Lesson Seven — Common Valves

Preface

Any industrial plant facility will have many valves which require attention. As a matter of routine, a maintenance craftsman must locate different valves, to inspect them, to make adjustments, and to repair or replace them. For that reason you should be familiar with all valves, but especially those that are vital parts of a piping system.

This lesson describes the more common valves with which you will work. You will learn what they are, how they work, what they're made of, and their major maintenance requirements.

Valves

7.01 VALVES are devices that permit control of the FLOW of fluids through piping systems. The fluid may be a liquid, a gas, or some loose material in bulk (like a concrete slurry, thick wastes, or even grains of wheat). Designs of valves vary, but all valves have two features in common: (1) a passageway through which fluid can flow; and (2) some kind of movable part that opens and closes the passageway.

7.02 Figure 7-1 represents the basic construction of a common valve type, and shows the principle of valve operation. Fluid flows into the valve through the inlet PORT. Port is the term for the openings of a valve to the outside. The fluid flows through passages in the body and past the opened element that closes the valve. It then flows out of the valve through the outlet or discharge port.

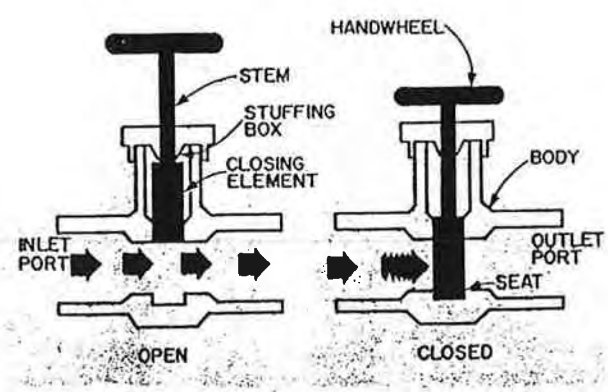
7.03 If the closing element is in the closed position, the passageway is blocked. Fluid flow is stopped at that point. The closing element keeps the flow blocked until the valve is opened again. This is done by raising the closing element, which is controlled by some means. Some valves are opened and closed automatically, and others are controlled by manually operated handwheels, like the one shown. Other valves, such as the check valves you will learn about later in this lesson, operate from pressure or the direction of flow.

7.04 The closing element of the valve in Fig. 7-1 is controlled by a handwheel mounted on the valve stem. To prevent leakage, a seal is used at that point. The seal is, in this case, a STUFFING BOX filled with packing. To keep the valve tightly closed, the closing element fits against SEATS in the valve body.

Valve Construction

7.05 In view of what you have already learned about piping and fittings, it will come as no surprise to you to learn that valves are made from many different materials. Although valves are interesting and important, they are only parts of a complete system. As such, they are designed, selected, and built to fit the requirements and

Fig. 7-1. How a valve operates.



conditions of the particular system. This means that they are subject to the same effects of corrosive materials, pressure, and temperature as piping.

7.06 Valves are made from bronze, cast iron, steel, monel, stainless steel, and other metals. They are also made from plastic and glass. Valves are made for service at the same pressures and temperatures that piping is subject to. They are also covered by codes and standards as are the other components of piping systems about which you have learned.

Valve Sizes

7.07 Valves are made in a full range of sizes, which match pipe and tubing sizes. For example, a 3 inch valve would be selected for use in a 3 inch piping section. As a rule of thumb, remember that a valve smaller than the pipe should never be used. That is, a 2 inch valve would not be put into a 3 inch pipeline. The effect would be to reduce fluid flow, and increase friction. It would be possible to use a larger valve, but ordinarily there is no reason for doing so.

Valve Functions

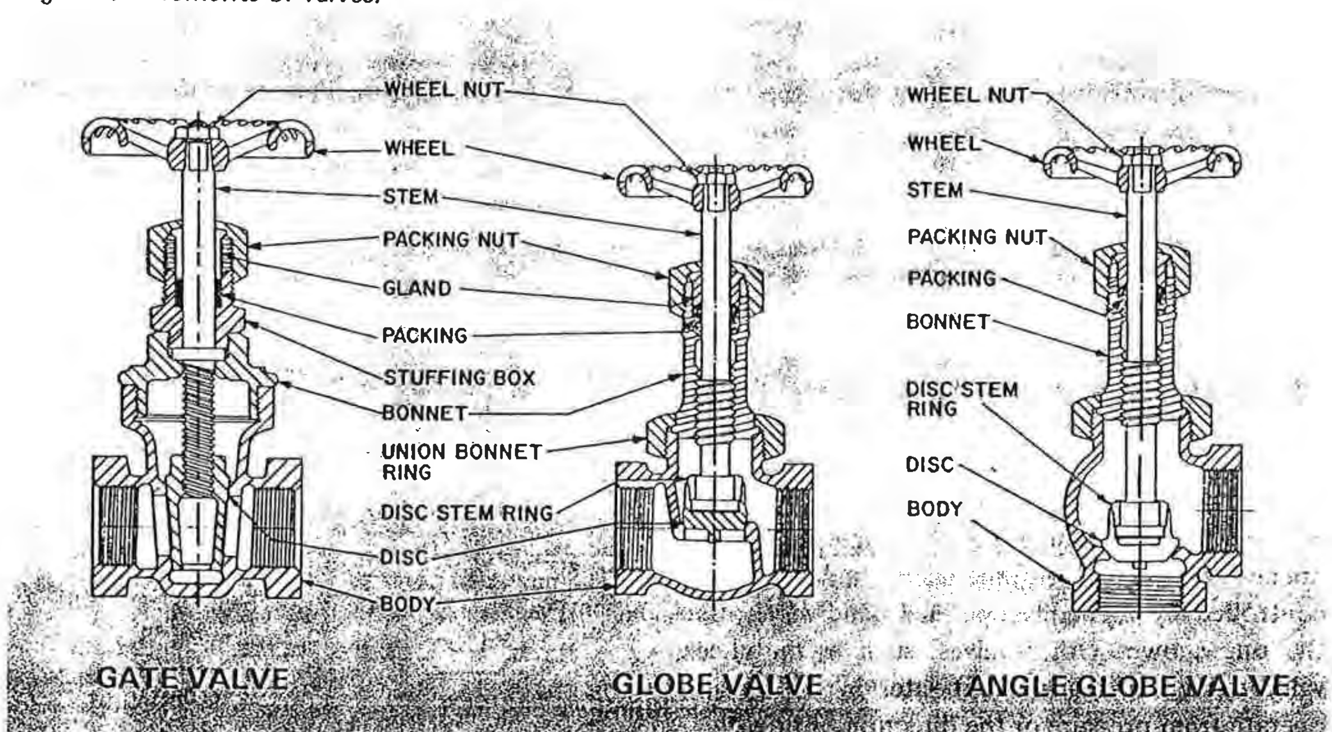
7.08 Valves control the flow of fluids in one of three ways: start or stop; throttle; and regulate. Starting and stopping flow means what it seems to. THROTTLING means controlling flow, by reducing it as desired. In REGULATING, the valve operates automatically according to changes in pressure in the line. A regulating valve opens or closes as necessary to increase or decrease flow, and so keeps the pressure constant.

7.09 A number of valves are familiar to almost everyone. A good example is the ordinary kitchen faucet, which serves two of the three functions mentioned. As it turns the water on and off, it starts and stops the flow. By adjusting the flow, as desired, it acts as a throttle.

Types of Industrial Valves

7.10 The types of common industrial valves covered in this lesson include the following: BALL, GLOBE, GATE, BUTTERFLY, PLUG, NEEDLE, CHECK, and QUICK-OPENING. Each of these is designed to perform one or more of the functions mentioned earlier, except for regulating. All except the quick-opening valve take their names from the type of internal element that controls the passageway. This fact makes it easier to get acquainted with them. A CHECK valve, as we shall see, permits the fluid to flow in ONE DIRECTION only, CHECKING the fluid if it tries

Fig. 7-2. Elements of valves.



Crane Co

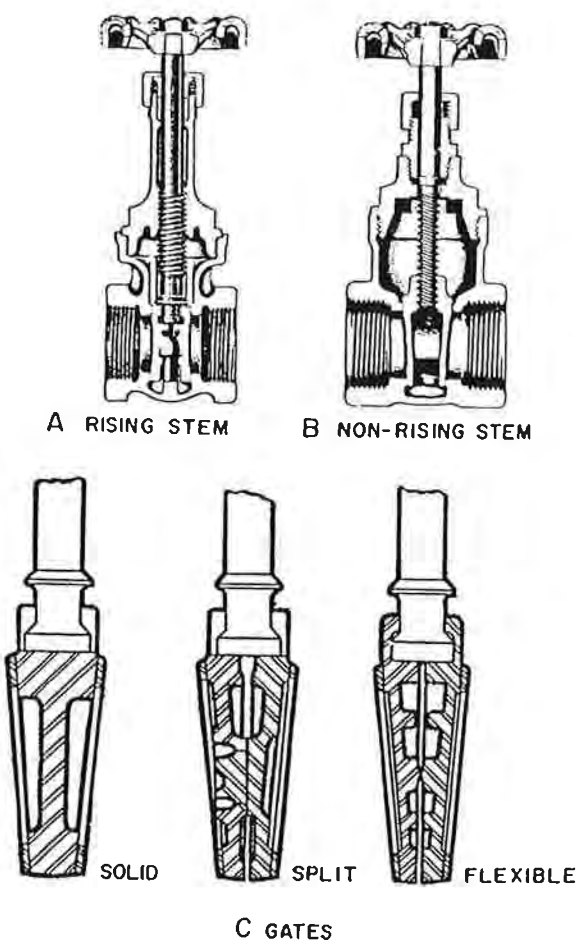


Fig. 7-3. Gate valve characteristics.

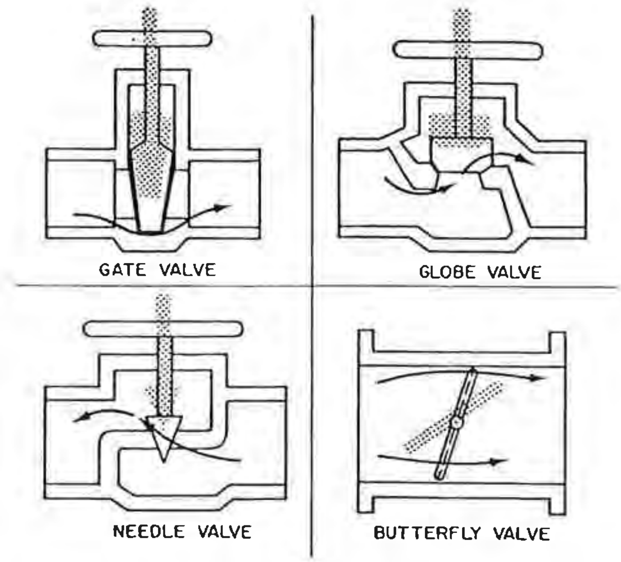


Fig. 7-4. Simplified views of common valves.

to flow in the opposite direction. A QUICK-OPENING valve, as the name suggests, is one that can be opened quickly.

7.11 The cutaway views in Fig. 7-2 show three common valves you will work with. As you study these drawings, you will note that many components of each are similar and, in fact, have the same names. The three principal parts of such valves are the BODY, the BONNET, and the TRIM. The body is connected to the piping. The bonnet contains the moving parts, and is usually bolted to the body. The trim includes the stem, the seat rings, and the closing element.

7.12 Every valve has openings called PORTS, by which fluid enters or leaves. The number of ports is the number of ways fluids may do this. These shown in Fig. 7-2 have two ports each, and so are called TWO-WAY valves.

7.13 Figure 7-3(A) shows a RISING-STEM GATE VALVE. The stem rises out of the valve as the valve is opened, and in this manner indicates the position of the gate. Figure 7-3(B) shows the same valve, except that it is a NON-RISING STEM valve. Rotation of the wheel operates the valve, but the stem does not come out of the housing. This type of gate valve is used where there is low headroom, or cramped space.

7.14 Figure 7-3(C) shows three types of gate-valve closing elements. The solid wedge on the left was the first of its type invented. The other two types are split up the middle. This permits the wedge to adapt itself to small amounts of distortion caused by pipeline strain or seat wear. The flexible wedge at the right is cut out between the two seats (the faces of the wedge that are pressed against the two walls of the valve body to seal the passageway). This flexibility is an advantage when the valve has to be closed while it is being subjected to extremely high temperatures. The body of the valve expands because of the heat. The gate then has less space to fit into, but it must be firmly seated if it is to stop the flow. Because the gate has some "give" in it, excess stress on the valve spindle isn't required to close the gate.

7.15 Figure 7-4 shows the closing elements used in gate, globe, needle, and butterfly valves. It also shows the pattern of fluid flow through these valves.

7-1. Valves control ________ ________ through piping systems.

7-2. Valve-closing elements fit against ________ in the valve body.

7-3. For a 3-inch section of pipe, you should use a ______-inch valve.

7-4. Besides starting or stopping flow, valves are used to __________ flow.

7-5. Most valves are named after which of their parts?

____

7-6. Name the part of a gate or globe valve that contains its moving parts.

____

7-7. A two-way valve has _______ parts through which fluid can enter or leave the valve.

7-8. What kind of gate valve is used in areas of low headroom?

____

Gate Valve

7.16 GATE valves are used primarily for open and closed service. They are not especially recommended for intermediate flow regulation or throttling. They should not be used in a kitchen because of disc-face wear and ultimate leakage. As you look at the fluid flow pattern in Fig. 7-4, you can see two important features of these valves: (1) the fluid flow is straight through the body of the valve; and (2) the passageway through the valve is practically the same size as the pipes to which the valve is connected. For this reason the pressure loss (pressure drop) through this type of valve is about equal with the loss in a piece of pipe of the same length.

7.17 Gate valves are well suited to service on equipment in distant locations, where they may remain in the OPEN or CLOSED position for a long time. When open, gate valves offer little or no blockage to the flow. It is important to remember that fluids are normally under pressure. The valves must be properly selected in terms of the pressures they are exposed to. Gate valves range in size from 3/8 inch to 108 inches. Because of space limitations, the 84 inch to 108 inch sizes have been replaced by butterfly valves in many applications.

Globe Valve

7.18 The GLOBE valve gets its name from the globe or disc element that presses against the valve seat to close the valve. As shown in Fig. 7-4, fluid flow through a globe valve is at right angles to the direction of flow in the pipes. When this type of valve is opened, the entire surface of the globe moves away from the valve seat at once. This is different from the gate valve, in which the gate is nearly always subject to fluid pressure against the valve seat. Because globe valves can be adjusted with fewer turns than gate valves, they are preferred where the application calls for frequent opening and closing. They also provide an excellent means of throttling flow.

7.19 The ANGLE valve shown in Fig. 7-2 has the same basic design as the globe valve. As shown in Fig. 7-5, its use reduces the number of joints required where a valve is needed near a right angle change in direction of the pipe line.

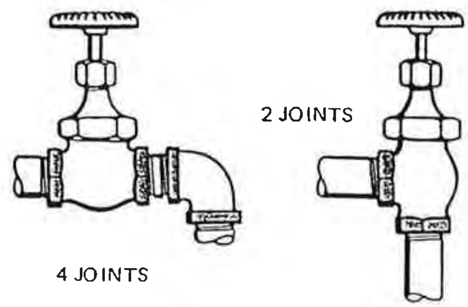


Fig. 7-5. Use of angle valves.

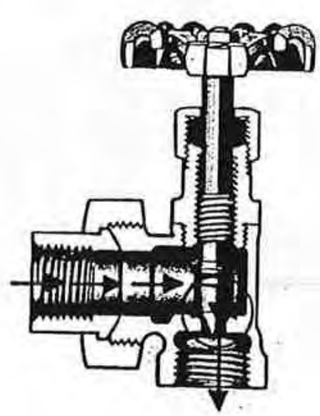
7.20 Three basic types of discs are used in these valves: ball, composition, and plug. In each case the disc seats against a tapered, flat-surfaced seat in the body of the valve. Composition discs are tailored for specific services, such as cold water, hot water, and petroleum products, and are renewable. The plug-type disc is in effect a metal cork, perfectly cylindrical, with tapered sides, that is inserted into a tapered seat.

Needle Valves

7.21 NEEDLE valves, which are a variation of globe valves, are so named because the closing element is long, narrow, and comes to a point. See Fig. 7-6. The diameter of the seat is smaller than that of the globe valve, and it reduces the amount of flow the valve can pass. Fluid flow is controlled by the extent to which the needle point is inserted into the seat.

7.22 Needle valves are used for very accurate throttling. For this service, the threads on the stem are closer than usual, to permit finer adjustment and control of the needle point. The needle fits

Fig. 7-6. Needle-point globe valve.



Crane Co.

accurately into the seat, which minimizes the effort needed to ensure tight closure.

Ball Valves

7.23 BALL valves use a ball to block the flow of fluid through the valve. The ball has a cylindrical hole through it. See Fig. 7-7. When the hole is in line with the pipe, flow is permitted. When the ball is turned 90 degrees, its solid surface blocks the fluid flow. In Fig. 7-7, the ball is in the open position. The ball and the facing pieces of the body of the valve are carefully machined to provide a good metal-to-metal seal. However, the ball is primarily sealed by two heavy seat rings that press tightly on the ball from opposite sides. It is as though a golf ball were sandwiched between two doughnuts. Assuming perfect circles, there would be a perfect contact and seal between each doughnut and the surface of the ball. The ring-shaped seals are also shown in Fig. 7-7.

7.24 When the valve is closed, pressure in the line helps to keep it closed, which is one advantage of this type of valve. Another advantage is that fluid can flow through it in either direction, as desired.

Butterfly Valve

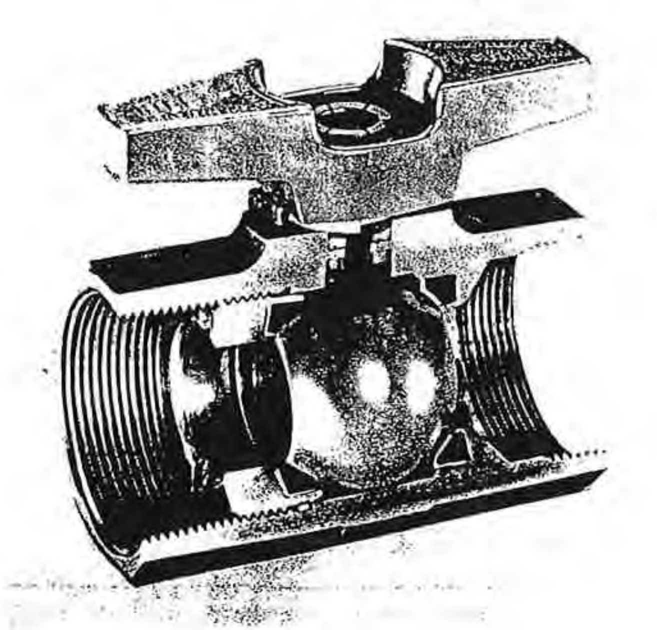
7.25 The term butterfly suggests something delicate or fragile. In fact, BUTTERFLY valves got their start under flimsy conditions as the valves (dampers) in stove pipes. Since butterfly valves have been made with rubber rather than metal seats, which permit a tight seal, they have become more widely used. A common application is in circulating water pipe lines in central power stations. With the increased size of equipment in these stations came the necessity for very large water piping. The butterfly valve came into its own.

7.26 Figure 7-8 is a cutaway view of such a valve. This valve is a fairly massive piece of equipment. Such a valve is not opened or closed easily by hand. Some kind of VALVE OPERATOR, or mechanical aid, is necessary. In this drawing a MANUAL GEAR REDUCER is used. When the wheel is turned, a gearbox converts this into the necessary force to operate the valve. Other types of valve operators include electric motors and hydraulic cylinders. These devices are discussed in Lesson Eight.

7.27 Butterfly valves have seals that the valve disc fits against tightly when in the closed position. A new use for these valves is in the air ventilation systems of nuclear reactor installations. A quick-closing butterfly valve is used to seal the ventilators in the event of any malfunction in the reactor.

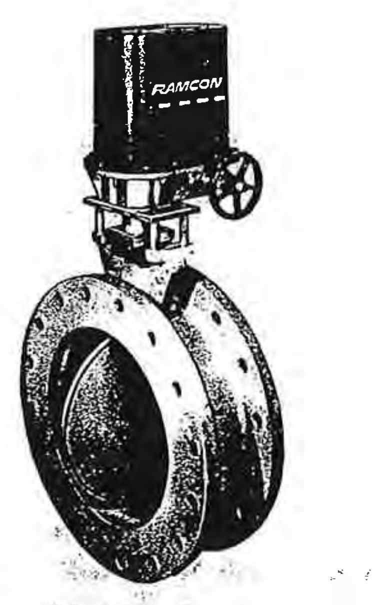
7.28 In steam power applications, butterfly valves are often installed with a "failsafe" feature.

Fig. 7-7. Ball valve.



Hills-McCanna

Fig. 7-8. Butterfly valve.



Hills-McCanna

This means that they close automatically if there is a pump or power failure. Mechanical valve operators close the valve rapidly until it is *almost* completely shut. Then the last part of the valve disc's travel (to complete SHUT) is more gradual. This relieves line shock pressures in the system.

7.29 Butterfly valves are compact, and they do not require supports other than those required for the pipeline itself. They can be used for flow in either direction. This feature is needed in plants that periodically reverse condenser flow, setting up what is called "backwash" to clean the condenser tube sheets. Butterfly valves are designed to handle pressures from 50 psi to 125 psi. They are excellent for throttling fluid flow, as well as for operation in a shutoff capacity.

Plug Valve

7.30 A PLUG valve, (also called a COCK, or PETCOCK) is something like a ball valve, in that the blocking element in the body of the valve has an open channel through it. See Fig. 7-9. However, the element is either a tapered or nontapered cylindrical plug, rather than a ball. The plug fits into the body of the valve, and offers either its open port or its solid side to the fluid; a quarter turn is all that is necessary to change from one position to the other. The shape of the port may be rectangular or round. Some ports are diamond shaped. These are used in throttling applications in such services as balancing air conditioning and heating systems.

Duriron Company

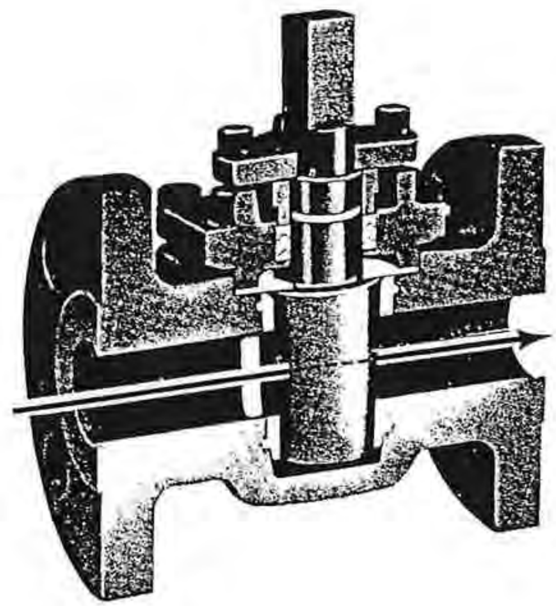


Fig. 7-9. Plug valve

7.31 Although primarily an OPEN-CLOSE valve, plug valves can be used for throttling. They are easily adapted to automatic control. These valves can safely and efficiently handle gas and liquid fuel, boiler-feed water, and condensate. They also handle food and beverages, paper and pulp, paint, varnish, lacquer, asphalt and other even thicker materials such as cement and ore slurries. Make a comparison of the size and shape and space requirements of the various valves in Figs. 7-2 and 7-9. The plug valve has no projecting bonnet, no exposed threads, and no underhanging body.

... of its internal construction, a gate valve is best suited for ______ and ______ service.

7-10. For throttling service, which should be used: a gate valve or a globe valve?

______

7-11. For what purpose is a needle valve ordinarily used?

______

7-12. Advantages of a ball valve include fast on-off, low pressure drop, good sealing, and flow in ______ one direction.
(only/more than)

7-13. A large, fast-operating shutoff valve commonly used in large water-circulating systems is called the ______ valve.

7-14. Butterfly valves can be used where the fluid must flow in ______ direction(s).
(one/two)

7-15. Except for the shape of its element, the plug valve is most like a ______ valve.

7-16. A plug valve that has a diamond-shaped port is ordinarily used for ______ applications.

Check Valve

7.32 CHECK valves are designed to control the direction of flow. See Fig. 7-10. They are used when it is necessary for a liquid or gas to move through the system in only one direction. When the flow is moving in the proper direction the valve remains open. When the flow reverses, the valve closes automatically from the fluid pressure against it.

7.33 Figure 7-10 shows the basic types of check valves. In each case, pressure from the flow in the proper direction pushes the valve element to an OPEN position. Flow in the reverse direction CLOSES the valve element.

7.34 In the SWING check valve the closing element swings open and shut like a trap door does. This valve offers little resistance to flow when it is in the open position. Swing check valves are generally used in piping applications where pressure drop is an important consideration. They can be used for handling liquids, and they can be installed in either vertical or horizontal positions.

7.35 HORIZONTAL-lift check valves are frequently assembled in the same valve bodies as those used for regular globe valves and they are used for applications in which the reversal of flow and pressure changes are very frequent. They are less likely to develop "disc slam" and valve chatter than the swing check valves just described.

7.36 VERTICAL-lift check valves are similar in construction to horizontal-lift check valves, except that they are designed for vertical mounting.

7.37 BALL check valves are designed to handle thick fluids, and for service where scale and other particles are present. They are made in vertical, horizontal, and angle designs. Ball check valves are recommended for applications of rapidly changing fluid flow because of their quiet operation. The ball moves rapidly up and down as it opens and closes, and rotates somewhat. This equalizes wear on both the ball and the valve seat.

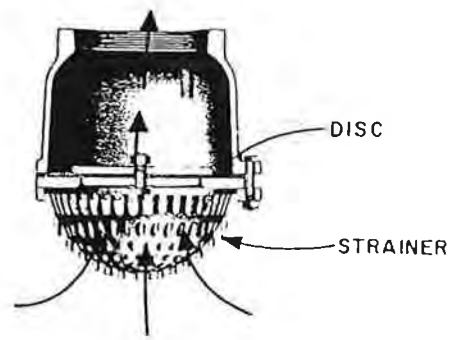


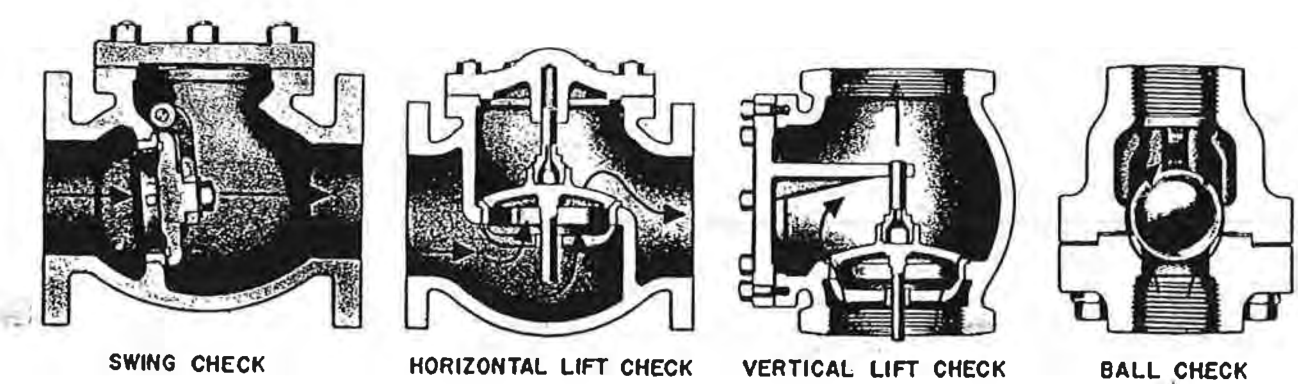
Fig. 7-11. Foot valve.

7.38 A FOOT valve is used at the foot of an open-end pipe submerged in a fluid, as in an oil tank or well. (See Fig. 7-11.) It is a variety of vertical-lift check valve, permitting fluid flow upwards in the pipe, but not back into the tank. Foot valves usually have a strainer on the intake side, as shown.

Quick-Opening Valves

7.39 QUICK-OPENING valves are adaptations of some of the valves just described. They are modified to provide a quick on/off action. Some kind of lever is used to operate the valve in place of the usual threaded stem and control wheel. Figure 7-12 shows quick-acting globe and gate valves. The globe valve is self-closing, and spring-operated. The gate valve lever is manually

Fig. 7-10. Types of check valves.



Crane Co.

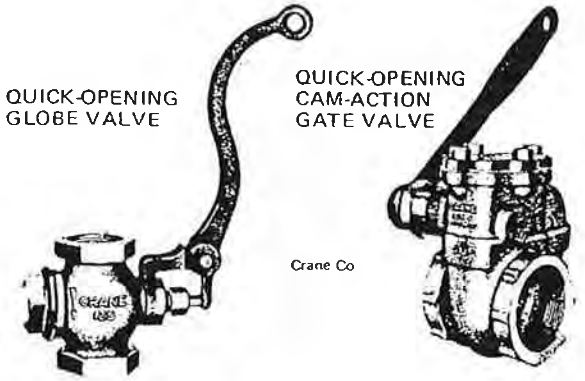


Fig. 7-12. Quick-opening valves.

operated, and it does not return itself to a closed position.

7.40 Quick-opening valves have many useful applications. Their quick action is necessary in industrial and laboratory emergency showers to provide a flood of water for washing chemicals or contaminants from a worker's eyes or skin. They also control the air supply for the horns on a highway truck. Quick-closing valves also have special uses, such as cutting off the flow of gas to a main or to individual outlets.

7.41 Plug valves, that require only a small amount of turn between the open and shut positions, are well adapted to quick-opening applications. If a stop collar is built into a quick-opening valve, you can easily tell whether it is fully open or fully closed. (In a normal valve you must rely on the feel of the wheel's resistance to determine when the valve is fully closed.)

Valve Maintenance

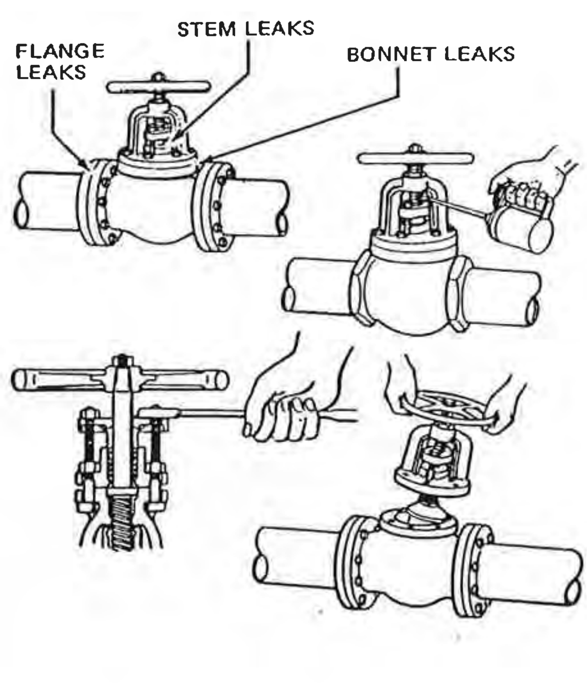
7.42 Valve maintenance begins with correct daily operation of controls. As an example of incorrect operation, consider the kitchen sink faucet again. As the faucet washers harden and deteriorate with time, it becomes difficult to shut the water off completely and the faucet drips. A common practice is simply to apply as much force as possible to the faucet handle. Doing so, however, places the threads of the valve stem and the body of the valve under great pressure. This can crack the valve housing, or ruin the threads, or both. All that is needed is a short maintenance job; remove the valve stem, clear out the old washer, clean the valve seat, insert a new washer, and reassemble the unit. For industrial valves, the term "seals" refers to what household plumbers call "washers." But in industrial applications, the same sealing conditions occur.

7.43 Good maintenance includes periodic inspection of valves, correct lubrication of all moving parts, and replacement of seals or stem-packing. When leakage or excessive friction develops, replace the seals. Reface leaking seats and discs.

7.44 Frequent lubrication helps prevent galling and seizing of the sliding parts. GALLING is frictional wear. SEIZING is the tendency of metal-on-metal surfaces to bind and stick to each other because of heat or excessive pressure. Any valve acquires a certain amount of corrosion and foreign particles. These conditions can develop in the stem threads, thrust washers, and other parts of the valve linkage.

7.45 Figure 7-13 illustrates several routine maintenance procedures. The top drawing shows the three places where leaks may develop. Whether small or large, leaks should not be overlooked. A small leak can often be quickly stopped simply by slightly tightening the packing nut or gland. Bonnet and flange leaks can be caused by the bolt loosening from strains in the line over a period of time. Some of these leaks can be stopped simply by tightening the bolts. If that doesn't work, install a new gasket in the joint.

Fig. 7-13. Routine valve maintenance.



Crane Co.

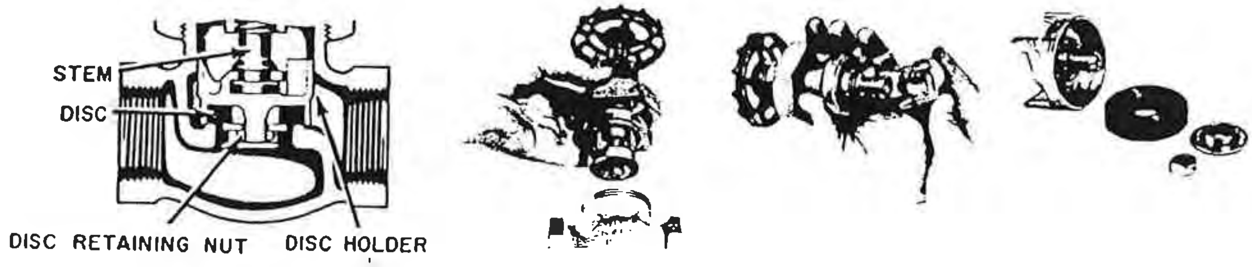


Fig. 7-14. Replacing disc in globe valve.

7.46 Wear on stem packing is caused primarily by the continued operation of the valve – the rising and turning motion of the valve stem, plus the effects of the fluids and varying pressure in the line. Lubricate the stem and the exposed threads at regular intervals.

7.47 Most valves are designed so that the complete bonnet and disc assembly can be removed without disturbing the valve body itself. The packing around the valve stem is kept in place by the gland, which is often bolted. It is important to tighten the gland bolts evenly, so there is no risk of binding the valve stem. Fig. 7-14 shows the steps to follow in replacing the composition disc of a globe valve. With the stem turned to the fully open position, loosen the bonnet and remove the stem-and-disc assembly. Remove the disc holder and install a new disc.

7.48 Different discs are designed for different types of service. Depending on the type of disc used, many valves are all-purpose. When a line is changed from one type of service to another, use the appropriate disc or an approved all-purpose disc.

Valve Connections

7.49 A valve is a fitting, in one sense, and is joined to sections of pipe. This is done by any of the several methods used for connecting fittings. Valves are connected to piping by welding, threading, and flanging. Procedures and precautions are exactly the same as they are for connecting elbow and tee fittings to a line, and for joining flanged ends.

Summary

This lesson covered the basic common valves, those you are likely to be working with. You will come across variations, of course, but the fundamentals of their construction and operation are very much the same as those which apply to common valves.

7-17.	When fluid flow must be in only one direction, a ________ valve is inserted in the line.
7-18.	Where pressure drop is an important factor, a ________ check valve is generally used.
7-19.	Check valves designed to handle heavy fluids carrying scale or other particles are called ________ check valves.
7-20.	An emergency shower system is usually controlled by a ________ - ________ valve.
7-21.	Good valve maintenance includes lubrication and replacement of packing and seals. What other step must come first? ________________________________
7-22.	Name the three places where valve leaks are most likely to develop. ________________________________ ________________________________ ________________________________
7-23.	If the gland bolts of a valve are not tightened evenly, what is likely to happen? ________________________________
7-24.	How are valves connected into a piping system? ________________________________ ________________________________