Lesson Ten – Accessories

Preface

Accessories in pipelines include many components that either (1) help improve operation and control of the system or (2) are absolutely essential to the type of equipment served. Because plant designers do not requisition components that are really not needed, most accessories fall within both categories. In this lesson some of the more widely used types are described. They include gages; accumulators and receivers; rotary pressure joints; and tools.

Pressure Gages

10.01 Correct pressure in pipes, tubes, and hoses is essential. Keeping pressure at proper levels is necessary mainly for three reasons: (1) efficient, economic transportation of fluids through the system, without waste of power; (2) delivery of fluids at the pressure required to all outlet points in the system (the places where the fluid is to be used); and (3) for prevention of excessive or inadequate pressure – either condition can damage the system and become hazardous to personnel. A good example is pressure failure in a lubricating line serving a compressor, like the one described in Lesson Nine. Pressure failure can mean inadequate lubrication of bearings and, in turn, expensive mechanical repairs (for a burned-out bearing), or even a thrown piston rod and cracked cylinder.

10.02 Pressure gages are located at key points in the piping system. Pressure levels are usually expressed in terms of pounds per square inch (psi). Learn about GAGE PRESSURE (psig) and ABSOLUTE PRESSURE (psia). Gage pressure means what it says – the pressure indicated by the gage. However, when the gage reads zero, it is actually subject to atmospheric pressure, or 14.7 psi (at sea level). When such a gage reads 20 psi, that means 20 pounds gage pressure (psig). The true pressure is the 20 pounds shown *plus* the 14.7 pounds of atmospheric pressure acting on the gage when it reads zero. The total or actual pressure is 34.7 psi. This is the ABSOLUTE PRESSURE – gage pressure plus atmospheric pressure. It is written 34.7 psia.

10.03 Pressure in any fluid pushes equally in all directions. The total force on any surface is the psi multiplied by the area in square inches. For example, a fluid under a pressure of 5 psi, pushing against an area of 4 square inches, produces a total force against that surface of 20 pounds (5 x 4).

10.04 The most common method of measuring pressure is to have the fluid press against a flexible or movable unit, moving it slightly. The unit is linked mechanically to a lever and a small gear that moves the indicator pointer or arrow to indicate the pressure on a dial. (A pressure gage.)

10.05 The surface that the pressure acts against may be the inner surface of a coiled tube; a diaphragm or disc; the end of a plunger; or a set of bellows. Whatever the type of element, it is normally fitted with a spring that resists the pressure, and returns the element (and the indicator pointer) back to the zero position when the pressure drops to zero. All such gages are called SPRING-LOADED gages.

10.06 Many pressure gages use a coiled tube called a BOURDON TUBE as the flexible element. See Fig. 10-1. Under pressure the fluid fills the tube. Note that one end of the tube is attached to

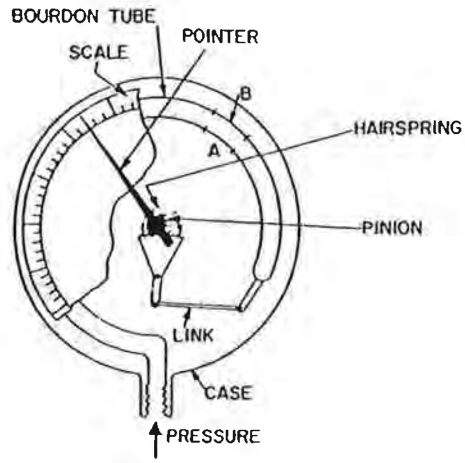


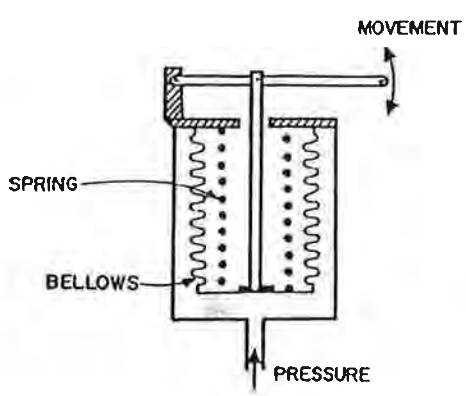
Fig. 10-1. Bourdon-tube gage.

the base of the gage. The other end, which is free to move, is connected by a short lever arm to the indicator or pointer.

10.07 Remember that pressure operates against surfaces. In this case the pressure pushes against the inner wall surface of the tube. Think of the inside walls of the tube as being two inner surfaces facing each other. The area of the wall that makes the tightest turn (A) is less than the surface area of the inner wall on the other side (B). Because the pressure inside the tube presses equally on all surfaces, the pressure on the larger area exerts more force, and causes the tube to start to uncoil or straighten out. The amount of uncoiling depends on the pressure applied in terms of pressure (psig), which is read on the dial.

10.08 Figure 10-2 shows a BELLOWS GAGE. The bellows is an expanding and contracting cylinder held in the zero position by a spring. Pressure operates against the end of the bellows to push it down to compress it. The pointer, which is linked to the bellows, registers the distance the bellows

Fig. 10-2. Bellows gage.



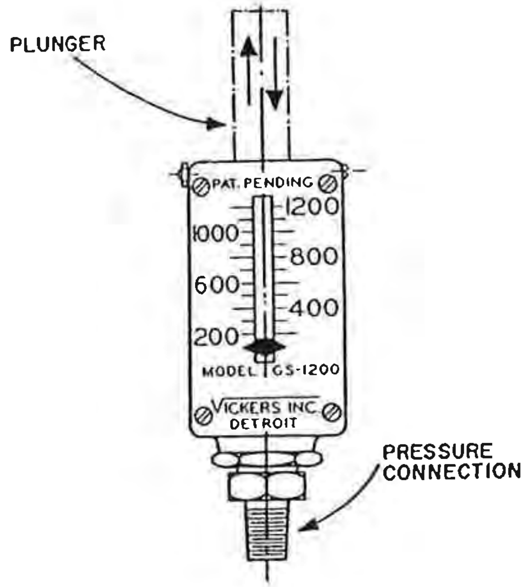


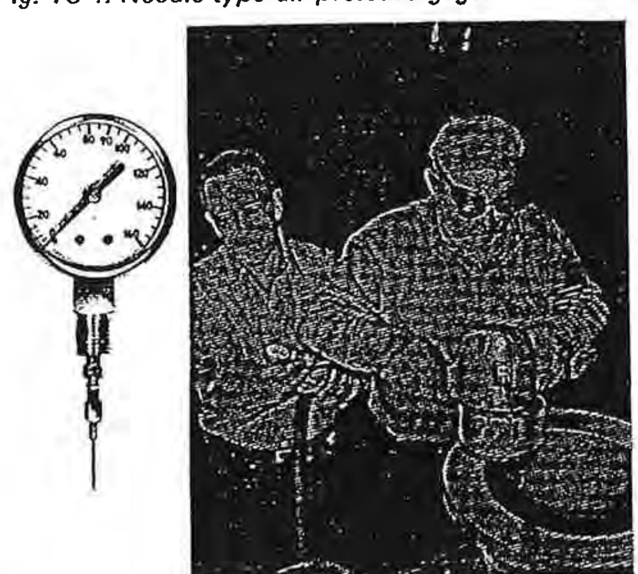
Fig. 10-3. Plunger gage.

moves. When pressure is released, the spring returns the bellows and pointer to the zero position.

10.09 Figure 10-3 shows a PLUNGER GAGE used in hydraulic systems. This is also a spring-loaded gage. Pressure from the line acts on the bottom of a cylindrical plunger in the center of the gage and moves it upward. At full pressure, the plunger extends above the gage as shown in the left-hand side of the drawing. As the pressure drops, the spring contracts to pull the plunger downward, back into the gage body.

10.10 Spring-loaded gages are not extremely accurate, but are entirely adequate where there is no

Fig. 10-4. Needle-type air-pressure gage and its use.



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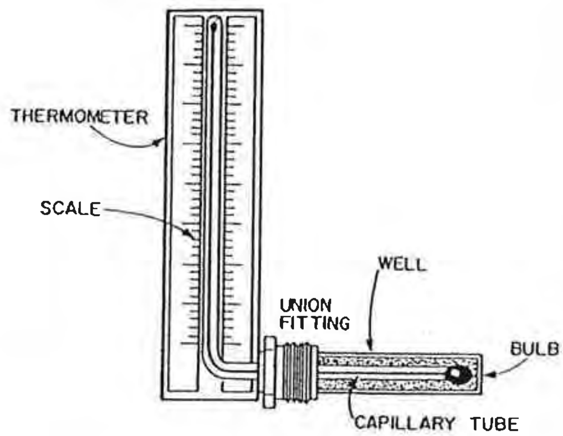


Fig. 10-5. Industrial thermometer.

need for more precise readings. Their accuracy is limited because springs lose their elasticity as they extend and contract repeatedly. For that reason, they do not long resist the applied pressure evenly, and the actual pressure may be slightly different from that shown on the dial. They can be recalibrated against a new gage if necessary.

10.11 Figure 10-4 shows a needle-type air-pressure gage equipped with a hypodermic needle. This needle easily pierces rubber hose. When inserted at a small angle to the hose, it does not leave a leak when withdrawn. Air presses against a movable member such as a Bourdon tube and causes the indicator to move.

Temperature Gages

10.12 For measuring the temperature of fluids in industrial piping systems, a rugged version of the familiar mercury thermometer is often used. See Fig. 10-5. The bulb and capillary tube are contained inside a protective metal tube called a "well." The thermometer is attached to the piping system (or tank, vat, or other component) by a union fitting.

10.13 Another common type of temperature gage is the BIMETALLIC GAGE shown in Fig. 10-6. The key to its operation is the bimetallic element in the body of the instrument. This is a coil made up of two metals that have different coefficients of expansion.

10.14 The COEFFICIENT OF EXPANSION is a figure that represents the amount a material expands with heat. (Steel, for example, expands 6 millionths of an inch per degree.) When two metals having different coefficients of expansion are wound together and subjected to heat, one metal expands more than the other. As a result, the bimetallic element bends slightly. The amount it bends is reflected in the movement of the indicator or pointer on the gage. (This type of element is commonly used in thermostats.)

10.15 THERMOSTATS are devices that open or close an electrical switch as temperature reaches a predetermined point. They do not provide readings of temperature, but cause action in response to changes in temperature (as explained in Lessons Eight and Nine).

10.16 Many industrial processes require a continuous record of temperature variations. In a RECORDING THERMOMETER, the pointer or indicator is a pen that traces a line on a continuously moving paper sheet, suitably marked or calibrated in time divisions and values. Figure 10-7 shows the pressure-spring element used in such instruments. The temperature-sensing device is a bulb filled with a gas or liquid that expands with temperature, producing motion in an attached Bourdon tube element. The element is linked to the pen-arm assembly. Other types of instruments used for recording fluid flow operate on the same principle.

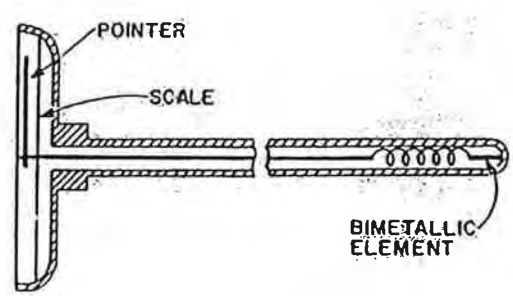
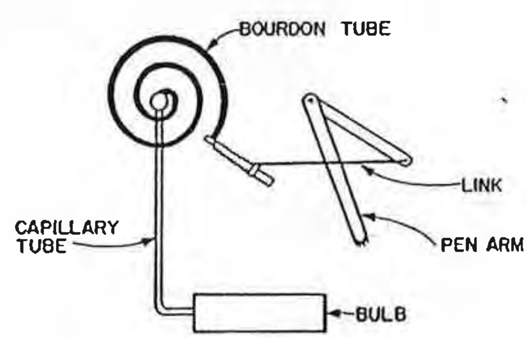


Fig. 10-6. Bimetallic gage.

Fig. 10-7. Elements of recording thermometer.



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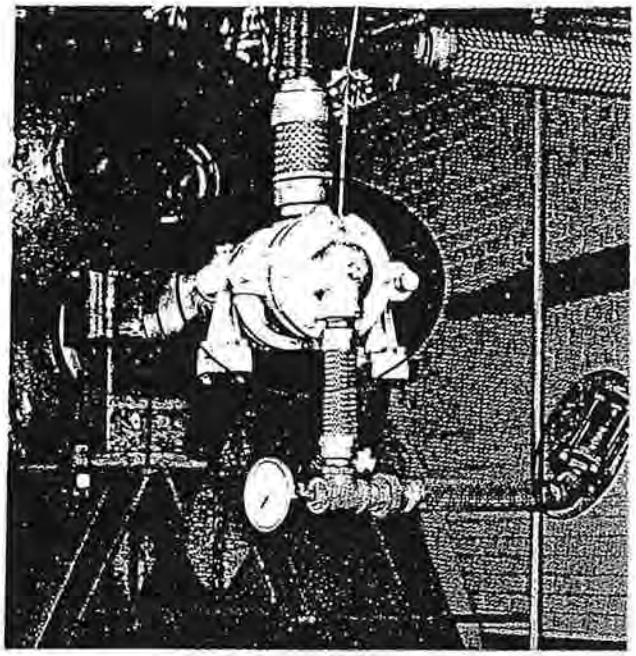

Fig. 10-8. Rotary pressure joint on paper dryer.

Rotary Pressure Joints

10.17 Some types of industrial equipment have rolls, dryers, or cylinders that rotate at high speed. Yet they must also be connected to a fluid line. For example, paper is run over dryers that are heated with live steam. See Fig. 10-8. The drum is 5 feet in diameter, about 20 feet long, and can handle a paper sheet running at speeds up to 4000 feet per minute. Using a rotary pressure joint, the dryer can be supplied with steam and the condensate removed.

10.18 Figure 10-9 is a cross-section drawing of one of these joints. Steam enters the joint at the top left and passes through the outer of two tubes into the drum. Condensate is picked up by the siphon elbow inside the drum.

10.19 The rotating member of the joint is the nipple (1) that is attached to the roll or drum and turns with it. The nipple has a convex collar that rotates against the matching concave surface (2) of a carbon-graphite seal ring. The spring (3) seats the nipple on the seal ring at the start of operations. During operation, the pressure of the steam produces the seal. The mating surfaces of the nipple and collar become smooth with operation. The steam or condensate is the only lubrication required for the carbon-graphite parts.

10.20 Rotary pressure joints of this kind are used in paper, textile, plastics, rubber, chemical, food, and many other industries that admit heating or cooling agents to rolls, dryers, or cylinders. These joints handle steam, water, brine, hot heat-transfer oils, and other fluids up to 343°C (650°F).

10.21 Swivel joints, ball-and-swivel joints, and ball joints are other types, more or less related, which allow the pipe to move and retain a tight seal.

10.22 In a steam application it may be useful to know what the flow of condensate from the drum or cylinder is at all times. One way of doing this is by inserting a SIGHT-FLOW INDICATOR in the line. See Fig. 10-10. As shown, it includes a short length of pyrex glass tubing mounted in a cast iron body and kept there by retainers and seals. The

Fig. 10-9. Rotary pressure joint construction.

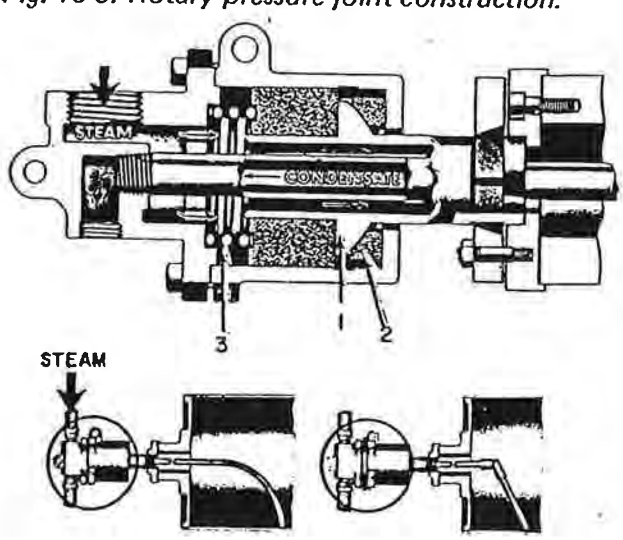

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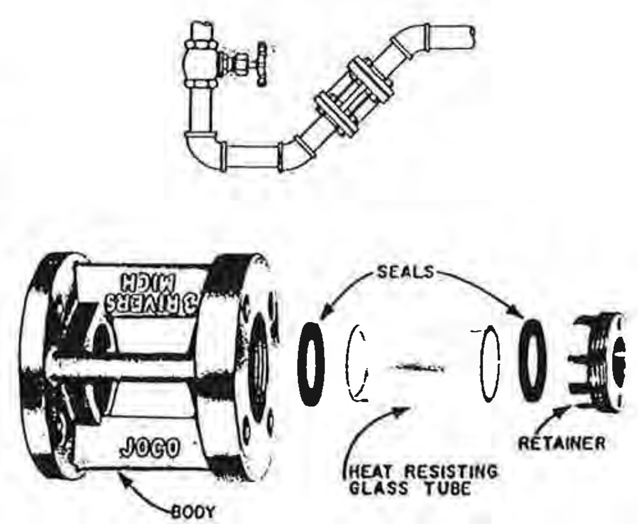
Fig. 10-10. Sight-flow indicator.



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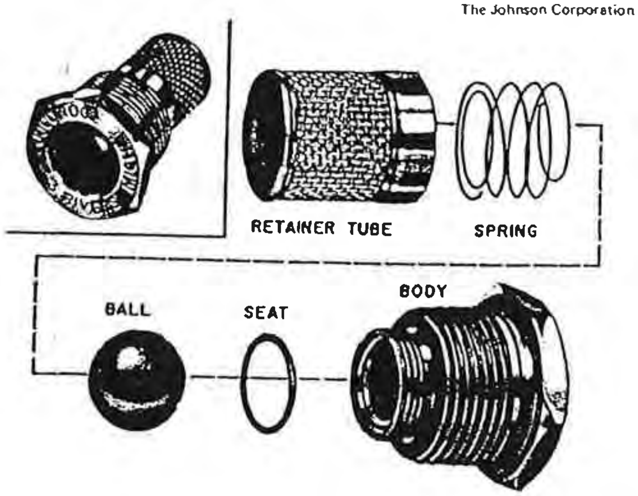

Fig. 10-11. Vacuum breaker.

flow in the condensate line is readily visible. Similar indicators are used in a variety of piping systems that include lubricating, chemical, and food processes.

10.23 Look at Fig. 10-8 again and you will see a sight-flow indicator at the right (in the condensate pipe line). Note that the rotary-pressure joint is connected to short pieces of all-metal hose. And note the temperature gage in the condensate line.

Vacuum Breakers

10.24 Another accessory found in pipelines is a VACUUM BREAKER as shown in Fig. 10-11. The function of a vacuum breaker is to admit air into the line whenever a vacuum develops. Vacuum is the absence of air. Vacuum in a pipeline can be serious because it can cause fluids to run in the wrong direction, possibly mixing contaminants with purer solutions; or it can cause the collapse of tubes or equipment.

10.25 The vacuum breaker uses a ball held against a seat by a spring. The ball is contained in a retainer tube mounted inside the piping system or component being protected. If a vacuum develops, the ball is sucked down into the retainer tube, working against the spring. Air flows into the system to fill the vacuum. The spring then returns the ball to its usual position, again sealing the system.

10-1.	Excessive pressure is potentially dangerous to ________ and piping system components.
10-2.	The reading on a pressure gage is called ______ pressure.
10-3.	Absolute pressure is equal to ______ pressure plus __________ pressure.
10-4.	Fluid pressure pushes __________ (equally/unequally) in all directions.
10-5.	Fluid pressure operates ________ all surface areas.
10-6.	The value that represents the amount a material expands with heat is called the __________ of __________.
10-7.	The presence of air is (atmospheric) pressure. The absence of air is a ________.
10-8.	The purpose of a vacuum breaker is to admit _____ into the system.

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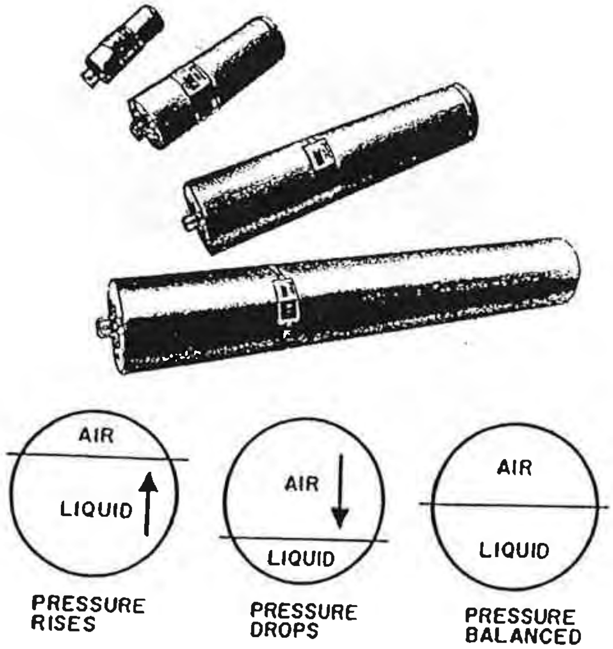


Fig. 10-12. Accumulators.

Accumulators

10.26 ACCUMULATORS in hydraulic systems are components that help keep pressure in the line smoothed out. They store and deliver energy as needed. If pressure in the line rises suddenly, the accumulator absorbs the rise, preventing shocks to the piping. If pressure in the line drops, the accumulator acts to bring it up to normal.

10.27 As shown in Fig. 10-12, an accumulator is a dome-shaped or cylindrical chamber or tank attached to a hydraulic line. Fluid rises inside the accumulator, compressing the air in it, until the pressure of the air and of the hydraulic fluid is balanced. If line pressure drops, the compressed air in the accumulator expands to push fluid into the line, thus restoring pressure. If line pressure rises, fluid flows into the accumulator, compressing the air again and relieving the strain on the system. Accumulators only supply fluid during peaks.

Receivers

10.28 AIR RECEIVERS are very much like accumulators. That is, they cushion shocks from sudden pressure rises in an air line. In an air receiver, there is no liquid. The air compresses as pressure rises. As pressure drops, the air expands to maintain pressure in the line.

10.29 Both accumulators and receivers help maintain line pressure if a leak develops or when there is a pump or power failure. The stored pressure can take over for a short time, long enough to maintain the pressure needed to shut down a machine or other piece of equipment.

10.30 Both units serve as shock absorbers for the system, acting to cushion the shock of valve closure and load starts, stops, and reversals.

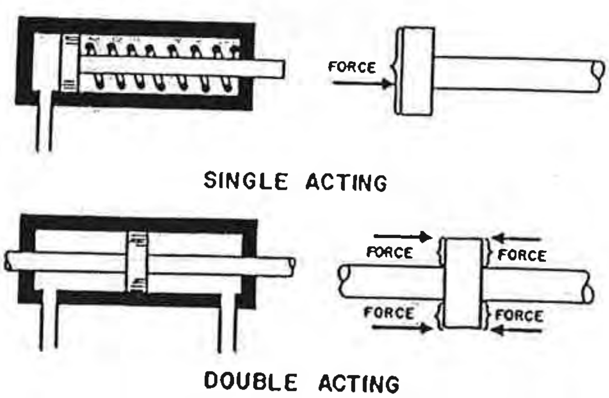
Actuators and Intensifiers

10.31 Another important accessory found in both air and liquid fluid-power systems is the ACTUATOR, a device that reacts to pressure to perform useful work of some kind. LINEAR ACTUATORS, which have straight line motion, are cylinders equipped with pistons and rods. The cylinders may be SINGLE- or DOUBLE-acting (see Fig. 10-13). In a single-acting cylinder, pressure in the line moves the piston in one direction. When the pressure is removed, the spring returns the piston to the starting point.

10.32 In a double-acting cylinder, pressure can be applied to either end, moving the piston in either direction. Figure 10-14 shows a cutaway view of an actuator.

10.33 These actuators are either hydraulically or pneumatically powered. Actuators powered by electric motors are also available. Instead of a piston rod moved by compressed air or hydraulic power, electric actuators use a motor and a screw-driven shaft as shown in Fig. 10-15.

Fig. 10-13. Single- and double-acting linear actuators.



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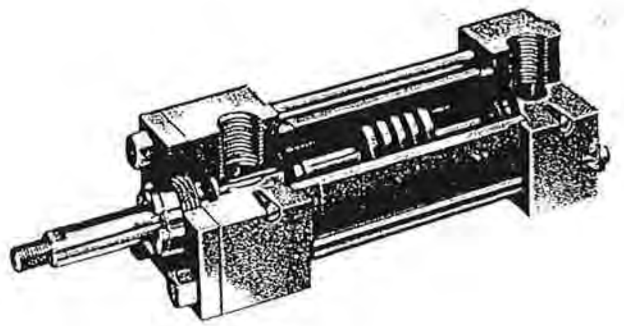
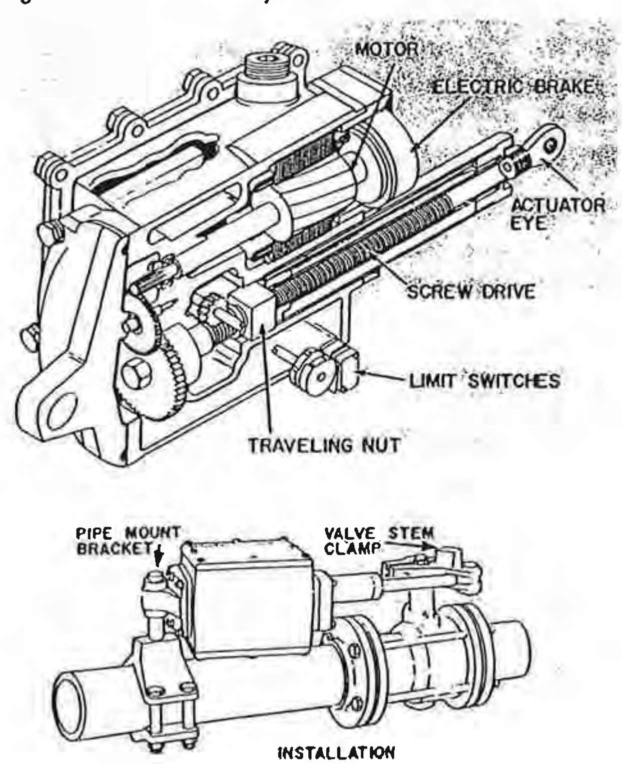


Fig. 10-14. Cutaway view of actuator.

10.34 Included in Fig. 10-15 is a view of an actuator mounted on a piping section, and connected to the stem of a large valve. The actuator in this case is electric, but a hydraulically powered model could also have been used. In either case, the actuator shaft or rod moves in and out to open and close the valve, as required, by remote control. Note the types of brackets used to mount the actuator on the pipe, and the valve-shank drive lever used to connect the actuator to the valve stem.

10.35 An INTENSIFIER, Fig. 10-16(A), is a pair of cylinders that produce a supply of high-pressure fluid at an output pressure HIGHER than the input pressure. For example, if an input pressure of 20 psi

Fig. 10-15. Electrically driven actuator.



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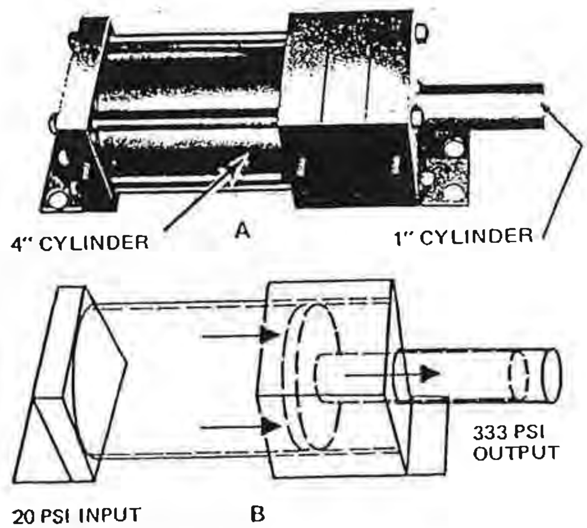


Fig. 10-16. Intensifier.

acts on the 4-inch piston in Fig. 10-16(B), the total input force is 20 lbs/sq.in. x 12.5 sq.in. (the area of the piston) or 250 pounds. The area of the 1-inch piston connected to the large one is roughly 3/4 sq.in. 250 lbs ÷ 3/4 sq.in. = 333 lbs/sq.in., the pressure available at the small piston.

10.36 The intensifier can therefore convert an input *pressure* of 20 psi to an output *pressure* of 333 psi. However, the total input *force* equals the total output *force*, ignoring friction. The pressure is concentrated on a very small area, so the output is intensified accordingly.

Pneumatic Pressure Line Accessories

10.37 In pneumatic pressure lines a frequent combination of accessories consists of a FILTER, REGULATOR, and LUBRICATOR. These items are shown in Fig. 10-17. The filter is on the left. A cross-sectional view of it is shown in Fig. 10-18. Air enters at top right and passes down past the whirlaway baffle producing a high-speed circular air pattern. This miniature tornado throws any liquids or solids in the air against the side of the bowl. There they drain and fall down into the bottom of the filter. This area, called a "quiet zone," is protected by the baffle plate. The air then passes through the cylindrical, porous metal filter element in the center of the filter, and out the top, back into the line. Such filters may have either a transparent or metal bowl.

Dyna-Quip

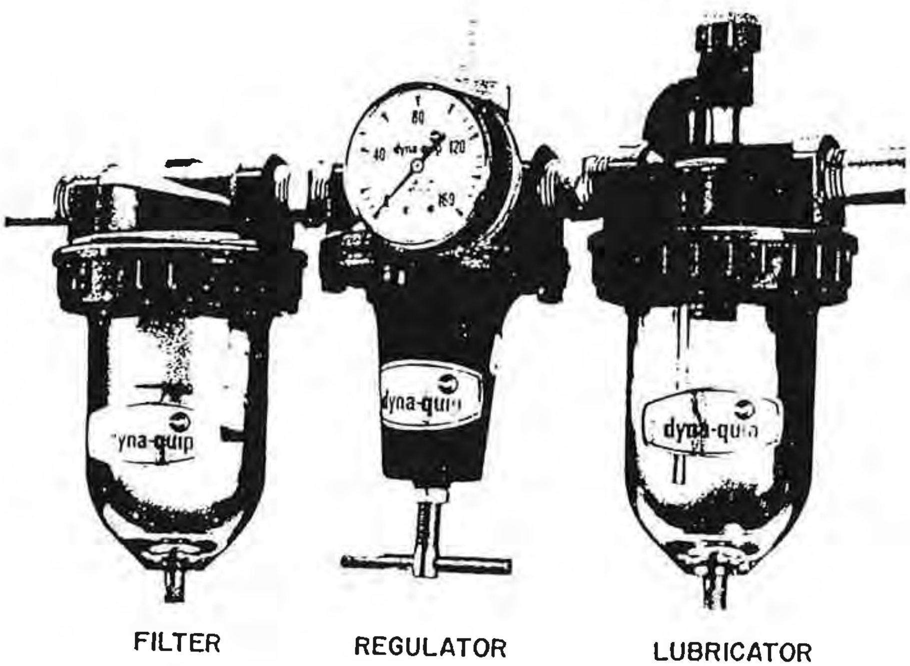
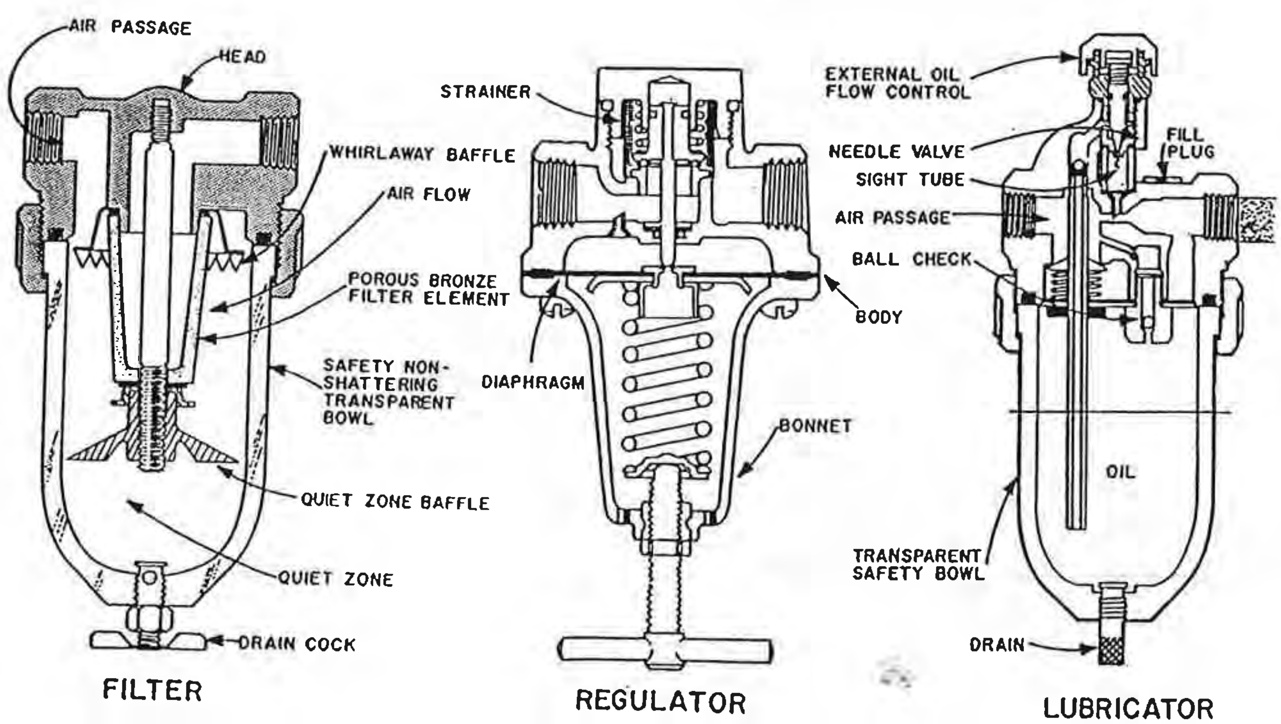


Fig. 10-17. Pneumatic-line accessories.

10.38 The center accessory in Fig. 10-17 is a regulator. When adjusted for a desired pressure, the regulator automatically maintains that pressure. It does so by means of a spring-loaded valve that responds to pressure changes, closing when the pressure rises and opening when pressure falls (see Fig. 10-18).

10.39 Outlet pressure raises the diaphragm against the spring pressure, causing the disc to move toward the valve seat. This has a throttling effect, which decreases fluid flow. When the outlet pressure drops, the diaphragm drops too. The spring pressure pushes the disc off the seat, thus increasing fluid flow.

Fig. 10-18. Cross-section views of filter, regulator, lubricator.



Dyna-Quip

10.40 The right-hand component in Fig. 10-17 is an AIR-LINE LUBRICATOR. Normally, both oil and water are contaminants in an air line and are filtered out. In some air lines, even though water is undesirable, oil is added to the air to provide lubrication for various tools, cylinders, and other components supplied by the line.

10.41 Figure 10-18 shows a cross-section view of the lubricator. Oil is introduced into the airstream by the siphoning or drawing action caused by the difference in pressure between the outlet and intake sides. The amount drawn into the airstream depends on the airflow demands made by tools along the system. It may be a few drops of oil per hour or only a few drops per day.

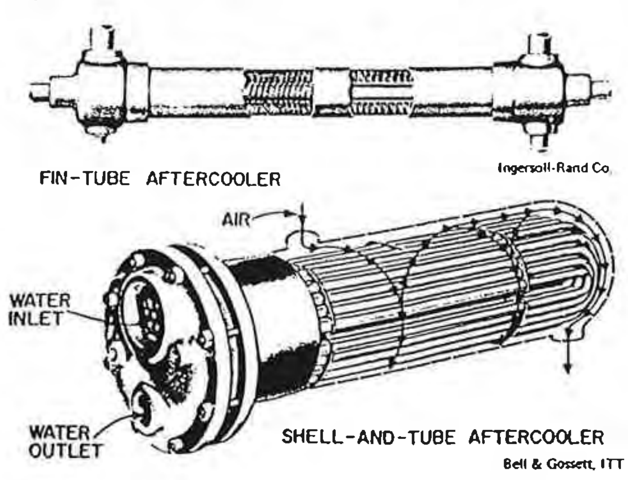
10.42 Oil drops mix with the air leaving the lubricator and move along the system to the tools being used. The amount of oil mixed with the air increases as the airflow does because oil flow is regulated by the needle valve. Even if various tools along the line are used only at intervals, all will receive the proper amount of lubrication.

10.43 It may seem odd that after the compressed air has been run through the filter to remove oil, water, and dirt, it is now desirable to add oil to the airstream. The reason is: Materials removed from the air by the filter include dirty oil and sludge that may have entered the airstream by way of the compressor. Such material has to be removed from the airstream and clean lubricating oil added.

Heat Exchangers

10.44 HEAT EXCHANGERS are devices for adding or removing heat and cold from a fluid (liquid or gas). They operate on the principle that heat flows from a warmer body to a colder one. The purpose may be to cool one body, or to warm the other. Whether you are warming or cooling, the principle remains the same. The design of the heat exchanger varies but it usually consists of one tube, or possibly a large coil of tubing, placed inside a larger cylinder. In the oil lubrication system described in Lesson Nine, the purpose was to cool the hot oil. Now the aim might be to heat up a processing fluid circulating through one part of the heat exchanger with steam circulating through its other section.

Fig. 10-19. Water-cooled aftercoolers.



10.45 In a compressed-air system, the air coming from the compressor is hot. To cool it down, compressed-air systems include water-cooled aftercoolers. The type shown in Fig. 10-19 has a double tube. Hot compressed air passes through the outer tube. Cooling water passes in the opposite direction through the inner tube, which has circular discs or fins to improve its heat transfer performance. As the compressed air cools down, condensate may result. This water, plus any oil that may have entered the airstream at the compressor, drains off into a condensate drainpipe at the bottom of the tube.

10.46 A different type of aftercooler (shown in Fig. 10-19) is the SHELL and TUBE unit, which is installed between the compressor and the air receiver or storage tank. Hot compressed air enters the shell and flows over and around the tube-coil assembly, which is filled with cold water. The water flows through the tubes continuously to maintain a constant cooling action. Condensate, formed when the air is cooled, is drained off so that only cool, dry air flows through the air line.

Wrenches

10.47 Figure 10-20 shows several kinds of wrenches that are used in working on piping and piping system components. Select the right type and size for each application. It is possible to do serious damage to a valve or fitting if the wrong wrench is used or the right wrench is used improperly.

10.48 A monkey wrench has smooth-faced jaws, which make it the best wrench for hex nuts on valves and fittings. A strap wrench is used on plated or polished surfaces. The strap itself is made

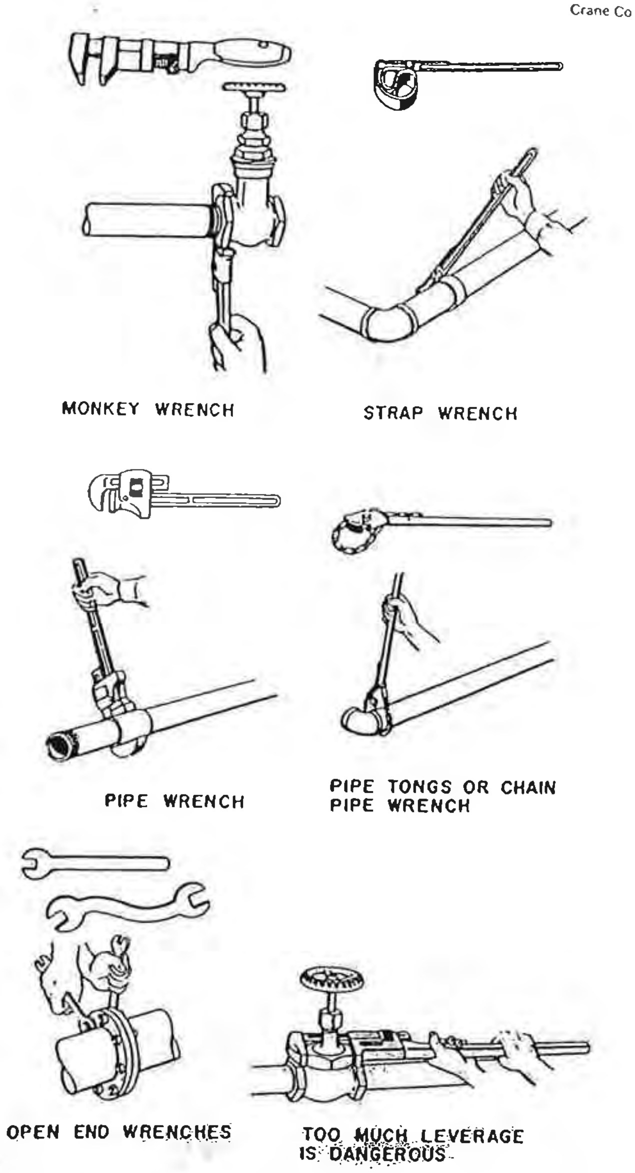


Fig. 10-20. Types of pipe wrenches.

of webbing and will not scratch. To use the wrench, open the strap, fit it around the pipe and refasten it. As you turn the wrench handle, the pressure tightens the strap and it catches hold. A pipe or Stillson wrench is used only on pipe. Its jaw faces have teeth (serrations) that provide a good grip. Pressure on the handle increases the grip.

10.49 Pipe tongs or chain pipe wrenches are used for pipe 3 inches in diameter or larger, and they are made in smaller sizes as well. Chain pipe wrenches operate on the same principle as strap wrenches. Open end or socket wrenches are used for tightening flange bolts. It is important to use the right size because wrench slippage can wear nut and bolt heads round and cause bruised knuckles.

10.50 Avoid the use of an oversize wrench if you are tempted to lean on the joint. Excess pullup can cause damage, especially to a valve.

Maintenance

10.51 Always keep in mind that there are two types of maintenance: PREVENTIVE MAINTENANCE and REPAIR MAINTENANCE.

10.52 Preventive maintenance, which is done at regularly scheduled intervals, is a matter of finding and correcting minor defects *before* they cause trouble. For example, you may find that some pipe hangers have become loose since your last inspection. If the hangers aren't tightened up against the pipe, it may sag or shift, causing enough strain on the joints to result in leakage. You may find that flange bolts have loosened. It is much simpler and more economical of time and work to tighten them now before something does go wrong.

10.53 Repair maintenance means correcting conditions that are already causing trouble. A leak in the bend of a pipe or tubing may require patching, or it may mean that a section of the line must be replaced. A joint may be leaky, a valve damaged, or a gage broken. All need immediate attention.

10.54 Some conditions occur naturally, because all components wear in time. Other troubles can be prevented by catching them early enough to make minor repairs out of potential major ones. Whenever there's a problem, you will find it useful and interesting to ask yourself, "How could this have been prevented?" Knowing the answer will save you much time and hard work.

Summary

Piping is one of the most interesting and important parts of any plant facility's operations. You will find it even more interesting as you learn more about the systems used in your own plant and gain experience.

One of the greatest rewards which any man can have is knowing what his work is about, knowing that it is important, and knowing that he is doing it well. As a maintenance craftsman whose work is maintaining piping systems, you are an important part of your plant's successful operation. You should experience considerable personal satisfaction as a result.

10-9.	Accumulators ________ and deliver energy as needed.
10-10.	If line pressure suddenly rises, the accumulator ________ the rise.
10-11.	Both accumulators and receivers help maintain line ________ if a leak develops.
10-12.	A device that reacts to pressure to perform useful work is called an ________.
10-13.	Heat flows from a ________ *(warmer/colder)* body to a ________ *(warmer/colder)* body.
10-14.	Name two units that make use of the temperature principle answered in the last question. ________ ________
10-15.	The appropriate wrench to use with 3 inch or larger pipe is called a ________ pipe wrench.
10-16.	Name the two types of maintenance to be applied to piping systems. ________ ________