Pneumatic circuit and applications

The material presented previously discussed the basic fundamentals of pneumatics in regard to air preparation and component operation. This discusses pneumatic circuits and applications. A pneumatic circuit consists of a variety of components, such as compressors, receivers, Filters, pressure regulators, lubricators, mufflers, air dryers, actuators, control valves, and conductors, arranged so that a useful task can be performed.

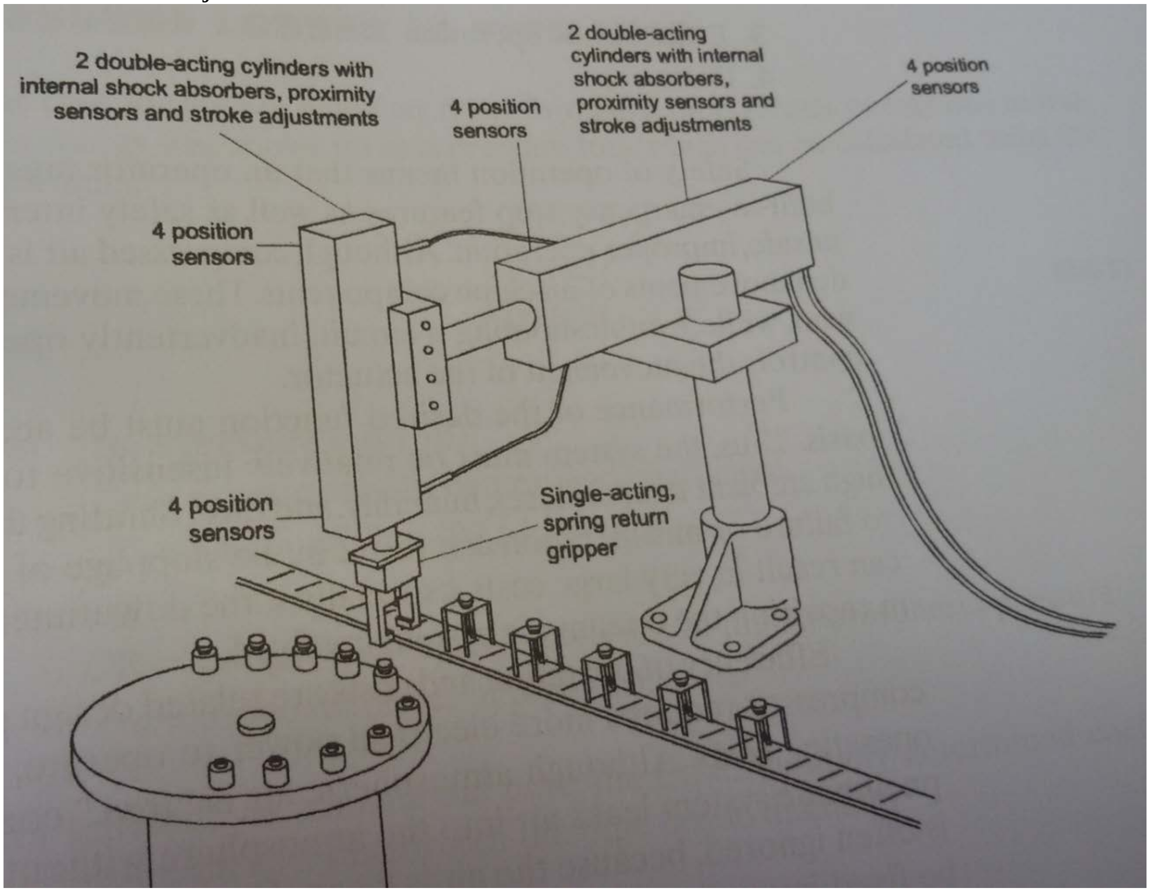
In a pneumatic circuit the force delivered by a cylinder and the torque delivered by a motor are determined by the pressure levels established by **pressure regulators** placed at the desired locations in the circuit.

Similarly, the linear speed of a pneumatic cylinder and the rotational speed of an air motor are determined by **flow control valves** placed at desired locations in the circuit.

The direction of flow in various flow paths is established by the proper location of **directional control valves**.

After the pressurized air is spent driving actuators, it is then exhausted back into the atmosphere.

Figure shows a riveting assembly machine, which performs continuous. high-speed, repetitive production of riveted components. The control system contains many pneumatic components such as regulators, filters, lubricators, solenoid valves, and cylinders. These machines were designed to operate under tough production-line conditions with a minimum of downtime for maintenance and adjustment.



Pneumatic circuit design and considerations

When analyzing or designing a pneumatic circuit, the following four important considerations must be taken into account:

1. Safety of operation

Safety of operation means that an operator must be protected by the use of build-in emergency stop features as well as safety interlock provisions that prevent unsafe, improper operation. Although compressed air is often quiet, it can cause sudden movements of machine components. These movements could injure a technician who, while troubleshooting a circuit, inadvertently opens a flow control valve that controls the movement of actuator.

2. Performance of desired function

Performance of the desired function must be accomplished on a repeatable basis. Thus, the system must be relatively insensitive to adverse conditions such as high ambient temperatures, humidity, and dust. Shutting down a pneumatic system due to failure or disoperation can result in the stoppage of a production line. Stoppage can result in very large costs, especially if the downtime is long due to difficulty in repairing the pneumatic system involved.

3. Efficiency of operation

Efficiency of operation and costs are related design parameters. A low efficiency compressor requires more electrical power to operate, which increases the system operating costs. Although atmospheric air is ·'free," compressed air is not. Yet if a pneumatic system leaks air into the atmosphere without making significant noise, it is often ignored, because the air is clean. On the other hand, a hydraulic leak would be fixed immediately, because it is messy and represents a safety hazard to personnel walking in the vicinity of the leak.

4. Costs

Pneumatic circuit air losses through various leakage areas with a combined area of a 0.25-in.-diameter hole would equal about 70 scfm for an operating pressure of 100 psig. Examples of such leakage areas include the imperfect sealing surfaces of improperly installed pipe fittings. A typical cost of compressing air to 100 psig is about \$0.35 per 1000 ft of standard air. Therefore, it costs about \$0.35 to compress 1000 ft^3 of air from 14.7 psig to 100 psig. Thus, the yearly cost of such a leaking pneumatic system operating without any downtime is

$$\text{yearly cost} = \frac{\$0.35}{1000\ \text{ft}^3} \times 70\ \frac{\text{ft}^3}{\text{min}} \times \frac{60\ \text{min}}{1\ \text{hr}} \times \frac{24\ \text{hr}}{1\ \text{day}} \times \frac{365\ \text{days}}{1\ \text{yr}}$$

$$= \$12{,}900/\text{yr}$$

Another cause of increased operating costs is significantly undersized components such as pipes and valves. Such components cause excessive pressure losses due to friction. As a result the compressor must operate at much higher output pressure, which requires greater input power. Of course, greatly oversized components result in excessive initial installation costs along with improved operating efficiencies.

Thus, a compromise must be made between higher initial costs with lower operating energy costs and lower initial costs with higher operating energy costs based on the expected life of the pneumatic system.