VALVES

CONTENTS

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- Valve Operators
- Specification Codes and Standards
- Classification of Valves
- Major Valve Parts
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INTRODUCTION

- Valve is a device that controls the flow of a fluid by opening, closing or regulating the various pathways.
- Used to control flow, rate, volume, pressure and the direction of fluid within a pipe.
- Applications include industries, transportation, commercial, military etc.
- Oil and gas, power generation, mining, sewerage, chemical manufacturing constitute majority of industrial valves.

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INTRODUCTION

- Valves can turn on or off, regulate, modulate, or isolate.
- They can handle temperatures from the cryogenic region to molten metal exceeding 1500°F, and valves can contain pressures ranging from severe vacuum to 20,000 pounds per square inch.
- Range in size from a fraction of an inch to as large as 30 feet in diameter
- Valves also can control the flow of all types of commodities from the thinnest gas to highly corrosive chemicals, from superheated steam to toxic gases, from abrasive slurries to radioactive materials

VALVE OPERATORS

- Defines the mechanism that causes a valve to perform its function.
- Operators can be automatic or manual.
- Manual operation is performed either by hand wheel, gear ,lever or pedal.
- Chain operators are used when the valve is installed at a greater height.
- Automatic operation is performed by external power supply such as pneumatic, hydraulic or electrical power.
- Automatic operators are also known as actuators.
- Actuators uses the change in pressure, temperature or flow to be acted upon a piston or diaphragm, which in turn activates the valves
- e.g.: safety valves in steam boilers.

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SPECIFICATION CODES AND STANDARDS

- ASME: B16.10, B16.33, B16.34, B16.38, B16.40, N278.1
- ANSI: 1003,1029, 1032 etc.
- AWWA: CS500-93, CS501-92, CS504-94, CS507-91, CS508-93, CS509-94, CS510-92, CS511-92, CS512-92, CS540-93, CS550-90 etc.
- API: 6D-94, 6FA-94, 526-95, 527-91, 589-93, 594-91, 598-90, 599-94, 600-91, 602-93, 603-91, 607-93, 608-95 etc.
- MSS: MSS-SP-6, MSS-SP-25, MSS-SP-42, MSS-SP-45, MSS-SP-53, MSS-SP-54, MSS-SP-55 etc.
- Also ARI, ASSE, ISA standards and specifications are also specify valves.

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INTERNATIONAL STANDARDS FOR VALVES

Design, construction, inspection and testing of valves are covered under various international standards. EG:

Gate valves :- API 600 for larger sizes, API 602 for smaller sizes.

Single check valves :- API 602 and BS 5352 for smaller sizes, BS 1873 for larges sizes.

Swing check valves :- BS 1868

Dual plate check valves :- API 594

Lift check valves :- BS 5352

Butterfly valves :- API 609, BS EN 593

Ball valves :- API 6D, BS 5351

Valve testing and inspection :- API 598, BS 6755 part-I

Fire safe testing :- API 607, API 6FA, BS 6755 part II

General valve design :- ASME B16.34

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HOW TO SPECIFY A VALVE

A valve is specified by following:-

1. Type of valve, gate, ball, globe, check etc
2. Size
3. Pressure class, 150, 300, 600, 900, 1500 & 2500 for flanged and welded end valves and class 800, 1500, for select welded and threaded end flanges
4. Body and bonnet material
5. Trim material
6. Packing & sealing material
7. Bolting material
8. International standard for design, inspection and resting
9. Hydrostatic test pressure for shell and seat.
10. Any other special requirements

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VALVE SPECIFICATION - EXAMPLE

Monel Gate Valve:

- Design: API 602,
- Thread ends: ASME B1.20.1
- Socket welded ends: ASME B 16.11,
- Test and inspection: API 598
- Body material: M-30C, M35-1, Monel 400, Monel 600, Monel K500
- Pressure rating: PN1.0MPa~PN6.4MPa, Class150~600
- Diameter size: DN15~600mm, NPS1/2~24 inch
- Temperature: -29~ +250 degree
- Working medium: strong corrosive medium

CLASSIFICATION OF VALVES

- Classification Based on Mechanical Motion:
- Linear Motion Valves: The valves in which the closure member, as in gate, globe, diaphragm, pinch, and lift check valves, 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, eccentric- and swing check valves, the valves are called rotary motion 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

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CLASSIFICATION OF VALVES

Valve type	Linear motion	Rotary motion	Quarter turn
Gate valve	X		
Globe valve	X		
Swing check valve		X	
Lift check valve	X		
Tilting-disc check valve		X	
Folding-disc check valve		X	
In-line check valve	X		
Stop check valve	X	X	
Ball valve		X	X
Pinch valve	X		
Butterfly valve		X	X
Plug valve		X	X
Diaphragm valve	X		
Safety valve	X		
Relief valve	X		

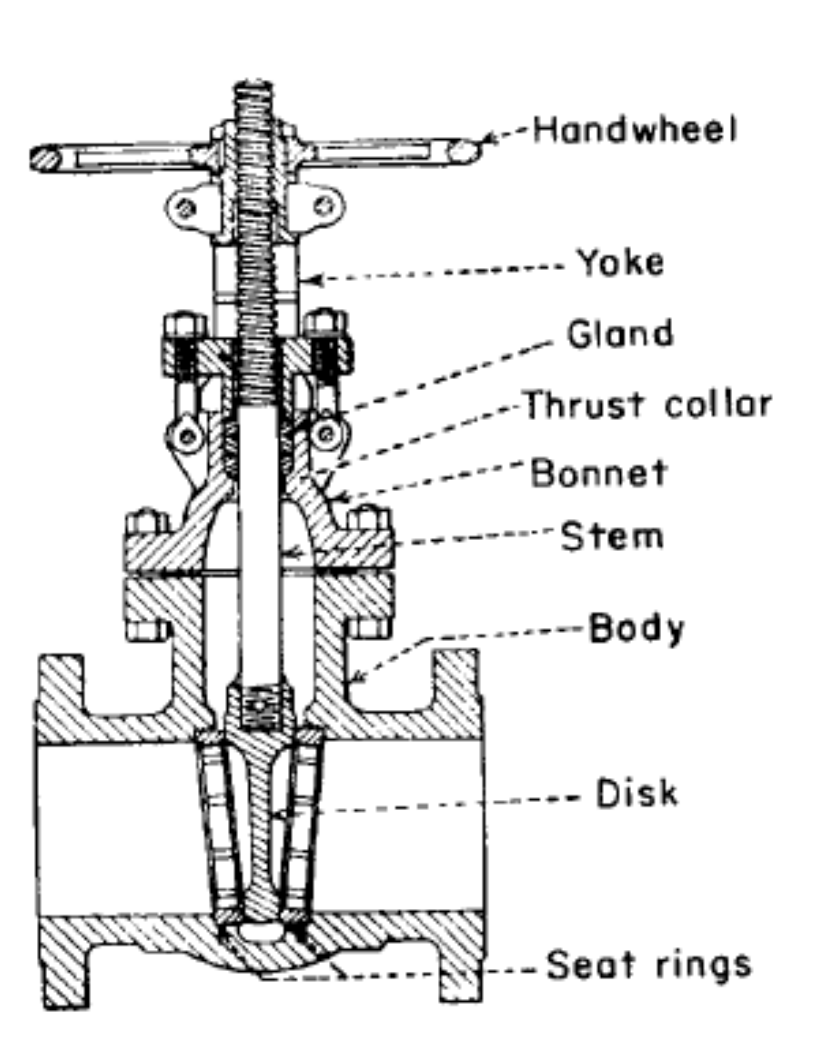
CLASSIFICATION OF VALVES

- Classification Based on Valve Size:
- Small Valves: NPS 2 (DN 50) and smaller valves are called small valves. At times, NPS 2½ (DN 65) and smaller valves are referred to as small valves
- Large Valves: NPS 2½ (DN 65) and larger valves are classified as large valves.As indicated earlier, NPS 2½ (DN 65) valves may be designated as small valves, depending on the criteria used in classifying small valves.

CLASSIFICATION OF VALVES

- Classification Based on Pressure-Temperature Rating:
- Class Ratings: According to ASME B16.34,MSS and API
- Cold Working Pressure (CWP) Rating: According to ASME B16.34 and other piping standards
- NFPA rating: National Fire Protection Association rating for safety standards
- General Service Rating:
- Steam Working Pressure (SWP) Rating:
- Dual or Multiple Ratings:

MAJOR VALVE PARTS



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MAJOR VALVE PARTS

- Pressure retaining parts
- Body
- Bonnet or cover bolting
- Valve Trim
- Bonnet or Cover
- Disc

- NonPressure retaining parts
- Valve Seat
- Galling Prevention
- Valve Stem
- Rising Stem with Outside screw and yoke
- Rising Stem with inside screw
- Non Rising Stem with inside screw
- Sliding and Rotary Stem
- Stem Packing and Protector
- Back seat

MAJOR VALVE PARTS

Valve parts can be classified as:-

- Pressure retaining parts which includes body, bonnet, or cover, disc etc.
- Non-pressure retaining parts which include seats, stem, globe, hand wheel etc.

PRESSURE RETAINING PARTS

Body:-

The valve body houses the internal valve parts and provides the passage for fluid flow. The valve body may be cast, forged, fabricated or a combination of these process.

The valve body ends are designed to contact the valve to the piping or equipment nozzle by different types of end connections such as butt or socket welded, threaded, flanged etc

PRESSURE RETAINING PARTS

BONNET OR COVER

- The bonnet or cover is fastened to the valve body to complete the pressure retaining shell.
- Not all valves have bonnets. Both gate and globe valves do have bonnets. The top closure of a check valve is called caver.
- The valve bonnet is attached to the valve body by different types of joints as follows:-
- Screwed and union joints:- they are compact but prone to leaks and vibration etc. Hence used in low pressure utility services of small sizes.
- Bolted bonnets:- This is the most commonly used design , where the body and bonnet are joined by bolts and gaskets.

PRESSURE RETAINING PARTS

- Welded bonnet:- These are used for high pressure services, and vibrating services for services where leakage is not acceptable. Maintenance of welded bonnet valves can be done only in factory.
- Pressure-seal joint:- These are used in high pressure services, mostly class 900 and above.

PRESSURE RETAINING PARTS

DISCS

- The disc is the part which allows, throttles or stops flow Depending on its position. In a ball valve the disc is called ball and in a plug valve it is called plug.
- The valve body will have seats and the discs is seated against the seat when the valve is in closed position. To open the valve, the disc is moved away from the seat.

NON-PRESSURE RETAINING PARTS

Valve seats:-

Valves may have one or more seats. A gate valve has two seats. One on the up stream, and other on the other stream side. The gate valve disc or wedge has two seating surfaces that come in contact with valve seats to form a seal for stopping the flow.

A globe valve or swing check valve has only one seat.

valve seats may be integral to the body or renewable which will be screwed in etc which can be removed.

NON-PRESSURE RETAINING PARTS

Stem:-

The valve stem imparts the required motion to the disc, plug or ball for opening or closing of the valve. It is connected to the valve hand wheel, actuator or lever at one end and the disc at other end. In gate or globe valves, the stem moves up and down for opening and closing of valve. Where as in ball and plug valves, the stem is rotated.

Check valves do not have stems. The disc is opened or closed by the fluid flow.

TYPES OF STEM DESIGN

Rings stem with outside screw and yoke (OSeY)

This is the most commonly used design for valve sizes 2” and above. The outermost part of the item is threaded, while the portion of stem inside the valve is smooth. A threaded sleeve causes the stem to rise through the hand wheel. So that the hand wheel will not move up and down. The stem packing isolate the stem threads from the flow medium. The stem packing also prevents leakage of the flow medium to the environment and prevent outside air from entering the valve in vacuum application.

TYPES OF STEM DESIGN

A portion of the threaded stem is exposed to atmosphere when the valve is in open position causing dirt and other substances to deposit on the stem and impairing its smooth operation. A stem protector in the form of a clear plastic sleeve, tubing or a pipe with a cap at the end is installed to protect the stem. The length of the stem protector must be adequate to allow full stem travel.

TYPES OF STEM DESIGN

Ringing stem with inside screw:- The threaded part of the stem is inside the valve body and the stem packing is along the smooth part which is exposed to atmosphere. In this case the stem threads are in contact with the fluid. When rotated, the stem and the hand wheel rise together to open the valve. This design is commonly used in the smaller sized low-to-moderate pressure gate and globe valves.

TYPES OF STEM DESIGN

Non-rising stem with inside screw:- The threaded part of the stem is inside the valve and does not rise. The valve disc travels along the stem like a nut when the stem is rotated. Stem threads are exposed to the flow medium in the passage and as such, are subjected to its impact. Hence this design is used where the space is limited to the allow linear stem movement and the flow medium does not cause erosion, corrosion or wear and tear of stem material.

NON-PRESSURE RETAINING PARTS

Back seat:- Back seat is comprised of a shoulder on the stem and a mating surface on the under side of the bonnet. It forms a seal when the stem is in the fully opened position. It prevent the leakage of the fluid in to the packing chamber and consequently to the environment. Backseat enables dismantling of the valve beyond the bonnet without disrupting the flow through the valve.

NON-PRESSURE RETAINING PARTS

Yoke The yoke contacts to the valve body or bonnet with the stem. On many valves the yoke and the valves are designed as one piece construction. The top of the yoke holds a yoke nut, stem nut or yoke bushing and the valve stem passes through it.

A yoke must be study enough to withstand forces, moments and torque developed by the actuator.

Valve Trim:-

The removable and replaceable valve integral parts that come in contact with the flow medium are collectively termed as valve trim. Trim include valve seats, discs, glands, guides, bushings, internal springs, stem etc._

VALAVE MATERIALS

Valve material selection depends on the fluid handled by the valve and the design temperature. It includes material for body, trim and packing.

BODY MATERIALS:-

- Valve body and bonnet are of the same material. Carbon steel is the most commonly used material. Construction is generally forged for the size up to 11/2” and casting for 2” and above.
- Brass and bronze are used for the brine services. Because of their high corrosion resistance.
- Stainless steel and chrome alloys rarely justified due to their high cost except for serious corrosion problems or extreme temperatures.

TRIM MATERIALS

Hardened 13% chromium steel is the most widely used material for the valve trim. A better material is stellite. Stellite is a trade name. It resists wire drawing, increasing valve life, and is specified for high temperature and pressure services.

Precipitation hardened stainless steel such as 17-4 PH are used for the stem materials. Steel valves in hydrogen service should have yoke bushings, sleeves, nuts, gland followers etc of materials with a melting point of 1750ºc for higher for fire resistance. In order to prevent or minimize galling (sticking) of the valve disc and valve seats. It is common practice to provide a differential hardness (Normally 50 BHN) between the disc and seats. The stationary seats will have a hardness of 50 BHN more than that of disc.

TRIM MATERIALS

The valve standard API-600 gives a table of various trim materials which are designated by trim number 1,2,3 etc

VALVE PACKING AND SEALS

- Packing material shall be properly selected to avoid leakage through the packing. Flexible graphite is the most commonly used packing material.
- Teflon packing should not be used in hydro carbon services, since it will be lost in a fire.

FLUORO CARBON SEALS:- Teflon is the fluoro carbon plastic which is chemically resistant to almost all common services. However they are not very resilient and are liable to leak if scratched or out. Its use is limited to 450 f or lower and where fire resistance is not critical. One exception is fire resistant seats with secondary metal to metal backup.

VALVE PACKING AND SEALS

- ELASTOMER SEALS:- They are resistant and are useful in dirty services. Where scale, sand or other solids are in full stream.
- Viton is a synthetic rubber limited up to 350ºf. It is mainly used for its proper resistance to aromatic hydro carbon. Viton should not be used with ammonia or amives.
- Nitnl (Buna-N) and Neoprene are common elastomer material used for water and hydro carbon services low in aromaticer. They are limited to maximum temperature of 300ºf .
- Seal material must suit the service fluid otherwise, it will swell reducing strength and life of the seal

VALVE CATEGORIES

- Stop (Isolation) Valves:
- Are used to stop flow or isolate a portion of the system until it is desirable to achieve flow downstream of the valve.
- The basic design requirement of stop valves is to offer minimum resistance to flow in the fully open position and to exhibit tight shut-off characteristics when fully closed.
- Gate, globe, ball, butterfly, plug, and diaphragm valves satisfy the above requirements in varying degrees and, therefore, are widely used in shut-off service

BACK

VALVE CATEGORIES

- Regulating Valves:
- Valves are generally used for the prevention of backflow.
- The valves are self actuating and the valve disc is kept open by the forward flow of fluid.
- The valve disc is quickly closed by reverse flow. In certain applications, pneumatic actuators may be used to assist in the rapid closure of the valves on reversal of flow

VALVE CATEGORIES

- Pressure-Relief Devices:
- Pressure-relief devices are used to protect piping and equipment from being subjected to pressures that exceed their design pressures
- the seating of relief valves is accomplished by a compressed spring, which exerts a force on the valve disc, pressing it against the valve seat. When the force exerted by the fluid on the valve disc exceeds the spring force, the valve automatically opens to release the excess pressure

COMMON VALVE TYPES

- GATE VALVES
- GLOBE VALVES
- CHECK VALVES
- BALL VALVES
- PLUG VALVES
- DIAPHRAGM VALVES
- BUTTERFLY VALVES
- ANGLE VALVES
- PRESSURE RELIEF VALVES
- SAFETY VALVES
- NEEDLE VALVES
- CONTROL VALVES

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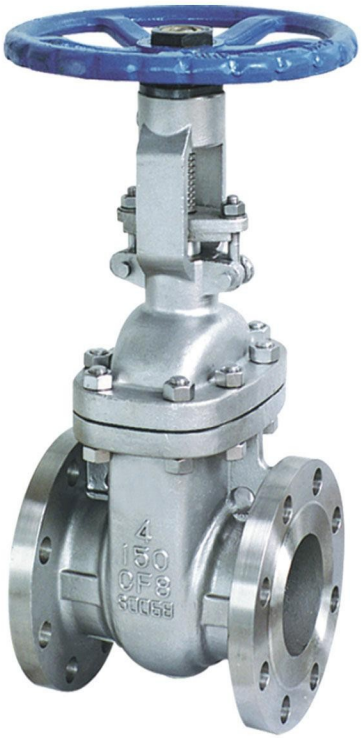
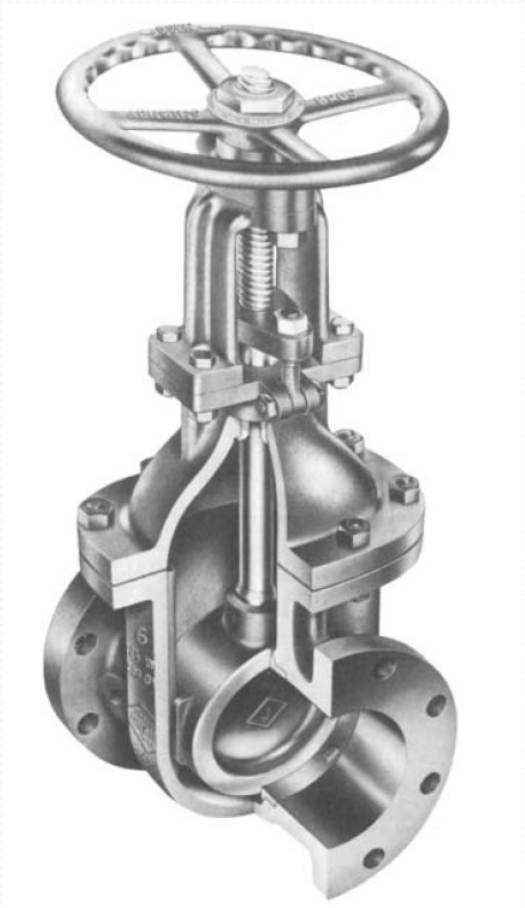
GATE VALVE





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GATE VALVE

- Most frequently used valve in piping system, also called sluice valve.
- Mainly used in on-off control and non throttling applications with low pressure drop.
- Operation: The turning of the hand wheel causes the vertical wedge or gate to slide up or down resulting in on/off position of the valve.
- Should not be operated in a partially opened or closed position.
- Distinct feature is the planar sealing surface b/w the gate and seats.
- Specification of gate valve is obtained from MSS SP-81, API 600, API 602, API 603, AWWA C500, MSS SP-70

CONSTRUCTION OF GATE VALVE

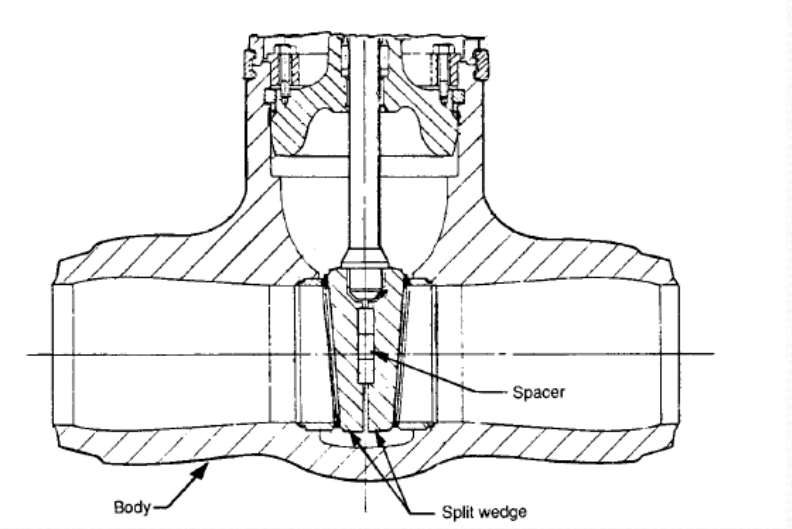
- Gate valves consist of three major components: body, bonnet, and trim.
- The body is generally connected to the piping by means of flanged, screwed, or welded connections.
- The bonnet, containing the moving parts, is joined to the body, generally with bolts, to permit cleaning and maintenance.
- The valve trim consists of the stem, the gate, the wedge, or disc, and the seat rings

TYPES OF GATE VALVE

- Wedge type gate valve
- Double Disc type gate valve

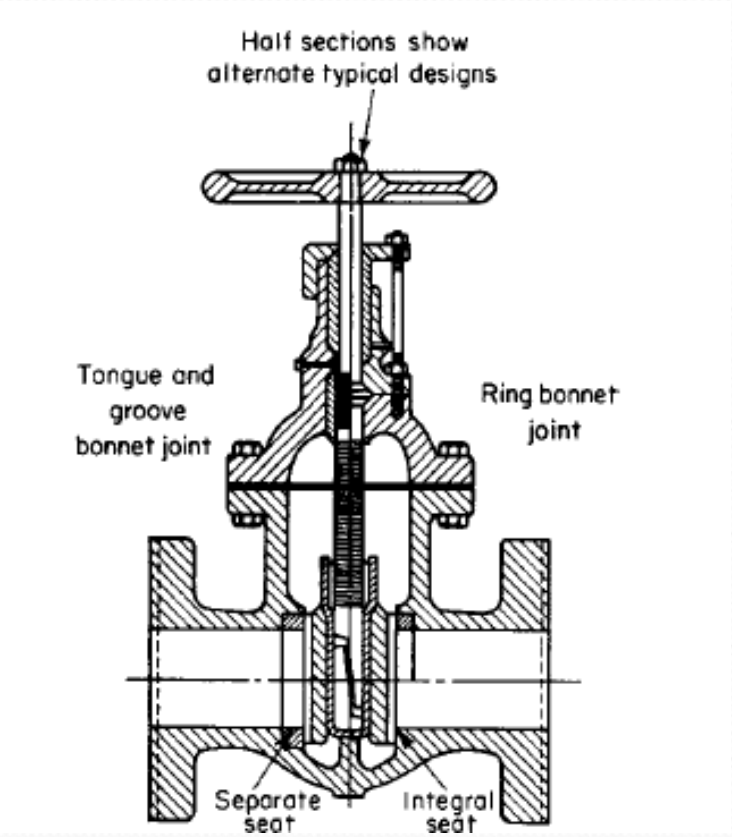
WEDGE TYPE GATE VALVE:

- There are four types of wedges: solid, hollow, split, and flexible wedge. The solid wedge is a single-piece solid construction. It does not compensate for changes in seat alignment due to pipe end loads or thermal fluctuations.



DOUBLE DISC TYPE GATE VALVE:

- In the double-disc parallel-seat valves the discs are forced against the valve seats by a wedging mechanism as the stem is tightened. The major advantage of this type is that the disc cannot be jammed into the body, an action that might make it difficult to open the valve



ADVANTAGES

- They have good shutoff characteristics.
- They are bidirectional.
- The pressure loss through the valve is minimal.

DISADVANTAGES

- Gate valves are not quick opening or closing valves. Full-stem travel to open or close a gate valve requires many turns of its hand wheel or an actuator.
- Gate valves require large space envelope for installation, operation, and maintenance.
- The slow movement of the disc near the full-closed position results in high-fluid velocities, causing scoring of seating surfaces, referred to as wire drawing. It also causes galling of sliding parts.

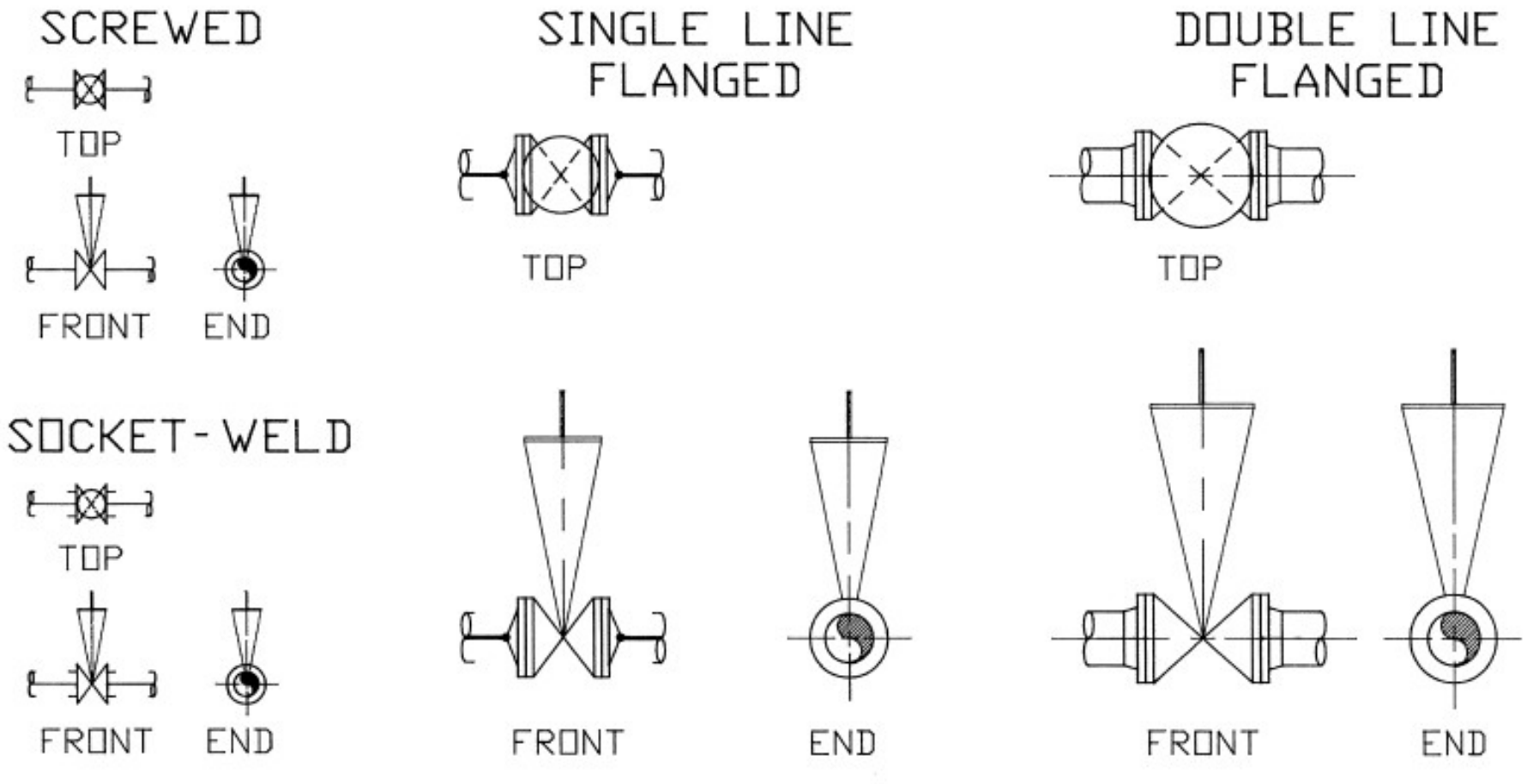
DISADVANTAGES

- Some designs of gate valves are susceptible to thermal or pressure binding, depending upon the application.
- In systems experiencing high-temperature fluctuations, wedge-gate valves may have excessive leakage past the seats due to changes in the angular relationship between the wedge and the valve seats caused by piping loads on the valve ends.
- Repair or machining of valve seats in place is difficult

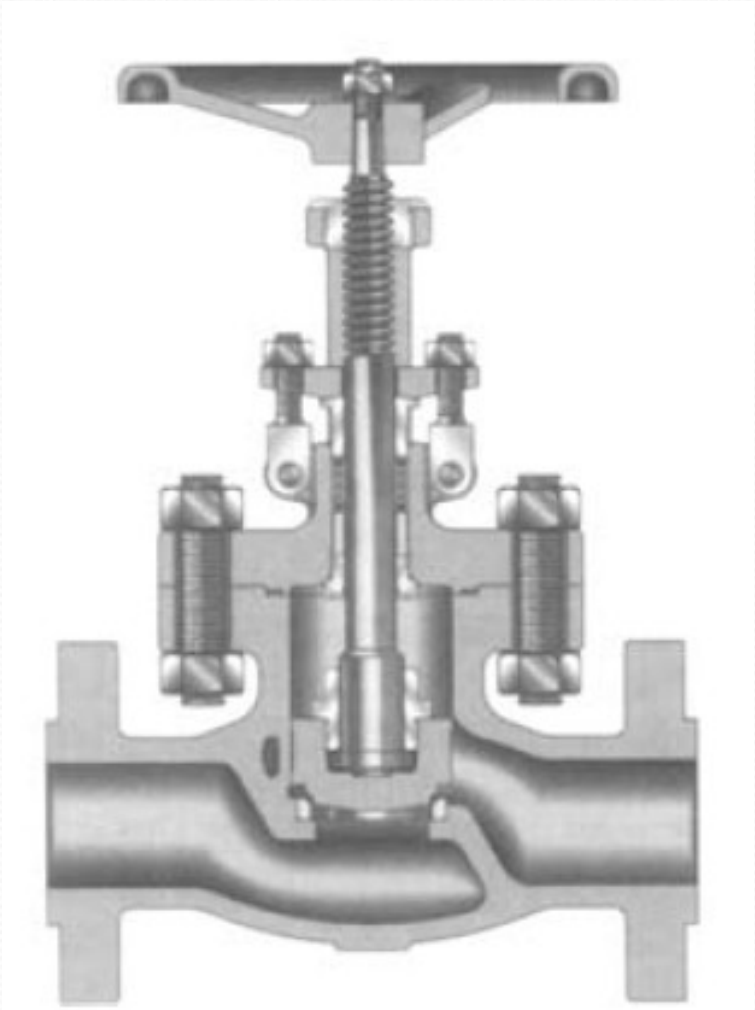
TYPICAL GATE VALVE APPLICATIONS

- Socket or butt-welding end-gate valves in air, fuel gas, feed water, steam, lube oil, and other systems are typical applications.
- Threaded-end gate valves may be usedin air, gaseous, or liquid systems. Concern for leakage from threaded connection can be addressed by seal welding the threaded connection or by using thread sealants, as appropriate.
- In low-pressure and low-temperature systems such as fire protection systems' water piping or water distribution pipelines, flanged gate valves are commonly used.

GATE VALVE DRAWING SYMBOLS



GLOBE VALVE



BACK

GLOBE VALVE

- Globe valves are spherical body with the two halves of the body are separated by an internal baffle.
- Primarily used in applications where throttling and frequent operation of the commodity is required.
- Good for regulating flow.
- It consists of a movable disc type element and a stationary ring seat in a generally spherical body.
- Operation: The rotation of the hand wheel adjusts the flow rate of the commodity to the desired level.
- Limitations: Pressure drop and turbulence.

CONSTRUCTION OF GLOBE VALVE

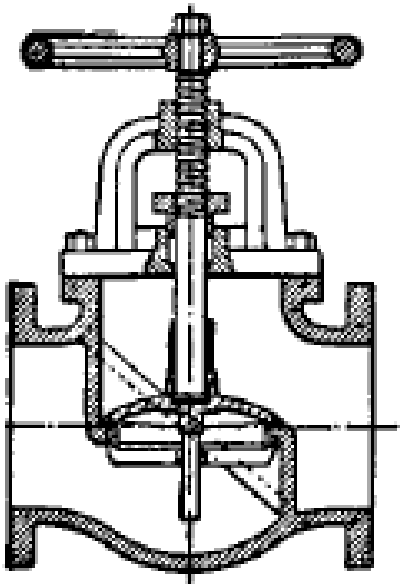
- Globe valves usually have rising stems, and the larger sizes are of the outside screw-and-yoke construction.
- Components of the globe valve are similar to those of the gate valve.
- This type of valve has seats in a plane parallel or inclined to the line of flow.
- The principal variation in globe-valve design is in the types of discs employed.
- Plug-type discs have a long, tapered configuration with a wide bearing surface providing maximum resistance to the erosive action of the fluid stream

TYPES OF GLOBE VALVE

- Tee Pattern globe valves
- Wye Pattern globe valves
- Angle Pattern globe valves

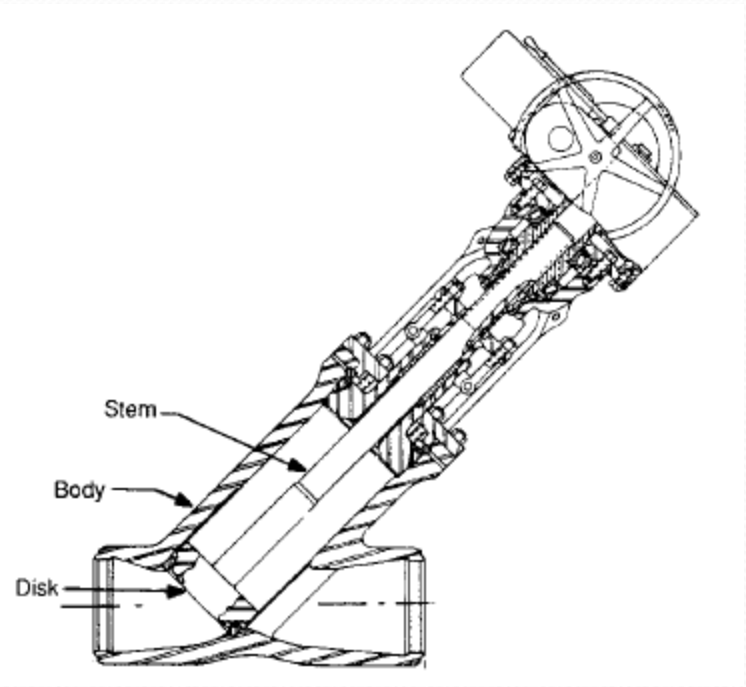
TEE PATTERN GLOBE VALVE

- Tee Pattern globe valves have the lowest coefficient of flow and higher pressure drop. They are used in severe throttling services, such as in bypass lines around a control valve



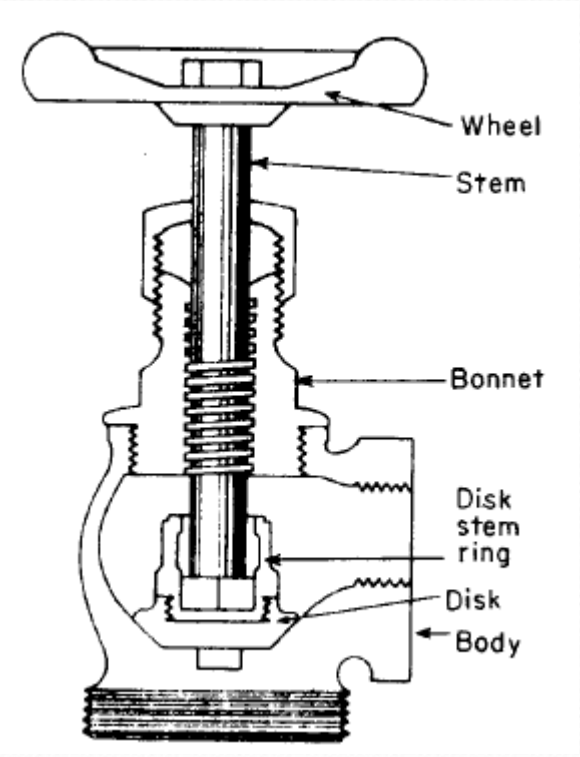
WYE PATTERN GLOBE VALVE

- Wye Pattern globe valves, among globe valves, offer the least resistance to flow. They can be cracked open for long periods without severe erosion. They are extensively used for throttling during seasonal or startup operations.



ANGLE PATTERN GLOBE VALVE

- Angle Pattern globe valves turns the flow direction by 90 degrees without the use of an elbow and one extra weld. They are used in applications that have periods of pulsating flow because of their capability to handle the slugging effect of this type of flow



ADVANTAGES

- Good shutoff capability
- Moderate to good throttling capability
- Shorter stroke (compared to a gate valve)
- Available in tee, wye, and angle patterns, each offering unique capabilities
- Easy to machine or resurface the seats
- With disc not attached to the stem, valve can be used as a stop-check valve

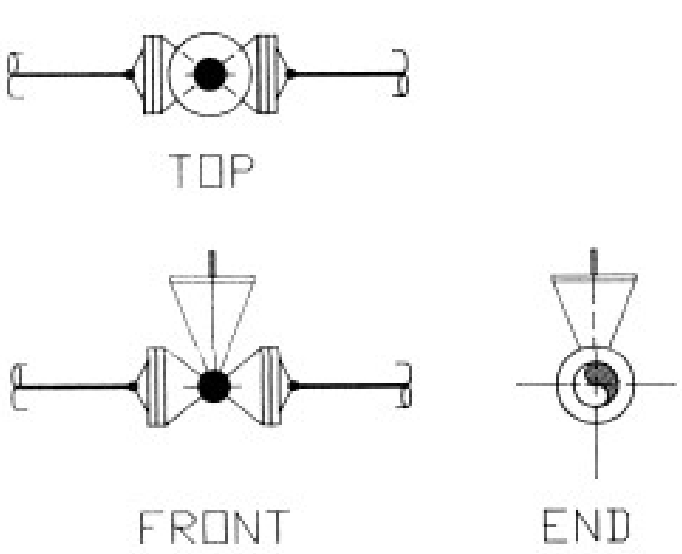
DISADVANTAGES

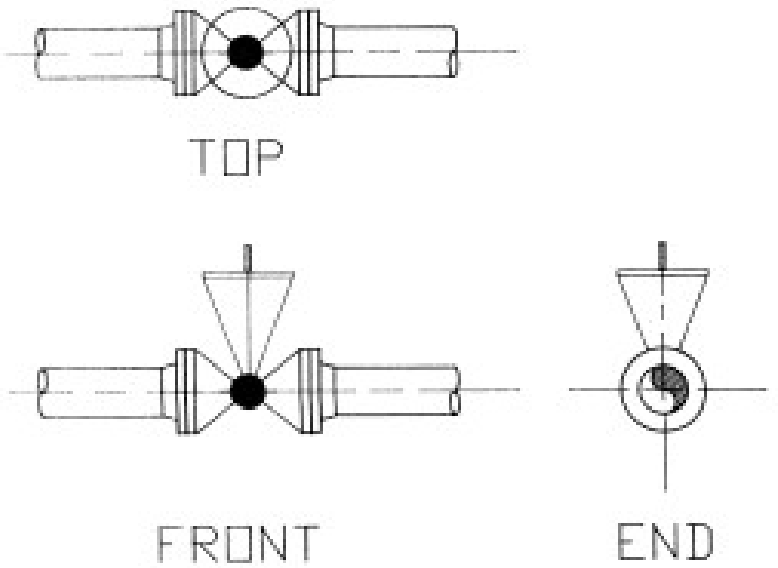
- Higher pressure drop (compared to a gate valve)
- Requires greater force or a larger actuator to seat the valve (with pressure under the seat)
- Throttling flow under the seat and shutoff flow over the seat

TYPICAL APPLICATIONS OF GLOBE VALVES

- Cooling water systems where flow needs to be regulated
- Fuel oil system where flow is regulated and leak tightness is of importance
- High-point vents and low-point drains when leak tightness and safety are major considerations.
- Feed water, chemical feed, condenser air extraction, and extraction drain systems.
- Boiler vents and drains, main steam vents and drains, and heater drains.
- Turbine seals and drains.
- Turbine lube oil system and others.

GLOBE VALVE DRAWING SYMBOLS





CHECK VALVE

BACK

CHECK VALVE

- Check valves are also known as non -return valves.
- Allows the fluid to flow in one direction only.
- Two port valves having two openings, one for entering and other for leaving the fluid.
- Works automatically, without using hand wheels.
- These valves use gravity and pressure of the commodity for its operation.
- The minimum upstream pressure at which the check valve will operate is known as cracking pressure.

CONSTRUCTION OF CHECK VALVE

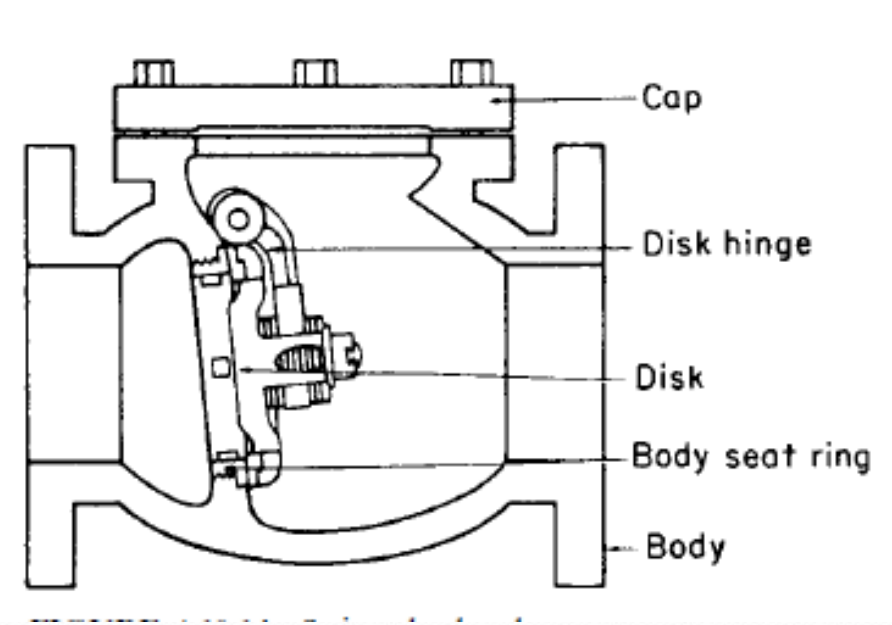
- A basic check valve consists of a valve body, bonnet or cover, and a disc which is attached to a hinge and swings away from the valve seat.
- This allows fluid to flow in the forward direction, as in a swing- or tilting-disc check valve, and returns to valve seat when upstream flow is stopped.
- Thus, reverse flow is prevented.

TYPES OF CHECK VALVE

- Swing Check Valve
- Lift Check Valve
- Tilting Disc Check Valve
- Folding Disc Check Valves
- Vertical or In-Line Check Valve
- Stop Check Valve

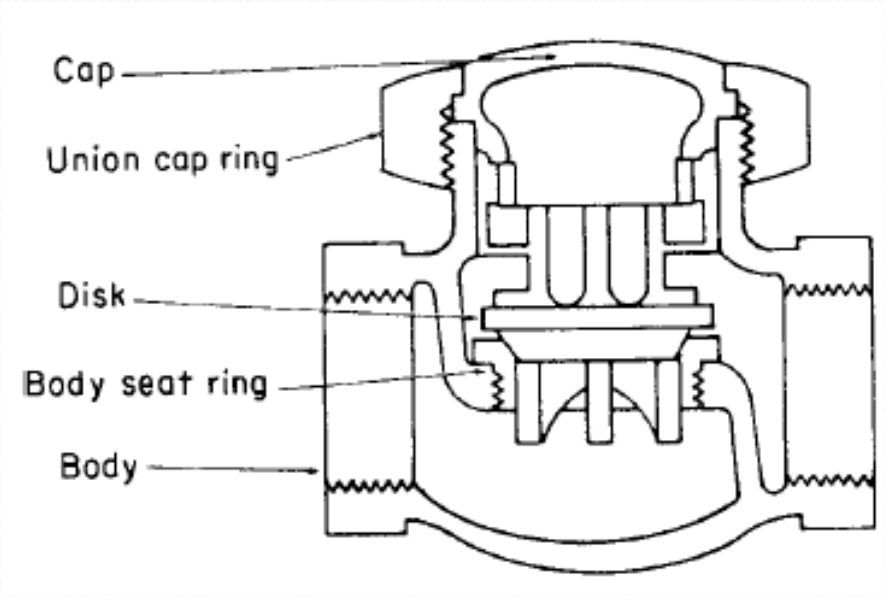
SWING CHECK VALVE

- In swing check valves, the disc is unguided when it moves to fully open position or to fully closed position. Many different disc and seat designs are available to satisfy requirements of varying applications.



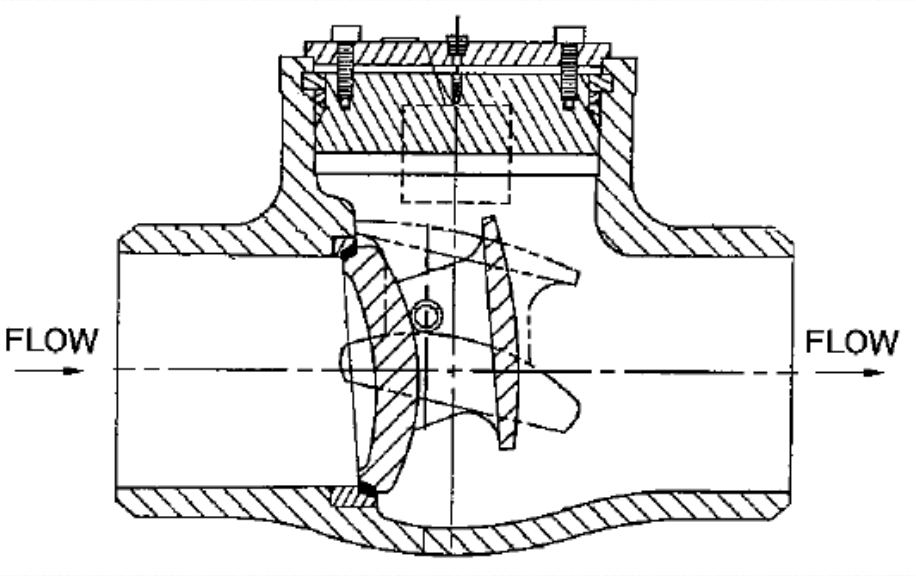
LIFT CHECK VALVE

- Lift check valves are particularly adapted for high-pressure service where velocity of flow is high. The seat design of a lift-check valve is similar to a globe valve



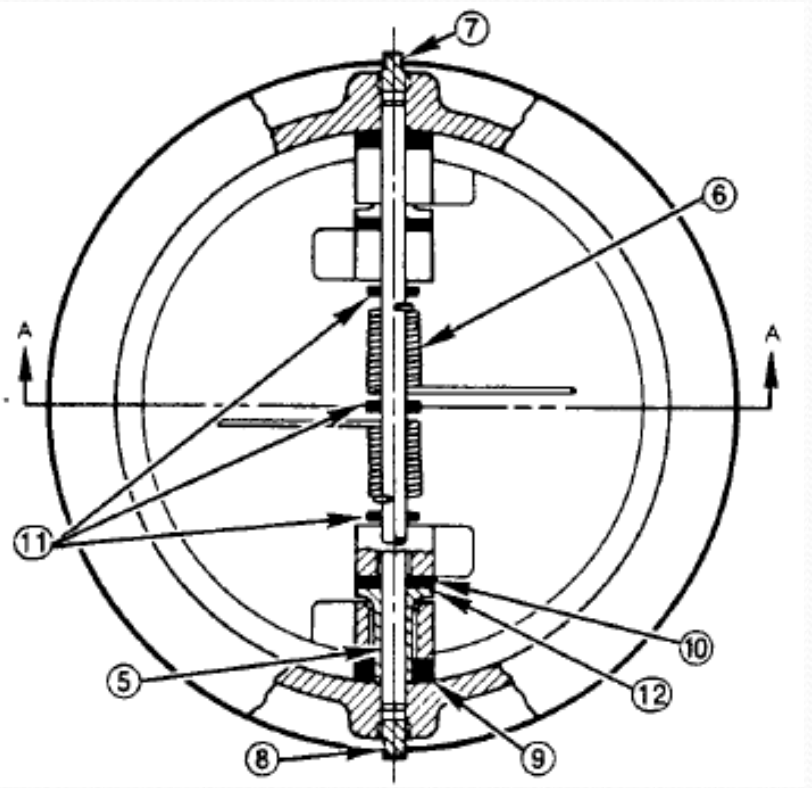
TILTING DISC CHECK VALVE

- The tilting-disc check valve is designed to overcome some of the weaknesses inherent in conventional swing check valves. A combination of design features enables the valve to open fully and remain steady at lower flow velocities and to close quickly upon cessation of forward flow



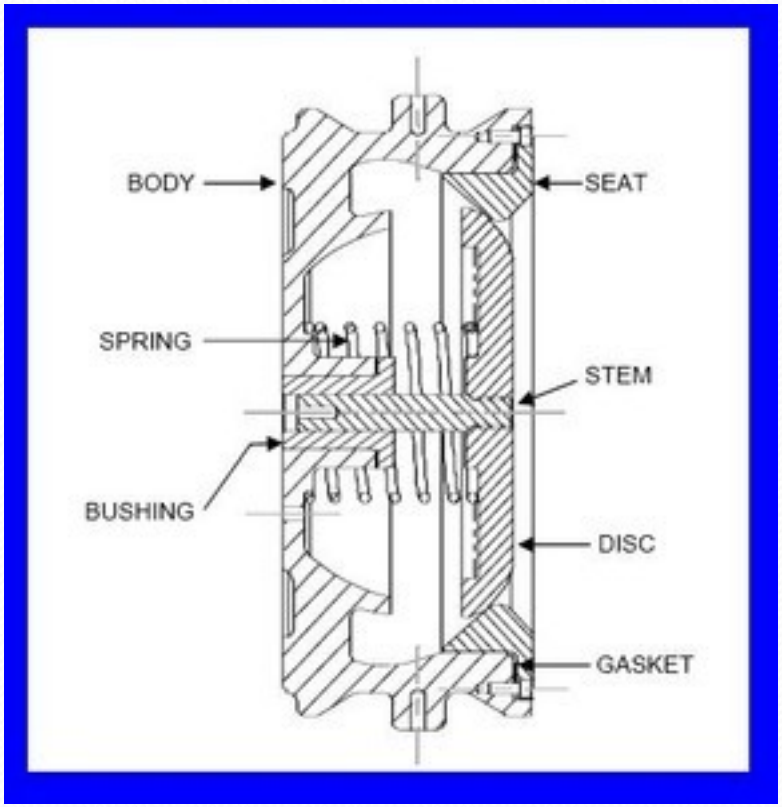
FOLDING DISC CHECK VALVE

- This valve is also referred to as double-disc or split disc check valve. It is manufactured in wafer-body pattern and is available with soft or hard seats. It is very popular in low-pressure liquid and gaseous services.



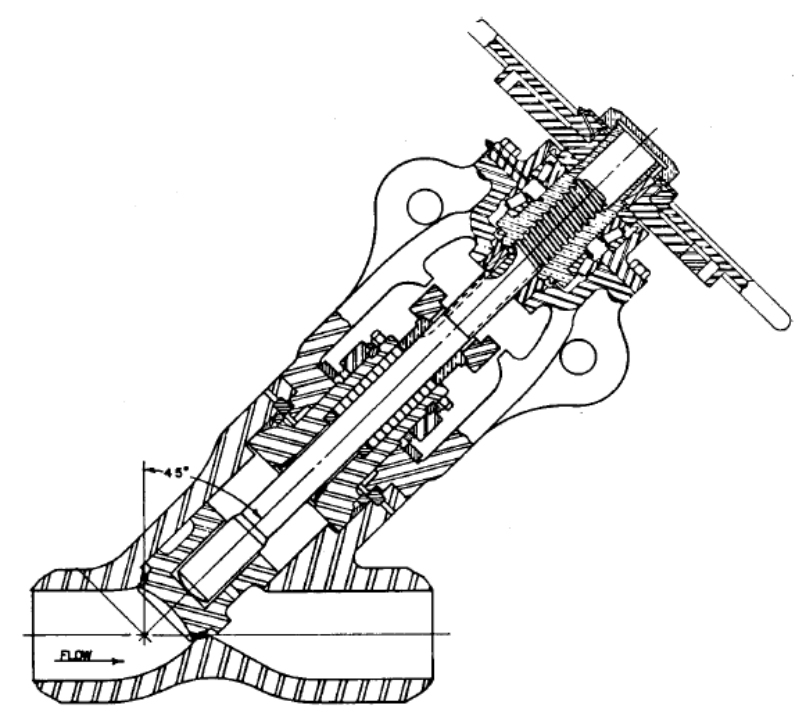
VERTICAL OR IN-LINE CHECK VALVE

- These valves are available in two configurations: in-line ball check and fully guided disc with soft or hard seats. They can be used in applications having pulsating flows, such as in a discharge line of a reciprocating compressor.



STOP CHECK VALVE

- A stop check valve can either be used as a unidirectional check valve or as an isolation (stop) valve like a gate or globe valve. These valves are available in tee-pattern, wye-pattern, angle-pattern, and inclined pattern.



ADVANTAGES OF CHECK VALVES

- They are self-actuated and require no external means to actuate the valve either to open or close.
- They are fast acting.

DISADVANTAGES OF CHECK VALVES

- Since all moving parts are enclosed, it is difficult to determine whether the valve is open or closed. Furthermore, the condition of internal parts cannot be assessed.
- Each type of check valve has limitations on its installation configurations.
- Valve disc can stick in open position.

TYPICAL APPLICATIONS OF CHECK VALVES

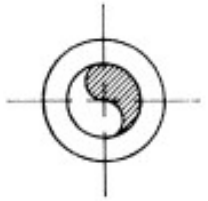
Type flow	Media type	Velocity range FPS (m/s)	Recommended check valve type
Uniform with insignificant reversal	Water or oil	1 to 6 (0.3 to 2)	Swing check w/ lever and ctr wt.
	Steam, water, gas	7 to 100 (2 to 30)	Simple swing
Uniform	Water or oil	5 to 10 max (1.5 to 3)	In-line guided disc
Pulsating	Air or gas	5 to 10 max (1.5 to 3)	In-line guided disc with cushion chamber
Uniform with normal reversal	Water or oil	7 to 10 (2 to 3)	Swing with spring assist to close

CHECK VALVE DRAWING SYMBOLS

TOP

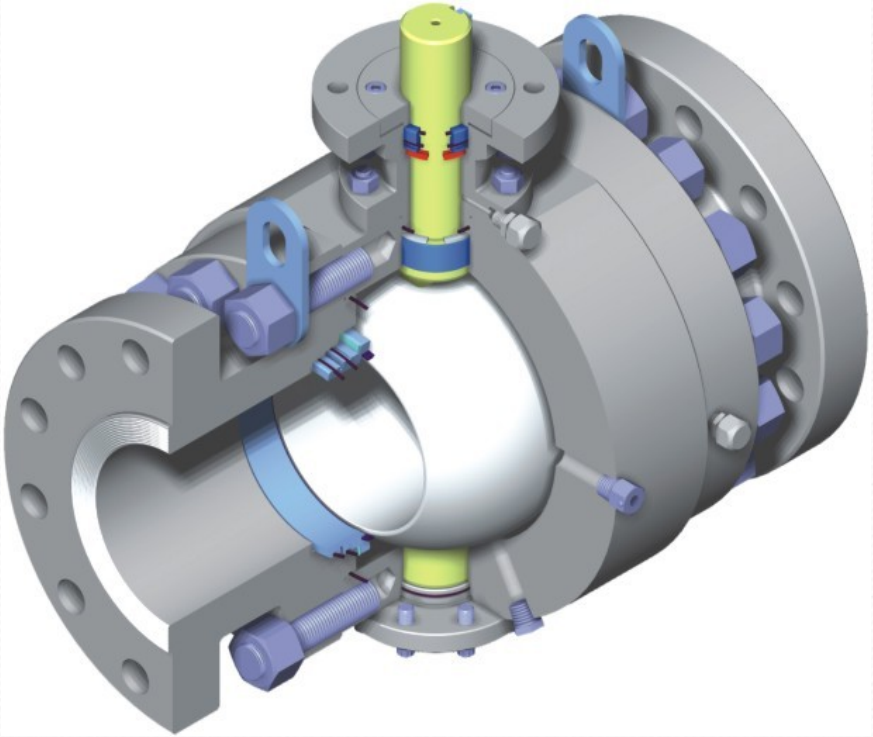
TOP

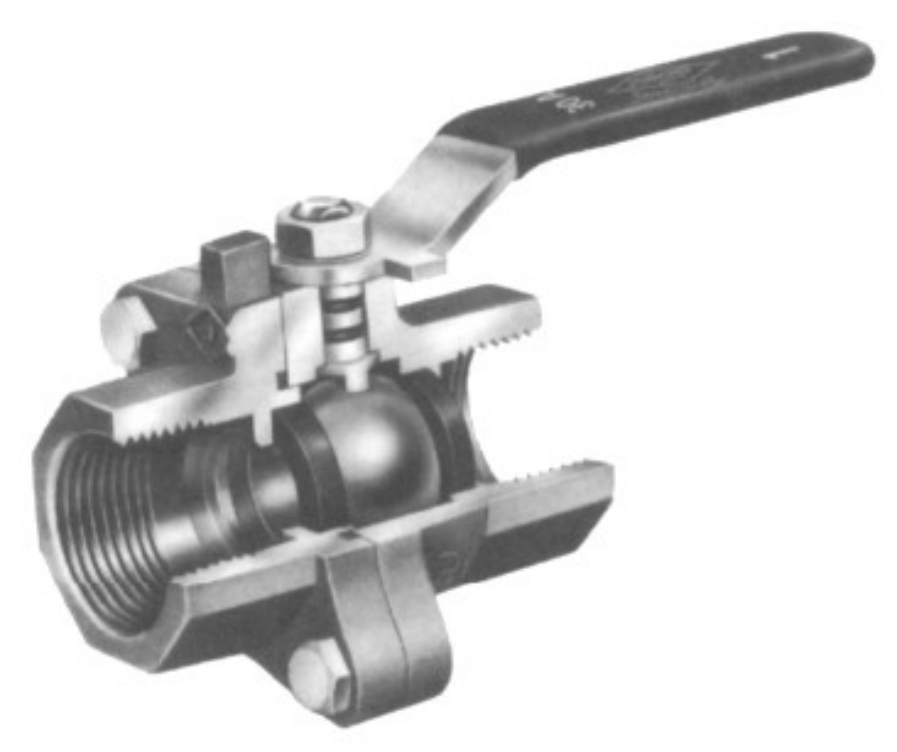
FRONT



END

BALL VALVE





BACK

BALL VALVE

- The ball valve is a quarter-turn valve suitable for clean gas, compressed air, and liquid service
- Used for on–off control without pressure drop.
- Uses a metal ball with a hole bored through the center and is sandwiched between two seats.
- Operation: Turning of the handle connected to the ball causes the opening of the valve.
- Advantages: versatile, durable, easy to repair and can operate manually or actuators.

CONSTRUCTION OF A BALL VALVE

- Major components of the ball valve are the body, spherical plug, and seats. Ball valves are made in three general patterns: venturi port, full port, and reduced port.
- The full-port valve has an inside diameter equal to the inside diameter of the pipe.
- In the venturi and reduced-port styles, the port is generally one pipe size smaller than the line size.
- Stem sealing is accomplished by bolted packing glands and O-ring seals.
- Valves are also available with a lubricant-seal system.

TYPES OF BALL VALVES

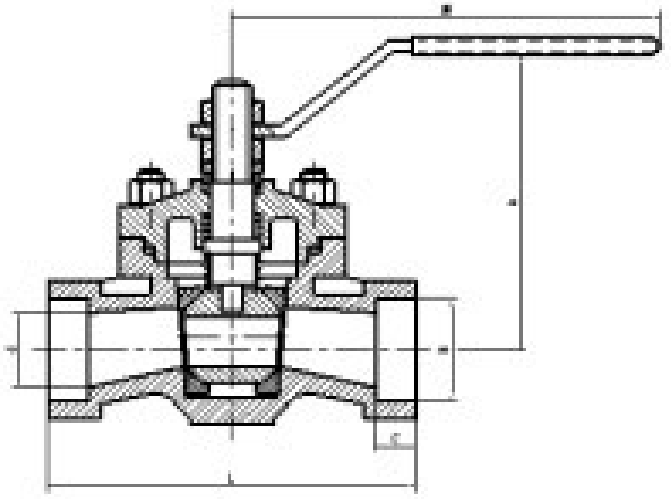
- Split-Body Ball Valve
- Top-Entry Ball Valve
- End-Entry Ball Valve
- Three-Piece—Body Ball Valve
- Double Trunnion Ball Valves
- Lubricated or Nonlubricated Ball Valves

SPLIT-BODY BALL VALVE

- The split body design consists of a two-part body, a cover, ball, seat rings, stem, and other internals. The two-part body is held together by a flange connection. One body part is smaller than the other. The ball is inserted in the larger body part and the smaller body part is assembled by a bolted connection

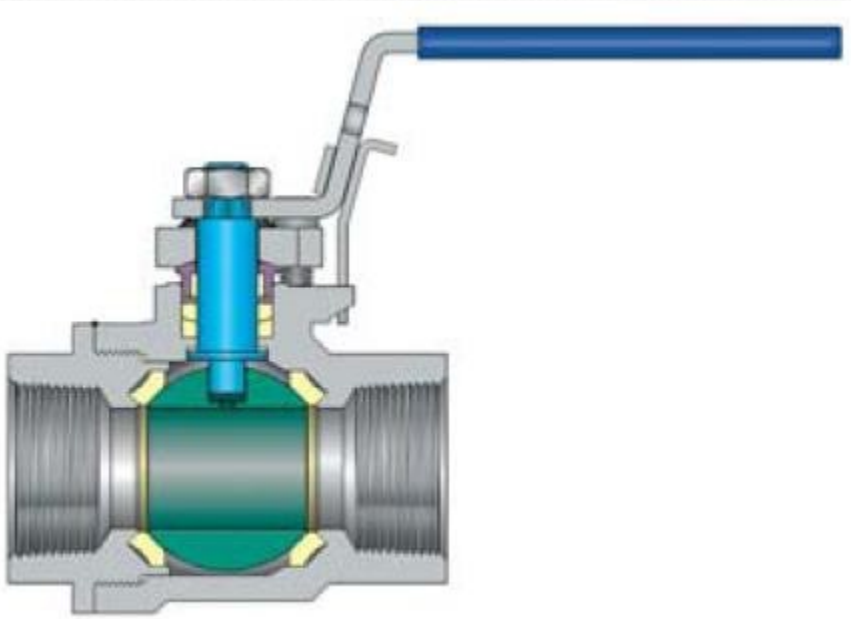
TOP-ENTRY BALL VALVE

- Top-entry ball valves allow access to valve internals for assembly, disassembly, repair, or maintenance by removal of the valve bonnet-cover. The valve is not required to be removed from the pipeline.



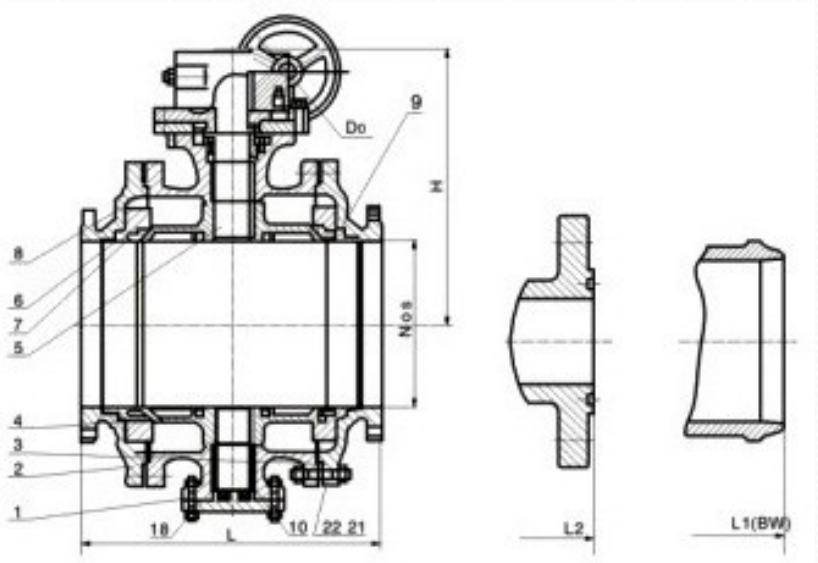
END-ENTRY BALL VALVE

- End-entry ball valves have a single-piece body. The ball is inserted from one end and is retained by an insert. These valves have flange- or screwed-end connections. This design is commonly used for inexpensive small valves.



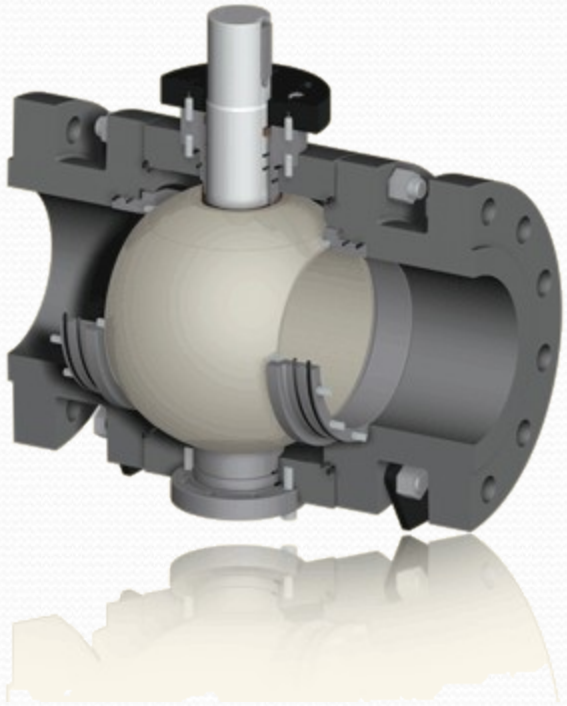
THREE-PIECE—BODY BALL VALVE

- The middle part of the valve is the major part that holds all valve internals, and the stem passes through a hole in the top. Two end caps are held together with the middle body by bolts or studs and nuts. The end connections are part of the end caps, and they may be butt-welding, socket welding, threaded, or flanged



DOUBLE TRUNNION BALL VALVES

- In this ball-valve design, the ball is provided with two integral short-shaft extensions called the top and the bottom trunnions. These trunnions are fitted in bearings and rotate freely when the shaft installed in the top trunnion is turned to open or close the valve.



LUBRICATED OR NONLUBRICATED BALL VALVES

- Like other valves, the stem sealing is usually accomplished by bolted packing glands and O-ring seals. Some valve designs are available with a lubricant-seal system similar to the one used in plug valves. The valves with lubrication seal systems are termed lubricated ball valves, while others are called non lubricated.

ADVANTAGES OF BALL VALVES

- Provides bubble-tight service.
- Quick to open and close.
- Smaller in size than a gate valve.
- Lighter in weight than a gate valve.
- Multiport design offers versatility not available with gate or globe valves. It reduces the number of valves required.
- Several designs of ball valves offer flexibility of selection.
- Can be used in clean and slurry applications.
- High-quality ball valves provide reliable service in high-pressure and high-temperature applications.
- Force required to actuate the valve is smaller than that required for a gate or a globe valve.

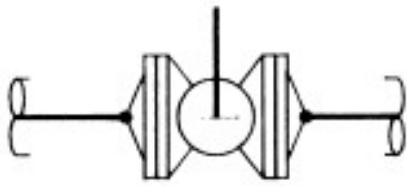
DISADVANTAGES OF BALL VALVES

- They are not suitable for sustained throttling applications.
- In slurry or other applications, the suspended particles can settle and become trapped in body cavities causing wear, leakage, or valve failure.

TYPICAL APPLICATIONS OF BALL VALVES

- Air, gaseous, and liquid applications requiring bubble-tight service
- Low-point drains and high-point vents in liquid, gaseous, and other fluid services
- Instrument root valves
- Cooling water and feed water systems
- Steam service

BALL VALVE DRAWING SYMBOLS



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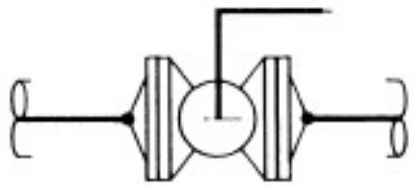

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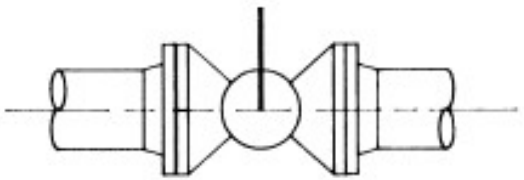

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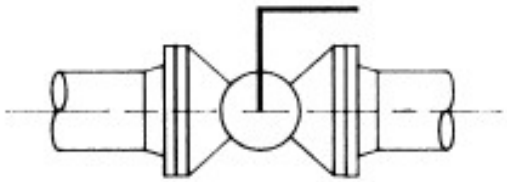

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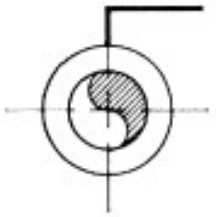


END

PLUG VALVE

BACK

PLUG VALVE

- Plug valves, also called cocks, generally are used for the same full-flow service as gate valves, where quick shutoff is required.
- They are used for steam, water, oil, gas, and chemical liquid service.
- In some applications, specially designed plugs are used for regulation of flow, particularly for gas-flow throttling.
- Plug valves generally can be readily repaired or cleaned without necessitating removal of the body from the piping system.

CONSTRUCTION OF PLUG VALVE

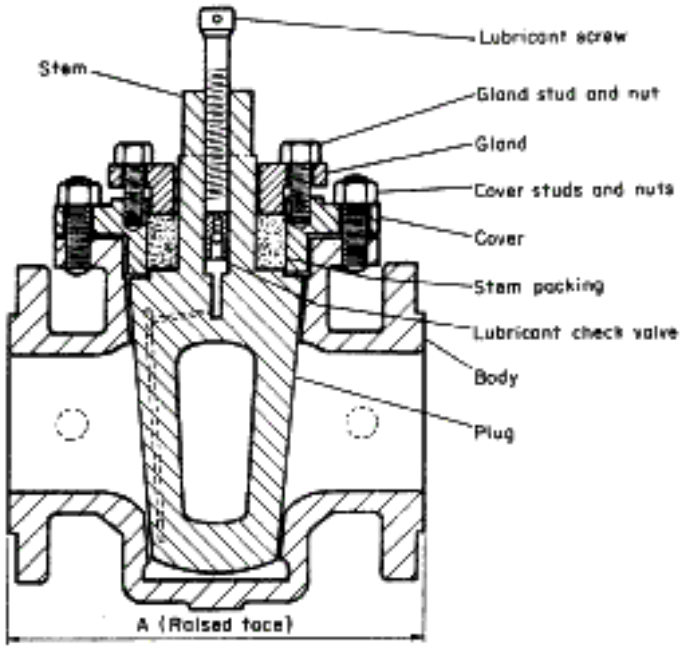
- Full flow is obtained when the opening in the tapered plug is aligned in the direction of flow.
- When the plug is rotated a quarter turn, flow is terminated.
- The body and tapered plug represent the essential features in plug valves. Careful design of the internal contours
- of the valve produces maximum flow efficiency. The port in the tapered plug is generally rectangular and also available with round ports.
- Major valve patterns or types are identified as regular, venturi, short, round-port, and multiport.

TYPES OF PLUG VALVE

- Lubricated plug valve
- Non Lubricated plug valve

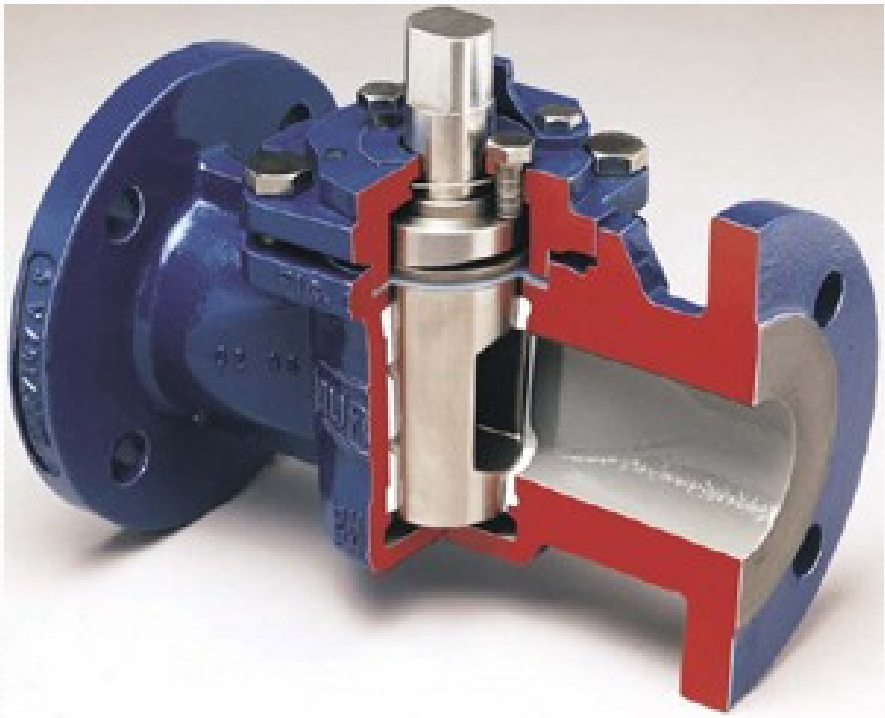
LUBRICATED PLUG VALVE

- The plug in a lubricated plug valve is provided with a cavity in the middle along its axis. This cavity is closed at the bottom and fitted with a sealant-injection fitting at the top. The sealant is injected into the cavity,and a check valve below the injection fitting prevents the sealant from flowing in the reverse direction.



NONLUBRICATED PLUG VALVE

- Nonlubricated plug valves contain an elastomeric body liner or a sleeve, which is installed in the body cavity. The tapered and polished plug acts like a wedge and presses the sleeve against the body. Thus, the nonmetallic sleeve reduces the friction between the plug and the body.



ADVANTAGES OF PLUG VALVES

- Simple design with few parts.
- Quick to open or close.
- Can be serviced in place.
- Offers minimal resistance to flow.
- Provides reliable leak tight service. Seal can be maintained by injection of sealant or by replacement of sleeve, in addition to utilizing the wedging action of a
- tapered plug.
- Multiple port design helps reduce number of valves needed and permits change in flow direction.

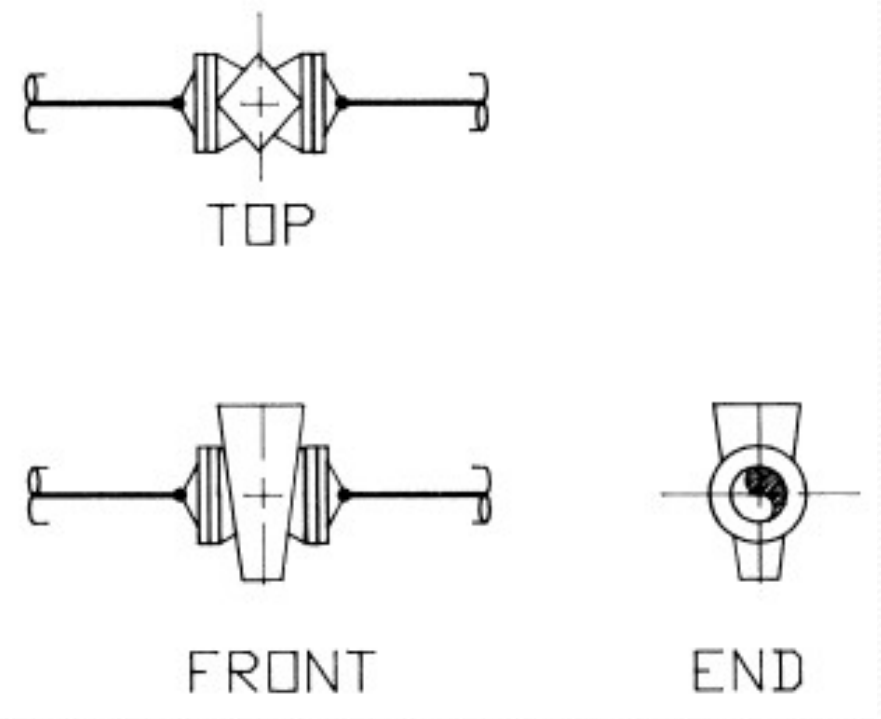
DISADVANTAGES OF PLUG VALVES

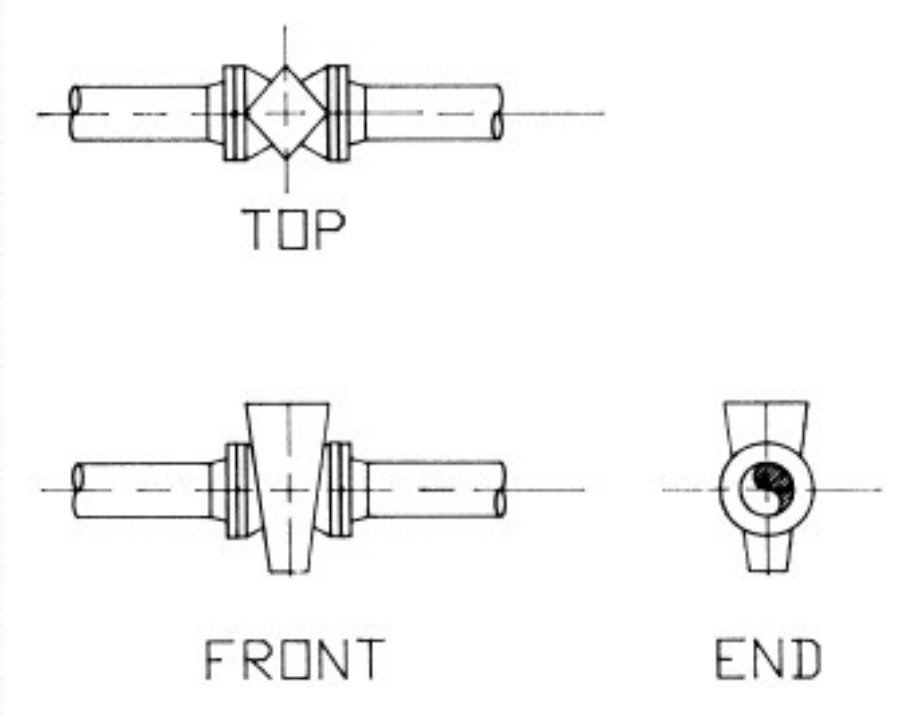
- Requires greater force to actuate, due to high friction.
- NPS 4 (DN 100) and larger valves require use of actuators.
- Reduced port, due to tapered plug.
- Typically, plug valves may cost more than ball valves.

TYPICAL APPLICATIONS OF PLUG VALVES

- Air, gaseous, and vapor services
- Natural gas piping systems
- Coal slurries, mineral ores, mud, and sewage applications
- Oil piping systems
- Vacuum to high-pressure applications

PLUG VALVE DRAWING SYMBOL





DIAPHRAGM VALVES

BACK

DIAPHRAGM VALVES

- All diaphragm valves are bidirectional.
- They can be used as on-off and throttling valves.
- Their fluid passages are smooth and streamlined, minimizing pressure drop.
- They are suitable for moderate throttling applications.
- They exhibit excellent leak-tight characteristics, even when conveying liquids containing suspended solids.
- Since there is no leak path around the valve stem, the valve is virtually leak tight.

CONSTRUCTION OF A DIAPHRAGM VALVE

- Diaphragm valves consist of a rigid body formed with a weir placed in the flow path, a flexible diaphragm which forms the upper pressure boundary of the valve.
- A compressor which is used to force the diaphragm against the weir, and the bonnet and hand wheel which secure the diaphragm to the body and actuate the compressor.
- Diaphragm valves are manufactured in a variety of end connections.
- The valve body is available in two patterns: tee-pattern and angle pattern.

TYPICAL MATERIALS USED FOR DIAPHRAGMS

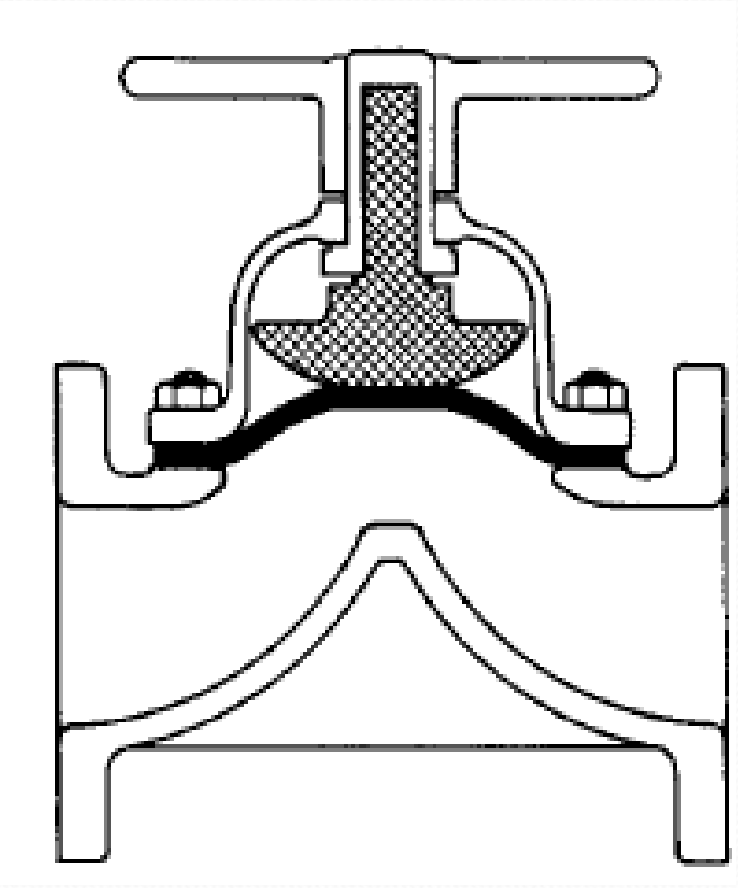
Valve type	Service	Material	Temp, °F (°C)	
			Min	Max
Conventional weir	Abrasive	Soft natural rubber	−30 (−34)	180 (82)
	Water	Natural rubber	−30 (−34)	180 (82)
	Food and beverage	White natural rubber	0 (−18)	160 (71)
	Weak chemical, air, oil	Neoprene	−30 (−34)	200 (93)
	Weak chemical, high vacuum	Reinforced Neoprene	−30 (−34)	200 (93)
	Other chemicals, gases	Black chlorinated butyl	−20 (−29)	250 (121)
	Food and beverage	White chlorinated butyl	−10 (−23)	225 (107)
	Special for hydrogen peroxide	Clear Tygon	0 (−18)	150 (66)
	Oils and gasoline	Hycar (gen. purpose)	10 (−12)	180 (82)
	Oxidizing services	Hypalon	0 (−18)	225 (107)
	Brewery services	Pure gum rubber	−30 (−34)	160 (71)
	Special service on temperature	Silicone	50 (10)	350 (177)
	Radioactive conditions	G.R.S.	−10 (−23)	225 (107)
	Severe chemicals, solvents	Teflon	−30 (−34)	325 (163)
	Severe chemicals	Kel-F	60 (16)	250 (121)
	Specific acids	Polyethylene	10 (−12)	135 (57)
Full flow	Cold beer	White rubber	−30 (−34)	160 (71)
	Hot wort and cold beer	White chlorinated butyl	−10 (−23)	225 (107)
	Cold beer	Pure gum rubber	−30 (−34)	160 (71)
Straightway	Water	Natural rubber	−30 (−34)	180 (82)
	Chemical, air, oil	Neoprene	0 (−18)	180 (82)
	Oils and gasoline	Hycar (gen. purpose)	10 (−23)	180 (82)
	Fatty acids	Black chlorinated butyl	0 (−18)	225 (107)
	Oxidizing services	Hypalon	0 (−18)	200 (93)
	Food and beverage	White chlorinated butyl	−10 (−23)	200 (93)

TYPES OF DIAPHRAGM VALVES

- Weir-Type Diaphragm Valves
- Straight-Through Diaphragm Valves

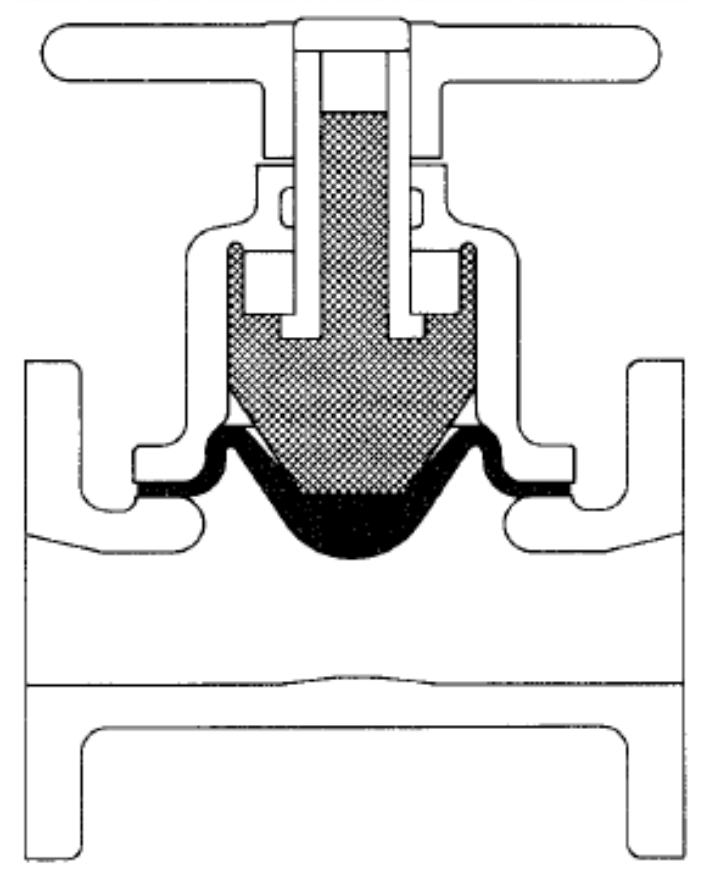
WEIR-TYPE DIAPHRAGM VALVES

- A weir is provided as an integral part of the valve body. The weir acts as the valve seat against which the diaphragm is compressed to stop the flow. This type of diaphragm valve is generally produced in large sizes. The raised weir reduces the amount of diaphragm travel from the fully open to the fully closed position.



STRAIGHT-THROUGH DIAPHRAGM VALVES

- When the straightway valve is open, its diaphragm lifts high for full streamline flow in either direction. When the valve is closed, the diaphragm seals tight for positive closure with gritty or fibrous materials in the line.



ADVANTAGES OF DIAPHRAGM VALVES

- Can be used as on-off and throttling service valves.
- Offer good chemical resistance due to variety of linings available.
- Stem leakage is eliminated.
- Provides bubble-tight service.
- Does not have pockets to trap solids, slurries, and other impurities. It is suitable for slurries and viscous fluids.
- These valves are particularly suitable for hazardous chemicals and radioactive fluids.
- These valves do not permit contamination of flow medium, thus they are used extensively in food processing,
- pharmaceutical, brewing, and other applications which cannot tolerate any contamination.

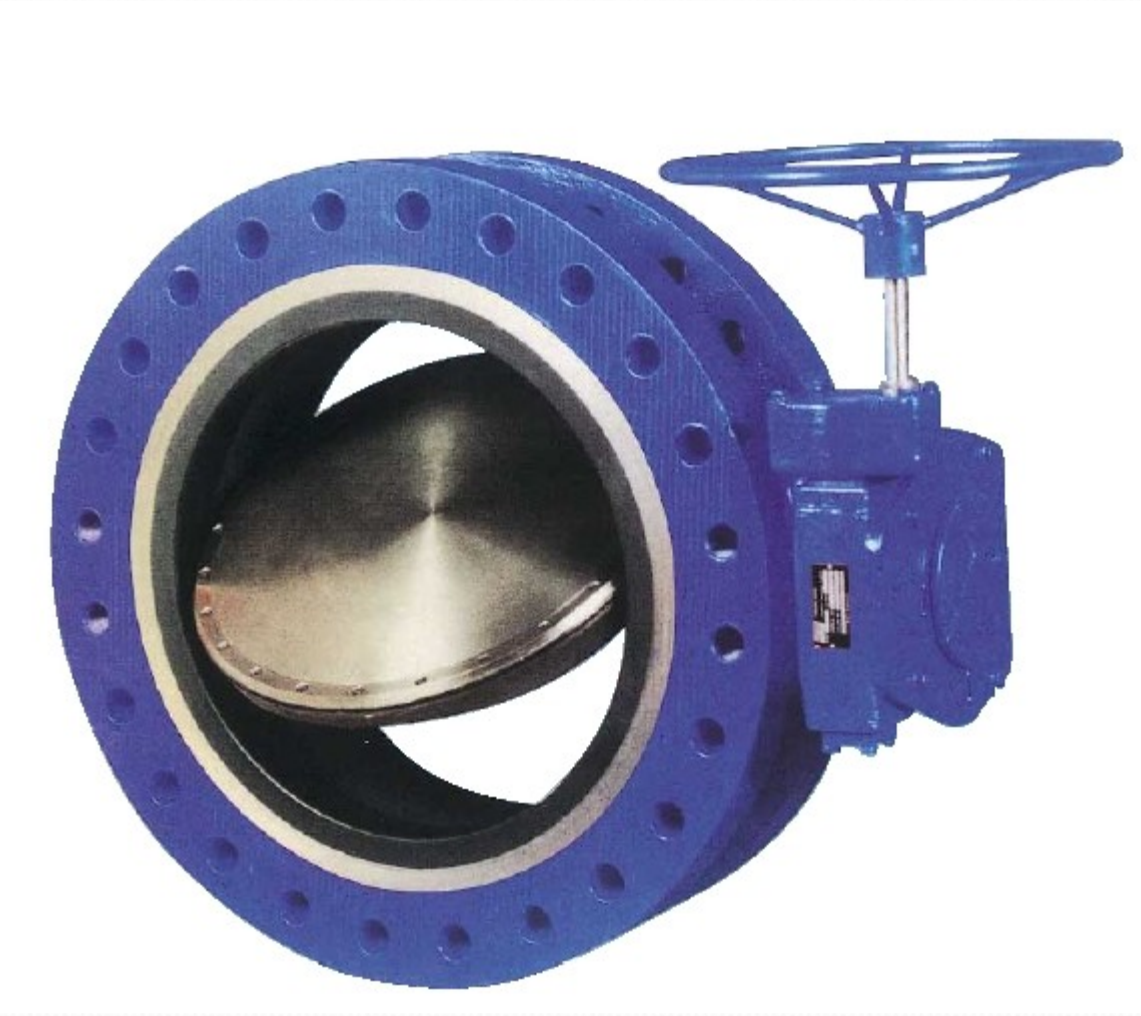
DISADVANTAGES OF DIAPHRAGM VALVES

- The weir may prevent full drainage of piping.
- Working temperatures and pressures are limited by the diaphragm material. Generally the pressures are limited to 200 psi (1380 kPa) and temperatures up to 400F (204◦C).
- The diaphragm may also limit the hydrostatic pressure.
- The diaphragm may experience erosion when used extensively in severe throttling service containing impurities.
- Diaphragm valves are available in limited sizes, usually NPS 1½ to 12 (DN 15 to 300).

TYPICAL APPLICATIONS OF DIAPHRAGM VALVES

- Clean or dirty water and air service applications
- Demineralized water systems
- Corrosive applications
- Radwaste systems in nuclear facilities
- Vacuum service
- Food processing, pharmaceutical, and brewing systems

BUTTERFLY VALVE



BACK

BUTTERFLY VALVES

- A flow control device typically used to regulate fluid flowing through a section of the pipe.
- Uses a circular plate operated by a wrench to control flow.
- Minimal turbulence and pressure drop.
- Rotation of the actuator connected to the plate, turns it either parallel or perpendicular to the flow.
- Valve fully open - disc rotate quarter turn allows unrestricted path to fluid.
- Valve closed – disc is turned to completely block the pathway.
- Used for flow regulation in large pipe diameters.

CONSTRUCTION OF A BUTTERFLY VALVE

- A butterfly valve has a short circular body, a round disc, shaft, metal-to-metal or soft seats, top and bottom shaft bearings, and the stuffing box.
- The valve body may have flanged ends, lugs, or wafer style configurations to be installed between pipe flanges.
- The welding-end butterfly valves are usually large and have butt-welding ends.
- Butterfly valves are also manufactured in rectangular or square configurations.

TYPES OF BUTTERFLY VALVES

- Low Pressure or Concentric Butterfly Valves
- High-Performance or Eccentric Butterfly Valves

LOW PRESSURE OR CONCENTRIC BUTTERFLY VALVES

- The disc and shaft axes are concentric. In open position, the disc divides the flow in two equal halves, with the disc in the middle and parallel to the flow. These valves are provided with resilient seats. These valves are available as lined or unlined.

ECCENTRIC BUTTERFLY VALVES

- The disc in high performance butterfly valves is offset from the center of the valve, and the shaft is also offset from the center of the disc. The offsets provided allow the disc to move eccentrically uninterrupted away from or toward the valve seat

ADVANTAGES OF BUTTERFLY VALVES

- The compact design requires considerably less space, compared to gate, globe, or other valves.
- Light in weight.
- Quick acting; as a quarter-turn valve, it requires less time to open or close.
- It is available in large sizes, ranging from NPS 1½ (DN 40) to over NPS 200 (DN 5000).
- They have low-pressure drop and high-pressure recovery.
- Provide bubble-tight service.

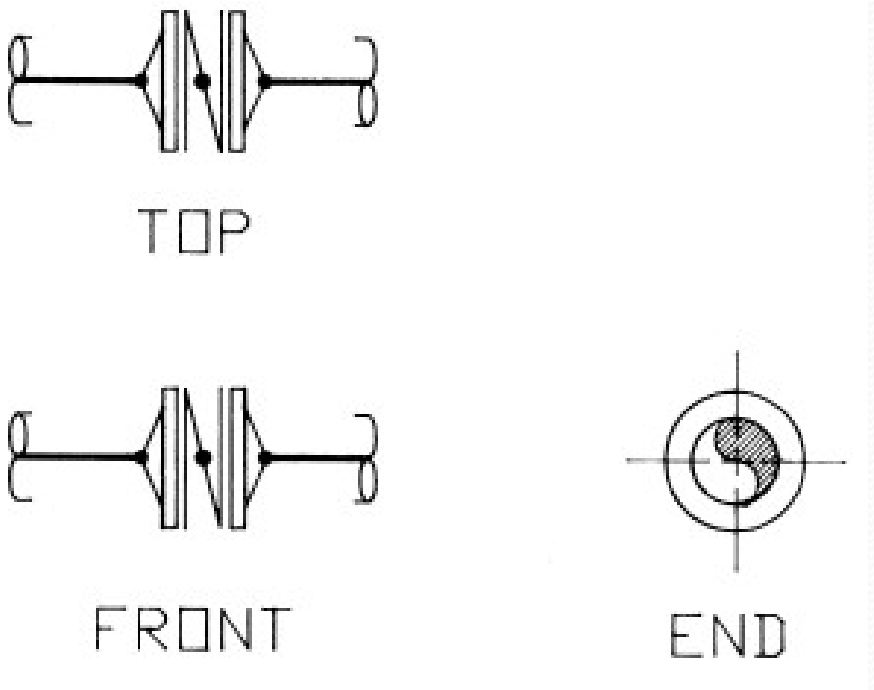
DISADVANTAGES OF BUTTERFLY VALVES

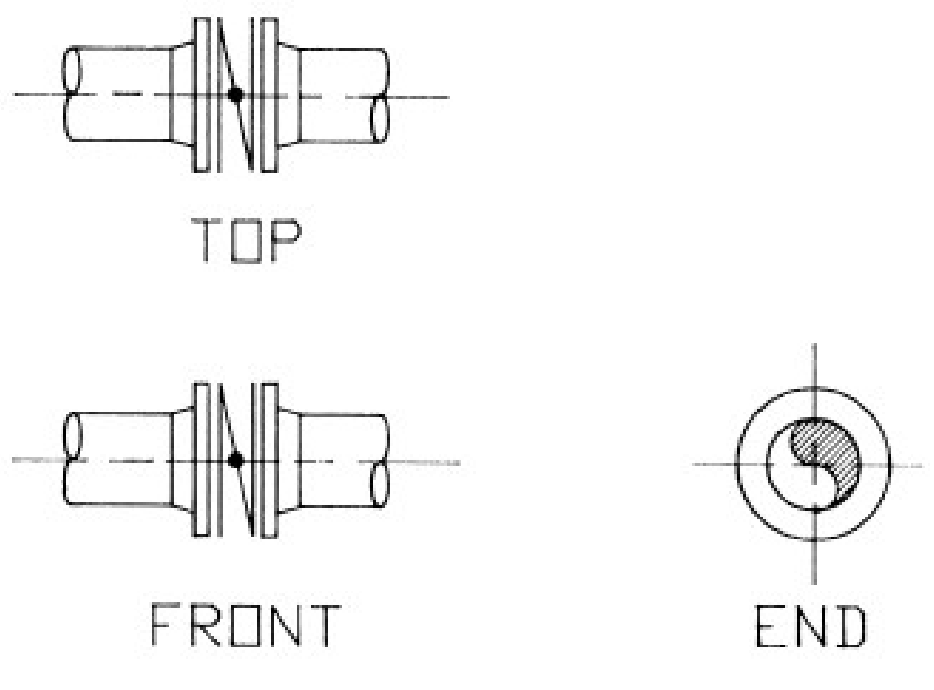
- Throttling service is limited to low differential pressure.
- Throttling is restricted to a 30- to 80-degree disc opening. Location of valve, pipe routing, free, and closed discharge are to be considered while using a butterfly valve in a throttling application.
- Cavitation and choked flow are two potential concerns.
- The disc movement is unguided and affected by flow turbulence.

TYPICAL APPLICATIONS OF BUTTERFLY VALVES

- Cooling water, air, gases, and other similar applications, such as fire protection, circulating water, et cetera
- Corrosive services requiring lined valves
- Food processing, chemical, and pharmaceutical services
- Slurry and similar services
- High-pressure and high-temperature water and steam services
- Throttling service involving low differential pressures, as in cooling water or air supply systems
- Vacuum service

BUTTERFLY VALVE DRAWING SYMBOL





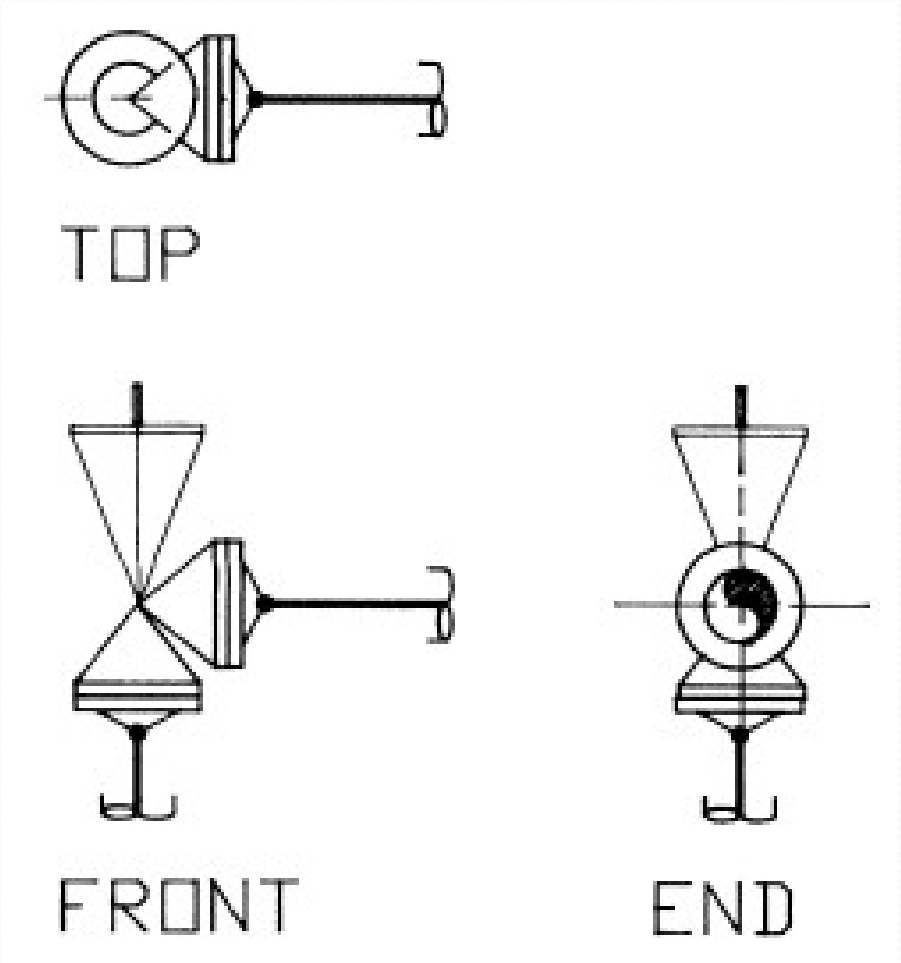
ANGLE VALVE

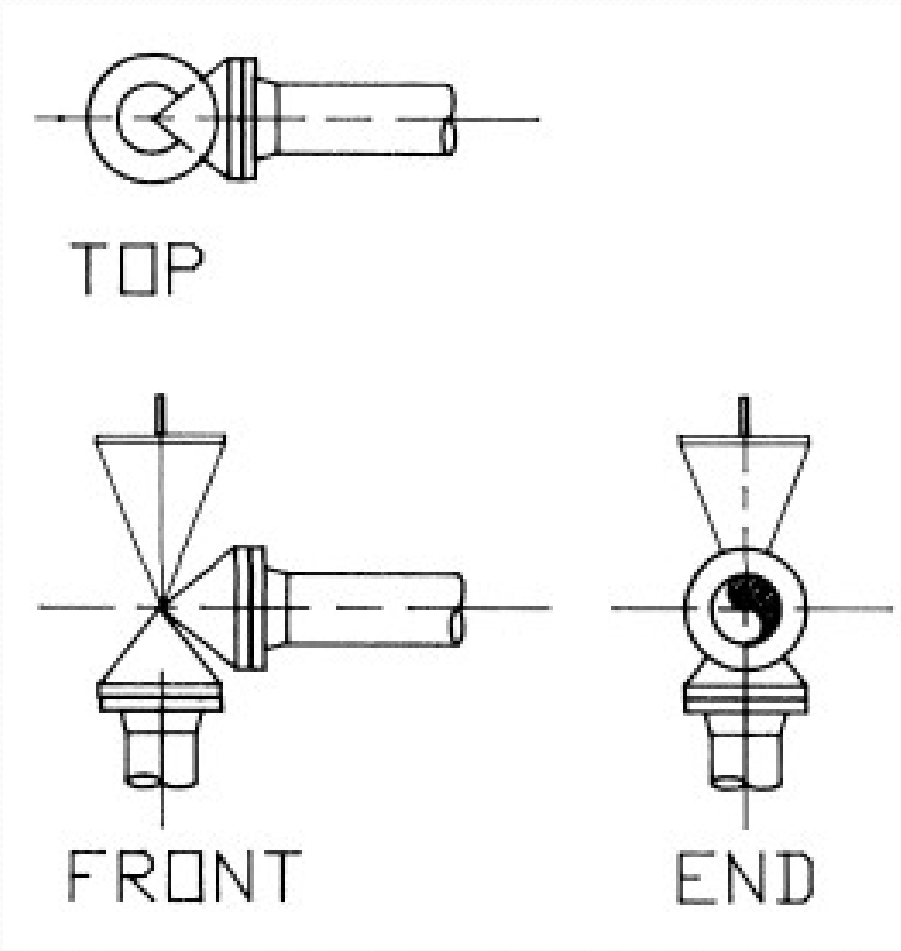
BACK

ANGLE VALVE

- Used for throttling.
- The ports of the angle valve that is inlet and outlet are oriented at an angle 90 deg.
- The commodity will follow an upward direction through the valve body.
- This movement keeps pressure under the disc, results in easier operation and reduction in corrosion.

ANGLE VALVE DRAWING SYMBOL





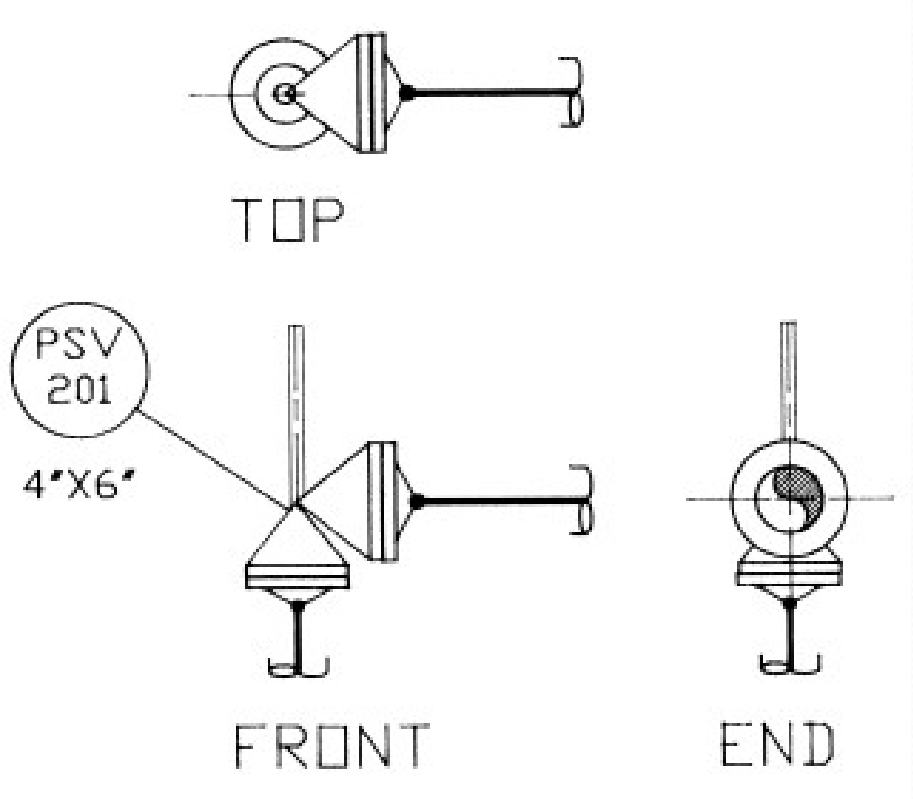
PRESSURE RELIEF VALVE

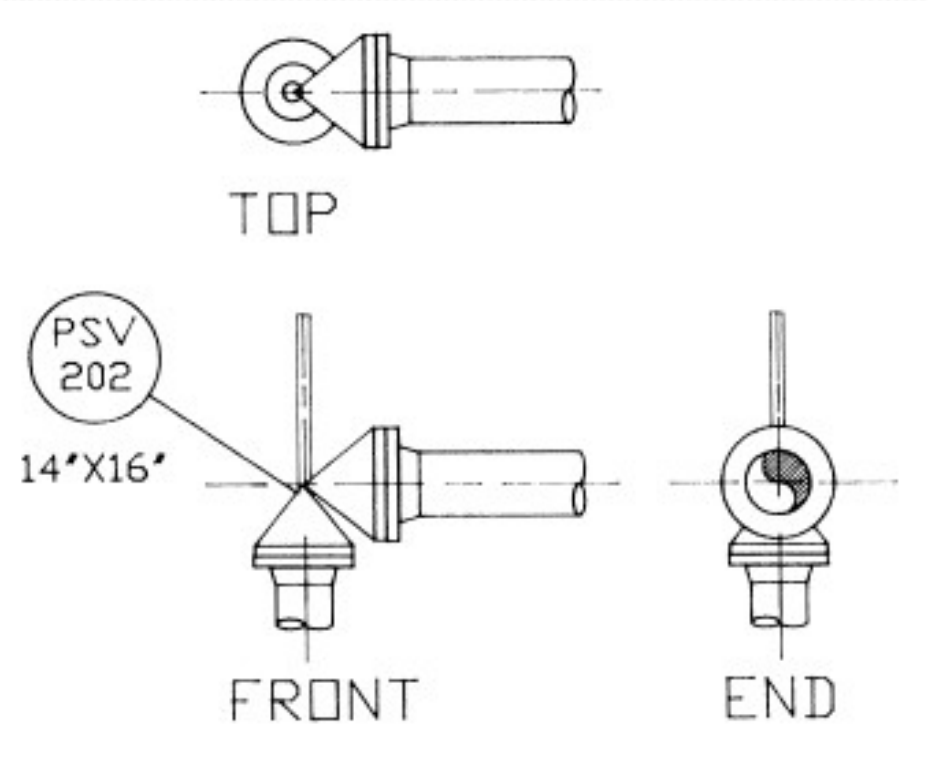
BACK

PRESSURE RELIEF VALVE

- Used in piping systems that service liquid commodities.
- Used to limit excessive pressure that builds up in equipments and piping systems.
- The pressure is relieved by allowing the pressurized fluid to flow from an auxiliary passage out of the system.
- When pressure is exceeded the valve becomes the path of least resistance, causing forced opening in proportionally.
- Pressure safety valves open completely other than relief valve.

PRESSURE RELIEF VALVE DRAWING SYMBOL





SAFETY VALVE

BACK

SAFETY VALVE

- Safety valves are generally used in gas or vapor service because their opening and reseating characteristics are commensurate with the properties and potential hazards of compressible fluids.
- The valves protect the system by releasing excess pressure. Under normal pressure, the valve disc is held against the valve seat by a preloaded spring.
- An added benefit to the safety valve disc design is that the pressure at which the valve reseats is below the initial set pressure, thereby reducing the system pressure to a safe level prior to resealing.
- The drawing symbol is same that of pressure relief valve.

NEEDLE VALVE

BACK

NEEDLE VALVE

- Needle valves generally are used for instrument, gauge, and meter line service.
- Very accurate throttling is possible with needle valves and, therefore, they are extensively used in applications that involve high pressures and/or high temperatures.
- In needle valves the end of the stem is needle point.

CONTROL VALVE

BACK

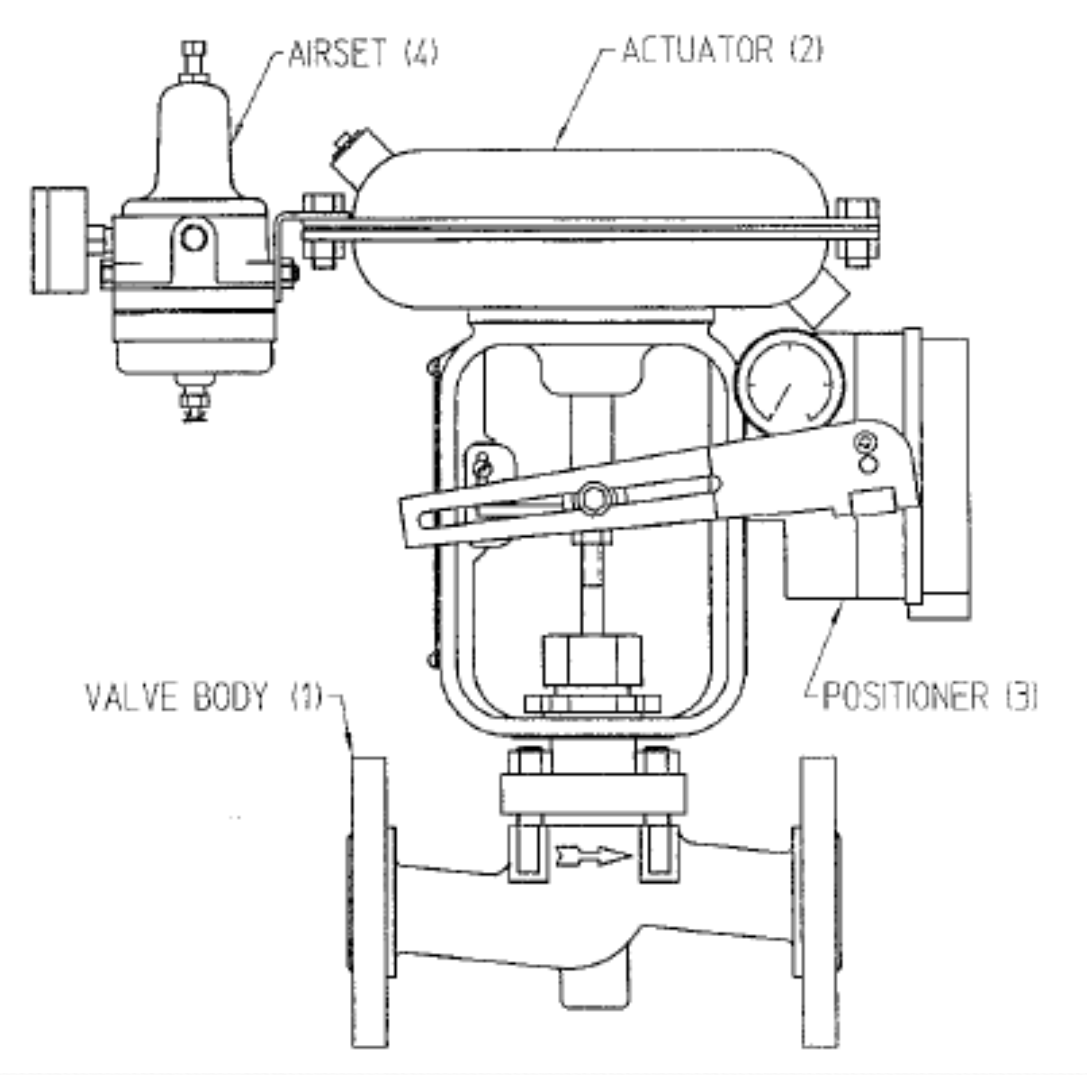
CONTROL VALVE

- Used to control operating conditions such as pressure, temperature, flow and liquid level.
- The most common body style in control valve is the globe valve.
- The opening and closing is done by electrical, pneumatic or hydraulic valves.
- Control valve manifolds are configured to provide readily access to plant workers.

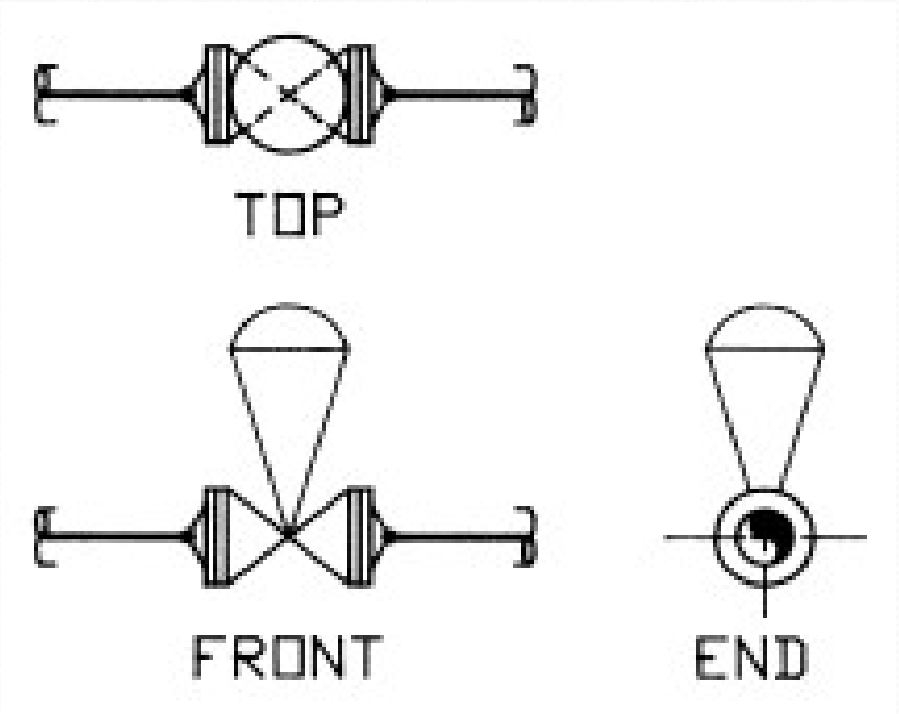
CONSTRUCTION OF CONTROL VALVE

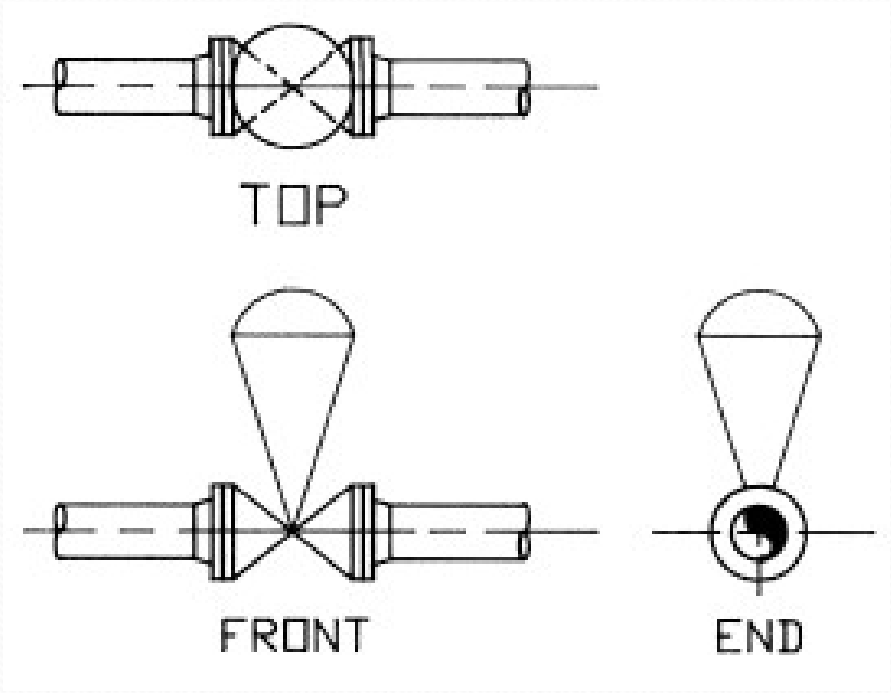
- Control valves have basically three interactive components:
- a valve body subassembly (either with a reciprocating or rotating stem)
- an actuating device (usually a spring diaphragm type)
- a valve positioner (an instrument that converts an electronic control signal from a controller, or computer, into an air signal to control the position of the control valve stem)
- an airset or regulator to supply air pressure to the positioner

CONSTRUCTION OF CONTROL VALVE



CONTROL VALVE DRAWING SYMBOL





ACTUATORS

- Actuators are external mechanisms or devices used for operating a valve.
- The valves to be furnished with an actuator utilizing external source(s) of energy, such as electricity, pneumatics, hydraulics, mechanical springs, or a combination of one or more of these energies, are called actuated valves.
- The major advantage of actuator is that it can operate the valve whenever there is an emergency in the piping system.

BACK

TYPES OF ACTUATORS

- Gear Actuators
- Electric Motor Actuators
- Pneumatic Actuators
- Hydraulic Actuators
- Solenoid Actuators

GEAR ACTUATORS

- Spur, bevel, or worm-gear actuators are used to reduce the manual force required to operate a valve. Spur gears are used with globe, angle, and nonreturn valves. Bevel-gear actuators are used on gate valves. Worm-gear actuators are usually used on quarter-turn valves.

ELECTRIC MOTOR ACTUATORS

- An electric motor provides the actuating energy to place the valve in the desired position. Upon loss of power, the failure mode is fail-as-is. The stem speed may vary from 12 in/min (30 cm/min), known as manufacturer's standard, to 60 in/min (150 cm/min).

PNEUMATIC ACTUATORS

- Pneumatic actuators utilize the motive force provided by a compressed gas such as air, nitrogen, or other inert gas. There are many different types of pneumatic actuators. These include linear, rotary, and linear-to-rotary. Linear-type actuators are used with valves having translating stems.

HYDRAULIC ACTUATORS

- Hydraulic actuators utilize pressurized liquids, usually oils but sometimes water, or the process liquid is used to provide the motive force for actuating the valve. Like pneumatic actuators, these actuators can help achieve fail-open or fail-close failure modes.

SOLENOID ACTUATORS

- Solenoid actuators have short-stroke and low-thrust capabilities. Two types of actuating methods are used in solenoid valves: direct acting and pilot operated. Solenoid valves can accomplish all failure modes.

THANK YOU