

Technical Presentation

Fundamentals of Valves



Outline

- ▶ What is valve?
- ▶ Classification of valves
- ▶ Valve types.
- ▶ Methods of controlling flow through a valve.
- ▶ Basic Parts of the valve.
- ▶ Valve types

What is valve?

A valve is a device that regulates, directs or controls the flow of a fluid by opening, closing, or partially obstructing various passageways.

Valve Functions

- ❑ Stopping and starting fluid flow.
- ❑ Varying (throttling) the amount of fluid flow.
- ❑ Controlling the direction of fluid flow.
- ❑ Regulating downstream system or process pressure.
- ❑ Relieving component or piping over pressure.

Classification of Valves

The following are some of the commonly used valve classifications, based on mechanical motion:

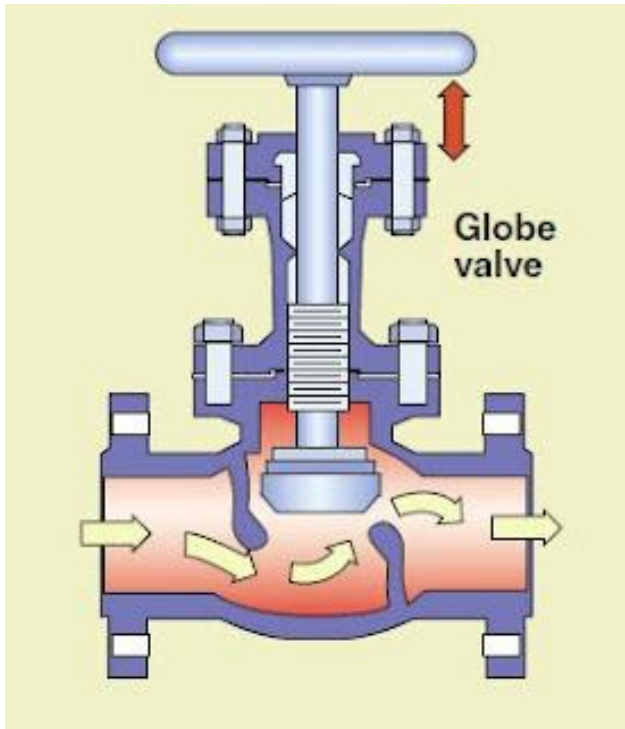
- **Linear Motion Valves.** The valves in which the closure member, as in gate, globe, diaphragm, pinch moves in a straight line to allow, stop, or throttle the flow.
- **Rotary Motion Valves.** When the valve-closure member travels along an angular or circular path, as in butterfly, ball, plug valves.
- **Quarter Turn Valves.** Some rotary motion valves require approximately a quarter turn, 0 through 90°, motion of the stem to go to fully open from a fully closed position or vice versa.

Classification of valves based on motion

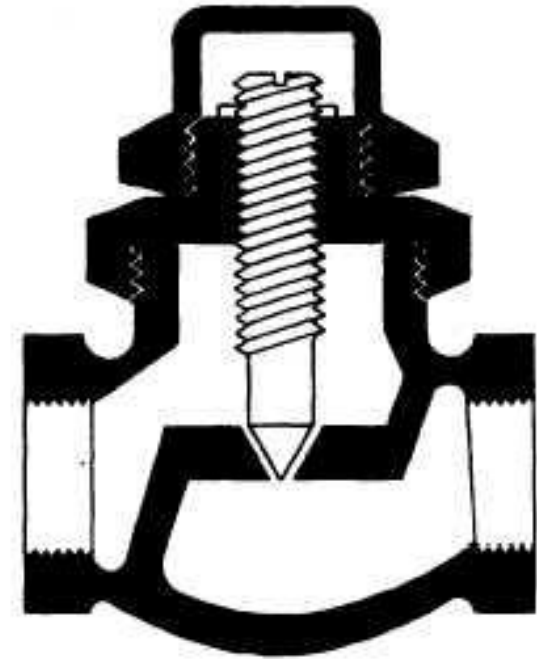
Valve types	Linear motion	Rotary motion	Quarter turn
Gate Valve	x		
Globe valve	x		
Plug valve		x	x
Ball valve		x	x
Butterfly valve		x	x
Diaphragm valve	x		
Pinch valve	x		

Methods of controlling flow through a valve.

1. Move a disc, or plug into or against an orifice globe or needle type valve)



globe valve



Needle valve

Methods of controlling flow through a valve.

2. Slide a flat, cylindrical, or spherical surface across the orifice.



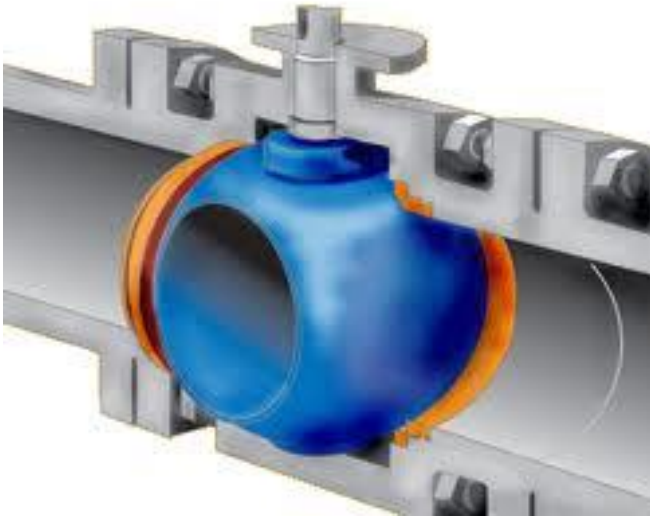
plug valve



gate valve

Methods of controlling flow through a valve.

3. Rotate a disc or ellipse about a shaft extending across the diameter of an orifice.



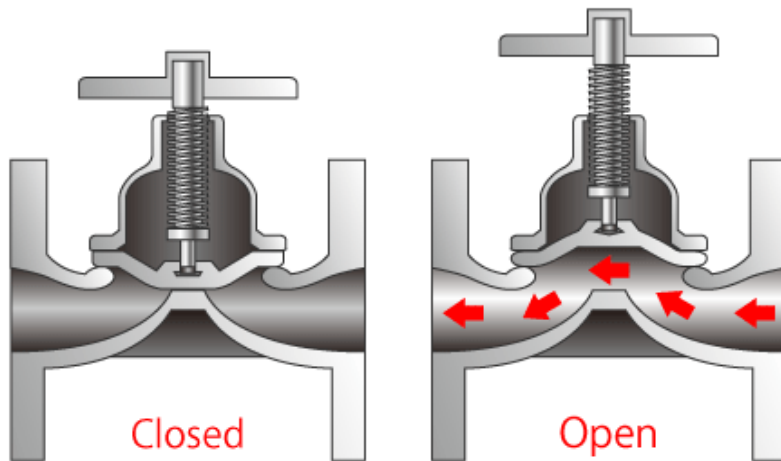
ball valve



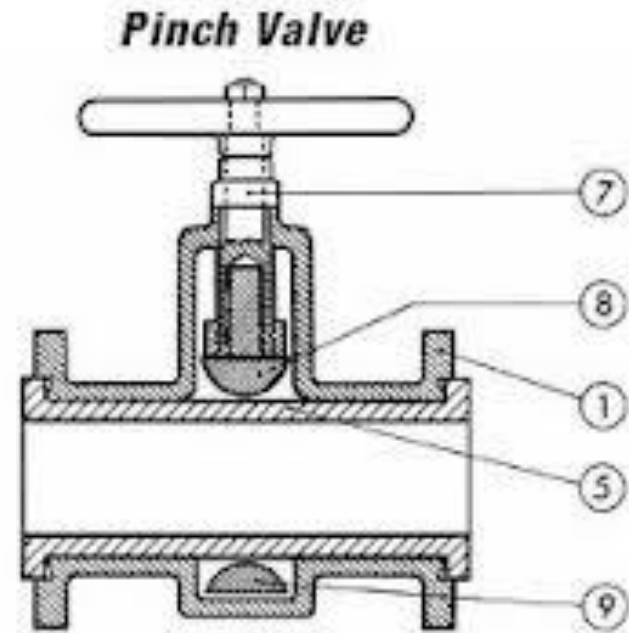
butterfly valve

Methods of controlling flow through a valve.

4. Move a flexible material into the flow passage.



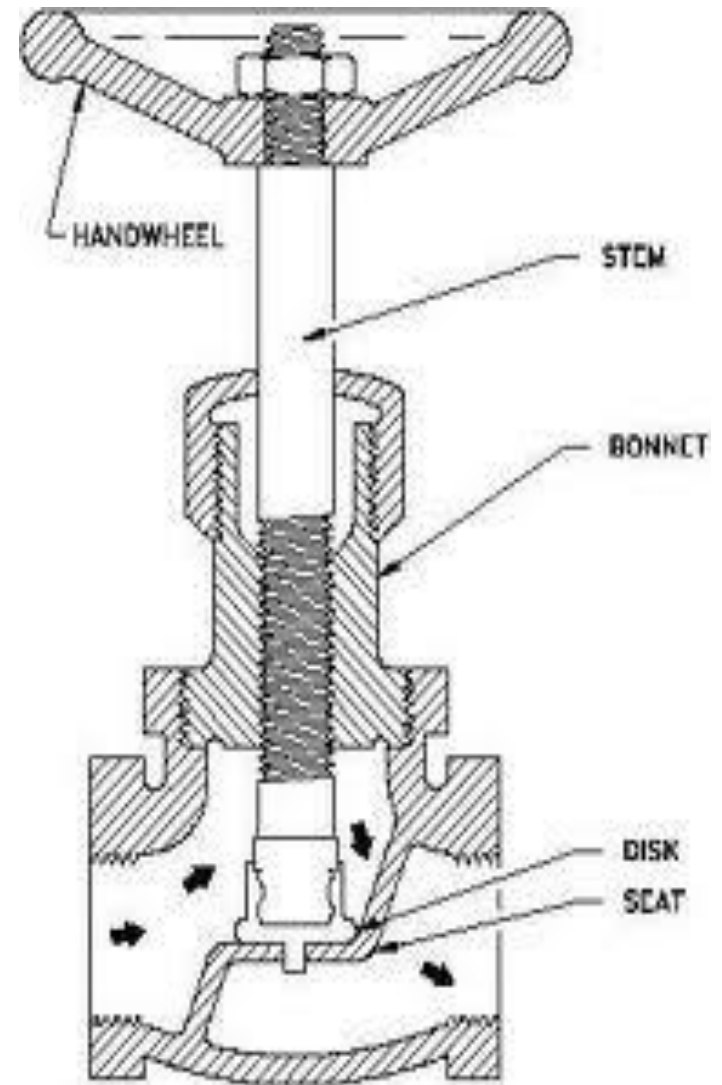
diaphragm valve



pinch valve

Basic Parts of the valve

- ▶ Body
- ▶ Bonnet
- ▶ Trim (internal elements)
- ▶ Actuator (Handwheel)
- ▶ Packing



Basic Parts of the valve

Body

It is called the shell, is the primary pressure boundary of a valve. It serves as the principal element of a valve assembly because it is the framework that holds everything together.



Basic Parts of the valve

Bonnet

The cover for the opening in the valve body.

Bonnets Features

- bonnet is the second principal pressure boundary of a valve.
- It is cast or forged of the same material as the body and is connected to the body by a threaded, bolted, or welded joint.
- the attachment of the bonnet to the body is considered a pressure boundary. This means that the weld joint or bolts that connect the bonnet to the body are pressure-retaining parts.
- Valve bonnets, although a necessity for most valves, represent a cause for concern,
 - Bonnets can complicate the manufacture.
 - Increase valve size.
 - Represent a significant cost portion of valve cost.
 - Bonnets are a source for potential leakage.



Welded Bonnet



Bolted Bonnet

Basic Parts of the valve

Valve Trim

The internal elements of a valve are collectively referred to as a valve's trim. The trim typically includes a disk, seat, stem, and sleeves needed to guide the fluid. A valve's performance is determined by the disk and seat interface and the relation of the disk position to the seat. Because of the trim, basic motions and flow control are possible.



Valve Trim

Basic Parts of the valve

Internal parts of the valve

Disk

Disk is the third primary principal pressure boundary. It provides the capability for allowing and stopping fluid flow. The disk is a pressure-retaining part. Disks are typically forged and, in some designs, hard-surfaced to provide good wear characteristics. Most valves are named, in part, according to the design of their disks.

Seat or seal rings

provide the seating surface for the disk. To improve the wear-resistance of the seal rings, the surface is often hard-faced by welding and then machining the contact surface of the seal ring.



Basic Parts of the valve

Internal parts of the valve

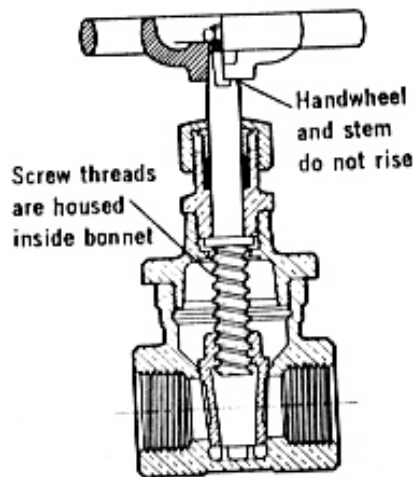
Stem

Connects the actuator (hand wheel) and disk, is responsible for positioning the disk.

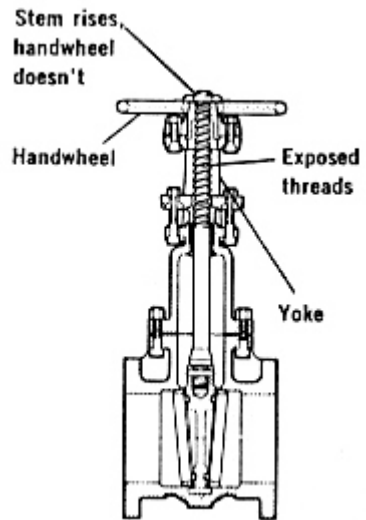
- Stem designs fall into four basic categories:
 - Rising stem with outside screw
 - Rising stem with inside screw
 - Non rising stem with inside screw
 - Sliding stem.



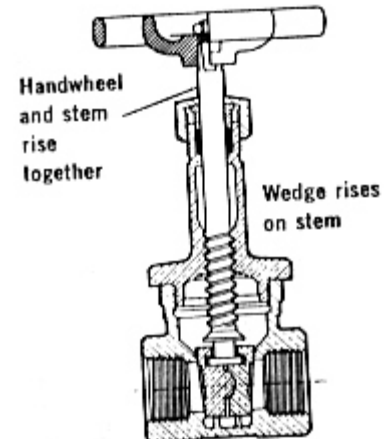
Stem



Inside Screw Non-Rising Stem



Outside Screw



Inside Screw Rising Stem (ISRS)

Basic Parts of the valve

Actuator (hand wheel)

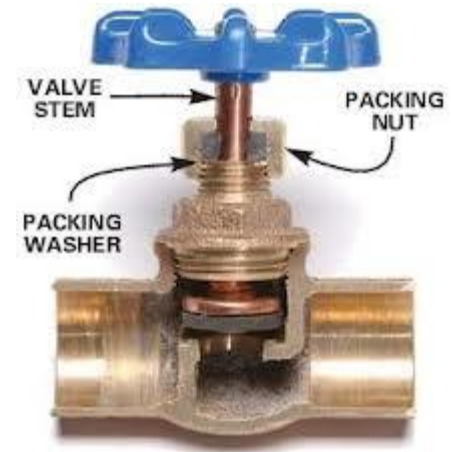
Operates the stem and disk assembly. An actuator may be operated manually or automatically.



Actuator

Packing

It is used to prevent leakage from the space between the stem and the bonnet.



Packing

Valve Selection

Valve Selection Considerations

- ▶ 1. Pressure.
- ▶ 2. Temperature.
- ▶ 3. Type of fluid.
 - A. Liquid.
 - B. Gas, i.e., steam or air.
 - C. Dirty or abrasive (erosive)
 - D. Corrosive.
- ▶ 4. Flow Considerations
 - A. On-off or Throttling.
 - C. Is the valve needed to prevent backflow.
 - D. Concern for pressure drop.
 - E. Velocity.
- ▶ 5. Operating conditions
 - A. Frequency of operation.
 - B. Accessibility.
 - C. Overall space/size available.
 - D. Manual or automated control.
 - E. Need for bubble-tight shut-off.
 - F. Concerns about body joint leaks.
 - G. Fire safe design.
 - H. Speed of closure.

Material Selection

- ▶ **There are factors govern the basic materials selection**
 - ✦ Corrosion–resistance requirements.
 - ✦ Thermal shock.
 - ✦ Piping stress.
 - ✦ Fire hazard.
- ▶ **Types of materials typically available include,**
 - ✦ Ductile iron.
 - ✦ Carbon steel.
 - ✦ Cast iron.
 - ✦ Stainless steels.
 - ✦ Brass.
 - ✦ Bronze.
 - ✦ Polyvinyl chloride (PVC) plastic.
- ▶ **Body Materials**
 - ✦ For small valves are usually brass, bronze, or forged steel
 - ✦ For larger valves, cast iron, cast ductile iron or cast steel as required for the pressure and service.

Material Selection

- ▶ **Seat and Valve Disk Materials**
- ▶ The valve seat and valve disk are sometimes referred to as the valve trim and are usually constructed of the same material selected to meet the service requirements.
- ▶ Valve stem material should be selected to meet service conditions. Stainless steel is commonly used for most HVAC applications, and bronze is commonly used in ball valve construction.

Table 2.9 Temperature Limits for Body Materials†

Material	Upper Limit (°F)	Upper Limit (°C)	Lower Limit (°F)	Lower Limit (°C)
Cast Iron	410	210	-20	-5
Ductile Iron	650	345	-20	-5
*Carbon Steel (Grade WCB)	1000	535	-20	-5
Carbon Steel (Grade LCB)	650	345	-50	-10
Carbon Moly	850	455	-20	-5
1-1/4 Cr - 1/2 Mo (Grade WC6)	1000	535	-20	-5
2-1/4 Cr - 1/2 Mo (Grade WC9)	1050	565	-20	-5
5 Cr - 1/2 Mo (Grade C5)	1100	595	-20	-5
9 Cr - 1 Mo (Grade C12)	1100	595	-20	-5
Type 304 (Grade CF 8)	1500	815	-425	-220
Type 347 (Grade CF8C)	1500	815	-425	-220
Type 316 (Grade CF8M)	1500	815	-425	-220
3-1/2 Ni (Grade LC3)	650	345	-150	-65
Aluminum	400	205	-325	-160
Bronze	550	285	-325	-160
Inconel 600	1200	650	-325	-160
Monel 400	900	480	-325	-160
Hastelloy B	700	370	-325	-160
Hastelloy C	1000	535	-325	-160
Titanium	600	315	N/A	N/A
Nickel	500	260	-325	-160
Alloy 20	300	150	-50	-10

†Courtesy of Valtek International.

*The carbon phase of carbon steel may be converted to graphite upon long exposure to temperatures above 775°F (415°C). Check applicable codes for maximum temperature ratings of various materials. Other specific data available in ANSI B16.34.

Body Type	Material	Body Standard	Bonnet Standard
Castings	Stainless Steel	A351-CF8M	A479-316
	Carbon Steel	A216-WCB	A675-70
	Chrome-moly	A217-WC6	A479-316
		A217-WC9	A479-316
		A217-C5	A479-316
Forgings	Stainless Steel	A743-CF8M	A479-316
	Carbon Steel	A105	A675-70
	Chrome-moly	A182-F11	A479-316
		A182-F22	A479-316
		A182-F5a	A479-316
Bar	Stainless Steel	A182-F316	A479-316
		A479-316	A479-316
	Carbon Steel	A675-70	A675-70
		Chrome-moly	See Forgings

Table 2.10 Common ASTM Materials for Bodies and Bonnets

Valve End Connections

▶ Threaded ends

- Used for small application up to 4 in. they are cheap but can be stripped and leak, for this reason they are used when leakage is not a problem. Threaded ends should not be used with corrosive processes, since the threads can either fail or become inseparable.



Threaded end

Valve End Connections

▶ Welded ends

- When zero leakage is required for environmental, safety, or any efficiency reasons the piping can be welded to the valve, providing one piece construction. Many users insist that high-pressure application requires a permanent end especially if they involve high temperatures



Welded end

▶ Flanged ends

- The most expensive but are the best from an installation and removal standpoint. The main advantage of flanges is that the valve can be removed easily from the line



Flanged end

Valve types

- Globe valve
- Gate valve
- Plug valve
- Ball valve
- Needle valve
- Butterfly valve
- Diaphragm valve
- Pinch valve
- Check valve
- Safety/relief valve
- Reducing valve

Globe Valves

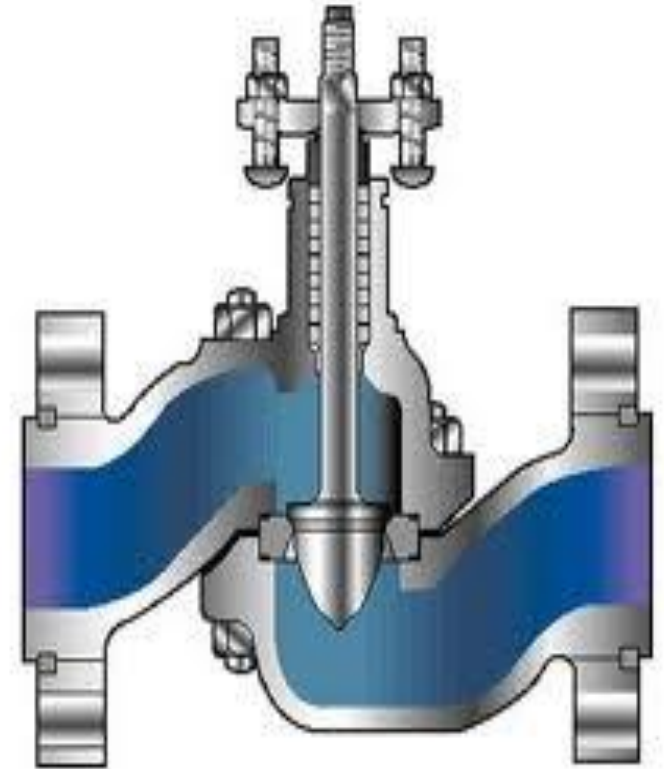
A globe valve is a linear motion valve used to stop, start, and regulate fluid flow. The three primary body designs for globe valves are Z-body, Y-body, and Angle.

Advantages

- Recommended for throttling applications.
- Good for frequent operation.
- Easy to repair.

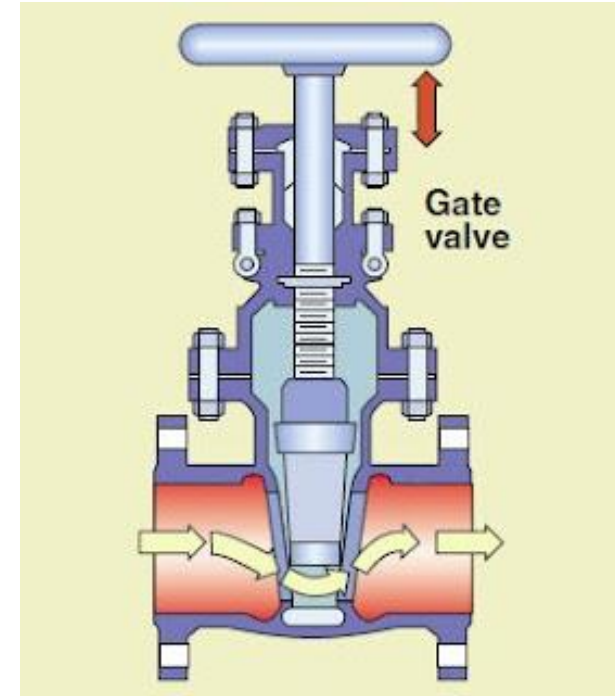
Disadvantages

- Flow path causes a significant pressure drop.
- Globe valves are more costly than alternative valves.



Gate Valves

Flow is controlled by raising or lowering the valving element. Gate valves are not usually used to regulate flow because the valving element can be damaged when in the partially open position. Similarly, they also limit the pressure drop across the valve when fully open.



Advantages

- Gate valves opens or closes slowly, which prevents fluid hammer and subsequent damage to the piping system.
- They need long operation time since setting the valve to the fully open or closed position requires the handle to be turned many times.
- Good choice for on-off service.
- Full flow, low pressure drop.
- Bidirectional.

Disadvantages

- It is not suitable for throttling applications.
- It is prone to vibration in the partially open state.
- It is more subject to seat and disk wear.
- Repairs, such as lapping and grinding, are generally more difficult to accomplish.

Ball Valves

A ball valve is a rotational motion valve that uses a ball-shaped disk to stop or start fluid flow.

Advantages

- Maintains and regulates high volume, high pressure, and high temp flow
- Low purchase and maintenance costs.
- No lubrication requirements.
- Give tight sealing with low torque.
- Time of valve operation is minimized.
- Can be used for throttling service.
- Can handle fluids with suspended solids.

Disadvantages

- Have relatively poor throttling characteristics.
- Difficult to clean, leads to contamination



Butterfly Valves

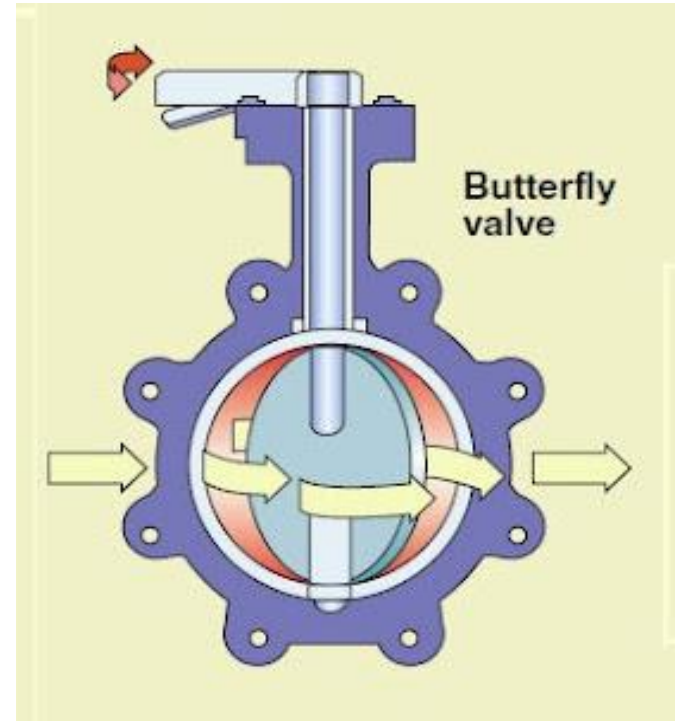
Butterfly valves are rotary motion valve that is used to stop, regulate, and start fluid flow.

Advantages

- They are suitable for large valve applications.
- Compact, lightweight design.
- The maintenance costs are usually low.
- Pressure drop across a butterfly valve is small.
- Used with chemical or corrosive media.

Disadvantages

- Difficult to clean
- Throttling limited to low differential pressure
- Potential for cavitations and choke
- Unguided disc movement is affected by flow turbulence



Diaphragm Valves

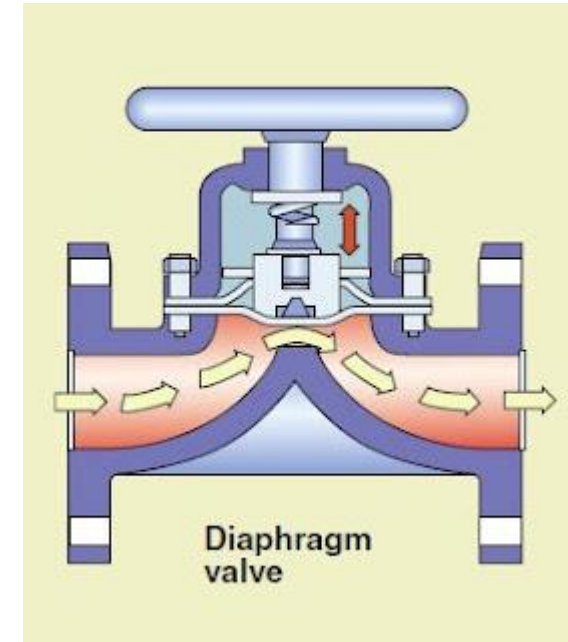
A diaphragm valve is a linear motion valve that is used to start, regulate, and stop fluid flow. The name is derived from its flexible disk, which mates with a seat located in the open area at the top of the valve body to form a seal.

Advantages

- valve components can be isolated from the process fluid.
- Valve construction prevents leakage of the fluid without the use of a gland seal (packing)

Disadvantages

- The diaphragm becomes worn more easily and regular maintenance is necessary.
- These types of valves are generally not suited for very high temperature fluids and are mainly used on liquid systems.



Pinch Valve

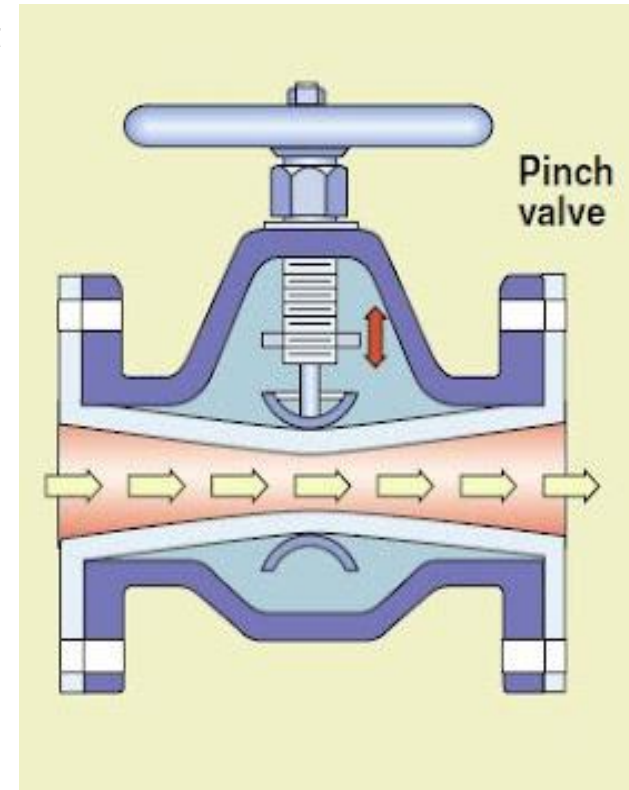
A pinch valve is the simplest valve design. It is a linear motion valve that is used to start, regulate, and stop fluid flow. It uses a rubber tube (pinch tube) to control the fluid.

Advantages

- They are ideally suited for the handling of slurries, liquids with large amounts of suspended solids, and systems that convey solids pneumatically.
- Can be used for application where corrosion or metal contamination of the fluid might be a problem.
- The flow passage is straight without any crevice.
- There are no internal moving parts in contact with the fluid.
- Low maintenance due to wear or pressure.
- Minimum items to change. Tube ONLY.

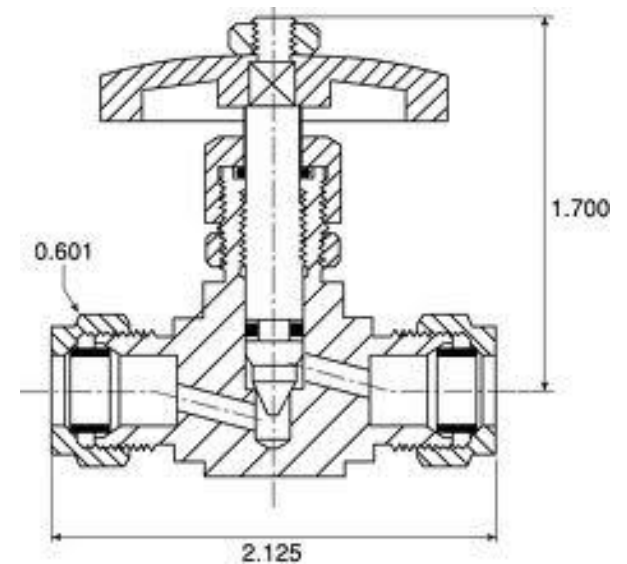
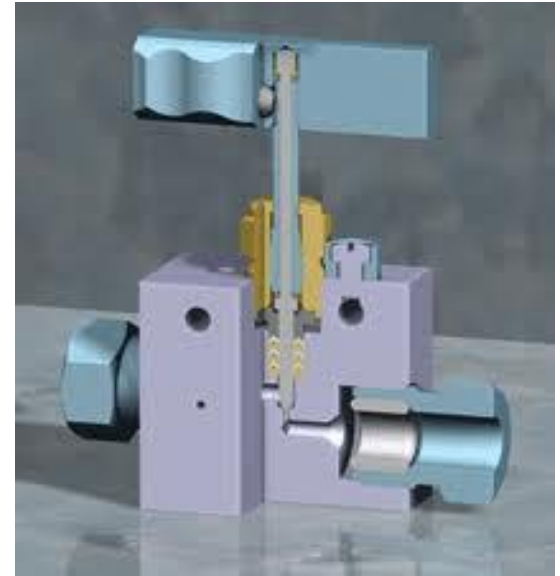
Disadvantages

- Cannot be used in high temperature/ pressure applications
- Cannot be used with gas media



Needle valves

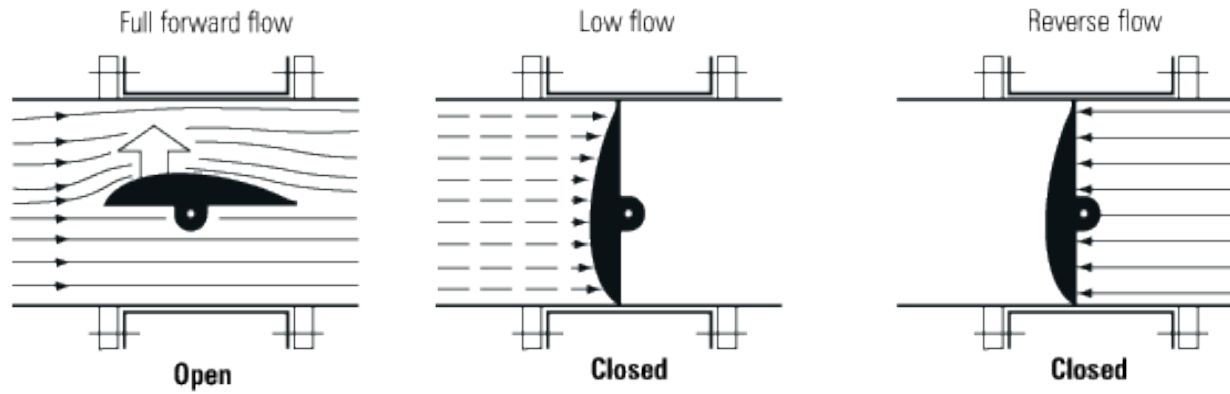
They are used to make relatively fine adjustments in the amount of fluid flow.



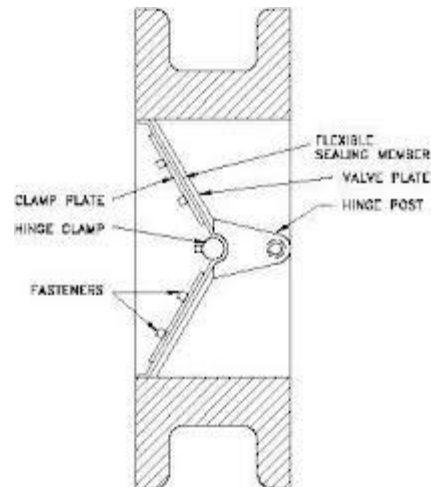
Check Valves

Check valves are designed to prevent the reversal of flow in a piping system. These valves are activated by the flowing material in the pipeline. The pressure of the fluid passing through the system opens the valve, while any reversal of flow will close the valve. Closure is accomplished by the weight of the check mechanism, by back pressure, by a spring, or by a combination of these means. The general types of check valves are swing, tilting-disk, piston, , and stop.

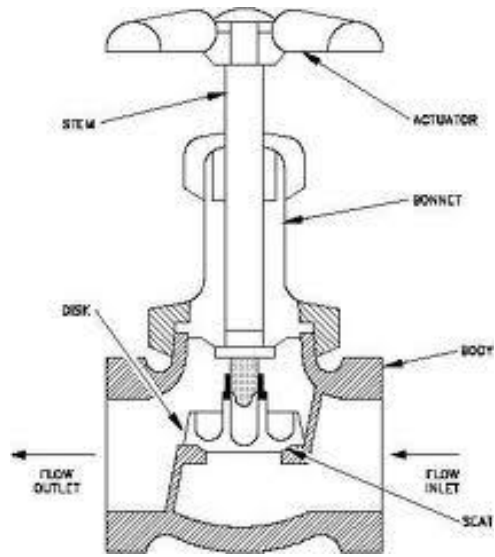




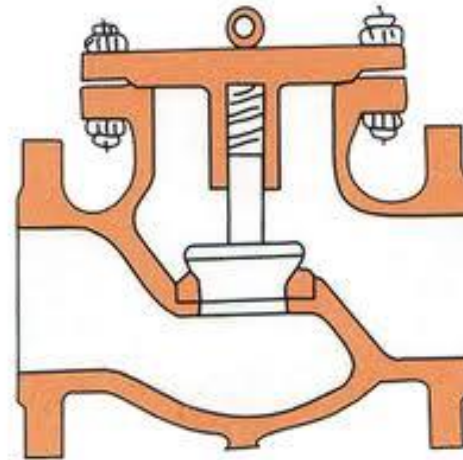
tilting-disk Check Valve



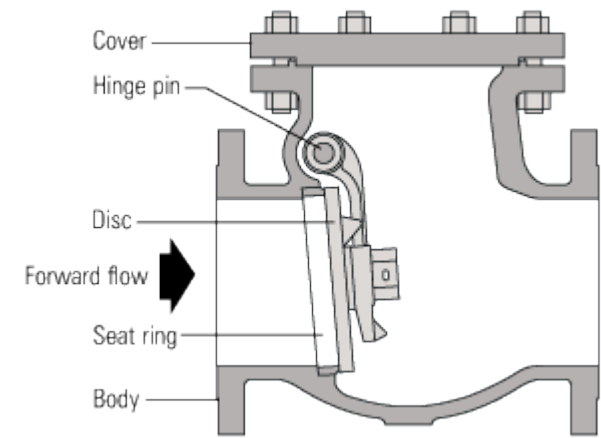
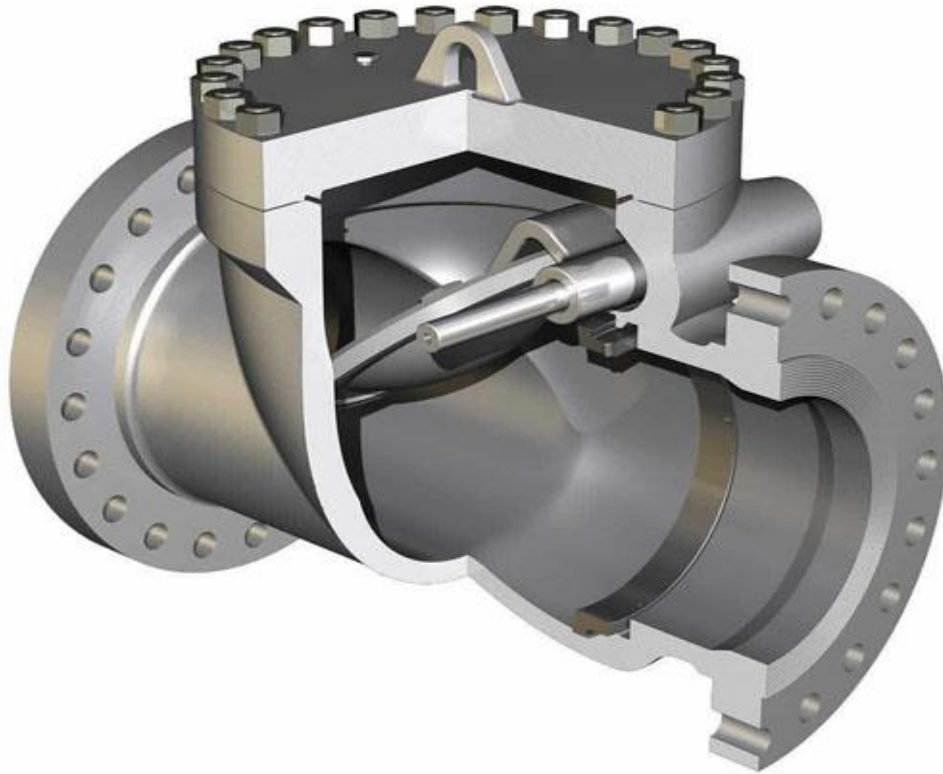
Butterfly Check Valve



Stop Check Valve



Lift Check Valve



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