HAVE YOU EVER ventured out to a paintball field and been blasted with paint? The basic paintball gun uses compressed gas (e.g., carbon dioxide, nitrogen, or air). The compressed air is contained in a storage tank until a person pulls the trigger, which opens a valve. The paintball is pushed by the compressed gas and propelled out to the desired target. This is a simple example of a pneumatic system.

Objective:

Describe the basic principles of a pneumatic system.

Key Terms:

- air filter
- air storage tank
- compressor
- flow meter
- manifold
- motor
- needle valves
- pneumatics
- pressure limit switch
- pressure regulator
- pressure system gauge
- safety filter
- safety valve

Understanding Pneumatic Systems

Pneumatics is any system or tool that uses compressed gas (typically air) to create motion or mechanical advantage. Most pneumatic systems, regardless of the machine complexity, have several parts in common.

SYSTEM PARTS

All pneumatic systems must utilize some form of a compressor. A compressor is a tool that takes in outside air and forces it into a storage tank where it cannot escape. As more air is forced into the tank, the pressure inside the tank continues to rise.
**Motor**

The compressor is driven by a motor, which is a gas- or electric-powered device that creates rotary motion. The rotary motion controls a piston in the compressor that takes in air and forces it into the storage tank.

**Air Storage Tank**

The air storage tank is a device that receives the air from the compressor to hold under pressure until needed by the pneumatic circuit.

**Air Filter**

Because dirt and debris particles can damage compressors and pneumatic tools, compressors are outfitted with an air filter, which is a porous screen-like material to catch foreign material.

**Safety Filter**

A safety filter is a secondary screen-like material to remove even smaller foreign particles from the air before it enters the compressor and storage tank.

**Pressure Limit Switch**

As the pressure inside the storage tank increases, the pressure limit switch is utilized. The pressure limit switch is a device that senses the tank pressure and will automatically turn the compressor off when a set pressure is reached. In addition, the pressure switch will engage the compressor when the tank pressure falls below a preset level. Pressure in most air tanks is measured in pounds per square inch (psi).

**Safety Valve**

If the pressure limit switch fails to shut the compressor off and pressure continues to build, a safety valve will open. A safety valve is a device designed to open and allow extra pressure to escape into the atmosphere to prevent the tank from rupturing.

**Manifold**

When the air in the storage tank is needed, it travels down a

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*FIGURE 1. This is an air pressure regulator with a safety valve (smaller red knob on left).*
manifold, which is a connector between the air supply system and the pneumatic circuit (tool).

**Pressure Regulator**

A pressure regulator is a device that controls the amount of air pressure allowed to enter the pneumatic circuit to operate the machine or tool. The regulator is adjustable, allowing the operator to increase or decrease the pressure for certain applications.

**Pressure System Gauge**

A pressure system gauge is a tool attached to the pressure regulator to show the air pressure entering the pneumatic circuit.

**Needle Valves**

Needle valves are tools used to stop the supply of pressurized air to the circuit. When the valves are turned in, they seal the opening for the compressed air to move through.

**FLOW METER**

A flow meter is a tool that measures the amount of air flowing through a pneumatic circuit, typically in standard cubic feet per hour (SCFH). A flow meter has various applications and is used whenever an operator must know how much air is flowing through a pneumatic system.

**Air or Another Gas**

In factories, a flow meter is used to measure how much air or another gas is flowing into a container. A flow meter ensures the products are correctly mixed with gases.

**Bottling Soda**

A flow meter is important in the bottling of soda. The carbonation is due to the mixing of carbon dioxide gas with the liquid. A flow meter can show how much carbon dioxide is being added. If there is too little, the soda is flat. If there is too much, the soda bottle could rupture.

**Potato Chip Production**

A flow meter is used in the production of potato chips. Gases are pumped into the chip bag to protect the chips during shipping and to increase freshness. A flow meter insures that the correct amount of gas is pumped into the bag without damaging the bag or the chips.
SAFETY

As with any system that operates under pressure, pneumatics can pose several safety hazards because of the nature of the operation. So you should always follow a few basic safety rules when working with pneumatic devices or tools.

Clothing

Always wear proper safety glasses or goggles when working with pressurized air. Objects can be propelled by the air and cause significant eye injuries if they strike you. In addition, a pressurized jet of air can damage unprotected eyes.

Valves

When using an air compressor to drive pneumatic tools or devices, always be sure to close the needle valves before connecting, disconnecting, or making any changes to the pneumatic circuit. The circuit should be completely depressurized before making any changes.

DIGGING DEEPER…

UNCOVERING ADDITIONAL FACTS:
Power Tool Safety

Operator safety should always be the first concern when working with power tools. Air guns, impact wrenches, air compressors, and spray guns can save time. These tools can improve projects with their versatility, durability, speed, and performance. However, it is important to observe safety measures to avoid injuries. Read the following article for safety tips:

Cylinders

Pneumatic cylinders can move quickly and can pose an injury hazard if body parts, loose clothing, or other objects come into contact with moving cylinders. So always be aware of your surroundings, especially where pneumatic cylinders are being used.

Fittings

Always handle all pneumatic components and fittings carefully. Damage to these components may not be immediately noticeable, but they may break and cause injuries when the pneumatic circuit is pressurized.

Guidelines

Always read, understand, and follow all safety guidelines associated with compressors, air tools, and other pneumatic devices. As stated previously, safety should be the top priority when working with any air-driven device.

INSPECTION AND REPAIR

Most pneumatic systems are composed of a few basic components that should be inspected regularly and repaired if necessary. Hoses, connectors, couplings, and compressors are common fail points in pneumatic systems and should be given the closest and most regular inspections.

Hoses

A pneumatic system is only as strong as the hoses delivering pressurized air to the system components or air tools. Therefore, pneumatic hoses should be inspected for any signs of wear, cracking, bulging, or tearing. If any of these conditions are found, the impacted hoses should be replaced immediately.

Hoses should always be the proper material, size, and pressure rating for the application of the hose in the equipment or tool. Choosing hoses that do not meet the demands of the machine is a sure way for a leak or rupture to occur. Cracks and bulges in hoses are signs that the hoses are exposed to heat or ozone from machinery, or they are underrated for the pressure needed and used in the machinery or tool.
**Connectors**

Connectors or couplings are typically crimped onto the ends of air hoses, which allow the hoses to be attached to a pneumatic compressor system. Make sure the hose end connector and compressor connector are meant to be used together; otherwise a blow off could occur when pressure is applied.

Inspect connectors and couplings for signs of leaking or cracking. Cracked connectors may operate well under low pressure, but they may fail unexpectedly under higher pressure applications. In contrast, excessive or under-crimping of pneumatic connectors could lead to hoses leaking or rupturing. Pneumatic hoses often are sold pre-assembled from the factory. Altering the connections on factory-made hoses is not safe.

**Routing**

Inspect the routing of hoses to insure that no crimps or bends in the hoses could cause disruption of air flow. Make sure hoses are not twisted or routed where they could rub on moving parts and cause wear. If poor routing of hoses is found, the machine should be shut down. Then the hoses should be repaired and rerouted before continuing use.

**CAREERS**

Even though the use of pneumatic-driven equipment has been around for many years, the number of careers and jobs associated with air-pressurized systems continues to grow—in agriculture and other industries.

**Engineers**

Mechanical engineers are responsible for designing and overseeing the manufacturing of new pneumatic systems or upgrading existing systems for better efficiency. Engineers must be able to troubleshoot problems in a system and suggest corrections to solve these problems.

**Mechanics**

Pneumatic mechanics construct the hoses, compressors, and other system components and install them into equipment. Mechanics are typically responsible for inspection and repair of existing air-pressurized systems.

**Product Managers**

Product managers work with engineers and pneumatic sales departments to insure that the product being produced is what is desired by customers. Managers must be able to see trends in the industry and suggest advancements necessary to meet the growing demands for pneumatics.
Sales

Sales managers work with manufacturers and retail outlets to provide the equipment that consumers desire to purchase. Managers must work with customers, retailers, and manufacturers. As a result, people skills are a must for sales work.

Maintenance

Shop technicians are entry-level careers that involve the maintenance and repair of pneumatic equipment. Technicians must be able to read and understand repair manuals and schematics. In addition, they must be able to perform physically demanding work.

EDUCATION

The education required for a career in pneumatic systems varies with each area. A mechanical engineer will require a bachelor’s degree in engineering or a related field, while a pneumatic mechanic may require an associate’s degree. Some areas, such as a shop technician, may only require a high school diploma. However, employers often search for candidates with more education or for those willing to further their education as they work.

Summary:

Pneumatics is any system or tool that uses compressed gas (typically air) to create motion or mechanical advantage. Flow meters have various applications and are used whenever an operator must know how much air is flowing through a pneumatic system.

Always wear proper safety glasses or goggles when working with pressurized air. Objects can be propelled by the air and cause significant eye injuries if they strike you. Always read, understand, and follow all safety guidelines associated with compressors, air tools, or other pneumatic devices. Hoses, connectors, couplings, and compressors are common fail points in pneumatic systems and should be given the closest and most regular inspections.

Checking Your Knowledge:

1. Define pneumatics.
2. List the common parts of a pneumatic system, and give a brief definition of each.
3. Explain two ways that a pneumatic flow meter could be used in industry.
4. What are three safety guidelines to follow when working with pneumatics?
5. Choose one of the career areas discussed in this unit, and give a brief description of that area.

**Expanding Your Knowledge:**

Build a backhoe or tower crane. Use a 2 × 4 (12" to 16" long) as the base. Allow for at least three arms. Use 1" × 1" pieces of wood with lengths of 10" for two arms and 8" for one arm. Then design a clasp. Attach spray hose/tubing and syringes (plastic without needles) to the arms. The hose/tubing and syringes will provide the fluid power (air) to the arms. All arms must move, and the clasp must open and close. The finished project must lift a golf ball and place it into a box.

**Web Links:**

- **History of Pneumatic Systems**
  [http://inventors.about.com/od/pstartinventions/a/pneumatic.htm](http://inventors.about.com/od/pstartinventions/a/pneumatic.htm)

- **Pneumatic and Hydraulic Systems**

- **Nail Guns**

- **Agricultural Career Profiles**
  [http://www.mycaert.com/career-profiles](http://www.mycaert.com/career-profiles)