Lesson Five – Hoses

Preface

Previous lessons described the uses and merits of pipes and tubing. This lesson describes hoses, which form a different tubular product classification. Their basic function is the same; and that is to carry liquids or gases from one point to another.

In this lesson, you will learn what industrial hoses are, how they are classified and constructed, and the ways in which sections of hose are connected to one another and to pipes or tubing. You will also learn about the maintenance requirements of hoses, and what to look for when checking them for trouble or routine maintenance.

Hoses

5.01 Basically, hoses do not differ in any way from pipe and tubing. All three are used to carry a variety of materials under a variety of circumstances. In their construction and in their advantages, however, hoses *are* different from pipes and tubing. The outstanding advantage of hose is its flexibility – its ability to bend to meet the requirements of numerous applications that cannot be met by rigid piping systems. Two familiar examples of this flexibility advantage are fire hose, and the hose used to supply compressed air to pneumatic hammers used on construction jobs. Clearly, rigid piping would be difficult to use and highly impractical in both situations.

5.02 In addition to its flexibility, hose also has a vibration-dampening effect. To use one of the same examples, a pneumatic hammer, or "jackhammer," vibrates to do its job. Tubing or piping couldn't stand up very long under such conditions because the rigid materials wouldn't withstand the vibration. Many types of equipment operate with a considerable amount of vibration. Other equipment, having hydraulically or pneumatically driven components, has moving members which require that the air or oil supply move with them. Again, rigid piping could not be used.

5.03 In general, hoses are subject to the same conditions that affect pipes and tubing. That is, hose must be selected according to the conditions of an application, and it must be protected, when necessary, against the effects of temperature, pressure, and corrosion. Hose applications range from the lightweight ventilating hose used to supply fresh air to electrical and telephone maintenance men working in tunnels, or other tight places, to the rugged suction hoses used in sand- and gravel-dredging operations. In plant facilities of all types, hoses are used to carry live steam, acids, corrosive chemicals and gases, and hydraulic fluids under thousands of pounds pressure. To meet such service, hoses are made from a number of different materials, as outlined later in this lesson.

Codes and Sizes

5.04 Standards groups have devised standards and codes for hoses just as they have for piping and tubing. Specifications include working pressures, sizes, and material requirements. As an example, the working pressure of a hose is ordinarily limited to 25% or one-fourth of the amount of pressure needed to burst the hose. In other words, a hose having a maximum rated working pressure of

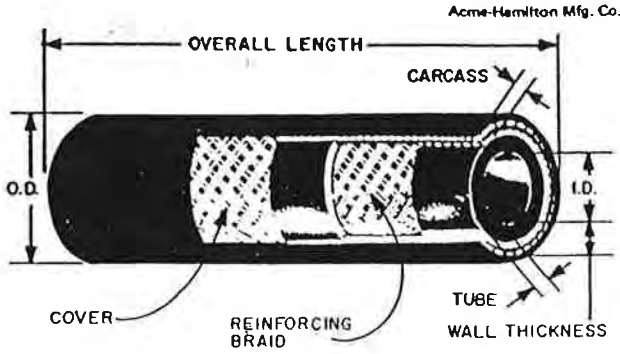


Fig. 5-1. Common hose terminology.

250 psi should not rupture until 1000 psi has been reached, and possibly not then. It is a safety measure to protect personnel and equipment.

5.05 Hose size is ordinarily rated by its I.D., and according to what is called the dash system, or dash-numbering system. Most manufacturers of hose and fittings use the dash system to identify both hose and fittings. To determine the size of a hose, just convert the size into 16ths. As an example, a 1/4-inch hose size becomes 4/16ths of an inch. The numerator (the top number) of the fraction is its dash size. A 1-1/4-inch size converts into 20/16ths, and so is identified as a −20 (dash 20). By using the dash numbering system a hose line can be matched to a tube or pipe with assurance that the I.D. of both will be the same. This makes certain that the smooth flow of fluid will not be interrupted. Hose sizes range from 3/16-inch to as much as 24 inches in diameter. Ordinarily, the dimension given refers to the I.D. of the hose.

Hose Classifications

5.06 Hose can be classified in several ways: by material, by type of service (hydraulic, acid-resistant), by pressure, and by type of construction. For convenience, however, you may consider hoses to be one of three types:

1. Nonmetallic.
2. Nonmetallic, reinforced.
3. Metallic.

In most cases, terminology is the same for each type with exceptions mentioned as they occur.

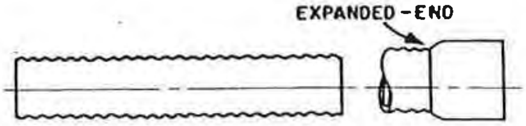


Fig. 5-2. Expanded-end hose.

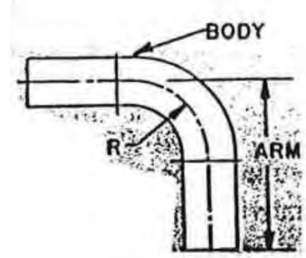
Hose Terminology

5.07 Figure 5-1 is a cutaway view of a rugged, high-pressure air hose for air drills and other pneumatic tools used in contracting, mining, and heavy industrial service. The hose is a reinforced nonmetallic type, which is the most common type in general use. Many of the terms given are already familiar to you. I.D., which is the hose size, refers to the inside diameter throughout the length of the hose body, unless the hose has enlarged ends. If the ends are enlarged, as if Figure 5-2, the letters E.E. are used (meaning either ENLARGED END or EXPANDED END). As in an automobile engine, some hoses have enlarged ends to tightly fit a fixed end of piping. The O.D. is the diameter of the outside wall of the hose.

5.08 The TUBE is the inner section or core of the hose, through which the fluid flows. REINFORCEMENT is the material put over the tube to provide resistance to pressure – either from the inside or outside. The hose in Fig. 5-1 has two layers of high-strength synthetic cord reinforcement called BRAID. In this case the hose is called MANDREL BRAIDED, because a mandrel (the spindle or core) is inserted into the tube before the reinforcing layers are put on. The mandrel provides a firm foundation over which the cords are tightly and evenly braided. The COVER of the hose is an outer, protective covering. The hose shown in Fig. 5-1 has a cover of tough, abrasion-resistant neoprene.

5.09 The OVERALL LENGTH is the true length of a straight piece of hose. Some hose, which is not

Fig. 5-3. Bend radius of hose.



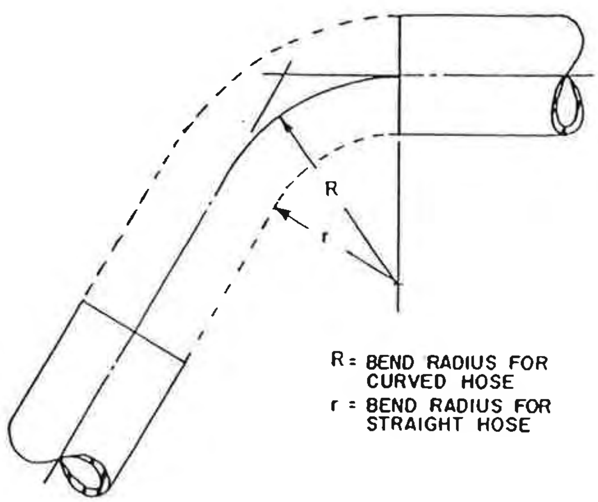


Fig. 5-4. Bend radius of curved and straight hose.

too flexible, is formed or molded in a curve. This hose is used in automobile heating systems, for example. The ARM is the section of a curved hose that extends from the end of the hose to the nearest centerline intersection, as shown in Fig. 5-3. The BODY is the middle section or sections of the curved hose. The BEND radius of curved hose is the radius of the bend measured to the centerline as shown in Fig. 5-4, and designated as the radius R. In a straight hose, bent on the job, the radius of the bend is measured to the surface of the hose (the radius r in Fig. 5-4).

5.10 Much of this terminology will not apply to unreinforced nonmetallic hose because such hose is not reinforced. This type of hose is less common in plant use, however.

5.11 One of the factors governing hose selection is the amount of pressure which it will be required to carry. In one of the classification methods used, pressure falls in any of three general groups: (1) low pressure, no more than 250 psi; (2) medium pressure, which ranges from 250 to 3000 psi; and, (3) high pressure, between 3000 and 6000 psi, and even beyond.

5.12 Within those ranges, some manufacturers make further distinction, such as "very high" and "super high." But a hose that is rated as "low pressure" won't automatically be useful at 200 psi. It is not as simple as that. It may, in fact, be built for pressures not to exceed 40 or 50 psi. When replacing sections of hose, you should use the same type and pressure-rating as used for the original hose. This precaution is especially important when you are working with hoses in high-pressure applications.

5.13 A related consideration is the VACUUM RATING of a hose. Vacuum rating refers to the amount of vacuum or suction that a hose can carry before it begins to collapse. A common example of this is an ordinary drinking straw, which, because it has a low vacuum rating, collapses quickly when too much suction is applied.

5.14 In some applications, both the working pressure and vacuum rating of the hose are important. A good example is the common automobile radiator hose, where the upper hose operates under pressure, but the lower hose operates under vacuum. Such applications are not otherwise common, however.

5.15 Temperature has a definite effect on hose operation. Although most low-pressure and medium-pressure hoses can safely handle temperatures of up to 121°C (250°F), low-pressure hose shouldn't be used for hot air above 71°C (160°F), or for hot oil above 82°C (180°F).

5.16 Usually these considerations are taken into account when the hose is selected originally. They should present no difficulties to you. Just be sure you use the right hose for the job.

5-1. The outstanding advantage of hose is its ____________.

5-2. An additional major advantage of hose is its __________ __________ effect.

5-3. The size of a hose is determined by its __________ __________.

5-4. Hose size is ordinarily expressed according to the ____________ system.

5-5. Name the three basic types of hose.

____

____

____

5-6. Applied to hose, the letters EE stand for __________ __________.

5-7. When replacing sections of hose, use the ____________ type and pressure rating as the original.

5-8. Low-pressure hose should not be used for oil which is hotter than ____________°F.

5.17 Hoses of one kind or another have been used for hundreds of years, but they were quite limited in what they could do. About 100 years ago, after new developments in the processing of rubber, hoses were made by building up layers of rubber around mandrels. The mandrel was later removed, leaving a flexible rubber hose. Hoses made in this way collapsed easily, but were a great improvement over the earlier types. Later, as a further improvement, manufacturers added layers of rubberized canvas. This gave hoses more strength, and gave them the ability to handle higher pressures. After the development of synthetic rubber, manufacturers had new, rugged, and more corrosion-resistant materials to work with. The synthetic rubbers used include neoprene, nitrile rubber, and butyl rubber.

5.18 But most hoses are not made from a single material. Different materials form layers in the hose, reinforcing it in various ways for strength and resistance to pressure. Hoses used today usually have a tube (made of some form of rubber) or a lining (such as plastic) surrounded by a carcass and cover, as you saw in Fig. 5-1. The carcass is usually braided. The type of braiding used is determined by the requirements of the application. Figure 5-5 shows the most common types of reinforced nonmetallic hose and the differences in their construction.

5.19 Two types of braiding are used to reinforce a hose, VERTICAL BRAIDING and HORIZONTAL BRAIDING. Vertical braiding strengthens the hose against pressure applied at right angles to the centerline of the hose. Horizontal braiding strengthens the hose along its length, giving it resistance to expansion and contraction. Descriptions of the two types follow, with references to their general applications.

5.20 VERTICAL BRAIDED. This hose has a seamless rubber tube. The reinforcing wrapping (carcass) around the tube is made of one or more layers of braided yarn. This type of hose is made in lengths of up to 100 feet with inside diameters up to 1½-inches. It is considered a small size hose and is used in low-pressure applications. Vertical braided hose is used to carry fuel oil, acetylene gas and oxygen used in welding, paint for spraying,

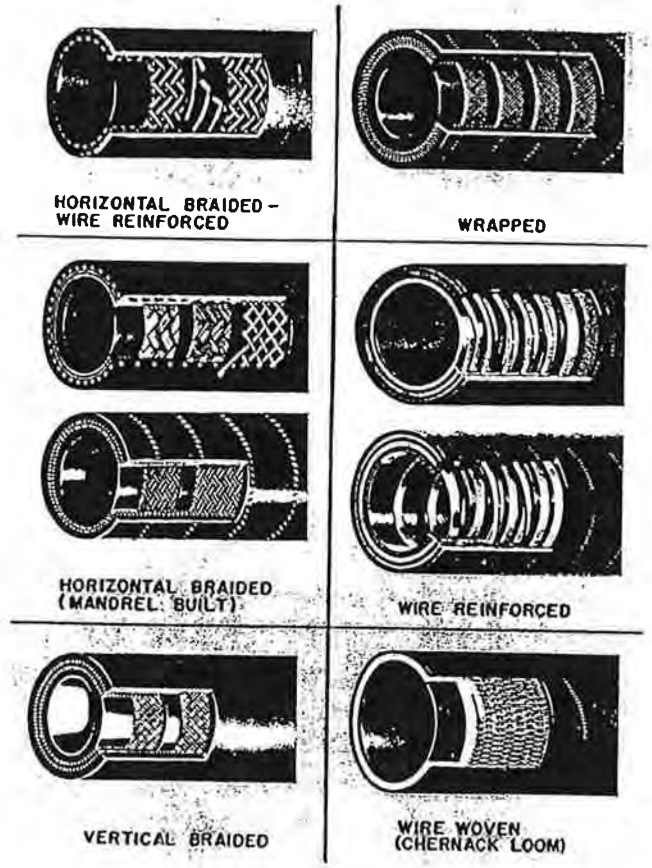


Fig. 5-5. Typical construction of reinforced nonmetallic hose.

and water for lawns, gardens, and other household uses.

5.21 HORIZONTAL BRAIDED (Mandrel-built). This construction is used to make hose up to 3 inches I.D. For higher working pressures, the seamless rubber tube is reinforced by one or more layers of braided fibers or wire. It is used to carry butane and propane gas, steam, and for various hydraulic applications requiring high working pressures.

5.22 HORIZONTAL BRAIDED-WIRE, REINFORCED. The carcasses around the seamless tube are made up of two or more layers of fiber braid with steel wire reinforcement between them. The inside diameter may be up to 4 inches. This hose is mechanically very strong, and it is used where there are both high working pressures and/or strong suction (vacuum) forces, such as chemical transfer and petroleum applications.

5.23 WRAPPED HOSE. Used primarily for pressure service rather than suction, it is made in diameters of up to 24 inches. The hose is built on mandrels, and to close tolerances. It also has a smooth bore, which encourages laminar flow and avoids turbulence. The reinforcement is several plies (layers) of woven cotton or synthetic fabric. The tube itself is made from a number of different synthetic rubbers, selected for their resistance to hard-to-handle or corrosive fluids. It is used in acid handling, and sandblast applications.

5.24 WIRE REINFORCED. In this type the reinforcement includes wires wound in a spiral around the tube, or inside the carcass, in addition to a number of layers of wrapped fabrics. Inside diameters of 16 to 24 inches are common. This type hose is used for materials-handling, or oil-suction and discharge situations that require special hose ends, maximum suction (without collapsing), or special flexing requirements (can be bent in a small radius without collapsing) – or all three of these requirements.

5.25 WIRE WOVEN. This hose has cords interwoven with wire running spirally around the tube, and is highly flexible, low in weight, and has good resistance to collapse even under suction conditions. This type is well suited for such suction applications.

Nonmetallic Hose

5.26 Hoses are also made of other materials, many of them nonmetallic, and nonreinforced. For example, plastics like teflon, polyethylene, nylon, dacron have been developed. Dacron remains flexible at very low temperatures, such as -212°C (350 degrees *below* zero F), nearly the temperature of liquid nitrogen. In fact, hoses made from dacron are used to carry liquefied gas in cryogenic applications.

5.27 Teflon® is used for applications that require the carrying of corrosive fluids and fluids at temperatures up to 232°C (450°F). Teflon® can also be used at temperatures as low as -55°C (-65°F). It is usually sheathed in a flexible, braided metal covering, which helps protect against abrasion and also provides added resistance to pressure.

5.28 Small-diameter nylon hoses are used as air hoses, supplying compressed air to small air-powered tools. The large plastic hoses used to ventilate street manholes are made of such materials as neoprene-coated cotton duck, neoprene-coated nylon fabric, and neoprene-coated glass fabric. The cotton duck variety is for light duty. The glass fabric type is used with portable heaters and for other applications involving hot fumes and air. Diameters range up to 24 inches.

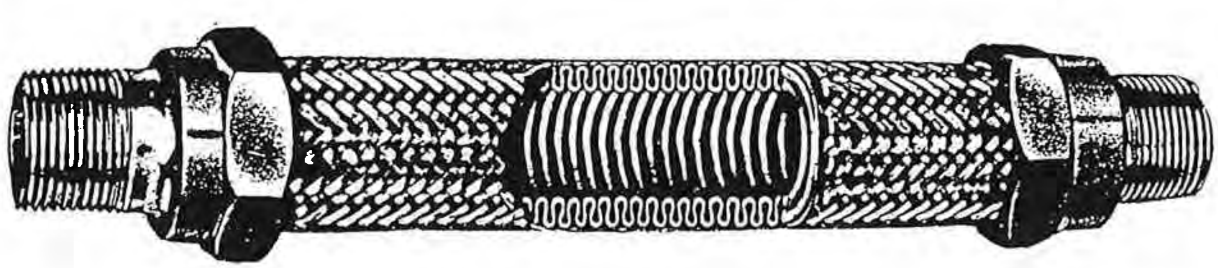
5.29 Hoses made from pure gum, natural latex, and silicone rubber are also available. The pure gum hose will safely carry acids, chemicals, and gases. Small hoses of natural latex, which can be safely sterilized, are used in hospitals, with pharmaceuticals, blood, and intravenous solutions; and in food-handling operations and laboratories. Silicone rubber hose is used in extreme-temperature and chemical-reaction situations. It is also used as jet starter hose for gas turbine aircraft starters, to which it provides compressed air in large volumes. This type of hose works successfully over a temperature range from -57°C (-70°F) to 232°C (450°F).

Metallic Hoses

5.30 Figure 5-6 shows the construction of a bronze-braided, flexible all-metal hose, which has a tube of corrugated bronze. The tube is covered with the woven bronze braid for protection against abrasion, and to provide increased resistance to pressure. Made in diameters up to 3 inches and in lengths of 24 inches, metal hose is also available in steel, aluminum, monel, stainless steel, and other corrosion-resistant metals.

Teflon is a tradename of E. I. duPont de Nemours & Co., Inc.

Fig. 5-6. Construction of all-metal hose.



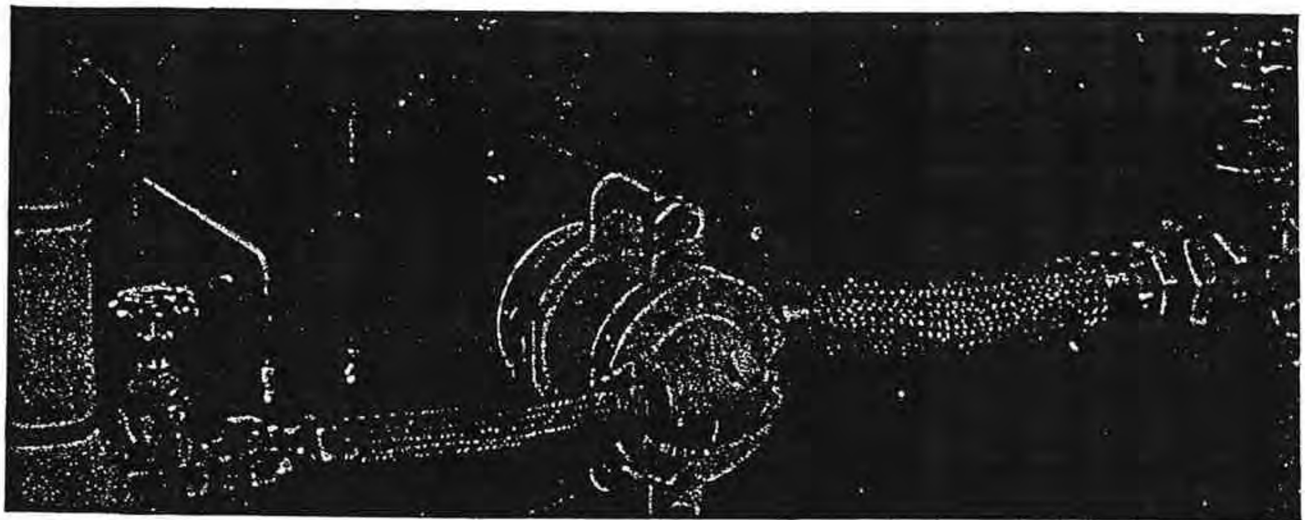


Fig. 5-7. Typical metal hose installation. Johnson Corporation

5.31 Another advantage of flexible metal hose is its ability to damp vibration, as, for example, where a pump is permanently mounted on a piece of equipment subjected to a high rate of vibration. It can be carrying a high-temperature, high-pressure corrosive fluid. The flexible hose runs from the pump to a fixed line of pipe and damps the vibration. The situation of constant bending at high temperature and pressure is excessively rough on most other types of hose. As another example, Fig. 5-7 shows a pair of these all-metal hoses used to carry water for cooling the rollers of heavy paper-mill machinery.

5.32 Other applications include use for saturated and superheated steam lines, gas and oil lines, lubricating lines, and exhaust hose for diesel engines. Basically, the corrugated type is used for high-temperature, high-pressure leakproof service. Another type of construction is the interlocked flexible metal hose, used for low-pressure applications. Examples include the flexible spouts on oil cans, wiring conduit, and oil lines. Other metal hose, having a liner of flexible, corrosion-resistant material, is available in diameters up to 24 inches.

5.33 Duct-type hoses are made of aluminum, galvanized steel, and stainless steel. These are used to vent corrosive fumes, also gases at extreme temperatures (hot or cold). Being metallic, these hoses resist weathering, dust, and they will not burn.

5-9. Hose is reinforced to provide strength and resistance to ____________.

5-10. Hose is reinforced by ____________ and ____________ braiding.

5-11. Horizontal braiding strengthens hose along its ____________.

5-12. Wrapped hose is used primarily for ____________ service rather than ____________ service.

5-13. Name four plastics used for nonmetallic hose.

____________ ____________
____________ ____________

5-14. Dacron hose remains flexible at extremely ____________ temperatures.

5-15. Name five metals used for making metallic hose.

____
____________ ____________
____________ ____________

5-16. Corrugated metal hose is used for service at high temperatures and ____________ pressures.

Hose Couplings

5.34 Just as hoses and the conditions under which they operate vary, so do the methods of joining hoses. Hose couplings are either permanent or reusable. They can also be made to connect or disconnect quickly, an advantage and requirement in many applications.

5.35 The fire hose is a good example of the need for a quick connect-disconnect coupling to permit rapid connections between separate lengths of hose, and between a hose end and a hydrant or nozzle. In compressed air systems, a single line may have a number of different uses. Changes involve disconnecting one section and connecting another. In filling stations, for example, compressed air from a single source is used to power tire-mounting machines, pneumatic wrenches, spark plug cleaning units, paint sprayers, and so on. Each unit has a hose that is equipped for rapid connecting or disconnecting at the fixed air line. Industrial applications have similar variety.

Anchor Coupling Co., Inc

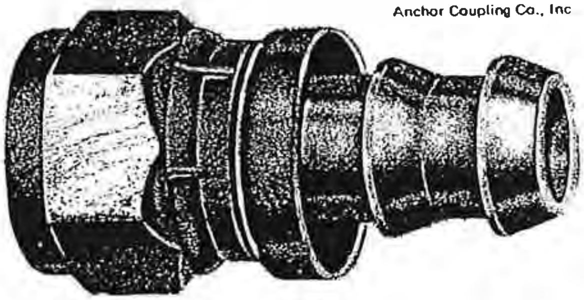
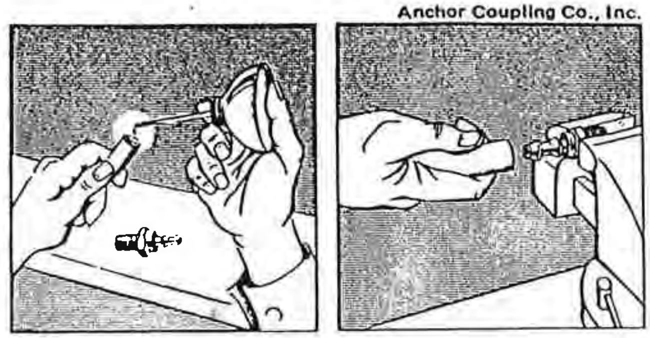


Fig. 5-8. Common low-pressure hose coupling.

5.36 For general low-pressure service, a coupling like that shown in Fig. 5-8 is used. Figure 5-9 shows how the coupling is placed on the hose by hand. No brazing is involved, and the coupling can be used over and over again. Where the pressure demands are greater, such a coupling can be blown out of the tube. Hose couplings designed to meet those conditions are used. After the coupling has been inserted in the hose, a yoke is placed over it in such a way that its arms are positioned along opposite sides of the hose behind the fitting. The arms are then tightly strapped or banded. Unless something breaks, the fitting remains securely inside the hose.

5.37 A variation of this type, shown in Fig. 5-10, uses a clamp that is put over the inner end of the fitting and is then tightly bolted, thus

Anchor Coupling Co., Inc.



Cut hose to proper length, then oil inside of hose and outside of coupling stem.

Force hose over stem into protective cap until it seats against bottom of cap.

Fig. 5-9. Installing a push-on coupling.

Anchor Coupling Co., Inc.

Fig. 5-10. Clamp-type coupling installation

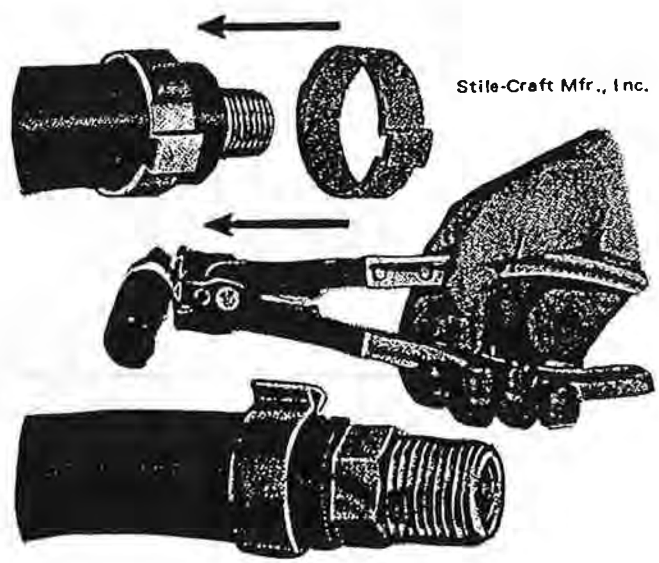
holding the hose firmly. In other cases, a plain clamp is used as shown in Fig. 5-11. Each size clamp is designed for a hose of specified diameter. It slides snugly over the hose, and is then crimped tight by means of a special hand- or air-tool.

5.38 Couplings for all-metal hose, described above, involve two brazing operations as shown in Fig. 5-12.

5.39 For large hoses of rugged wall construction, it is not possible to insert push-on fittings by hand. Special bench tools are required.

Fig. 5-11. Installing a clamping ring.

Stile-Craft Mfr., Inc.

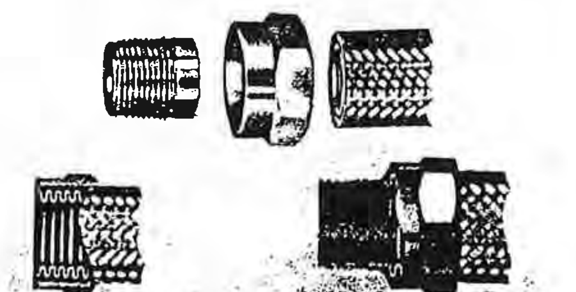


5.40 Quick-connect, quick-disconnect hose couplings provide flexibility in many industrial process lines where a number of different fluids or dry materials from a single source are to be either blended or routed to different bins, vats, or other containers. The two parts of a quick-connect coupling are shown in Fig. 5-13. One is mounted in a hose, and the other is mounted in a fixed pipeline. The upper fitting (A) has a circular recessed section at the bottom. The element in the lower part (B) has two levers or cams. The lower element slips over the upper one. The cam levers are then pulled down and their inner ends engage the circular recess firmly.

5.41 A round gasket or washer (C), where the two faces of the fitting come together, forms a tight seal. The connection is complete when the two cam arms have engaged the groove. It is as quick and easy as snapping a lunch bucket shut. These fittings are connected to the hoses in various ways. The coupling itself has no threads or lugs to engage, and requires no tools. It is a quick connection, with pressure-tightness. It can be used for handling chemicals, gasoline, water, and dry products. Figure 5-14 shows an array of fixed pipes fitted for these quick-connect couplings. Hoses can be quickly hooked up to one or another of these outlets.

5.42 In some hose applications, especially those where acids are involved, metal flanges or fittings cannot be used because of the corrosive effect the acid would have on them. Instead, hoses that have flanged ends are used as shown in Fig. 5-15. The flange is a built-in part of the hose. Another approach is a flanged-end hose surrounded by a metal flange that does not come into contact with the fluid at all. See Fig. 5-16.

Fig. 5-12. Coupling installation for all-metal hose.



Top (left to right) threaded nipple, bronze sleeve, hose. Bottom (left to right) sleeve slipped over hose end and brazed to it; nipple brazed to sleeve.

Johnson Corporation

Dover Corporation

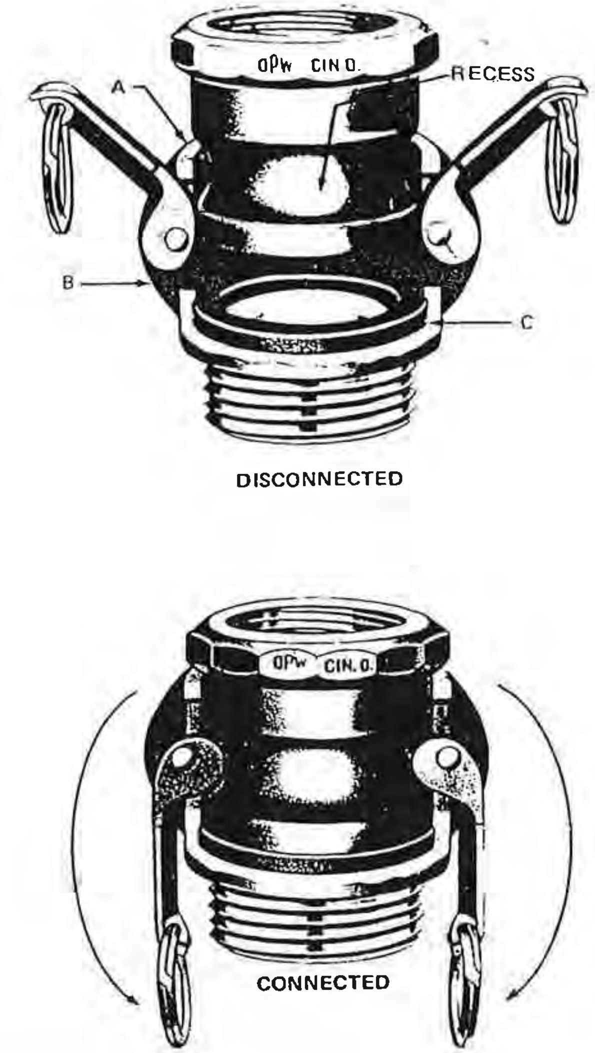
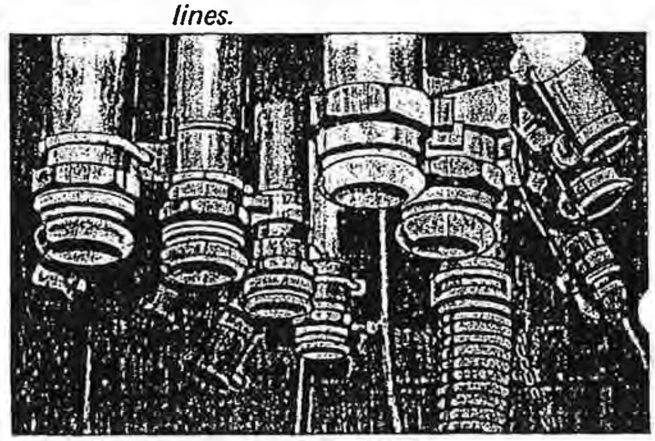


Fig. 5-13. Quick-connect, disconnect coupling.

Maintenance

5.43 All types of hoses require proper maintenance. Some require more frequent checking than others. The maintenance required for steam hose is typical, and is given here as an example.

Fig. 5-14. Quick-connect couplings in process lines.



Acme-Hamilton Mfg Co

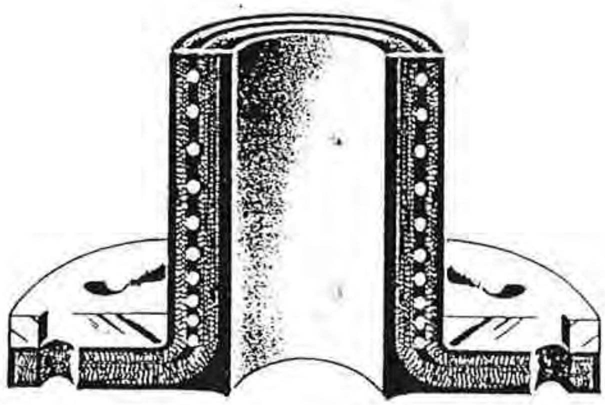


Fig. 5-15. Built-in rubber hose flange.

Acme-Hamilton Mfg Co.

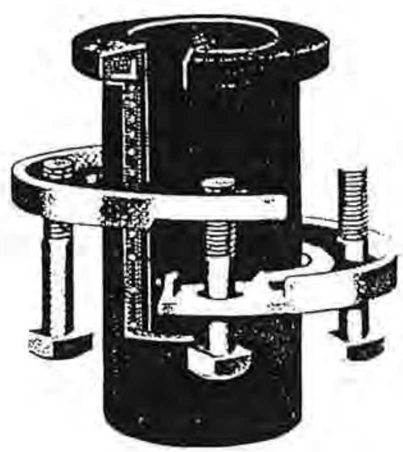


Fig. 5-16. Split-ring metal flange for hose.

5.44 To maintain steam hose (1) examine the line for cracks in the cover caused by heat, weather, oil, and physical abuse; (2) look for a restricted bore because of tube-swelling; (3) hunt for cover blisters, sometimes caused by tube failure, which permit steam pockets to form between carcass and cover; (4) watch for leaking steam, which is usually caused by improper couplings or faulty fastening of couplings. And check couplings carefully for corrosion damage.

5.45 Because any of the faults mentioned can result in a dangerous hose blowout or rupture, regular inspections are necessary. At the first sign of weakness or failure, remove the hose. If the failure is at one end, cut off at least 1 foot of the hose beyond the damaged area before recoupling. And reverse the ends of the hose. Where steam hose is used constantly, it should be uncoupled once a month and examined at the steam inlet end. Look for signs of brittleness, swelling, softening, or breaks in the cover. Pressure and temperature gauges should be checked frequently. The maximum rated temperature and operating pressure of the particular hose must never be exceeded.

Summary

Hoses are more widely used than might be supposed. You now know that they are furnished in many types for many applications. Among the many ways to classify hose is the one according to application as follows: Acid and chemical; air drill; multi-purpose; air; beverage, food and cleanup; hydraulic; materials-handling (dry cement, flour, sugar, syrup, edible grains, sand, gravel, feed, seed, concrete slurries); air- and vapor-duct; fish-handling; sand-suction and dredge; spray; steam; water-suction; water-discharge; welding.

Quite a variety of materials are transported through hoses, which perform a variety of services in doing so.

5-17. Hose couplings are either __________ or __________.

5-18. Hose couplings are commonly made to __________ or __________ quickly.

5-19. Each size of hose clamp is designed for a hose of a __________ diameter.

5-20. Couplings attached to metal hoses are __________ in place.

5-21. A quick-connect, quick-disconnect hose coupling has __________ basic parts.

5-22. Where couplings might corrode, hoses having __________ ends are used.

5-23. At the first sign of weakness or failure, a hose section should be __________.

5-24. A hose should not be used if its maximum __________ and __________ ratings will be exceeded.