressed air clean and dry to prevent tool damage.
10. Never point the air gun at anyone is a recommended safety precaution for pneumatic systems.

Unit Two: Develop and validate modification pneumatic system

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Setting Objectives for Modifications
- Identifying Performance Goals
- Design the Modifications
- Tools and Technology for Planning Modifications

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify Objectives
- Identify and Conduct Performance Goals Feasibility Studies
- Prepare Design the Modifications
- Identify Tools and Technology for Planning Modifications

2.1 Setting Objectives for Modifications

Define the purpose of the modification (e.g., improved braking power, reduced weight, enhanced responsiveness). Consider the specific advantages such as fuel efficiency, safety, or performance benefits.

- Set SMART goals: Make sure goals are specific, measurable, achievable, relevant, and time-bound.
- Prioritize goals: Focus on a few key objectives instead of trying to do too many things at once.
- Break down large goals: Start with one or two goals and break them down into smaller steps.
- Set timelines: Create deadlines to give your team a sense of urgency, but make sure they are realistic.
- Communicate goals: Let everyone involved know the reasons, benefits, and implications of your goals.
- Celebrate achievements: Acknowledge milestones and successes to boost morale and motivation.
- Be flexible: Be ready to adapt your goals if organizational needs change.
- Align goals: Ensure goals are suitable and in line with the company's strategic objectives.

2.2 Identifying Performance Goals

Reasons for pneumatic System Modification

Identify and Analyze existing pneumatic systems to determine areas for improvement. Evaluate potential modifications through simulations or prototyping to assess their impact on vehicle performance.

- ➢ Improved Performance:

- Modifications can enhance the system's efficiency, such as improving the speed of response, increasing the load-handling capacity, or reducing energy consumption.
- For example, replacing outdated compressor with higher efficiency ones can reduce power loss and improve overall system efficiency.
  - ➢ Adapting to New Applications:
- A pneumatic system designed for one purpose may need to be modified to suit a different application. For example, an automotive pneumatic system in a passenger car might need modifications to accommodate larger payloads in a utility vehicle or to enhance comfort in a advanced vehicle.
- In industrial settings, a pneumatic press may be modified to handle a different material or perform a different function.
  - ➢ System Upgrade:
- ✓ Over time, technological advancements in hydraulic components such as pumps, valves, and accumulators may make it beneficial to upgrade older systems to keep up with modern standards.
- ✓ For example, upgrading from a mechanical to an electronically controlled pneumatic system can provide more precise control and reduce wear on components.
  - ➢ Increased Safety:
- ✓ In some cases, hydraulic systems may need modifications to meet newer safety standards or mitigate risks like overpressure, overheating, or gas leaks. Upgrading the safety features such as pressure relief valves or monitoring systems can help prevent accidents.
- ✓ Introducing sensors for temperature, pressure, and flow rate can provide real-time data for safety and troubleshooting.
  - ➢ Cost Reduction:

- ✓ pneumatic systems can sometimes be modified to reduce operational costs, such as improving energy efficiency by replacing inefficient components or by using alternative pneumatic that are cheaper or environmentally friendly.
- ✓ Optimizing the layout or design of the system to reduce the length of piping or number of components can also minimize maintenance costs and improve reliability.
  - ➢ Maintenance and Longevity:
- ✓ Modifications can enhance the durability and longevity of pneumatic systems by replacing worn-out or outdated parts with more durable, modern components.
- ✓ Regular modifications and upgrades can help reduce downtime, minimize repairs, and prolong the lifespan of the system.

2.3 Design the Modifications

Create detailed schematics that outline new components or changes to current ones. Choose suitable materials and technologies that can handle the demands of the vehicle's operation. Developing and applying pneumatic system modifications involves identifying the need for a modification, creating specifications, testing the modification, and documenting the process. Here are some ways to modify pneumatic systems:

Design for minimum flow and pressure: Use variable pressure or divide the machine into sections that use different pressures.

- Use larger solenoid valves: This allows air to flow through more quickly.
- Use small bore cylinders: This reduces the amount of air needed to extend the piston.
- Shorten tubing: This uses less air to move.
- Add a surge tank: This provides a large supply of air that doesn't need to flow through the solenoid.
- Use high-bandwidth valves: These are placed on the brake chamber to create more effective braking controllers.

- Use a closed-loop pressure controller: This is designed for the actuator using thermodynamic arguments and one-dimensional flow theory.

Pneumatic systems are used in many industries because they are safe, clean, low cost, and require low maintenance. They can also operate in wet, dusty, and chemically aggressive environments without the risk of fire or explosion.

The solution to a control problem is worked out according to a system with documentation playing an important role in communicating the final result.

- The circuit diagram should be drawn using standard symbols and labeling. Comprehensive documentation is required including most of the following:
- ➢ Function diagram
- ➢ Circuit diagram
- ➢ Description of the operation of the system
- ➢ Technical data on the components Supplementary documentation comprising:
- ➢ Parts list of all components in the system
- ➢ Maintenance and fault-finding information
- ➢ Spare parts list

Design of the circuit diagram

The circuit diagram shows signal flow and the relationship between components and the air connections.

- The structure of the circuit diagram should correspond to the control chain, whereby the signal flow is represented from the bottom to the top.
- Simplified or detailed symbols may be used for the representation of the circuit diagram.
- In the case of larger circuit diagrams, the power supply parts (service unit, shut-off valve, various distributor connections) are shown on a separate page of the drawing for the purpose of simplification.

Common Types of Pneumatic System Modifications

- Component Replacement or Upgrades
- ➢ compressor/Pumps: Swapping out a pump for a more efficient or higher capacity model.
- ➢ Regulator /Valves: Replacing control valves or pressure-relief valves for more precise control or improved safety.
- ➢ Pneumatic/hydraulic Cylinders: Upgrading cylinders for greater force, stroke length, or durability.
- ➢ Filters: Upgrading filtration systems to improve fluid cleanliness and prevent component wear
- System Configuration Changes:
- ➢ Piping and Tubing: Modifying the layout of Pneumatic lines to optimize gas flow and reduce losses or pressure drops.
- ➢ Air Reservoirs: Expanding or improving the design of the reservoir to increase fluid capacity, improve cooling, or reduce contamination.
- Control System Modifications:
- ➢ Automation and Electronics: Adding electronic controls such as sensors, programmable logic controllers (PLCs), or variable speed drives to improve control and adaptability in real-time operations.
- ➢ Pneumatic Circuit Modifications: Reconfiguring circuits for better pressure or flow control, or adding accumulators to store energy and smooth out pressure variations.
    - Air Leak Prevention and Sealing:
- ➢ Seals and Gaskets: Replacing old seals to prevent air leaks, improve pressure retention, and reduce contamination risks.
- ➢ Improved Sealing Materials: Using advanced sealing materials to cope with higher pressures, temperatures, or specific chemical environments.

- Integration of New Technologies:

- Integrating smart sensors to monitor hydraulic pressure, flow rate, and temperature, providing real-time feedback and enhancing control over the system's performance.
- Implementing energy recovery systems, such as hydraulic hybrids or regenerative braking systems, to capture and reuse energy in systems like electric or hybrid vehicles.

Requirements of Automotive Pneumatic system modification

When modifying an automotive Pneumatic system, several key requirements must be met to ensure that the modification is effective, safe, and aligned with the vehicle's performance goals. These requirements include considerations related to system compatibility, safety, efficiency, cost, and regulatory standards. Below are the primary requirements for modifying an automotive Pneumatic system:

A. Compatibility with Existing System

- System Integration: Any modifications must be compatible with the existing Pneumatic system. This includes ensuring that new components, such as pumps, valves, cylinders, or actuators, are compatible with the system's pressure, flow rate, and fluid type.
- Component Matching: New components must be selected based on their ability to integrate seamlessly with existing components. For example, upgrading a pump might require adjustments in the piping, reservoir size, or valve specifications.
- Pneumatic Compatibility: If any parts of the system are replaced (e.g., seals, hoses), it's important to ensure that they are compatible with the existing Pneumatic fluid in terms of viscosity, chemical properties, and temperature range.

B. System Efficiency and Performance Enhancement

- Improved Power Transmission: The modification should enhance the overall efficiency of the system. This may involve upgrading pumps for better flow or pressure handling, using more efficient valves, or optimizing the Pneumatic circuit to reduce losses.

- Optimizing Flow and Pressure: Pneumatic systems in automotive applications often rely on precise flow and pressure control. Modifications must maintain or improve the performance characteristics of these systems, such as ensuring that pressure relief valves are set to appropriate levels and that the system can operate efficiently under varying loads.
- Reduced Energy Consumption: A modification might aim to reduce the energy consumption of the hydraulic system by using more efficient components or optimizing system configuration. This can include replacing an inefficient pump with a variable displacement model or integrating energy recovery systems.

C. Safety Considerations

- Overpressure Protection: Pneumatic systems need reliable protection against overpressure conditions. Modifications should ensure that pressure relief valves are correctly rated and located to prevent damage to system components.
- Air Leak Prevention: All Pneumatic lines, hoses, and seals must be leak-proof to avoid loss, contamination, and fire hazards. Modifying seals or incorporating better sealing materials might be required.
- Pressure Monitoring and Controls: Adding sensors for real-time pressure monitoring can help prevent dangerous pressure spikes or drops. This can help maintain optimal system performance and ensure safe operation.
- Emergency Fail-Safes: Incorporating fail-safe mechanisms such as emergency pressure relief, pressure shutdown systems, or backup Pneumatic pumps can ensure safety if the system fails.

D. Cost-Effectiveness

- Cost-Benefit Analysis: The benefits of the modification should outweigh the costs. For instance, modifying the Pneumatic system to improve efficiency or performance should result in long-term savings through reduced fuel consumption, reduced maintenance, or increased vehicle lifespan.

- Affordable Components: While upgrading to more efficient or advanced components may offer better performance, it's important to ensure the modifications don't make the vehicle overly expensive or introduce excessive costs that outweigh the benefits.
- Maintenance Considerations: Modifications should be made with an eye toward ease of maintenance. Complex modifications that require specialized tools or knowledge could result in higher long-term maintenance costs.

E. Compliance with Industry Standards and Regulations

- Environmental Regulations: Modified Pneumatic systems must comply with environmental standards, particularly those regarding the use of Pneumatic fluids (e.g., non-toxic, biodegradable fluids) and the management of any air leaks.
- Safety Standards: Compliance with local and international safety standards (e.g., SAE, ISO) is critical. The modification should meet or exceed the regulatory requirements for the vehicle, including standards for Pneumatic pressure, fluid quality, and safety.
- Certification and Testing: Some modifications may require testing or certification, especially if the vehicle is to be used in commercial or industrial settings. This ensures that the modifications meet legal and operational standards.
- Vehicle Manufacturer Specifications: It's important to adhere to the original manufacturer's guidelines, especially if the modification affects a critical component like braking or steering. Some manufacturers may require specific approvals for modifications to the hydraulic system to avoid voiding warranties.

F. Long-Term Reliability and Durability

- Wear Resistance: Any modified Pneumatic component must be durable enough to handle the expected loads and operational conditions over the vehicle's lifespan. This includes ensuring that parts are resistant to wear, corrosion, and fatigue, particularly in harsh driving conditions.
- Corrosion Resistance: Materials used in the Pneumatic system, such as pipes, cylinders, and pumps, should be resistant to corrosion from Pneumatic and external

elements (e.g., moisture, road salt). Modifications might include switching to corrosion-resistant materials or adding protective coatings.

- Lifecycle Considerations: Consideration should be given to the full lifecycle of the modified system, including ease of replacement or servicing over time. Components should be chosen based on their expected durability and ease of maintenance.

G. Improved Control and Precision

- Precision Control: For systems requiring precise control (e.g., active suspension or automatic transmission), modifications may involve adding or upgrading electronic control systems that manage Pneumatic pressure, flow, and actuation more accurately.
- Automation: Modifications can include upgrading the system to include automation, such as electronically controlled valves or actuators, allowing for better integration with modern vehicle control systems and improving performance in adaptive systems.
- Integration with Vehicle Systems: If modifying an automotive Pneumatic system like the power steering or suspension, ensuring the hydraulic system is well integrated with the vehicle's electronic control systems (e.g., CAN bus or ECU) is essential for optimized performance.

H. Space and Weight Considerations

- Compact Design: Many modifications aim to reduce the size of the Pneumatic system components to save space in a vehicle, which can be critical for meeting design goals or improving fuel efficiency.
- Weight Reduction: Modifications should ideally reduce the overall weight of the hydraulic system or vehicle without compromising performance. This can be achieved by using lightweight materials or optimizing the design to eliminate unnecessary components.

- Layout Optimization: Redesigning the Pneumatic circuit layout to improve fluid flow efficiency and reduce the number of parts or fluid loss points can save space and weight.

I. Pneumatic Handling and Quality

- Filtration and Fluid Quality: The quality of the Pneumatic is critical to system performance. Modifying the system may include upgrading or improving the filtration system to ensure clean fluid, which helps extend component life and prevent system failures.
- Fluid Containment: Any modifications that introduce higher pressures or larger volumes of Pneumatic fluid must include adequate containment measures to prevent spills or leaks, especially in automotive applications where fluid leakage can cause serious problems.

Selection and modification of engine selection of engine

We are using 100CC two stroke petrol engine for our project. We closed the inlet and outlet of engine and compressed air supplied to the spark plug socket. In two stroke engine one revolution complete in two stroke so efficiency of two stroke engine is higher than the four stroke engine and load carrying capacity also high. All running or completed projects on compressed air vehicle are on four stroke engine but we tried on two stroke engine for high load carrying capacity. Side ports are closed by adhesive and cylinder liner and for reducing the weight of engine we cut the fins which provided for cooling.

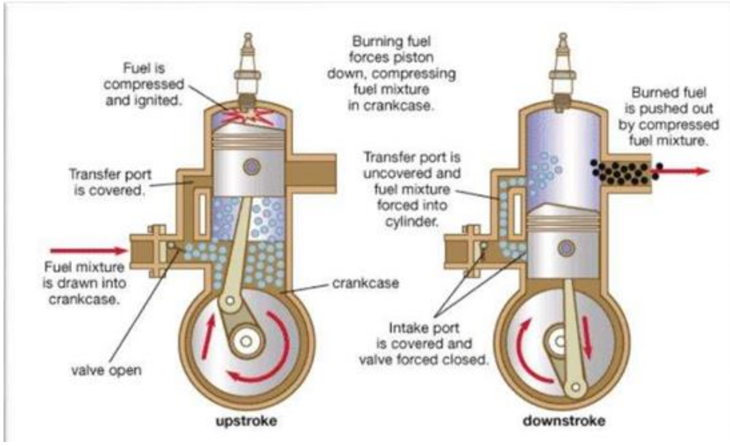


Figure 2.1 Selection and modification of engine selection of engine

A two-stroke engine completes all the same levels, but in just two piston strokes. The simplest two-stroke engines do this using the crankcase and the underside of the moving piston as a new charge pump. As the two-stroke piston increases on compression, its underside draws a partial vacuum into the crankcase. In four stroke engine one rotation is complete in four stroke so for CAE it gives low efficiency that's why we are using two stroke petrol engine. All the unnecessary parts are removed for making light weight like casing, cooling fins, carburetor, electric motor, magneto and gear box.

Modification of engine

we convert two stroke petrol engine to two stroke compressed air engine. First of all, we closed the inlet and outlet port with the adhesive and side port with the cylinder liner and make a closed chamber. After closing all the ports, we need to make a new inlet for air supply so we make 1.4cm diameter hole on the piston head casing. Weight of our engine is high so we need to reduce the weight of engine by removing all unnecessary components like cooling fins, motor, and casing cover. In the first trial we use battery operated 5/2 solenoid valve for controlling air supply but timer setting become very difficult for this engine because of the piston movement is unpredictable so we need to use Roller Spring 5/2 DCV valve for controlling compressed air supply. Roller Spring operated DCV valve one roller is attached at the end of solenoid valve. When pressure is applied on the roller by comes in contact with the other end then air is supply to the engine. Dead weight attached to plate witch is mounted on engine shaft. For arrangement of Roller Spring operated DCV valve we need to find specific angle. and we attached solenoid valve by the welding process. For revolution of crank it is necessary to breakdown of continues air pressure so we decide to modify the main shaft of engine as shown in figure. After constructing the engine base, we need to connect the engine(Driver) gear to rear wheel(Driven) gear in same alignment. We attached a dead weight to the main shaft for making regular contact between crank and Roller Spring operated DCV valve. and other side of main shaft we joint a motorcycle main gear for transmitting rotation from engine to rear wheel. Modified engine is mounted on the compressor for making compact size vehicle. To control and for the proper flow of the fuel (compressed air) pressure regulators and pneumatic specialized parts are used and proper flow is provided to the engine and pressure is maintained inside the bore. While working with 4 stroke engine it requires more number of modification than 2 stroke in 4 stroke engine first of all number strokes are needed to be made accordingly to the two stroke engine and the camshaft section are needed to be changed while in comparison these kind of changes and modification And more over two stroke engine has more power capacity than 4 stroke .due to 4 stoke engine has two to complete two revolution in one stroke and two stroke completes one revolution in one power stroke. While working with two stroke engine as it has ports and transfer port and mainly the inlet port at the bottom at near to BDC. And due to this there is most of the fuel is been leaked and the piston movement operation is not occurring properly so to over- come this the piston bore is replaced by cylinder linear and all the transfer ports and remaining ports been blocked and the exhaust port is shifted to the top of piston and by this the piston movement is obtained.

Figure 2.1 Modification of engine

2.4 Tools and Technology for Planning Modifications

A service manual is absolutely necessary when performing any type of Maintaining Pneumatic Systems testing, diagnosis, calibration, servicing and repairing works. Not only does the manual clearly illustrate all components and their servicing procedure, it also lists many vital specifications.

As the result of technology variation, any type of technical product has its repair and service manual. Hence, you should identify and make ready the right manual for the type and model of the Pneumatic Systems.

Benefits of Pneumatic Tools and Equipment in Industrial Operations.

- Easy to use: The simple levers and push buttons make it easy to start, accelerate, decelerate and stop.
- Accurate: The controls increase accuracy and make it easier to operate machinery, reducing the chance of human error
- Handles a huge weight range: Pneumatic systems are fluid systems and have no levers, pulleys, or gears. This means it can easily accommodate weight variations.
- Constant force and torque: The pressurized fluid system supplies consistent force and torque, and the effects are not affected by speed changes.

- Fewer moving parts: This makes the Pneumatic system simple, safe, and easier to maintain. It also makes them economical compared to electrical and mechanical systems.
- Doesn’t spark: This makes Pneumatic systems safe to use in mines and chemical plants.

Unit Three: Apply and test modification specifications

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Accepting and completing modification
- Applying tests and testing equipment
- Verifying test results and diagnostic findings

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Accept and completing modification
- Apply tests and testing equipment
- Verify test results and diagnostic findings

3.1 Accepting and completing modification

Developing and applying modifications to a vehicle's pneumatic system can lead to significant enhancements in performance, safety, and efficiency. By following a structured approach that includes understanding the existing system, thorough design and testing, and careful implementation, vehicle engineers and modifiers can optimize pneumatic systems to meet the evolving demands of the automotive landscape. Keeping abreast of technological advancements and regulatory changes will ensure that modifications are both innovative and compliant with industry standards.

Once developments have been validated, the application phase begins. Here are some key considerations:

Regulatory Compliance

Ensure that all modifications comply with local and national regulations regarding vehicle safety and emissions. Document all modifications for regulatory review and maintenance records.

Maintenance and Support

Establish maintenance protocols to keep the modified pneumatic system functioning optimally. Provide training for vehicle operators and maintenance personnel on the new system’s functionality and care.

Monitoring Performance

Implement a system of continuous monitoring to assess how the modifications affect overall vehicle performance and reliability. Collect data to support future modifications or improvements to the pneumatic system.

3.2 Applying tests and testing equipment

3.2.1 Pneumatic system testing producers

Pneumatic testing is a commonly employed technique in the oil and gas industry to assess the integrity of pressure vessels, pipelines, and other components. Pneumatic testing has various benefits making it become a preferable technique. In this discussion, we will explore the basics of pneumatic testing, its benefits and limitations, and the importance of following proper safety procedures according to ASME PCC.

What Is Pneumatic Testing?

Pneumatic testing is the process of using gas to verify a vessel's ability to withstand normal usage pressures under normal usage. It ensures that the system can withstand pressures beyond its designed pressure limit and be safely subjected to its maximum operating pressure.

Pneumatic testing is essentially utilized to confirm the leak-tightness and structural soundness of pressure vessels, pipelines, and other similar components that are designed to contain or transport fluids or gases under pressure. This type of testing involves using compressed air or another gas to simulate the pressure that the component is expected to experience during normal use.

What Are the Limitations of Pneumatic Testing?

The ASME PCC-2 standard provides guidance on pneumatic testing of pressure vessels, piping, and other pressure-containing components, while also addressing the limitations of this type of testing to guarantee its safe and accurate execution.

i. Safety Measures

One of the limitations of pneumatic testing is the potential danger posed by the energy stored in compressed gases if the component being tested fails catastrophically. To mitigate this risk, ASME PCC-2 recommends venting pressure vessels to the atmosphere or installing safety devices such as rupture discs or relief valves to protect personnel and equipment in case of an unexpected pressure release.

ii. Materials Selection

Another limitation of pneumatic testing is that the test gas used may not be compatible with the materials or process fluids contained in the component. To avoid adverse reactions or contamination, ASME PCC-2 suggests carefully selecting the test gas and ensuring its thorough cleaning and drying.

iii. Test Pressure and Duration

ASME PCC-2 also offers guidelines for selecting the appropriate test pressure and duration to avoid damaging or overstressing the component while still ensuring adequate testing. The standard advises keeping the test pressure below 1.5 times the maximum allowable working pressure (MAWP) of the component and setting the test duration long enough to identify any leaks or deformations, but not so long as to cause permanent damage.

By following these guidelines, ASME PCC-2 ensures that pneumatic testing is conducted safely and accurately, despite its limitations, thus guaranteeing that pressure-containing components are tested effectively and suitable for their intended applications.

What Are the Benefits of Pneumatic Testing?

Compared to hydrostatic testing, pneumatic testing has several benefits, such as the ability:

i. Small Leaks Detection

Pneumatic testing can detect small leaks by pressurizing the system and measuring the pressure drop over time. As the pressure drops, it indicates the presence of a leak and the rate of pressure drop can also help in identifying the location and size of the leak.

ii. Specific Components

Pneumatic testing can test components that cannot be filled with liquid by applying compressed gas to the component and detecting any pressure drops, which can indicate leaks or other defects.

iii. Non-corrosive and Non-conductive Usage

Pneumatic testing is advantageous because it can use non-corrosive and non-conductive gases, which do not require special disposal procedures, for conducting testing. This is beneficial for testing components that cannot be filled with liquid, and it also allows for the detection of small leaks. Additionally, the use of compressed air in pneumatic testing allows for faster testing compared to hydrostatic testing. Moreover, compared to hydrostatic_testing, pneumatic testing is generally quicker and more cost-effective and can test components at higher pressures, although it also poses safety risks and limitations that need to be carefully managed to ensure safe and accurate testing. The American Society of Mechanical Engineers (ASME) provides guidelines for conducting pneumatic testing in ASME PCC-2. This standard addresses the limitations and safety concerns of pneumatic testing, providing recommendations for safe and accurate testing.

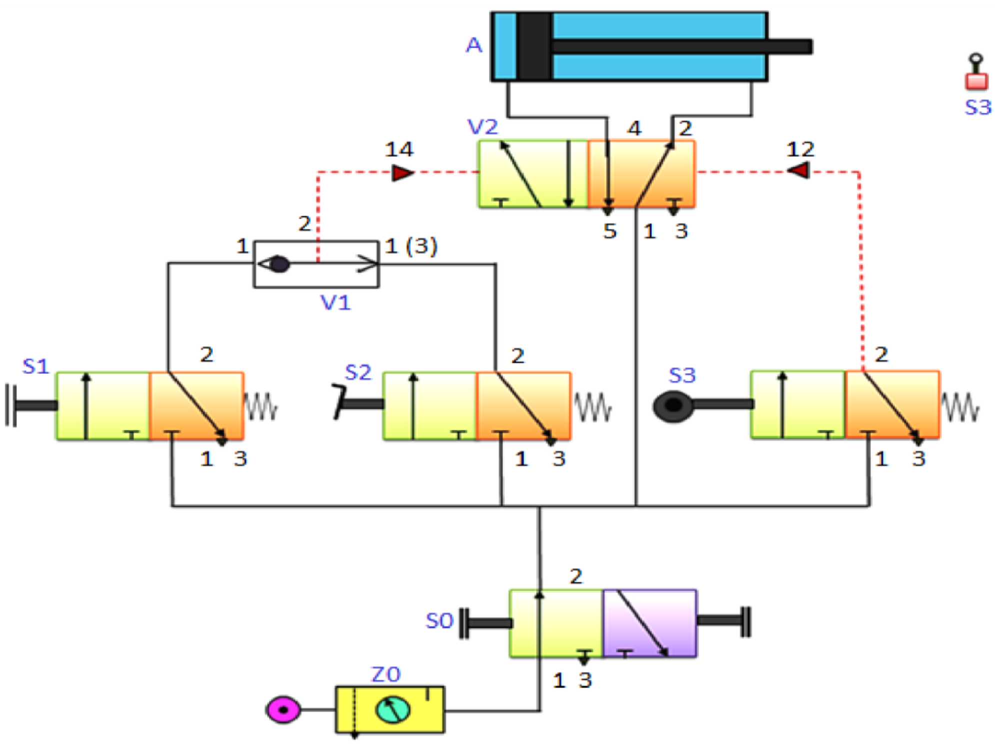
Under ASME PCC-2 standards, engineers can have the proper guidelines for selecting the appropriate test pressure and duration, choosing the right test gas, and addressing the potential hazards of the energy stored in compressed gases during testing. By following these guidelines, pressure-containing components can be effectively tested to ensure their safe and reliable use.

pneumatic systems assembly/installation procedures

Consider a simple operation where a double-acting cylinder is used to transfer parts from a magazine. The cylinder is to be advanced either by operating a push button or by a foot pedal. Once the cylinder is fully advanced, it is to be retracted to its initial position. A 3/2-way roller lever valve is to be used to detect the full extension of the cylinder. Design a pneumatic circuit for the above-mentioned application.

The pneumatic components which can be used to implement the mentioned task are as follows:

- double acting cylinder
- 3/2 push button valve
- 3/2 roller valve
- shuttle valve
- 3/2 foot pedal actuated valve
- 5/3 pneumatic actuated direction control valve
- compressed air source and connecting piping



As the problem stated, upon actuation of either the push button of valve (S1) or the foot pedal valve (S2), a signal is generated at 1 or 1(3) side of the shuttle valve. The OR condition is met and the signal is passed to the control port 14 of the direction control valve (V2). Due to this signal, the left position of V2 is actuated and the flow of air starts. Pressure is applied on the piston side of the cylinder (A) and the cylinder extends. If the push button or pedal valve is released, the signal at the direction control valve (V2) port is reset. Since DCV (V2) is a double pilot valve, it has a memory function which doesn't allow switching of positions. As the piston reaches the rod end position, the roller valve (S3) is actuated and a signal is applied to port 12 of the DCV (V2). This causes actuation of right side of DCV (V2). Due to this actuation, the flow enters at the rod end side of the cylinder, which pushes the piston towards left and thus the cylinder retracts.

3.2.2 Test pneumatic system

Steps to troubleshooting pneumatic systems

Troubleshooting a pneumatic system has been considered an art, a science, or just hit-or-miss luck. In the minds of maintenance personnel, production managers, and plant managers, the word troubleshooting conjures up images of hours of downtime and lost production. However, when reduced to its basic elements, troubleshooting a pneumatic system is a step-by-step procedure. Using this process can speed up the ability to determine what the problem is, the probable cause of the malfunction or failure, and a solution. Every pneumatic circuit has a logical sequence of operation that can involve timing logic, pressure sensing, position sensing, and speed regulation. Troubleshooting is initiated when the circuit does not operate properly.

Certain general diagnostic and testing steps can be applied to any troubleshooting problem, whether the problem occurred at startup of a new system or at a breakdown of an existing system.

Think safety first

Safety should always be a prime concern of maintenance personnel. Compressed air is a volatile element in a pneumatic circuit. Air receiver tanks have exploded, causing severe injury to personnel and damage to property. It is imperative to relieve pressure in a receiver tank prior to making any repairs.

Air is also highly compressible, which is another reason to be cautious in the approach to troubleshooting a pneumatic system. When working with overhead loads that are supported by cylinders, but not mechanically locked into position, block the load before servicing the system to prevent falling or drifting.

Many pneumatic systems are controlled by electrical or electronic devices. Before attempting service or repair on these components, be sure the electrical power supply has been turned off.

Pneumatic directional control valves that use electrical solenoids to operate the valve spool are often equipped with manual overrides that can be used during troubleshooting to operate the system. Pneumatic lockout valves are excellent safety devices that, when used properly on pneumatic systems, can prevent accidental operation. Ensuring a safe condition should always be the first step in troubleshooting pneumatic systems.

Ask the three Ws

When a breakdown in the system occurs, the pressures of downtime loom large in the minds of all concerned. Before beginning repair of a system, stop and ask these three questions:

- What is or is not occurring in the system's operation?
- When did the problem begin? Was it a sudden failure or a gradual failure?
- Where in the machine cycle does the problem occur? Was it at startup or after the system has been operating for a while?

What is or is not occurring in the system can often be answered by the system operator. Answers to questions such as slow actuator speed or inability of the actuator to move could lead to looking for a low flow rate or low pressure.

Asking," *When* did the problem begin?' can often lead to troubleshooting steps looking for worn components or leaks. Sudden malfunctions can point to breaks and possible mechanical problems, ruptures in lines, or other catastrophic failures. By determining the when, the problem search can be narrowed in its scope.

Asking," *Where* in the machine cycle does the problem occur?" can reveal a reoccurring condition.

If good maintenance records have been kept, reoccurring problems should have been recorded. This information makes the troubleshooting process much easier. A maintenance person who stops and asks the three Ws can reduce downtime by not having to guess at what is wrong. However, if these questions do not yield a satisfactory diagnosis the maintenance person must begin the mechanics of troubleshooting by visually inspecting the machine.

Make a visual inspection

Walking around the machine will often uncover problems such as worn or burst hoses, loose components, and broken components. This is the time to become familiar with the components contained in the pneumatic system.

If unfamiliar with the components, or if unfamiliar with the machine operation, ask as many pertinent questions about the system as possible. Before trying to operate the system or attempt repairs, understand the interrelations of all the components and the sub-systems found on the machine.

Read the schematics

Every pneumatic system should have two forms of documentation that will assist in troubleshooting. One document is a schematic drawing of the pneumatic circuit (Fig. 3). The schematic is a road map. It not only explains the operating function of the components but also is a valuable diagnostic tool.

The schematic contains useful information about pressure test point locations; pressure settings of regulators and other pressure valves; flow rates within the system; cylinder stroke lengths, and air motor speeds as well as a bill of materials for the system. This type of information can aid in determining if the system is operating within its design parameters.

Along with schematics supplied by the manufacturer, another set of documents, the service/maintenance manual and its service bulletin updates, may be available to assist in the diagnosis and repair of the machine. These may contain information about the problem that has occurred.

Operate the machine

After becoming familiar with the components and operation of the pneumatic system, start the machine and operate it to get a first-hand view of the malfunction. See if the malfunction that has been reported occurs again. While operating the machine, perform a visual inspection.

Some questions to ask during the inspection:

- Is there any excessive air leakage?
- Are system pressures at the levels specified on the schematic or in the maintenance manual?
- If there are manual controls for the machine, do they feel stiff or loose in their operation?
- Are components that move, moving smoothly or erratically?
- By operating the machine, any abnormalities may become obvious, shortening troubleshooting time.
- Recheck all services

Before attempting repair on the machine after it has been operated, once again check to see if power supplied to the machine has been turned off. Check to see if any stored pressure remains in the system, because this stored pressure can cause premature actuation of the system's actuators and cause injury to personnel and damage to the machine.

Isolate subsystems

A malfunction in one part of the machine can be caused by a malfunction in a different subsystem on the machine. Isolating the subsystems, can help focus on one system at a time.

Narrowing the diagnostic area by isolation of subsystems requires extra precaution while operating the machine. Any lines that have been disconnected and any ports that have been opened should be plugged properly to prevent unnecessary air leakage and the entrance of contaminants.

While operating the machine, a close watch should be kept on the pressures within the system, so maximum allowable pressures are not exceeded. Caution and safety are the two keys to this diagnostic step.

Make a list

During the previous step, the immediate problem may be quite obvious. However, in troubleshooting, the obvious may not be the root cause. As an example, the obvious problem may be slow actuator speed but the root cause of the problem could be insufficient lubrication, no lubrication due to a faulty lubricator (Fig. 4), or bad seals within the directional control valve that controls the actuator.

After making a list of possible causes, check those items on the list and eliminate them without going back over ground previously covered. This list will also reduce the time required for troubleshooting and can eliminate the parts exchanging syndrome that often accompanies troubleshooting. The example of slow actuator speed shows why a thorough understanding of component and system operating principles is required to accurately match the problem to the cause. After making a list and narrowing the possible causes, it is now time to make a decision on which one of the remaining causes is most likely to be the reason for the malfunction. Reaching this conclusion may, at first, appear difficult but this step is essentially the starting point for the repair portion of troubleshooting. Up to now the system has been evaluated, now it is time to test the conclusion.

In the example, testing the conclusion may be merely the need to add lubricant to the lubricator or make an adjustment to the drip rate of the lubricator.

Conducting various tests such as pressure checks with an accurate gauge, checking actuator alignment, checking flow rate in the system with a flow meter, or temperature checking of the air system, can further reduce the number of causes remaining on the list and accurately pinpoint the cause.

Repair or replace

Testing the conclusion automatically leads to deciding whether to repair or replace a component. Many factors can influence this step. Repairing parts immediately for reinstallation on the machine increases downtime, and the cost factor of this downtime is a significant consideration. To simply replace the part with a new or rebuilt component would reduce the amount of downtime; however, the question of inventory cost now becomes a factor.

Another point that may influence the repair-or-replace question is component availability. Obviously if the component is not readily available, then repairing may be the only alternative. Still another aspect may be the in house capability to make repairs. After the malfunction has been corrected, one final step remains, the need to report the findings.

3.2.3 Report

- Recordkeeping The following recordkeeping requirements apply for these requirements: Inspection Custodian maintains completed inspection report forms, keeping a copy of record for five years and also forwarding a copy to the pressure systems program manager, who adds it to the Pressure Systems Database
- Maintenance Custodian maintains completed maintenance and repair report forms, keeping a copy of record for five years and also forwarding a copy to the pressure systems program manager, who adds it to the Pressure Systems Database – If maintenance procedures include pressure testing as required by code, a record of the test must be submitted to the pressure systems program manager

- Repair Custodian maintains completed maintenance and repair report forms, keeping a copy of record for five years and forwarding a copy to the pressure systems program manager, who adds it to the Pressure Systems Database

3.3 Verifying test results and diagnostic findings

3.3.1 Diagnosis and Maintain pneumatic systems components

Easy Troubleshooting Steps

Having your equipment down for any time or not working at peak capacity can lead to losing production and money. Always look for the most common causes of problems and simple fixes first. Using a set procedure for inspections and preventative maintenance will ensure continuity. Operation is systematic and runs on a carefully planned logic system, so troubleshooting should follow suit. When working with compressed air, relieving pressure before initiating repairs is important for the safety of technicians. Any moving parts should be locked into place using manual overrides or lockout valves if the system is so equipped and electrical circuits shut down.

Three questions should help you get to the root of the problem or at least tell you where to start:

- What is the nature of the problem? Is something going on that shouldn't, or are operations that should be taking place not occurring?
- Was the issue sudden, or has there been a gradual slowdown of performance over some time? Premature breakdowns signal mechanical problems and incremental reductions in function can signal the degradation of wearable parts.
- Where in the process is the problem occurring? Are there issues at startup or after the machinery has been running for a while?

Pneumatic systems are known for their high function and longevity. They're relatively trouble-free with daily inspections and preventative maintenance. When you need replacement parts for your plan, consider using quality Airtac pneumatic components to protect your investment. Choosing parts from trusted manufacturers will reduce equipment repair and maintenance costs and help ensure a longer life for your pneumatic systems.

Inspection

Pressure systems must be maintained according to a schedule appropriate to system type and the operating conditions. Maintenance types include

- Preventive, which is generally determined by the manufacturer
- Break down, which is an opportunity for maintenance due to unforeseen equipment shutdown
- Periodic, which is required maintenance as determined by manufacturer's recommendation and/or SLAC policy
- Inspections will be performed only by pressure system inspectors, designated by line management and trained and qualified by the pressure systems program manager.
- Inspectors will follow one or a combination of the following for performing inspections:

SLAC National Accelerator Laboratory Environment,
Safety & Health Division Pressure Systems | Installation,
Inspection, Maintenance, and Repair Requirements

- National Board Inspection Code (NBIC)
- International Code Council (ICC) codes
- American Petroleum Institute (API) standards
- Compressed Gas Association (CGA) standards
- Manufacturer's recommendations

The two pressure system inspection types are external and internal. An external inspection is conducted while the system is operating and includes

- Examination of system components, including structural attachments, vessel connections, inlet piping, outlet piping, drain piping, piping supports, and appurtenances
- Identifying evidence of leakage or inadequate insulation or other coverings an internal inspection is conducted once the pressure has been released and the system is open for inspection. It includes inspecting for corrosion and wear around, and defects at,
- Welded seams, nozzles, and areas adjacent to welds
- Vessel connections
- External fittings or controls
- Frequency and Pressure Test
- Leak Test and Mechanical Integrity for Vacuum Systems
- Pressure Relief Devices
- Recordkeeping

To complete an electrical system inspection, a technician may perform any or all of the following actions: Check and clean battery cable connections Test the battery Unplug and inspect any wiring connectors leading to components causing issues Inspect wiring harnesses and connections relating to any component causing issues.

- Checking and cleaning battery cable connections
- Testing the battery.
- Unplugging and inspecting any wiring connectors leading to components causing issues.
- Inspecting wiring harnesses and connections relating to any component causing issues.

Please note that this is not an exhaustive list, and the specific steps involved in an electrical system inspection may vary depending on the vehicle and the mechanic performing the inspection. On making the truck ready to be delivered to the customers, final inspection is made by the inspector. The inspector is responsible for checking and confirming the vehicle is ready to be delivering to the customer.

Some of the duties and responsibilities include

- Test drive
- Report to the Forman if deviation exists
- Compare the operation with the customer job letter

Operation sheet 3.1

Operation Title: conduct Visual inspection of Pneumatic Systems and replace worn sealed, filter and lubricant.

Purpose: Visual inspection of Pneumatic Systems and perform periodic maintenance

Conditions or situations for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Socket set
- Combination wrench set
- ESTs (especial service tools)
- ESTs perform the following functions(OBD):
    - Clear fault codes
    - Display valve and sensor configuration data
    - Display auxiliary codes

Quality Criteria: Assured performing of all the activities according to the procedures

Precautions:

- Wearing proper clothes, eye glass, glove
- Make working area hazard free
- Read and interpret manual which guide you how to use tools and equipment
- Compare your finding with the service manual

Steps in doing the task:

1. Check for Leaks
2. Lubricate the System
3. Be Careful Where the Air Compressor Sits

4. Change the Filters Regularly
5. Check and Lubricate the Seals
6. Refill Mist Lubricators
7. Check and Service the Silencer
8. Replace Worn or Failing Parts Before They Break Down
9. Design or Redesign Systems to be Easy to Maintain

Operation Sheet 3.2

Operation Title: Install Simple Pneumatic System Circuit.

Purpose: To practice how the pneumatic system circuit are working.

Conditions for the operations:

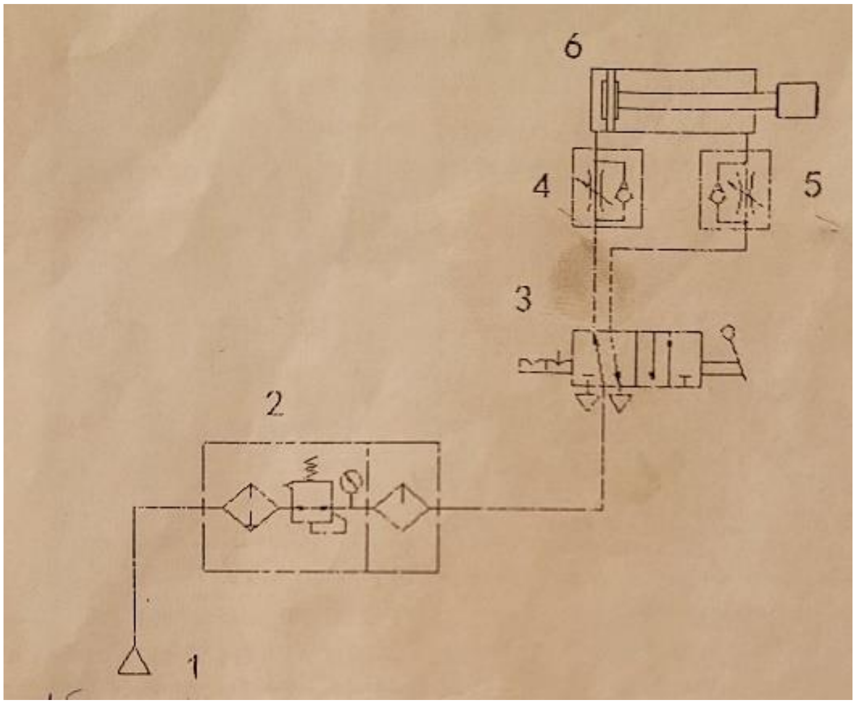
- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

The pneumatic components to be used to implement this task are:

- Single acting cylinder
- 5/2 push button valve
- 2/5 roller valve
- shuttle valve
- 5/3 pneumatic actuated direction control valve
- pressure sequence valve
- compressed air source
- pressure gauge and connecting piping

Quality Criteria: Assured performing of all the activities according to the circuit below



Precautions:

- Wearing proper clothes, eye glass, glove
- Make working area hazard free
- Read and interpret manual which guide you how to use tools and equipment

Steps in doing the task

1. Know the element name and figure of the element
2. Familiar with the system schematic
3. Select the necessary pneumatic component
4. Connect the types according to the system schematics
5. Realize the manual shuttle valve control double acting cylinder circuit
6. Put the component to the original position

Operation Sheet 3.3

Operation Title: Construct one simple pneumatic circle with single acting cylinder.

Purpose: To practice how the pneumatic system circuit are working.

Conditions for the operations:

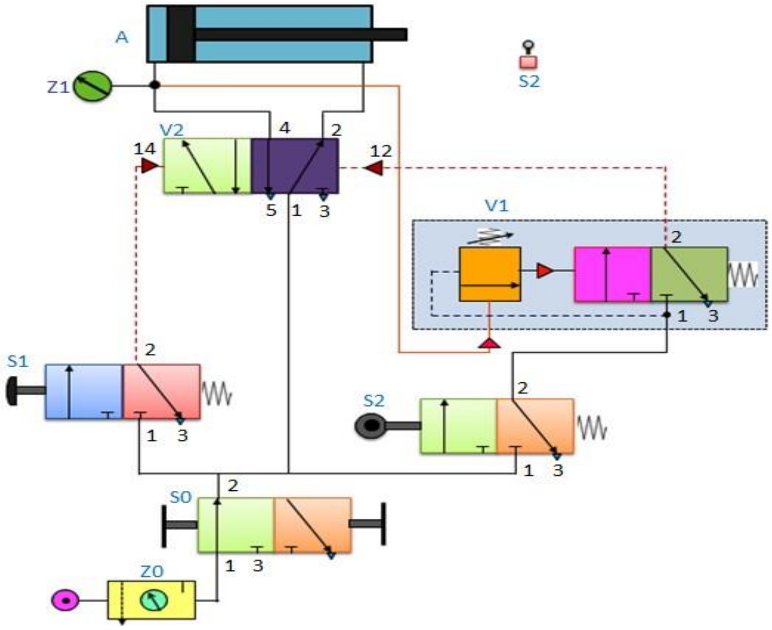
- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

The pneumatic components to be used to implement this task are:

- double acting cylinder
- 3/2 push button valve
- 3/2 roller valve
- shuttle valve
- 5/3 pneumatic actuated direction control valve
- pressure sequence valve
- compressed air source
- pressure gauge and connecting piping

Quality Criteria: Assured performing of all the activities according to the circuit below



Precautions:

- Wearing proper clothes, eye glass, glove
- Make working area hazard free
- Read and interpret manual which guide you how to use tools and equipment

Steps in doing the task

1. Identify the pessary component
2. Identify the necessary connectors
3. Install the circuit using the given diagram
4. After completion the installation recheck the circuit
5. Supply the pneumatic power
6. Check the performance

Operation Sheet 3.4

Operation Title: modify petrol engine to pneumatic engine

Purpose: To practice how the pneumatic engine circuit are working.

Conditions for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Selection and modification of engine

We are using 100CC two stroke petrol engine for our project. We closed the inlet and outlet of engine and compressed air supplied to the spark plug socket. In two stroke engine one revolution complete in two stroke so efficiency of two stroke engine is higher than the four stroke engine and load carrying capacity also high. All running or completed projects on compressed air vehicle are on four stroke engine but we tried on two stroke engine for high load carrying capacity. Side ports are closed by adhesive and cylinder liner and for reducing the weight of engine we cut the fins which provided for cooling.

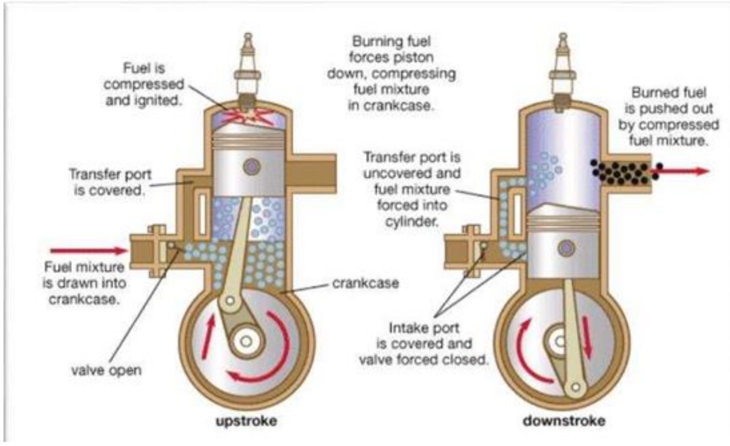


Figure 3.1 Selection and modification of engine selection of engine

A two-stroke engine completes all the same levels, but in just two piston strokes. The simplest two-stroke engines do this using the crankcase and the underside of the moving piston as a new charge pump. As the two-stroke piston increases on compression, its underside draws a partial vacuum into the crankcase. In four stroke engine one rotation is complete in four stroke so for CAE it gives low efficiency that's why we are using two stroke petrol engine. All the unnecessary parts are removed for making light weight like casing, cooling fins, carburetor, electric motor, magneto and gear box.

Modification of engine

we convert two stroke petrol engine to two stroke compressed air engine. First of all, we closed the inlet and outlet port with the adhesive and side port with the cylinder liner and make a closed chamber. After closing all the ports, we need to make a new inlet for air supply so we make 1.4cm diameter hole on the piston head casing. Weight of our engine is high so we need to reduce the weight of engine by removing all unnecessary components like cooling fins, motor, and casing cover. In the first trial we use battery operated 5/2 solenoid valve for controlling air supply but timer setting become very difficult for this engine because of the piston movement is unpredictable so we need to use Roller Spring 5/2 DCV valve for controlling compressed air supply. Roller Spring operated DCV valve one roller is attached at the end of solenoid valve. When pressure is applied on the roller by comes in contact with the other end then air is supply to the engine. Dead weight attached to plate witch is mounted on engine shaft. For arrangement of Roller Spring operated DCV valve we need to find specific angle. and we attached solenoid valve by the welding process. For revolution of crank it is necessary to breakdown of continues air pressure so we decide to modify the main shaft of engine as shown in figure. After constructing the engine base, we need to connect the engine(Driver) gear to rear wheel(Driven) gear in same alignment. We attached a dead weight to the main shaft for making regular contact between crank and Roller Spring operated DCV valve. and other side of main shaft we joint a motorcycle main gear for transmitting rotation from engine to rear wheel. Modified engine is mounted on the compressor for making compact size vehicle. To control and for the proper flow of the fuel (compressed air) pressure regulators and pneumatic specialized parts are used and proper flow is provided to the engine and pressure is maintained inside the bore. While working with 4 stroke engine it requires more number of modification than 2 stroke in 4 stroke engine first of all number strokes are needed to be made accordingly to the two stroke engine and the camshaft section are needed to be changed while in comparison these kind of changes and modification And more over two stroke engine has more power capacity than 4 stroke .due to 4 stoke engine has two to complete two revolution in one stroke and two stroke completes one revolution in one power stroke. While working with two stroke engine as it has ports and transfer port and mainly the inlet port at the bottom at near to BDC. And due to this there is most of the fuel is been leaked and the piston movement operation is not occurring properly so to over- come this the piston bore is replaced by cylinder linear and all the transfer ports and remaining ports been blocked and the exhaust port is shifted to the top of piston and by this the piston movement is obtained.

Figure 2.1 Modification of engine

Lap test 3.1

Name ____

Date: ____

Time started: ____

Time ending: ____

Instruction:

1)You are required to perform the given task based on the manual and specification.

Task 1: conduct Visual inspection of Pneumatic Systems and replace worn sealed, filter and lubricant

Task 2: Install Simple Pneumatic System Circuit.

Task 3: Construct one simple pneumatic circle with single acting cylinder.

Task 4: modify ICE engine to pneumatic assist engine

Unit four: Prepare vehicle/ modification pneumatic system for use or storage

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Final inspection
- Job card
- Clean and store tool, equipment

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Perform Final inspection
- Prepare Job card
- Clean and store tool, equipment

4.1 Final inspection

On making the truck ready to be delivered to the customers, final inspection is made by the inspector. The inspector is responsible for checking and confirming the vehicle is ready to be delivering to the customer.

Some of the duties and responsibilities include

- Test drive
- Report to the Forman if deviation exists
- Compare the operation with the customer job letter

4.2 Job card

Finalizing Job Card Process

- Complete work documentation that perform during the practical repairing work.
- Processing Job card based on workplace procedures.
- Forwarding report based on the work place procedure to the customer.

Table 1: Job Card Description

To be completed by the Mechanic					
Description of work carried out		Start Time	Finish Time	Hours Per Job	Mechanic Signature
			Total		

		Hours:	
Hourly Rate:		Total Labour Cost:	

4.3 Clean and store tool, equipment

Cleaning and making ready workplace for next work is not just a measure of respect for the workspace, it also removes hazards. Plan to easily and regularly remove trash and debris. Enforce a strict clean up policy throughout the workspace. Keep work areas tidy as well by minimizing the number of wires running around. Extension cords quickly become tripping hazards, and power strips also cause trouble on the ground or as they tumble erratically on a desktop. We suggest you provide access to grounded outlets all along the perimeter of the room and/or dropped from the ceiling for each workbench.

Cleaning procedures are: -

- Clean up every time whenever you leave an area, including sweeping the floor.
- Clean and return all tools to where you got them.
- Use compressed air sparingly; never aim it at another person or use it to clean hair or clothes.
- Shut off and unplug machines when cleaning, repairing, or oiling.
- Never use a rag near moving machinery.
- Use a brush, hook, or a special tool to remove chips, shavings, etc. From the work area. Never use the hands.
- Keep fingers clear of the point of operation of machines by using special tools or devices, such as, push sticks, hooks, pliers, etc.
- Keep the floor around machines clean, dry, and free from trip hazards. Do not allow chips to accumulate.

- Mop up spills immediately and put a chair or cone over them if they are wet enough to cause someone to slip.

Self-check 4.1

Give short answer for the given question

1. Prepare your own job card?
2. List the Maintenance types?
3. Describe cleanup procedure?

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Developer Profile

No	Name	Qualification	Field of Study	Organization/ Institution	Mobile number	E-mail
1)	Natnael Genene	MSc	Automotive Technology	Athlete kenenisa PTC	0920397105	Natnaelgenene143@gmail.com
2)	Israel Taye	MSc.	Automotive Technology	General Wingate PTC	0913424100	Isra.taye@gmail.com
3)	Tatek Mamo	PhD	Automotive Engineering	Ethiopian Defense University College of Engineering	0911841121	mimibaba928@gmail.com /tatekm@.etdu.edu.et