4. *Valve operation.* It must be determined whether the valve be used only for ON /OFF use or for throttling.

5. *Pressure drop.* Allowable pressure drop must be established and the size (equal to or less than that figure) selected.

6. *Corrosion resistance.* This is affected by the nature, concentration, and temperature of the fluid.

7. *Velocity.* The velocity of the fluid through the valve must be considered.

8. *Firesafe.* It must be known if this is a requirement. (Refer to previous discussion.)

9. *Hazardous material.* When the fluid being transported is considered hazardous or lethal, valves must be specifically designed to handle these materials. Redundant stem packing and leak detection ports are typical design features. ANSI B 31.3, category M, defines this category of fluids.

GATE VALVES

Gate valves, illustrated in Fig. 2.23, use a wedge-shaped disk or gate as the closure member operating perpendicular to the flow; it is raised to open and lowered to close the valve. As the disk closes, it fits tightly against the seat surfaces in the valve body. A gate valve is used fully opened or closed only. It should not be used for throttling service (partly open), as the gate will vibrate and quickly become damaged and subject to wire drawing caused by the velocity of the liquid flowing past the disk.

Primary Gate Valve Components

There are four main features that dictate gate valve design: the disk, stem, bonnet/body connection, and body. The body materials and end connections have been previously discussed.

Often, iron body valves use a combination of materials to provide corrosion-resistant bearings for stems and other wear points such as seating surfaces. These valves are called iron body bronze mounted (IBBM).

Disk Design. There are three types of disk constructions: solid wedge, split wedge, and flexible wedge (illustrated in Fig. 2.24).

Solid Wedge. Solid wedge disks are most prevalent because of their simple and usually less expensive design.

Split Wedge. Split wedge disks, also called double disks, have somewhat better sealing characteristics than solid disks because the two disk halves are forced outward against the body seats by a spreader after the disk has been fully lowered into its seating position. When the valve is opened, pressure on the disk is relieved before it is raised, eliminating the friction and scoring of body seats and disk.

Flexible Wedge. Flexible wedge disks are solid only at the center and are flexible at the outer edge and seating surface. This design enables the disk face to overcome the tendency to stick in high-temperature service where wide swings in temperature occur. This type of disk is generally found only in steel valves.

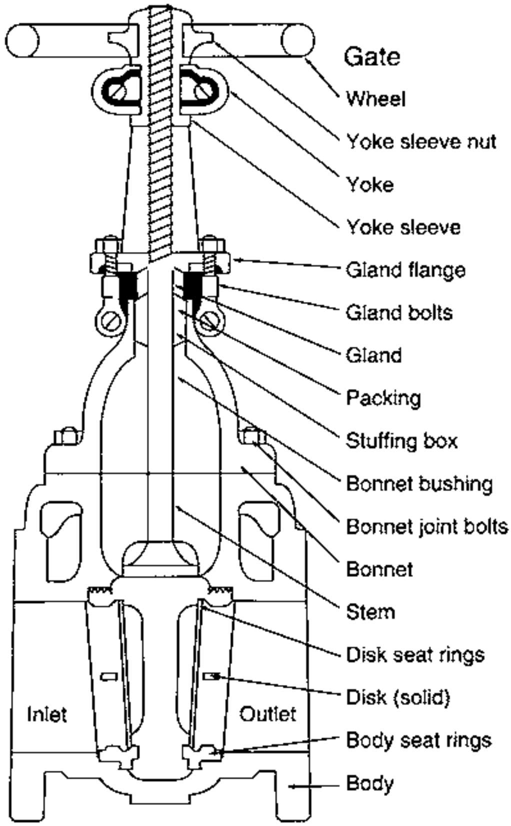

FIGURE 2.23 Gate valve. (*Courtesy Stockham.*)

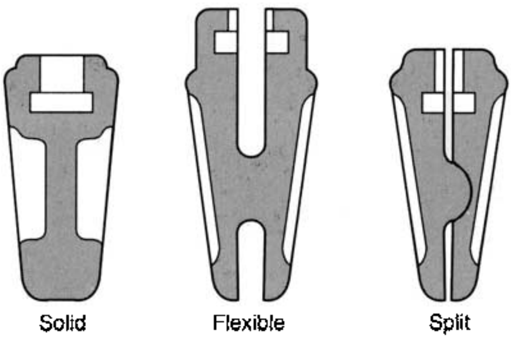

FIGURE 2.24 Gate valve disk construction.

Stem Construction. There are also five basic types of stem construction, shown in Fig. 2.25.

Rising Stem/Outside Screw and Rising Stem/Outside Screw and Yoke. These two types of stem construction keep stem threads outside the valve and are recommended where high temperatures, corrosives, and solids in the line might damage stem threads inside the valve. When the hand wheel (nonrising) is turned, the stem rises as the yoke bushing engages the stem threads. The external threads enable easy lubrication; however, care must be taken to protect the exposed stem threads from damage.

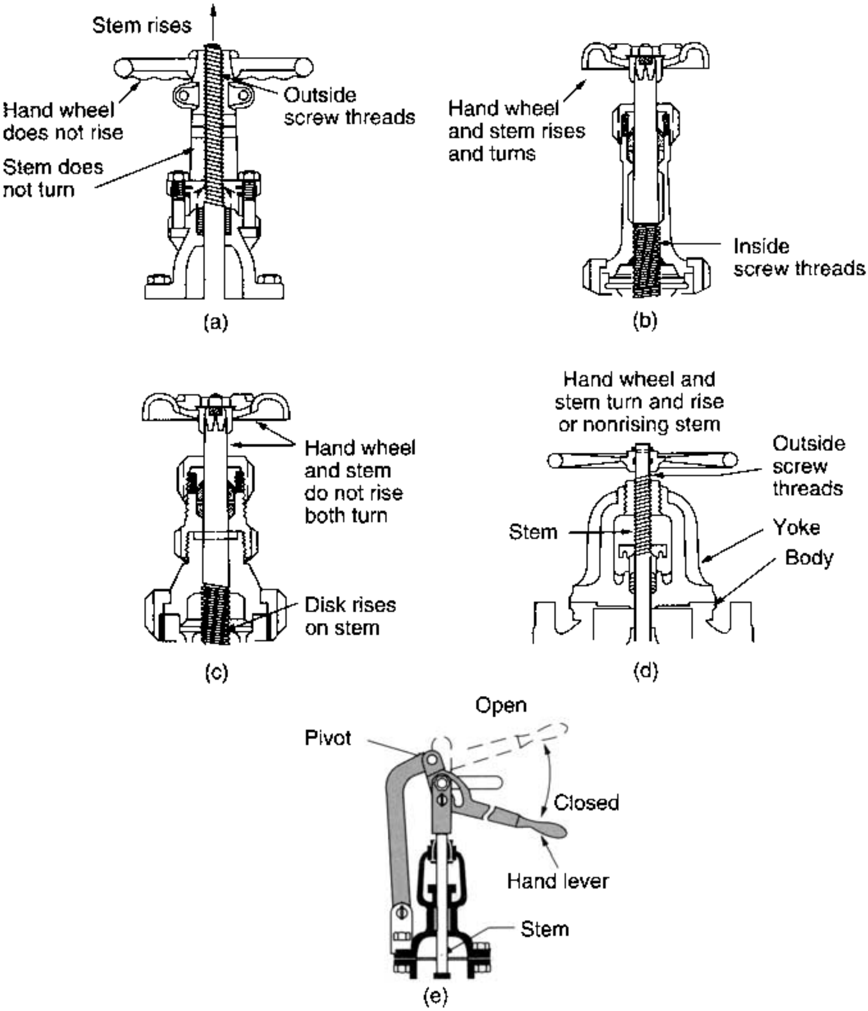

FIGURE 2.25 Basic stem construction. (*a*) Rising stem, outside screw; (*b*) rising stem, inside screw; (*c*) nonrising stem, inside screw; (*d*) rising stem, outside screw and yoke; (*e*) sliding stem.

Rising Stem/Inside Screw. Rising stem/inside screw is the most common stem design in bronze gate valves. Because the hand wheel and stem both rise, adequate clearance must be provided for operation. The stem and hand wheel positions indicate the position of the disk inside the valve. In the open position, the backseat helps protect the stem threads, but care must be taken to protect the stem externally.

Nonrising Stem/Inside Screw. Nonrising stem/inside screw design has the chief advantage of requiring minimum head room for operation. Since the stem does not travel vertically, packing wear is reduced. Heat, corrosion, erosion, and solids may damage the stem threads inside the valve and cause excessive wear. Also, it is impossible to determine the disk position since the hand wheel and stem do not rise.

Sliding Stem. The operation of the stem is linear, straight up and down. A lever takes the place of a hand wheel and there are no threads on the stem. Available on gate and globe valves, this type of stem is useful where quick closing or opening of a valve is desired.

Bonnet Construction. The basic types of bonnet construction include union, screwed, and welded designs (shown in Fig. 2.26). Union bonnets are preferred for rugged service. Screwed bonnets are the least expensive design and should be used for lower pressures only. Welded bonnet construction provides the most leak-free body-to-bonnet joint. The disadvantage of the welded bonnet is that it provides no access to the trim parts if repairs are needed.

GLOBE VALVES

Globe valves are so named due to the globular shape of the valve body. Globe valves are used where throttling and/or frequent operation is desired. Each uses the same method of closure-a round disk or tapered plug-type disk that seats against a round opening (port). This design deliberately restricts flow, so globes should not be used where full, unobstructed flow is required. There are three basic types of globe valve: the standard globe valve (Fig. 2.27), the angle globe valve (Fig. 2.28), and the needle valve (Fig. 2.29).

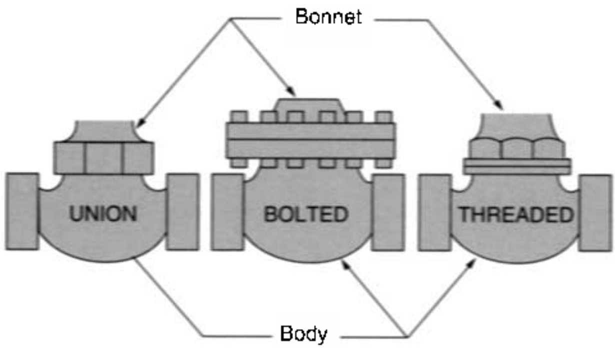

FIGURE 2.26 Typical bonnet construction.

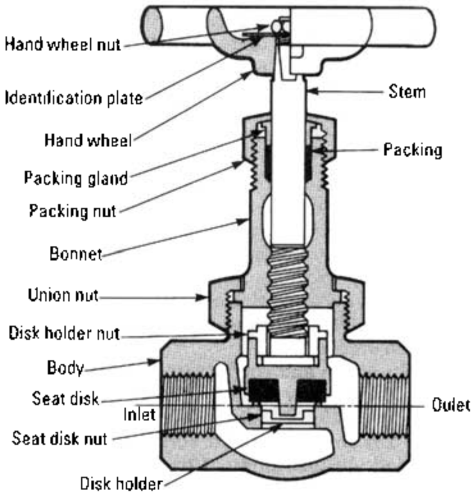

FIGURE 2.27 Standard globe valve.

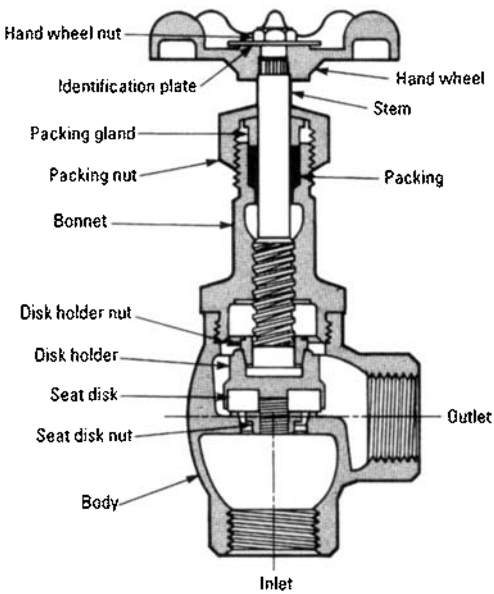

FIGURE 2.28 Typical angle globe valve.

Angle valves are identical to standard globe valves in seat design and operation. The basic difference is that the body of the angle valve acts as a 90° elbow, eliminating the need for a fitting at that point in the system. Angle valves also have less resistance to flow than the combination of globe valves and the fittings they replace. Needle valves are generally small in size and are intended to provide

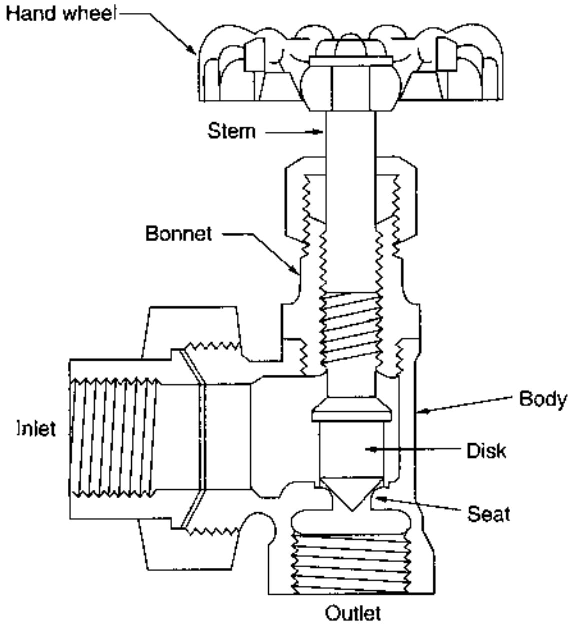

FIGURE 2.29 Typical needle valve.

precise flow control. Many turns of the handle are required to adjust flow in order to achieve precise control.

A globe valve should be installed with the flow entering under the disk. The end of the valve through which you can see the disk seat when the valve is closed is the end where the flow should enter. This is necessary for good throttling control of flow and best shutoff conditions. Globe valves should also be installed with the disk closed to prevent seat damage during installation.

Most globe valve leakage is due to foreign matter settling on the area between the disk and seat. When this occurs, it can often be corrected by opening the valve slightly and then closing it.

PLUG VALVES

A plug valve, shown in Fig. 2.30, is a quarter-turn valve that uses a tapered cylindrical plug that fits a body seat of corresponding shape. When the port in the plug is aligned with the body opening, flow is permitted in a way similar to a ball valve. A one-quarter (90°) turn operates the valve from opened to closed and vice versa.

Plug valves fall into two basic categories, lubricated and nonlubricated. A lubricated plug valve is designed with grooves in the surface of the plug. The grooves are connected to a lubricant channel in the stem. When the grooves are filled with lubricant (also called sealant), a tight seal develops between the plug and valve body. Lubricant is usually applied with a hand pump, providing a hydraulic jacking force and lifting the plug slightly for easier turning. When properly lubricated, this valve gives tight shutoff and is easily operated. Proper lubrication requires addi-

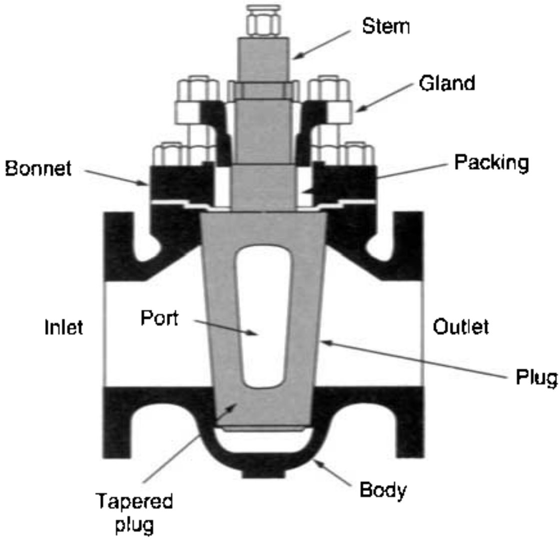

FIGURE 2.30 Typical plug valve.

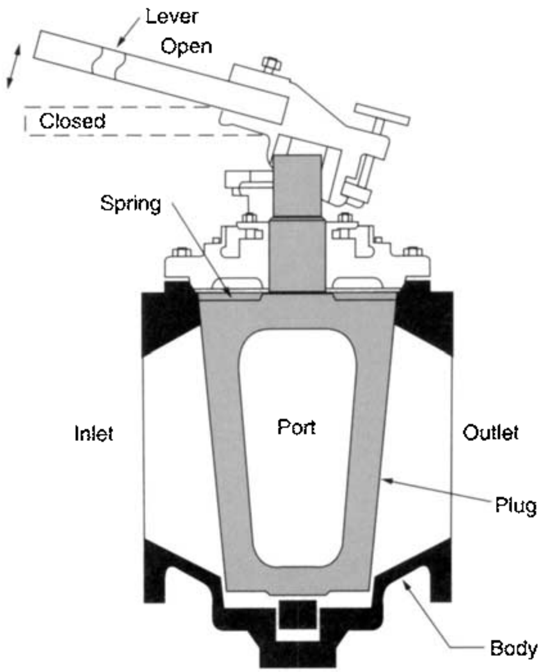

FIGURE 2.31 Typical lift-type plug valve.

tional maintenance. This valve is often used in natural gas service. A disadvantage is that the lubrication may enter the product stream and is not recommended where purity is a primary concern.

Nonlubricating plug valves have two basic designs, lift type and sleeved. In the lift type (Fig. 2.31), the plug is mechanically lifted while being turned to disengage it from the seating surface, thereby reducing seating force. The sleeve type generally has a fluorocarbon sleeve (retained in the body) that surrounds the plug, giving a continuous seal.

There are three port sizes: 100, 70, and 40 percent of inlet pipe size opening, as shown in Fig. 2.32. The size of the port determines the physical size of the valve, with the larger port having the largest valve size. The 70 percent port is normally supplied.

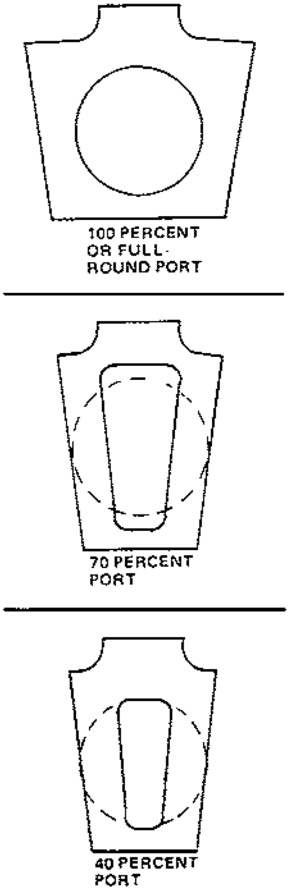

FIGURE 2.32 Plug valve port sizes.

BALL VALVES

A ball valve utilizes a ball with a hole drilled through it as the opening/closing device. It is a quarter-turn valve. The ball seals by fitting tightly against resilient seat rings on either side. Flow is straight through, and pressure loss depends on the size of the opening in the ball (port).

Ball valves are available in one-, two-, or three-piece body types (Fig. 2.33). The one-piece body, also called "end entry," is machined from solid bar stock material or is a one-piece casting. The ball is inserted into one end for assembly, and a body insert that acts as a seat ring is threaded in against the ball. The two-piece body, also an end-entry design, is the same as a one-piece valve except the body insert is larger and acts as an end bushing. The three-piece body consists of a center body section containing the ball that fits between two body end pieces. The entire assembly is held together by two or more body bolts. This design allows the valve to be repaired without disassembling surrounding piping. This type is recommended for utility services.

There are three port sizes, standard, reduced, and full port. Standard port is generally one pipe size smaller than the valve size, reduced port is up to two sizes smaller, and full port has the same opening as the connecting pipe.

Ball valves are generally selected for ON/OFF service. They are easily adapted to power actuation and are generally less expensive than equivalent sizes of gate and globe valves. With the development of high temperature and superior grade elastomeric seating material, tight seating problems have been overcome.

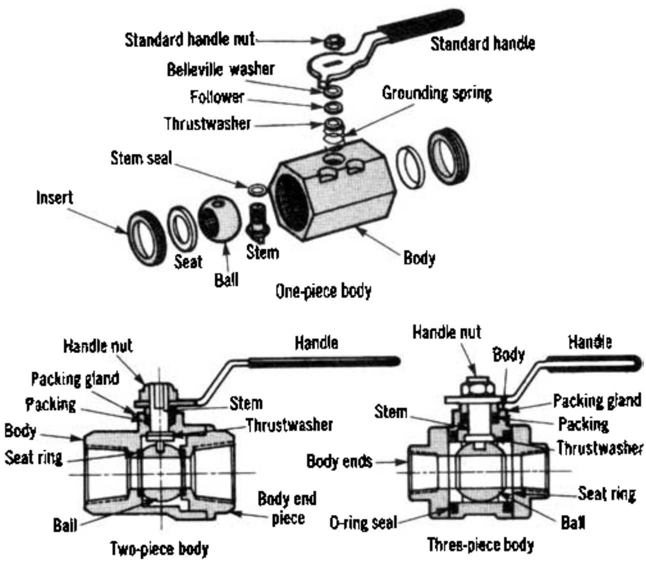

FIGURE 2.33 Typical ball valves.

BUTTERFLY VALVES

A butterfly valve has a wafer-shaped body with a thin rotating disk as the closing device. Like the ball valve, the butterfly operates with a one-quarter turn from fully opened to fully closed. The disk is always in the flow path, but since it is relatively thin, it offers little restriction to the flow. When the valve is closed, the disk edge fits tightly against a ring-shaped liner (seat).

These valves generally have one-piece bodies that fit sandwich-style between two pipe flanges. The two most common body types are wafer body and lug body, illustrated in Fig. 2.34. The wafer body is placed between pipe flanges, and the flange bolts surround the valve body. The lug body has protruding lugs that provide bolt holes matching those in the flanges.

Another design has an extended body for connections to grooved end piping. In this valve, the sealing member is the disk itself, which is fully encapsulated with a resilient material selected for the service conditions at hand.

Butterfly valves have continued to grow in popularity, generally at the expense of gate valves, because they are lightweight, easy to install, low in cost, easy to actuate, and easy to insulate and also because they feature one-quarter turn operation, tight shutoff (due to resilient seal), and a variety of construction materials.

DIAPHRAGM VALVES

A diaphragm valve uses a rubber, plastic or elastomer diaphragm to seal the stem. The diaphragm not only seals the stem but forms the closure element.

There are two styles of diaphragm valves, one having a body with a weir and the other having a straight-through body. On the weir type, shown in Fig. 2.35, the stem is connected to a finger arrangement, which in turn presses the diaphragm down onto a weir. This creates an extremely tight seal that will seal even on some solids. This valve has been used extensively in radwaste services and maintenance

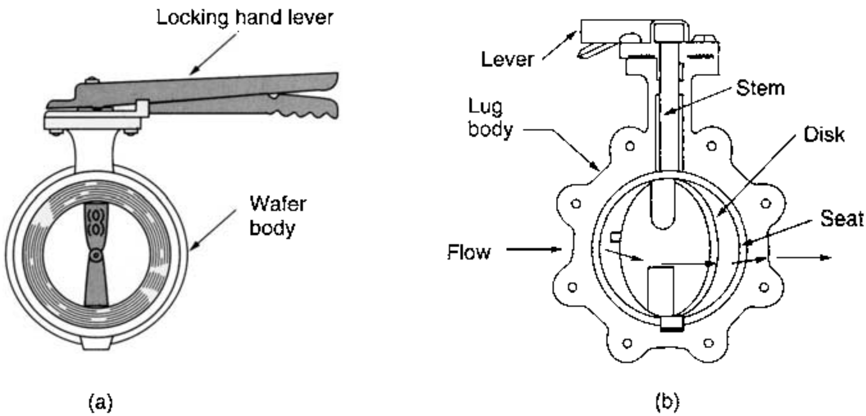

FIGURE 2.34 Butterfly valves. (*a*) Wafer body; (*b*) lug body.

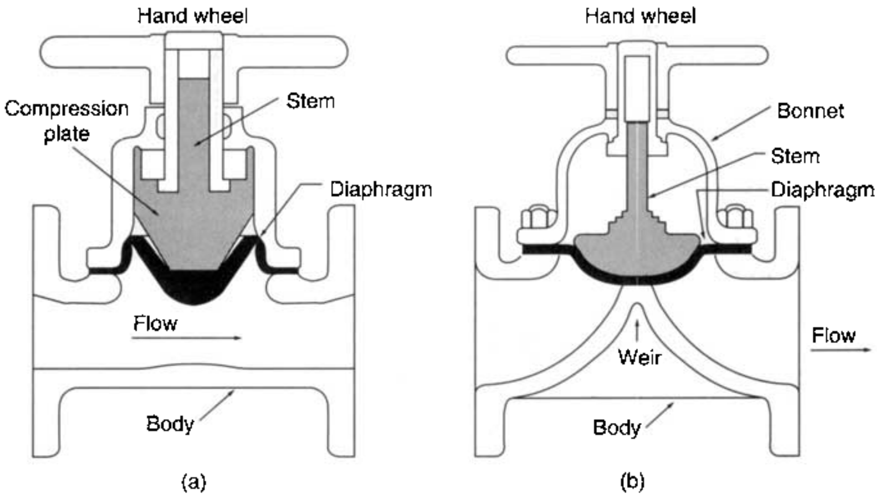

FIGURE 2.35 Diaphragm valves. (*a*) Straight-through valve in open position; (*b*) weir-type valve in closed position.

is extremely simple. On the straight-through type (Fig. 2.34), the diaphragm presses onto the bottom of the valve body for seating.

Since the diaphragm is not metallic and forms the closure, the valve is severely limited in pressure and temperature. A wide variety of diaphragm materials are available for use with different fluids. To enable draining of horizontal pipelines, the weir valve must be mounted 15° from the horizontal plane (because of the weir). This complicates installation, especially with air actuators.

PINCH VALVES

A pinch valve (Fig. 2.36) uses a round elastomeric sleeve connected to the valve body from inlet to outlet that completely isolates the liquid passing through the valve from all internal valve components. Closure is made by a movable closure element outside the sleeve that pinches the sleeve between the element and the valve body.

This type of valve is used for slurry and other liquids with highly corrosive properties.

CHECK VALVES

Check valves (Fig. 2.37) automatically check or prevent the reversal of flow. Basic types are the swing check, lift check, ball check, and wafer check designs. Another designation used for sanitary waste systems is a backwater valve. The swing check has a hinged disk, sometimes called a flapper, that swings on a hinge pin. When flow reverses, the pressure pushes the disk against a seat. The flapper may have a

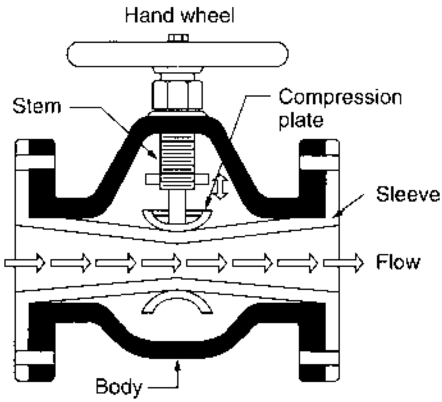

FIGURE 2.36 Pinch valve.

composition disk, rubber or Teflon, rather than metal when tight closure is required. Swing checks offer little resistance to flow.

The lift check has a guided disk that is raised from the seat by upward flow pressure. Reversal of flow pushes the disks down against the seat, stopping back flow. Lift checks have considerable resistance to flow, similar to that of a globe valve. They are well suited for high-pressure service.

Another common check is a wafer design which fits between flanges in the same fashion as a butterfly valve. Wafer checks come in two types: a dual flapper that is hinged on a center post and a single flapper that is similar to the standard swing check. They are generally used in larger size piping (4 in and larger) because they are much lighter and less expensive than traditional flanged end swing check valves.

A demand check value is of two-piece construction, with one piece having a spring-loaded closure similar to the air values found on automobile tires. The second piece, when inserted into the first, opens the valve, allowing free passage of air. The demand check valve is used for connecting gauges, allowing removal without permitting air to escape from the pipe.

MISCELLANEOUS VALVE TYPES

Various other types of valves are often used in utility systems. They can be either independently installed to operate as self-contained units or controlled electronically from a panel, system signal, or other remote source.

Pump Control Valve

This type of valve is used on pumped systems to control or eliminate surges caused by pump start and stop. It operates by using a spring-loaded closure member that opens or closes slowly to restrict the initial flow of water when a pump starts and stops.

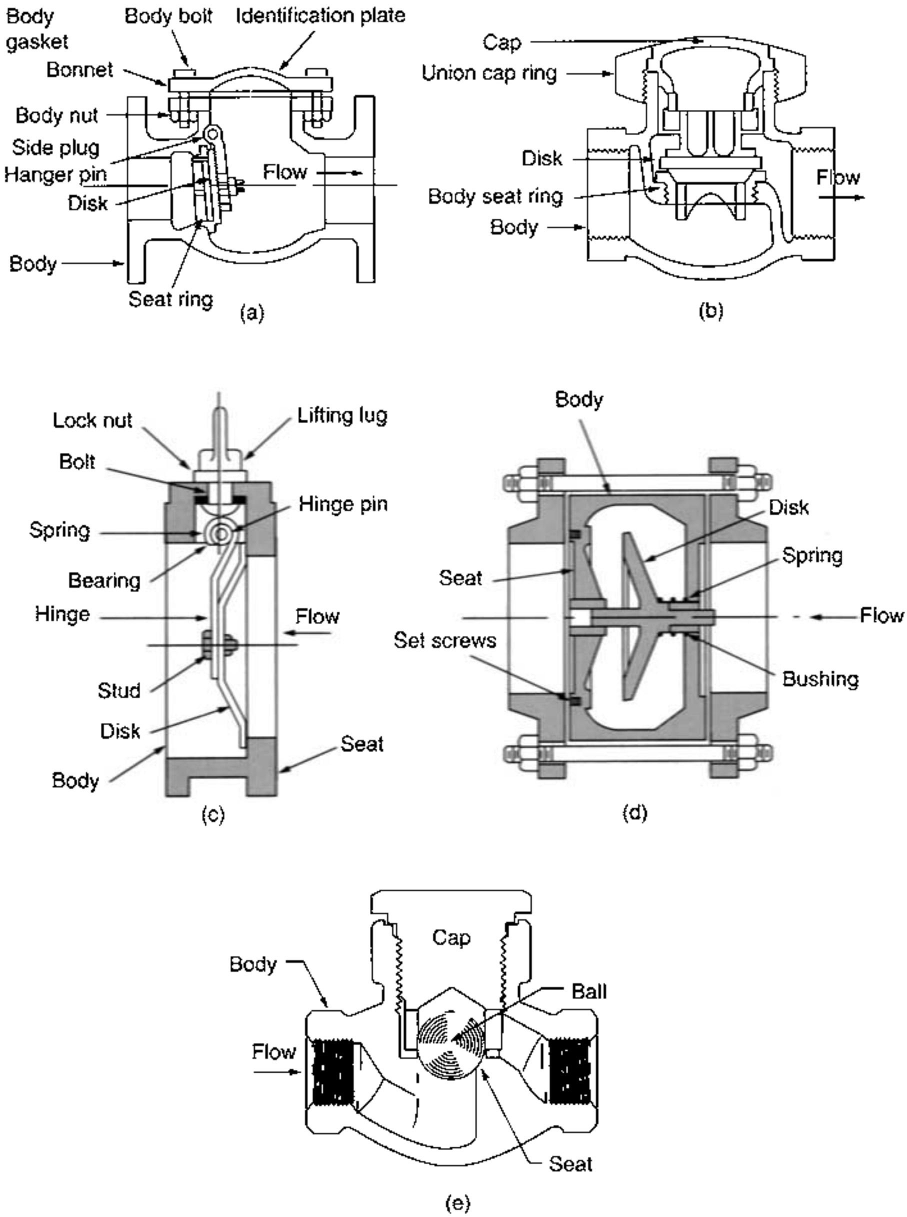

FIGURE 2.37 Check valves. (*a*) Swing check; (*b*) lift check; (*c*) single flapper wafer check; (*d*) double flapper wafer check; (*e*) hall check.

Flow Control Valve

This valve operates by using a calibrated orifice or venturi tube to control the flow of liquid to a predetermined set point regardless of fluctuating line pressure.

Pressure Control Valve

Similar to the flow control valve, this valve limits the pressure of a flowing liquid to a predetermined set point regardless of fluctuating flow rate.

Level Control Valve

This valve accurately controls the level of liquid in a tank or vessel. An altitude valve uses a controlling device to maintain the level, and a float valve uses a movable float on an arm (similar to that in a water closet) to stop the flow at a predetermined level.

Conduit Valve

A conduit valve (Fig. 2.38) is used where an unobstructed opening through the valve is required, such as when pigs are used to clean the pipeline.

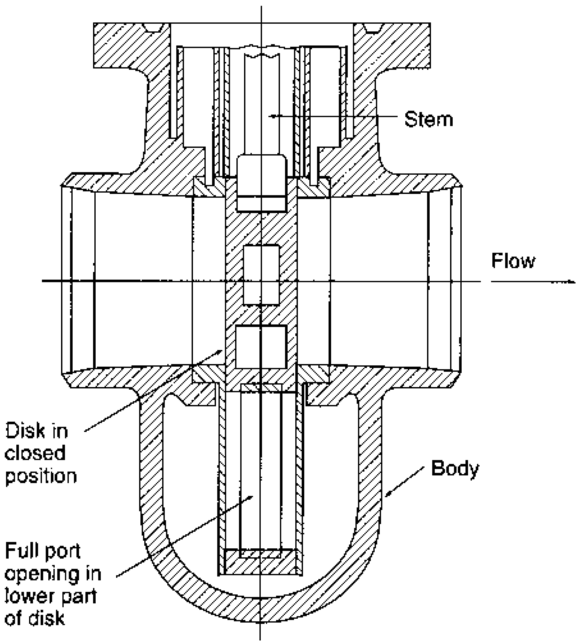

FIGURE 2.38 Lower portion of conduit valve.