VALVES TECHNOLOGY

Presented by

Ahmed Yehia Mohamed

Process engineer,

Suez Oil Processing Company (SOPC)

INTRODUCTION

Consider the different type of liquids and gases that flow around plant pipeline. High pressure, Low pressure, Corrosive, Non-Corrosive, Low and High Viscosities and Volatilities. If we understand this, then we can see why so may different types and sizes of valves are in use.

Valve classifications

- **According to valve type (Gate, Globe, Check,….)**
- **According to function (Modulation, On Off)**
- **According to method of operation (Hand wheel, Gears , Actuators,…)**
- **According to design standard (API, DIN,…).**
- **According to stem movement (Rising stem, Quarter turn,...)**
- **According to flow direction (One direction, Bi directional)**
- **According to material selection (Carbon steel, Alloy steel,...)**
- **According to end connection (Flanged, socket weld,,...)**

International Standards

- **AFNOR** Association Francaise de Normalisation (France)
- **AISI** American Iron and Steel Institute
- **ANSI** American National Standards Institute
- **API** American Petroleum Institute
- **ASM** American Society of Metals
- **ASME** American Society of Mechanical Engineers
- **ASTM** American Society for Testing and Materials
- **AWS** American Welding Society
- **BSI** British Standards Institute
- **DIN** Deutsches Institut fur Normung (Germany)
- **EPA** Environmental Protection Agency

International Standards

- **HSE** Health and Safety Executive
- **ISA** Instrument Association of America
- **ISO** International Standards Organization
- **JIS** Japan Industrial Standard
- **MSS** Manufacturers Standardization Society
- **NACE** National Association of Corrosion Engineers
- **NFPA** National Fire Prevention Association
- **SAE** Society of Automotive Engineers
- **SPE** Society of Petroleum Engineers
- **TEMA** Tubular Exchanger Manufacturers Association
- **VMA** Valve Manufacturers Association

Standards Pertaining to Valves

- **ANSI** American National Standards Institute
- **API** American Petroleum Institute
- **ASME** The American Society of Mechanical Engineers
- **ASTM** American Society for Testing and Materials
- **AWWA** American Water Works Association
- **MSS** Manufacturers Standardization Society
- **AFNOR** Association Francaise de Normalisation
- **BSI** British Standards Institute
- **DIN** Deutsches Institut fur Normung eV

Most Common Standards for Valves

- **ASME B16.1**, cast iron pipe flanges and flanged fittings
- **ASME B16.5,** pipe flanges and flanged fittings
- **ASME 16.34,** valves-flanged, threaded, and welding end, is one of the most widely used valve standards. ASME B16.34 covers class 150, 300, 400, 600, 900, 1500, 2500, and 4500 valves.
- **API 6D,** pipe line valves
- **API 600,** steel gate valve-flanged and butt welding ends
- **API 608, -** Ball Flanged valves
- **API 598,** valve inspection and testing
- **MSS SP44,** steel pipeline flanges

Valve classifications

- **According to pressure classes**
- **According to valve size.**
- **According to valve bore (Full, Reduced,...)**
- **Hazard area classification.**

VALVE CLASSIFICATION

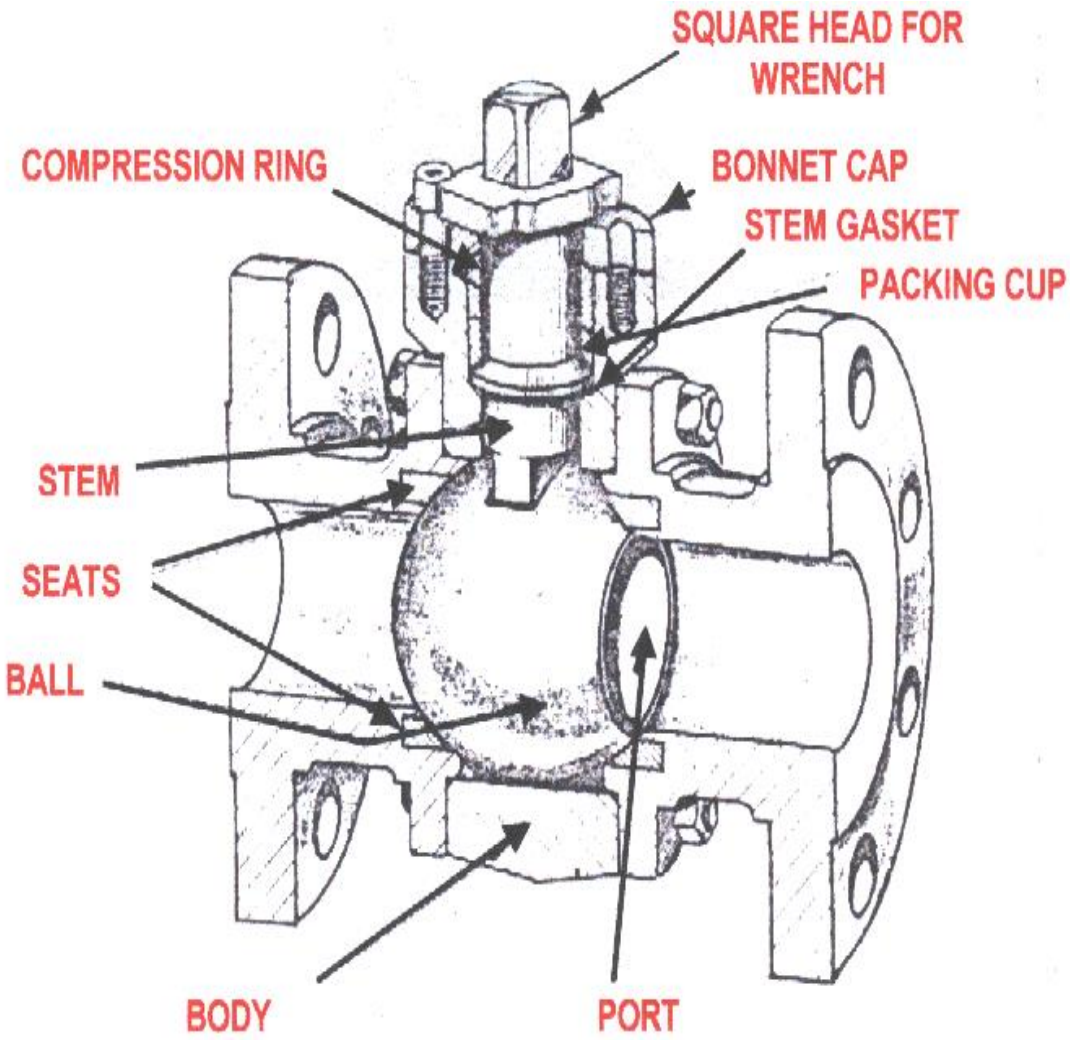
The various types of valve can be sub-divided into the following groups.

- Isolation Valves (Ball, Plug, Butterfly, Gate)
- Regulating Valves (Globe, Needle and Diaphragm)
- Check Valves or Non – Return Valves
- Relief Valves

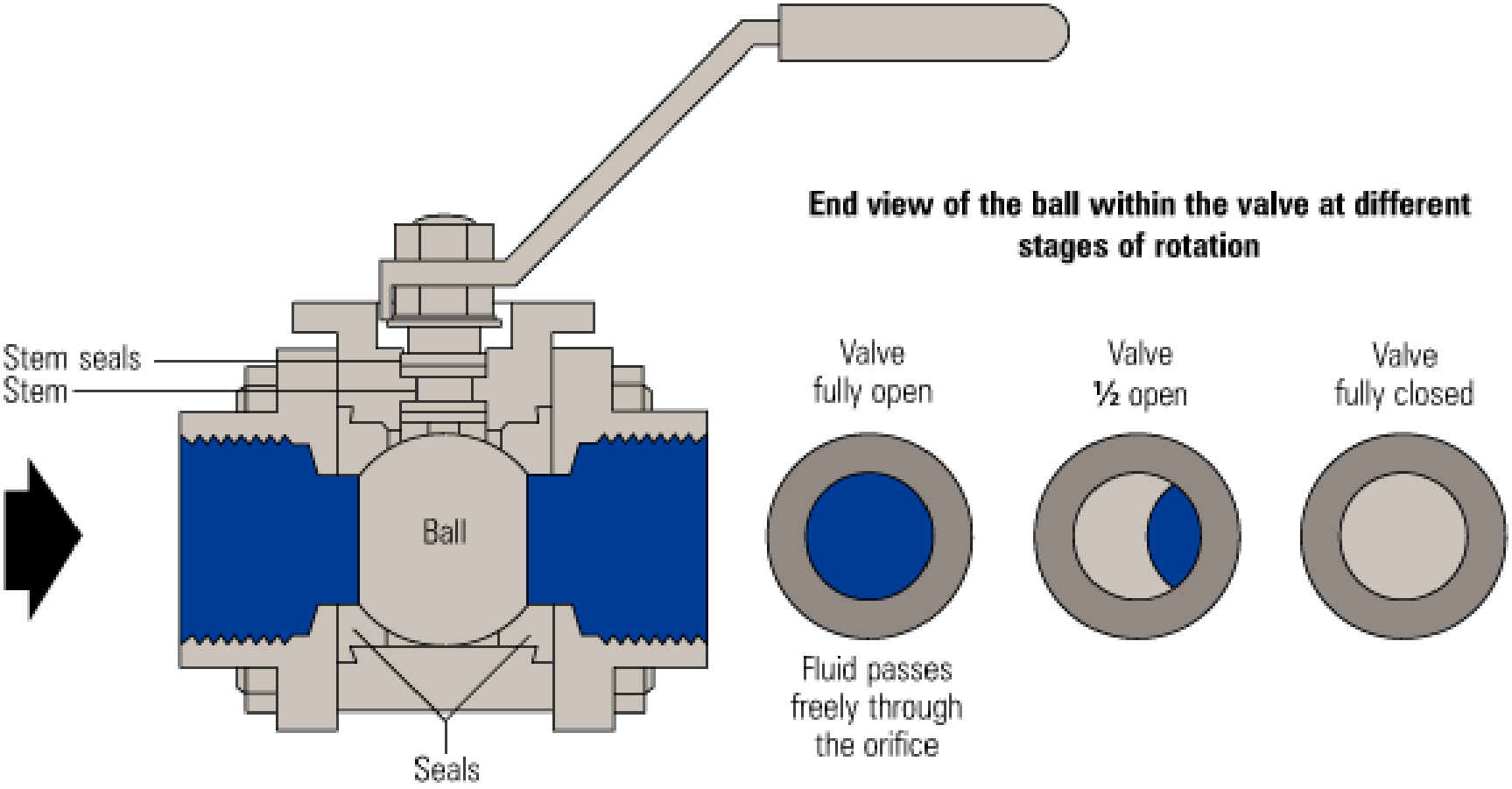
ISOLATION VALVES

Ball, Plug, Butterfly, Gate

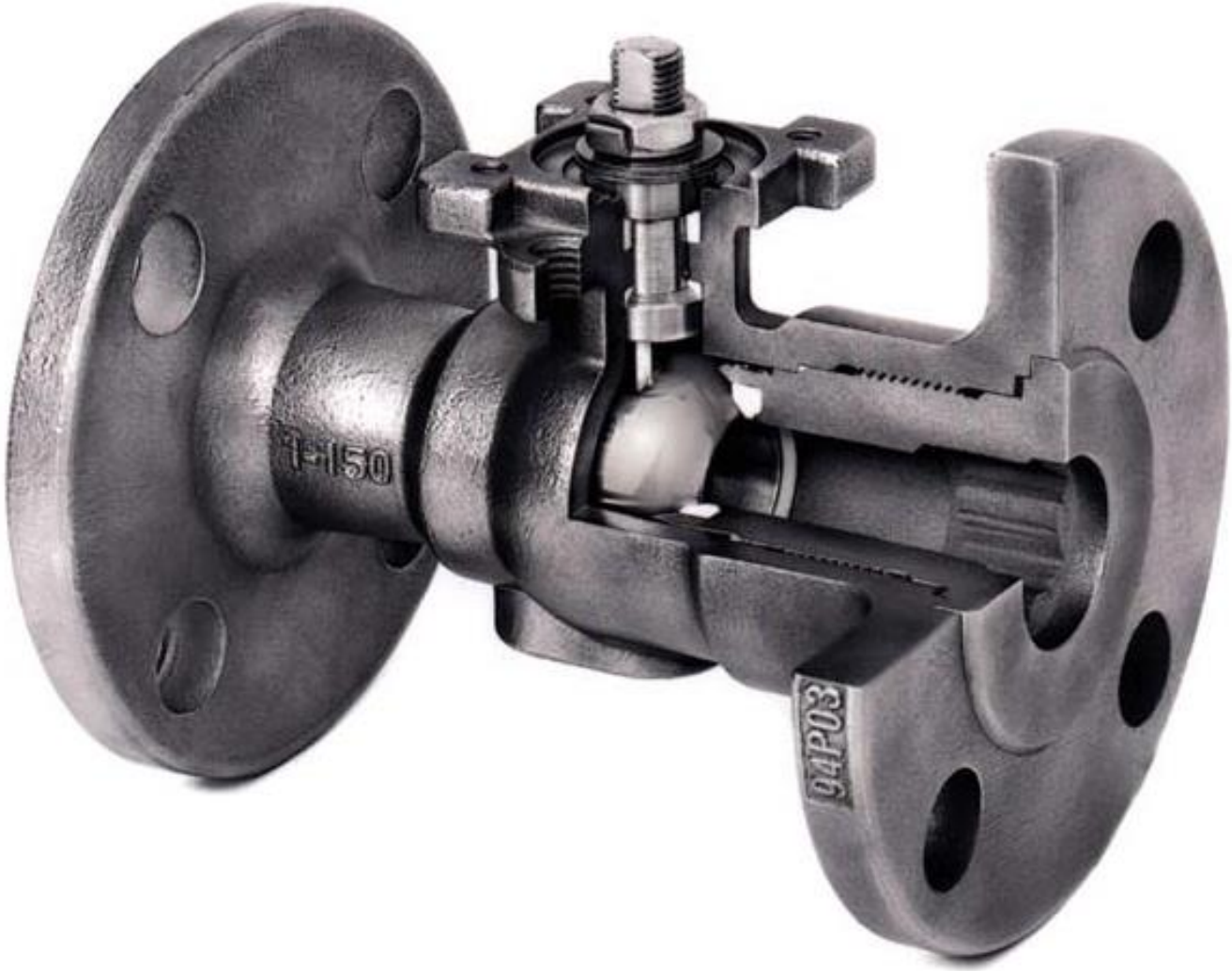
BALL VALVES


SQUARE HEAD FOR WRENCH
COMPRESSION RING
BONNET CAP
STEM GASKET
PACKING CUP
STEM
SEATS
BALL
BODY
PORT

BALL VALVES


Stem seals
Stem
Ball
Seals
End view of the ball within the valve at different stages of rotation
Valve fully open
Valve ½ open
Valve fully closed
Fluid passes freely through the orifice

BALL VALVES



BALL VALVES

- Hydraulic systems .
- Water .
- Air.
- Oil .
- Petrochemical .
- High volume, high pressure and high temperature flow .

BALL VALVES

- The basic concept of the ball valve is the use of spherical ball-plug held between tow lip seal seats. The inside diameter of this lip is always slightly larger than the ball-port so that no “growth” of the seal occurs to prevent operation. The metal ball closure member is usually hard chrome-plated, both to resist abrasion and to give long life.
- Pressure ratings are as high as 7,500 p.s.i. and temperatures ordinarily up to 575ºF.

OPERATION OF BALL VALVES

- The Ball Valve has always been considered on of the most efficient type of valve because it provides an unrestricted throughway, ease of operation, and minimum weight.
- Operating is by means of a shouldered stem which engages in a slot in the ball. By operating the lever, the ball plug is rotated so that its port is in line with the body ports or at right angles to body ports, ie. Closing them off and preventing any flow.

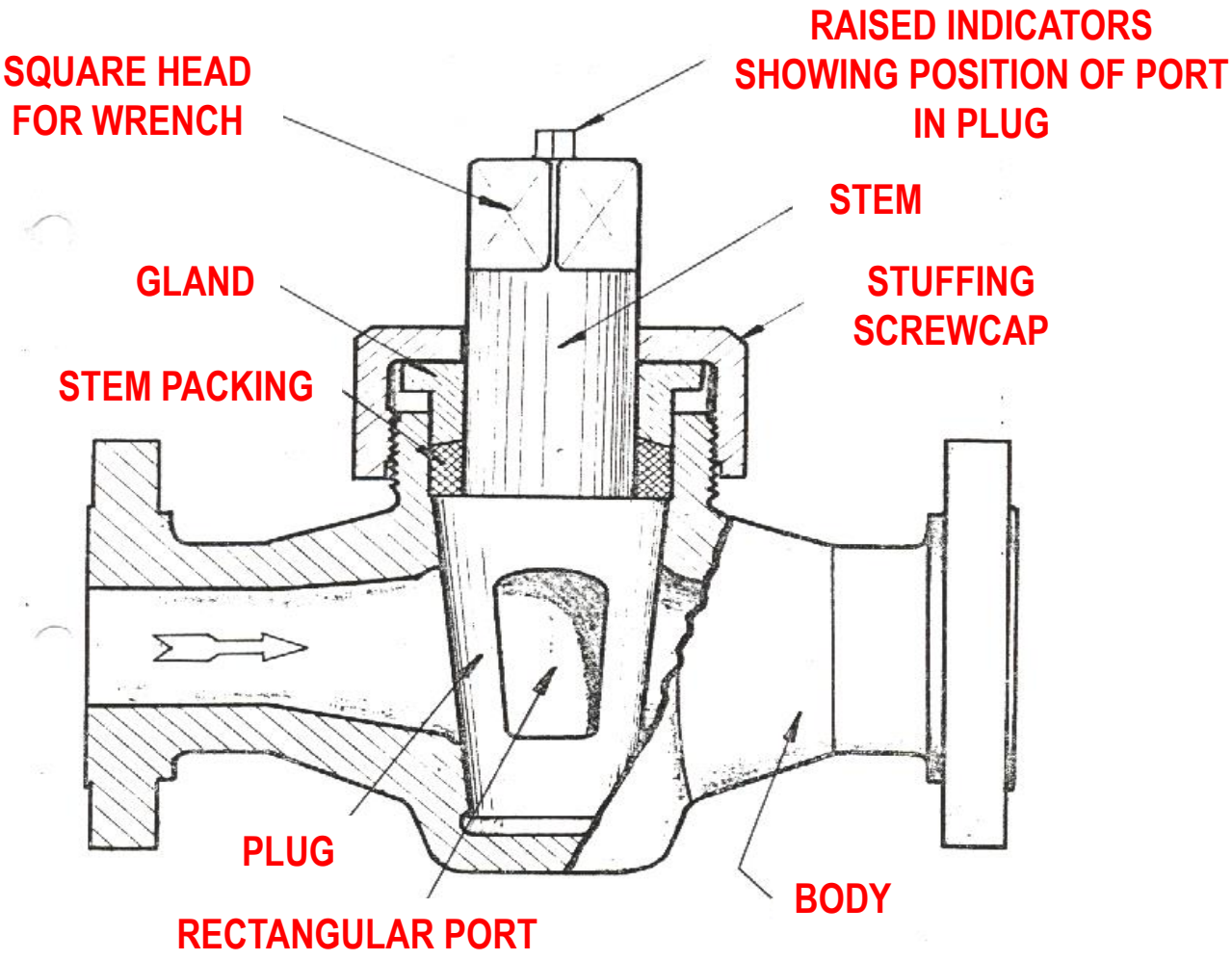
OPERATION OF BALL VALVES

- **Complete shut off** The well designed lip seals on the flexible seats deflect under pressure and follow the contour of the ball in the absence of pressure, ensuring a dead tight seal in both directions of flow.
- **Minimum maintenance** The seats are self-acting and pressure energised, thus requiring no adjustment or attention in service. The valve requires no lubrication and only infrequent attention to the gland.

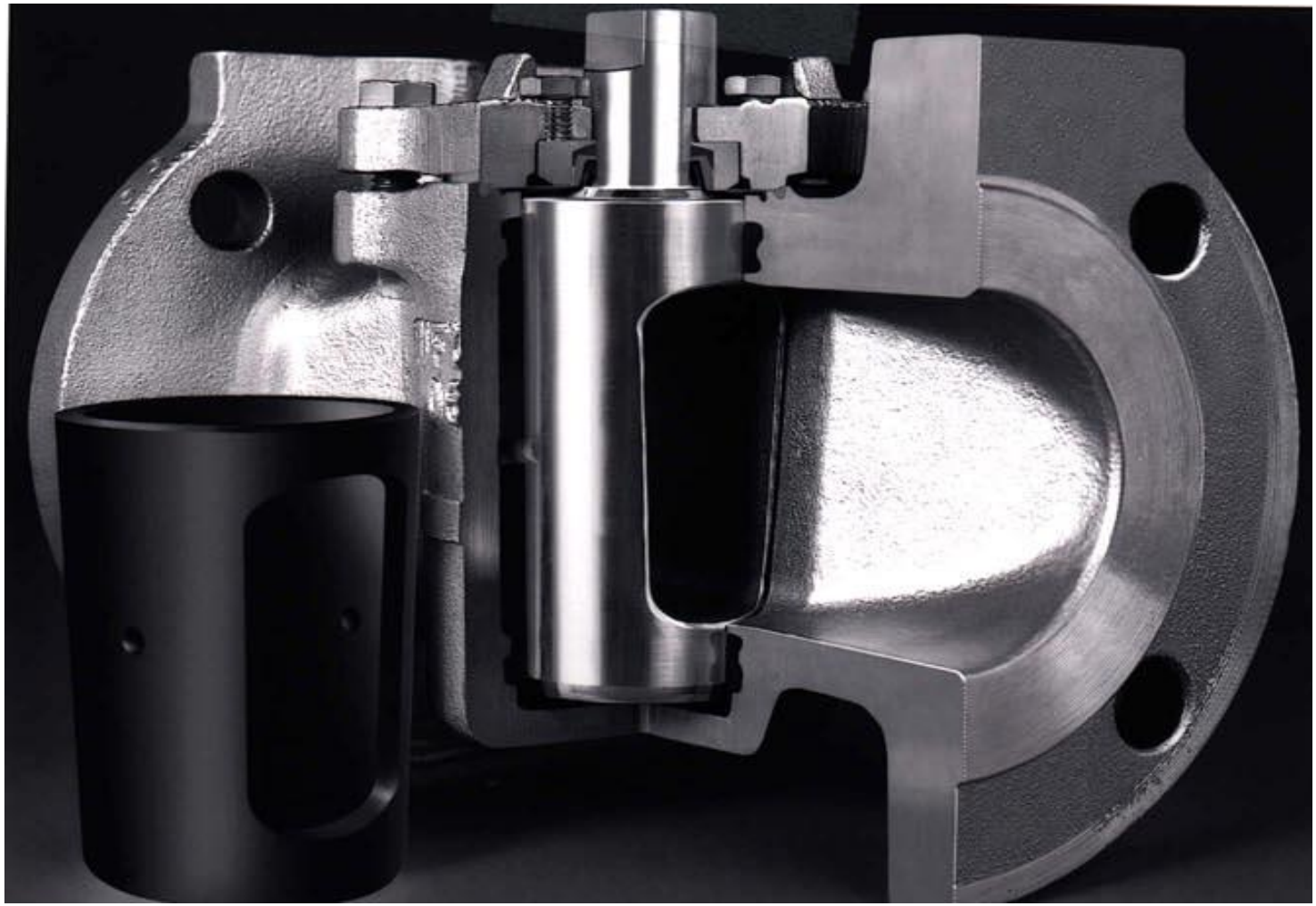
OPERATION OF BALL VALVES

- **Very compact size** It requires very little head-room and can be sited at any angle.
- **Round bore straight-through flow** Produces exceptionally low pressure drop with almost negligible turbulence.
- **Two-way sealing** The design of the seat is such that line pressure forces the upstream seat on to the ball and the ball on to the downstream seat, thus providing a “Double Seal” ball valve.

PLUG VALVES


SQUARE HEAD
FOR WRENCH
RAISED INDICATORS
SHOWING POSITION OF PORT
IN PLUG
STEM
GLAND
STUFFING
SCREWCAP
STEM PACKING
PLUG
RECTANGULAR PORT
BODY

PLUG VALVES



PLUG VALVES

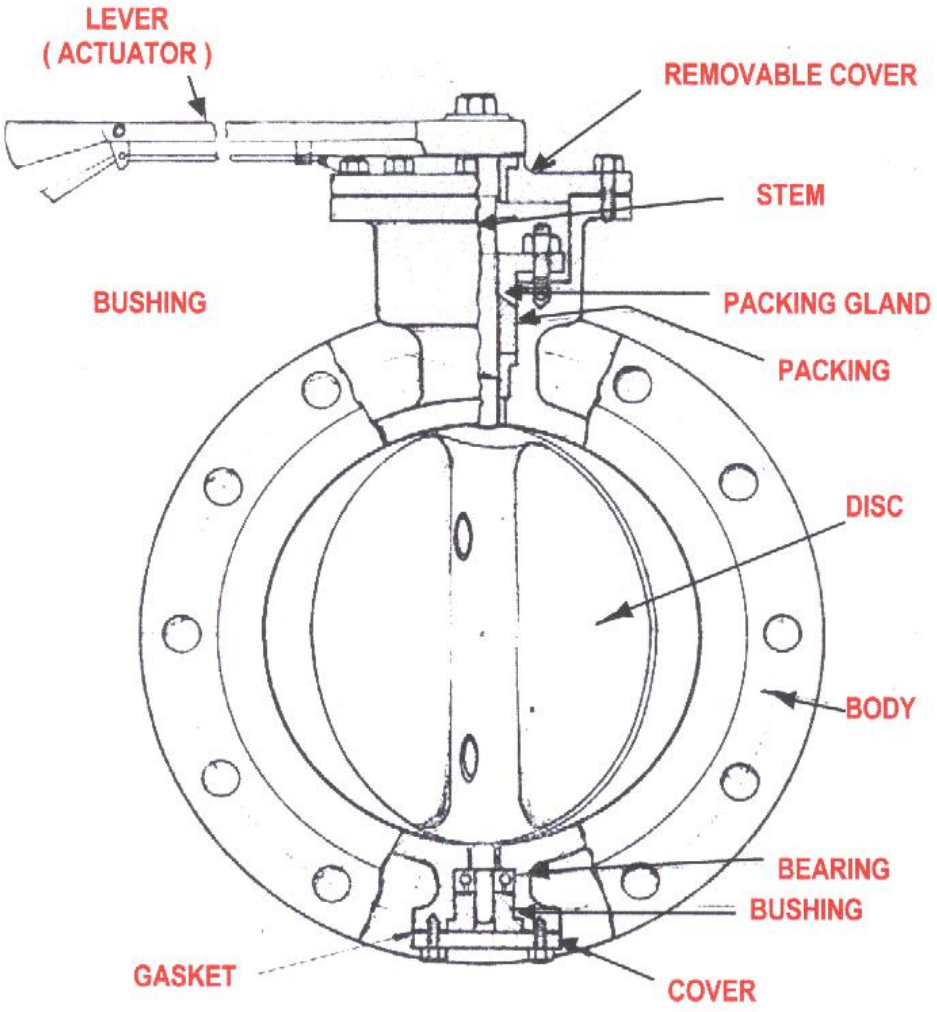
Plug valve Applications

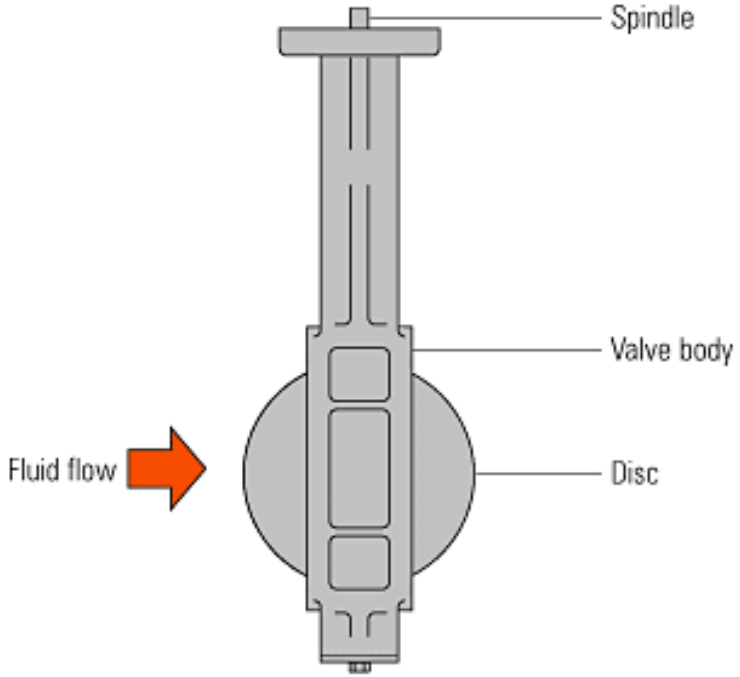
- Gas and liquid fuel
- Water.
- Extreme temperature flow
- Boiler feed water.
- Low Pressure Steam .
- Corrosive Liquids and Gases

Plug Valves

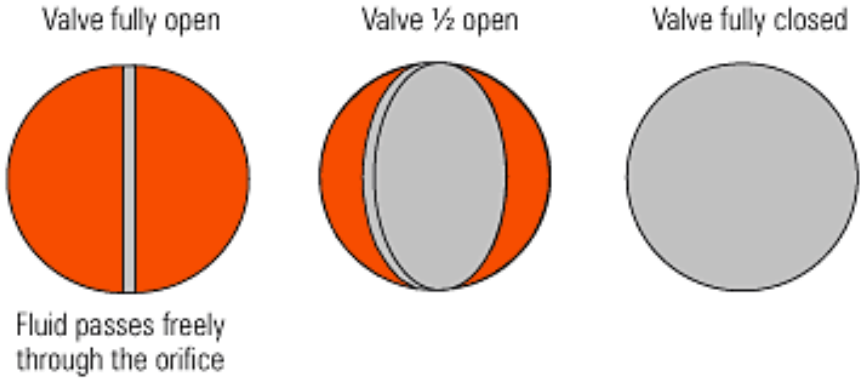
- A form of shut-off device, having a plug, either parallel, taper or spherical in shape, which can be turned to move its port or ports relative to the body seal ports to control the flow of fluid.
- The plug is suitable for high pressure and temperatures. Flow through the valve is smooth, straight and uninterrupted. Pressure drop across the valve is therefore low.

BUTTERFLY VALVES





End view of the disc within the butterfly valve at different stages of rotation



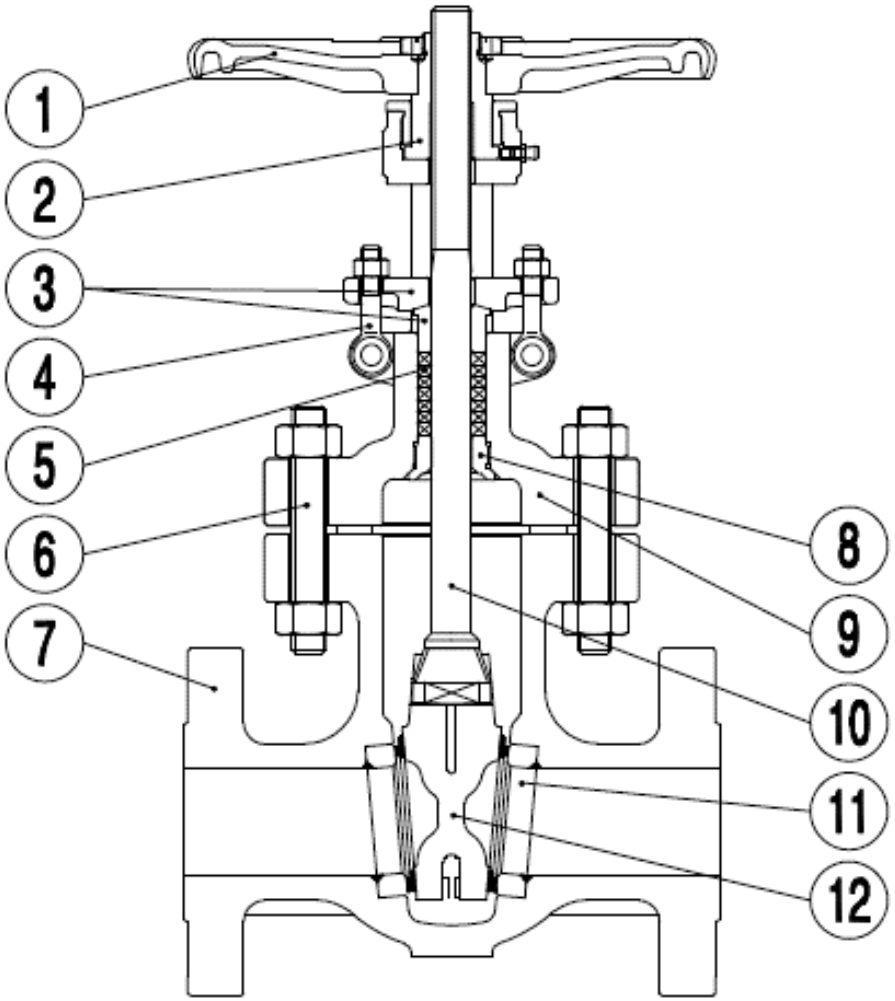
BUTTERFLY VALVES

- A butterfly valve consists of a housing in which a shaft passes through. On this the vane and valve plate are connected.
- The top of the housing can adapt various types of shaft actuators, both power or manually operated. The actuator is connected on the end of the shaft. The valve is in the fully open or closed position by turning the actuator 90 angular degrees.

BUTTERFLY VALVES

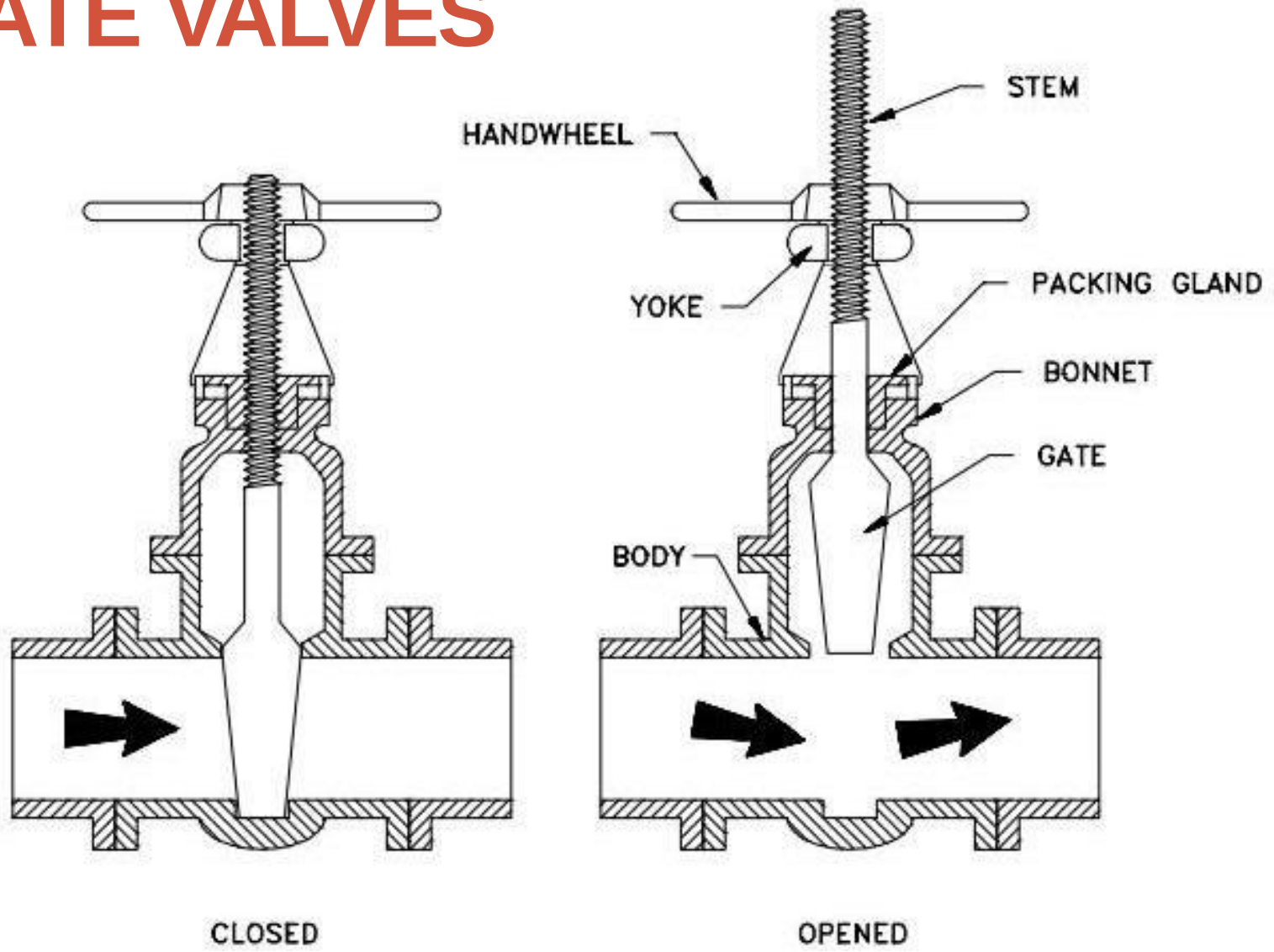
- Butterfly valves are multi-purpose valves and are applicable to rather low pressures, say up to 10 kg/cm^2. They are characterised by their large capacity and are less expensive than plug or globe valves.

GATE VALVES



IT.	DESCRIPTION
1	HANDWHEEL
2	YOKE SLEEVE
3	GLAND FLANGE
4	GLAND EYE BOLT
5	PACKING
6	BONNET BOLT
7	BODY
8	BONNET
9	BACK SEAT
10	STEM
11	SEAT RING
12	WEDGE

GATE VALVES


STEM
HANDWHEEL
YOKE
PACKING GLAND
BONNET
GATE
BODY
CLOSED
OPENED

GATE VALVES

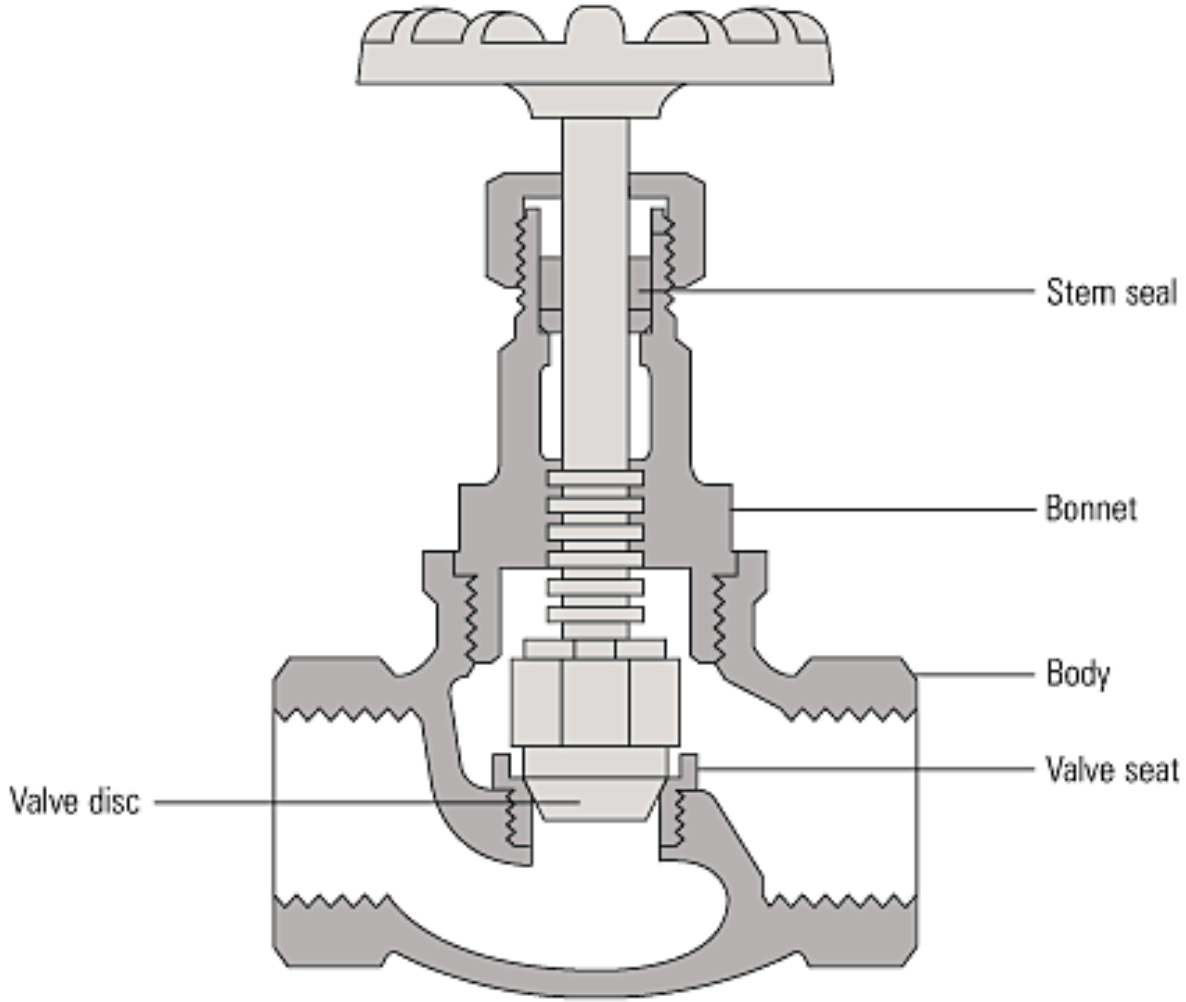
GATE VALVES

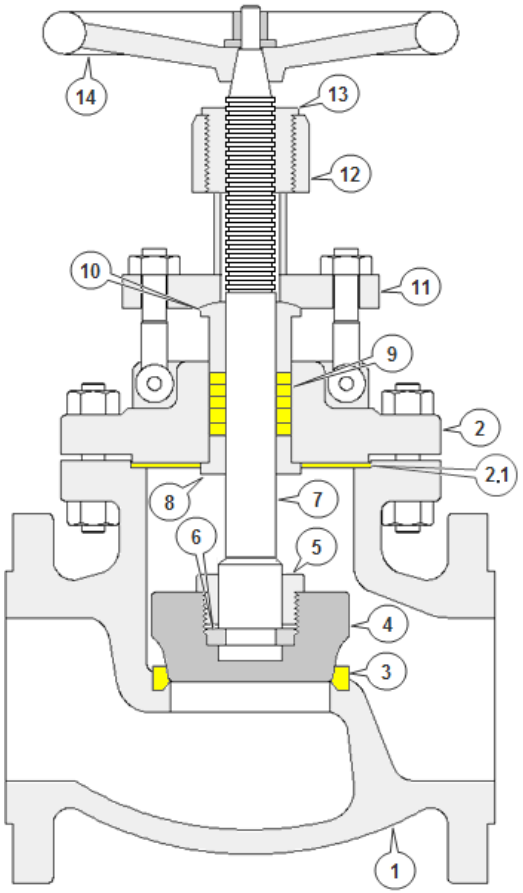
- These valves are widely used where uninterrupted flow is required and are suitable for general purposes on such services as steam, water, oil, gas and many other fluids. They should not be used in throttling service and should only be used either fully open or fully close.

REGULATING VALVES

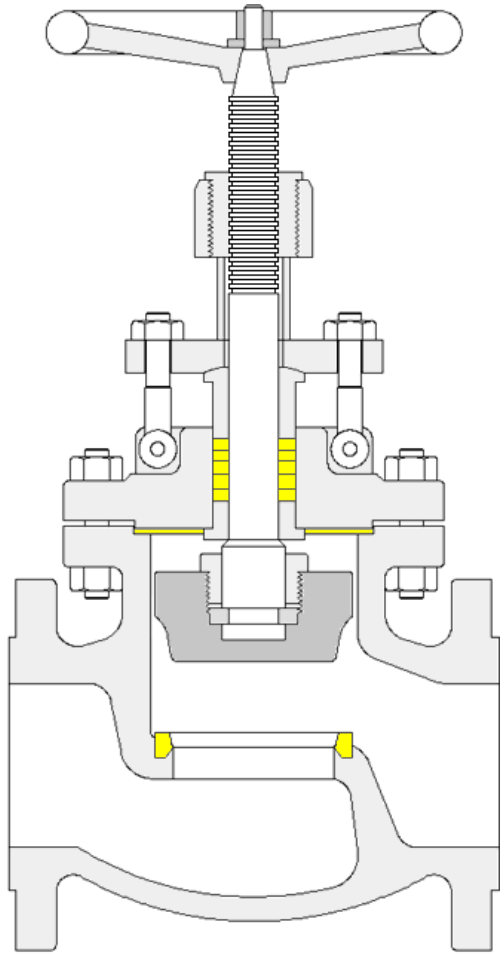
Globe, Needle and Diaphragm

Globe Valve (High pressure)





CLOSED



OPEN

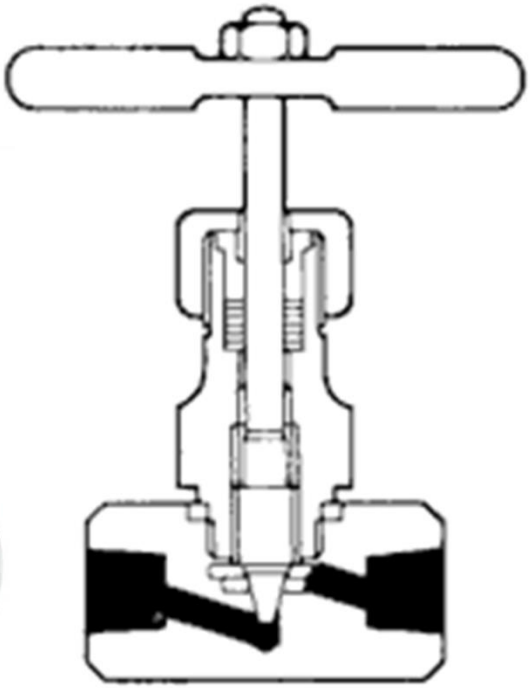
1. Body
2. Bonnet
2.1 Body-Bonnet gasket
3. Seat ring
4. Disk
5. Disk locknut
6. Disk washer
7. Stem
8. Back seat
9. Packing
10. Gland
11. Gland follower
12. Set srew
13. Stem nut
14. Handwheel

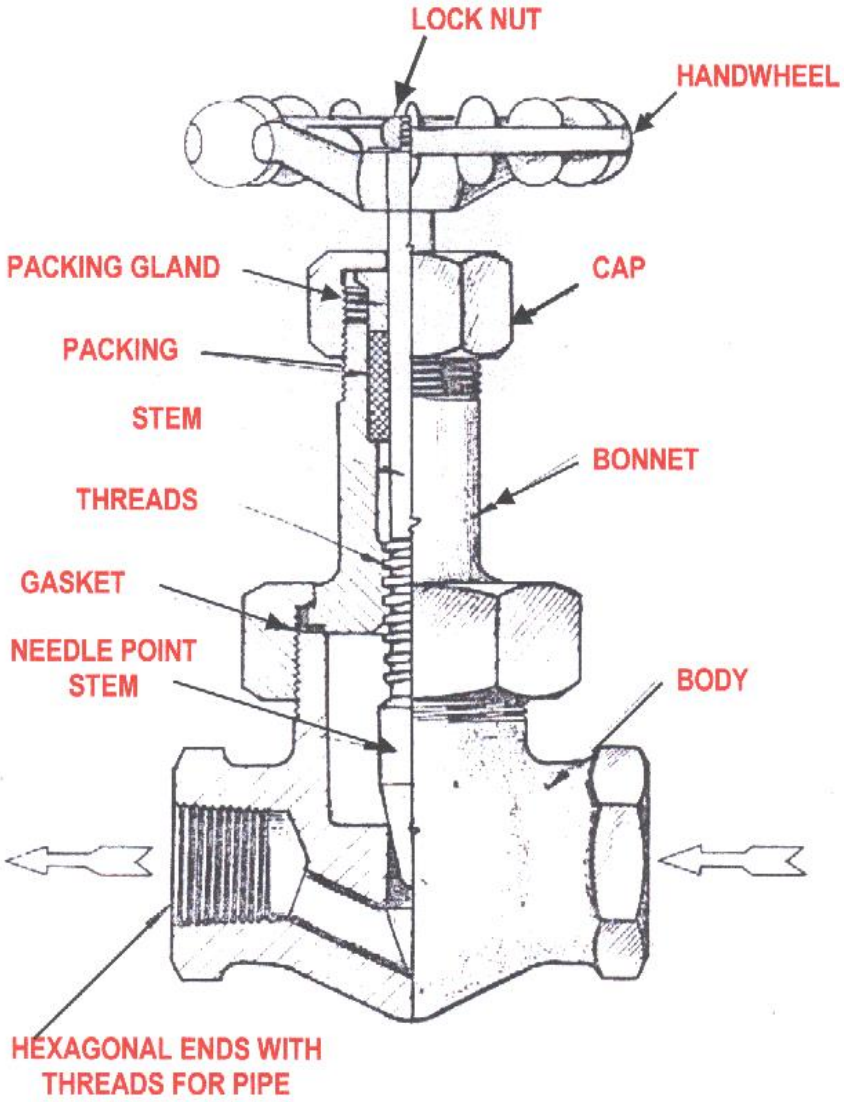
Globe Valve

Globe Valve

- Generally have a spherical body in which the body ends are in line with each other and in which the axis of the stem is oblique to that of the body ends.
- Mainly used on highly corrosive duty.
- It can be seen that a screw-down stop valve creates a higher-pressure drop than a gate valve. It has been found that these valves give better isolation than gate valves. The main advantage of this valve is the control of flow, nearly all control valves will be found to have this type of valve.

NEEDLE VALVE

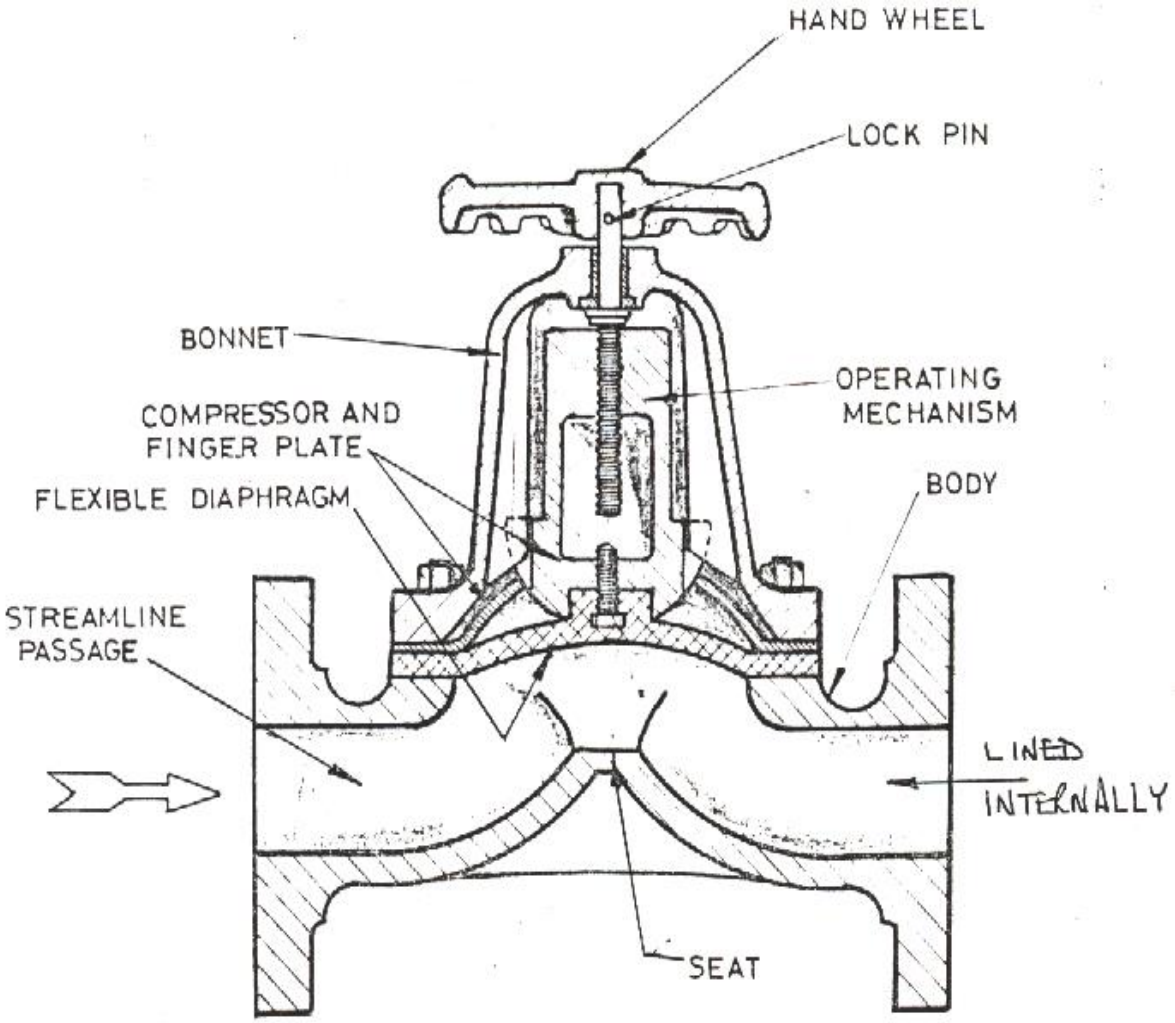


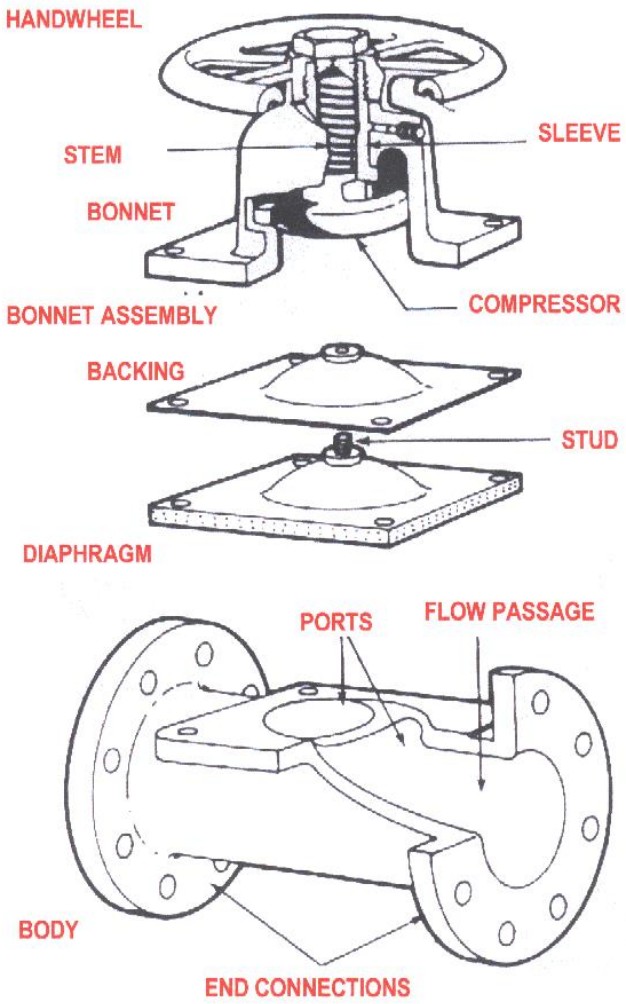


NEEDLE VALVE

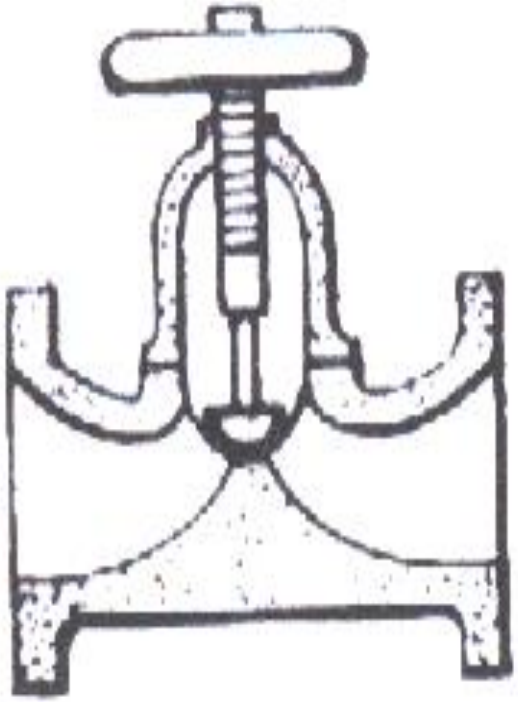
- Needle valves consist of housing in which a sharp pointed needle plug passes through the gland and can be screwed down on its seat.
- A needle valve has the same principle characteristics as the globe valve and is mainly used to control small amounts of gas or liquid flows through the valve. These are normally used where the flow has to be controlled at fine limits.

DIAPHRAGM VALVE

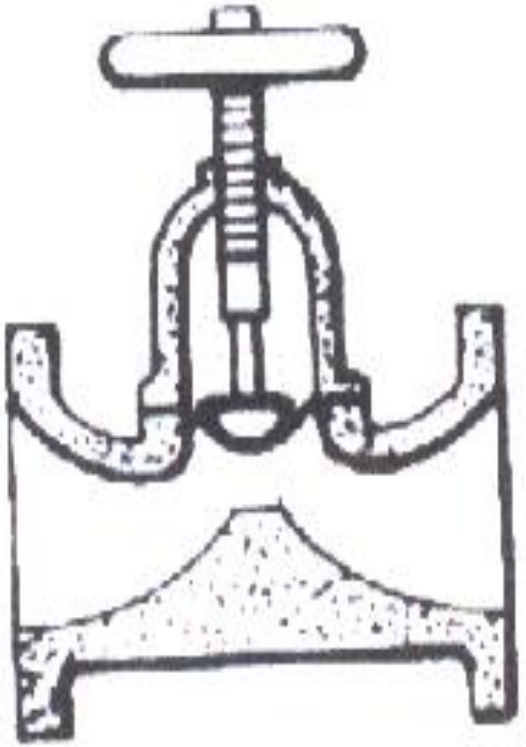




DIAPHRAGM VALVE



CLOSED



OPEN

DIAPHRAGM VALVE

- This is valve is used on a large scale in the chemical industry where a large amount of corrosive material is handled.
- The diaphragm isolates the operating mechanism in the bonnet assembly from the fluid being handled. This isolation preserves the lubricated part from possible damage by abrasive or corrosive fluids and is equally effective in preventing contamination of pipe contents

DIAPHRAGM VALVE

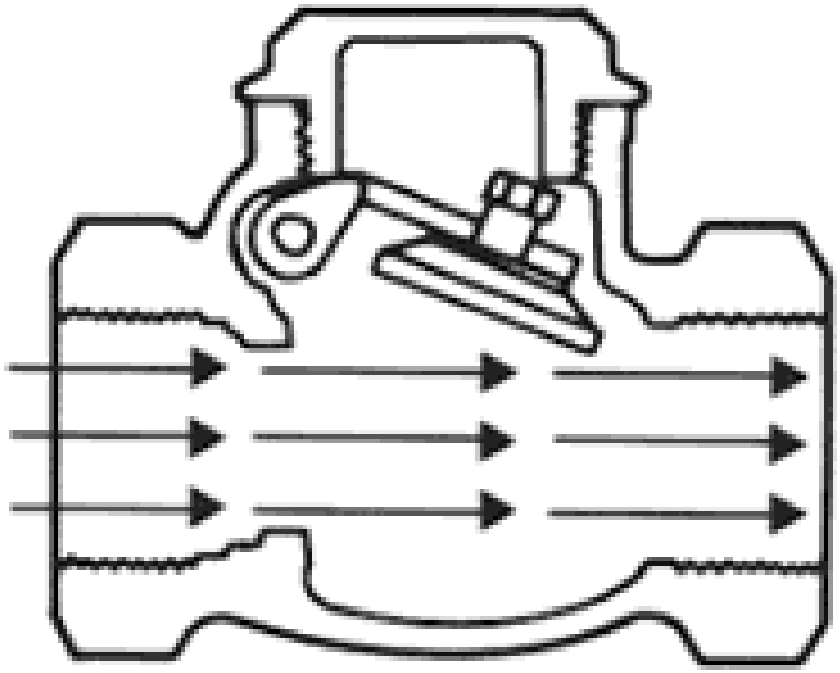
- Diaphragm valves are made in different designs for different types of service and can be equally effective for liquids, slugs, slurries, pulps or fluids containing solid matter in suspension. Diaphragms are now manufactured to suit temperature conditions ranging from -85°F to 392°F (-65°C to 200°C).
- The outer portion of the diaphragms also forms the body to bonnet joint, thus sealing off the fluid from the moving parts.
-

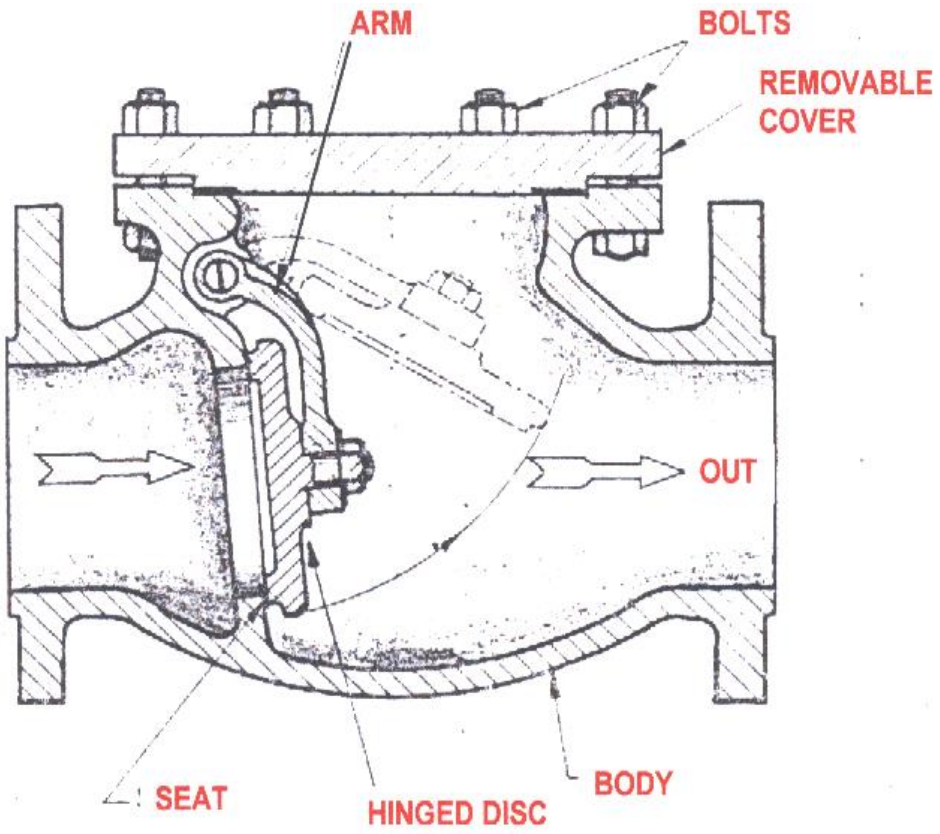
CHECK VALVES OR NON – RETURN VALVES

CHECK OR NON RETURN VALVES

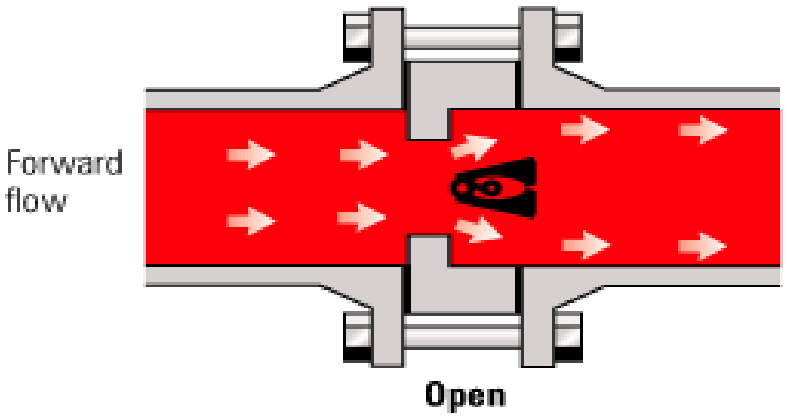
- A check valve in which the check mechanism incorporates a disk, piston or ball which lifts along an axis in line with the axis of the body seat. Lift type check valves are described according to the type of check mechanism, as follows:
- Disk check - the check mechanism is a disk and used for liquids
- Piston Check - containing a moving piston disc and Recommended for Vapor service
- Ball check - the check mechanism is a ball and used for heavy fluids

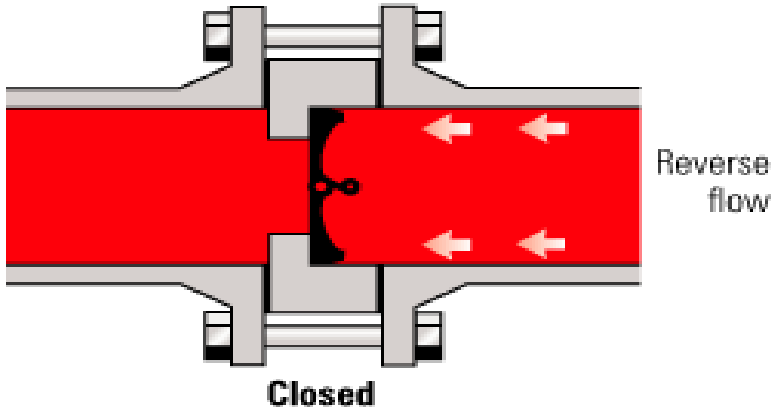
Swing check valve



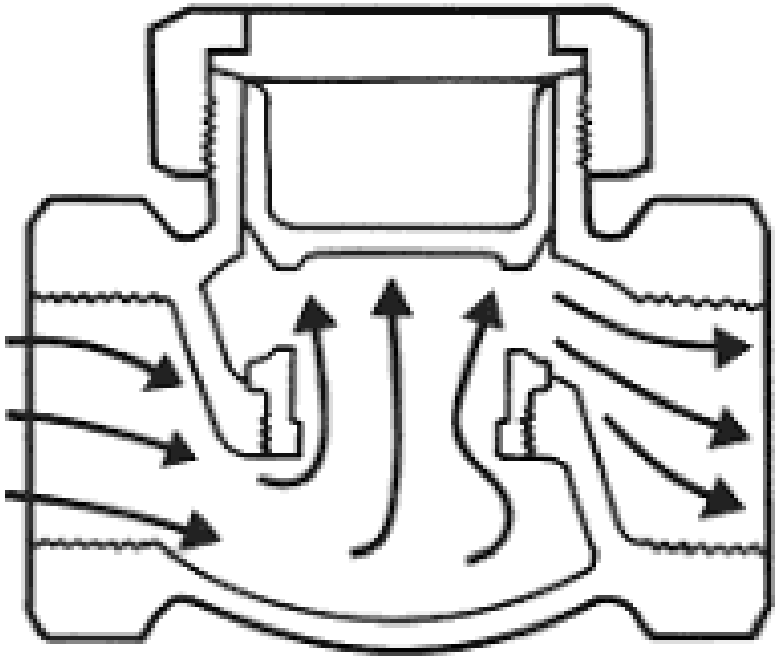


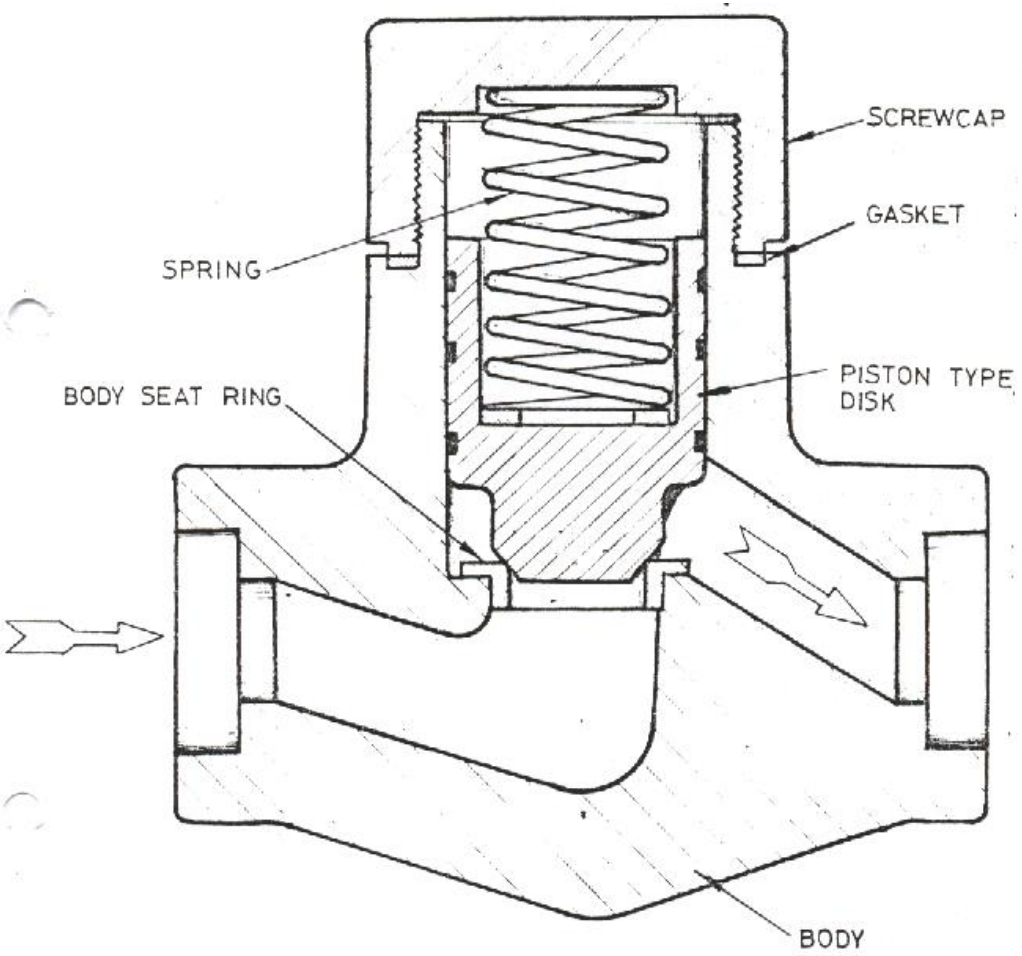
split disc check valve



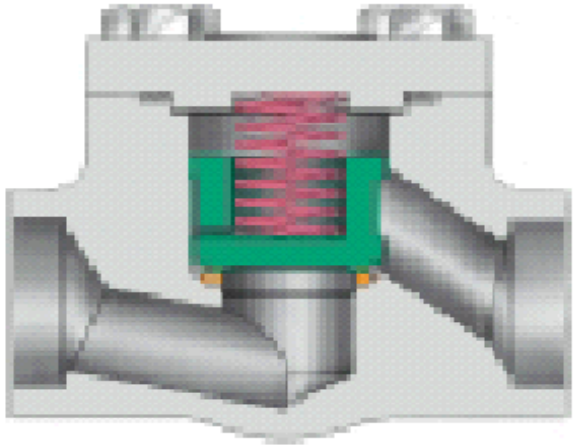


SPRING PISTON CHECK VALVE

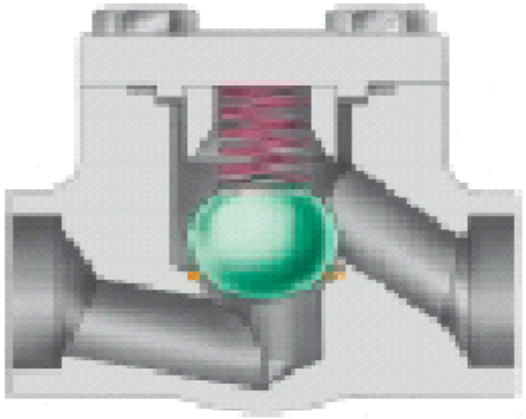




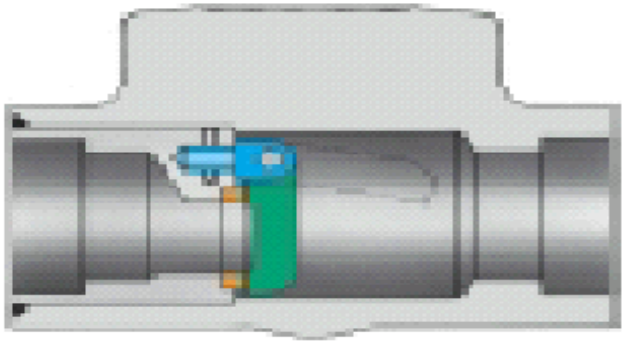
Ball check valve



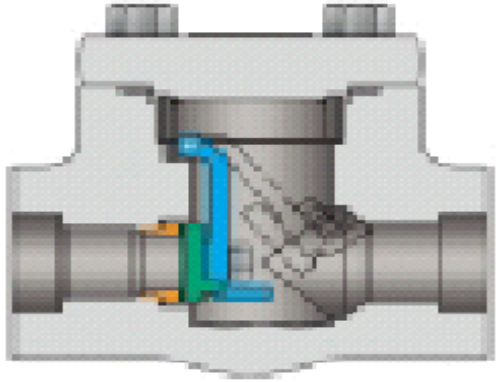
PISTON BOLTED COVER



BALL TYPE BOLTED COVER



COVERLESS SWING CHECK



SWING CHECK BOLTED COVER

Ball check valve

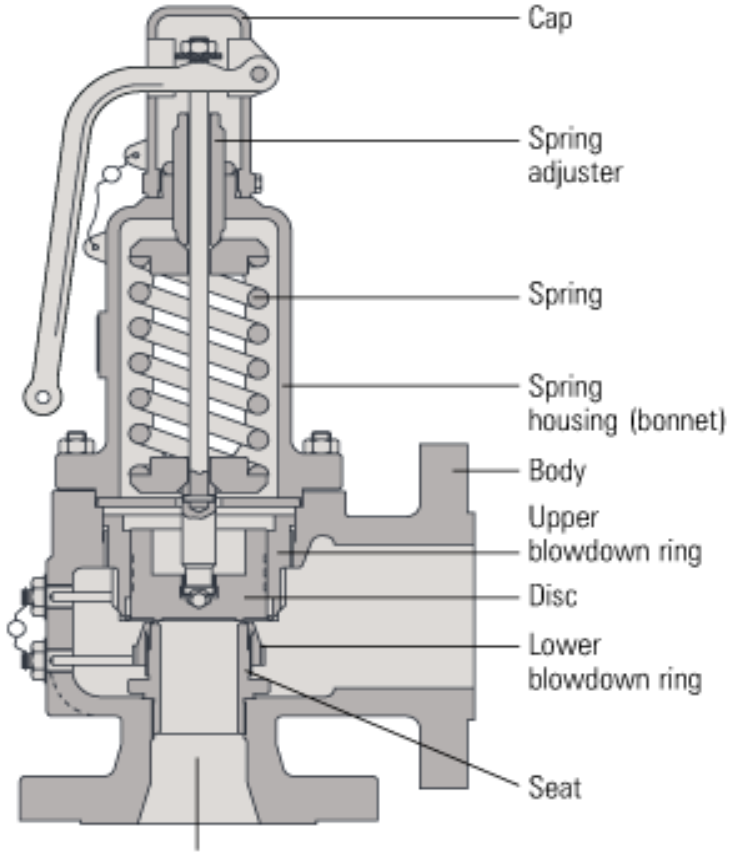
RELIEF VALVES

Type of Pressure Relief Valve

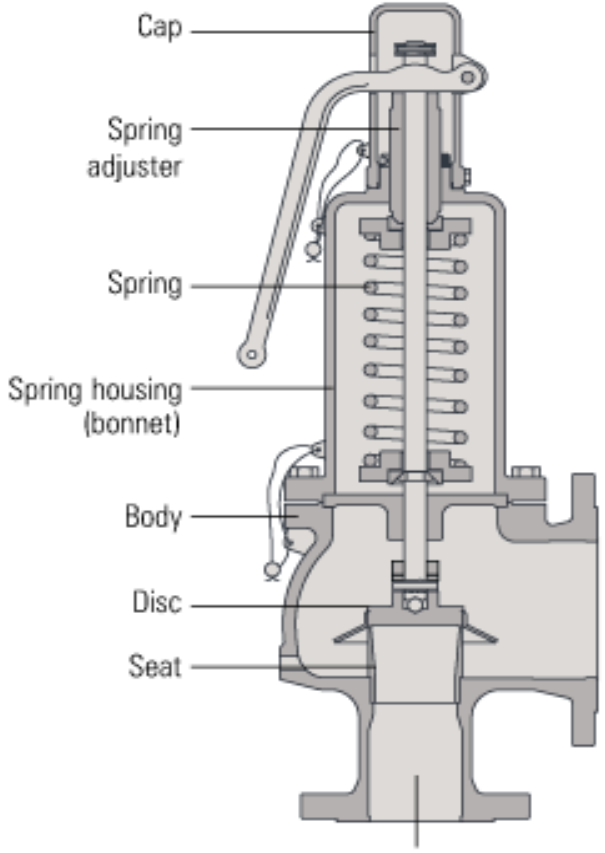
A relief valve is an automatic pressure relieving device actuated by the static pressure upstream of the valve and which opens in proportion to the increase in pressure over the opening pressure.

- **Safety valve :** Used with compressible gases steam and air services .
- **Relief valve :** Used in liquid systems. as pressure overspill devices .
- **Safety relief valve :** used either for liquid or compressible fluid.

Examples of safety valves



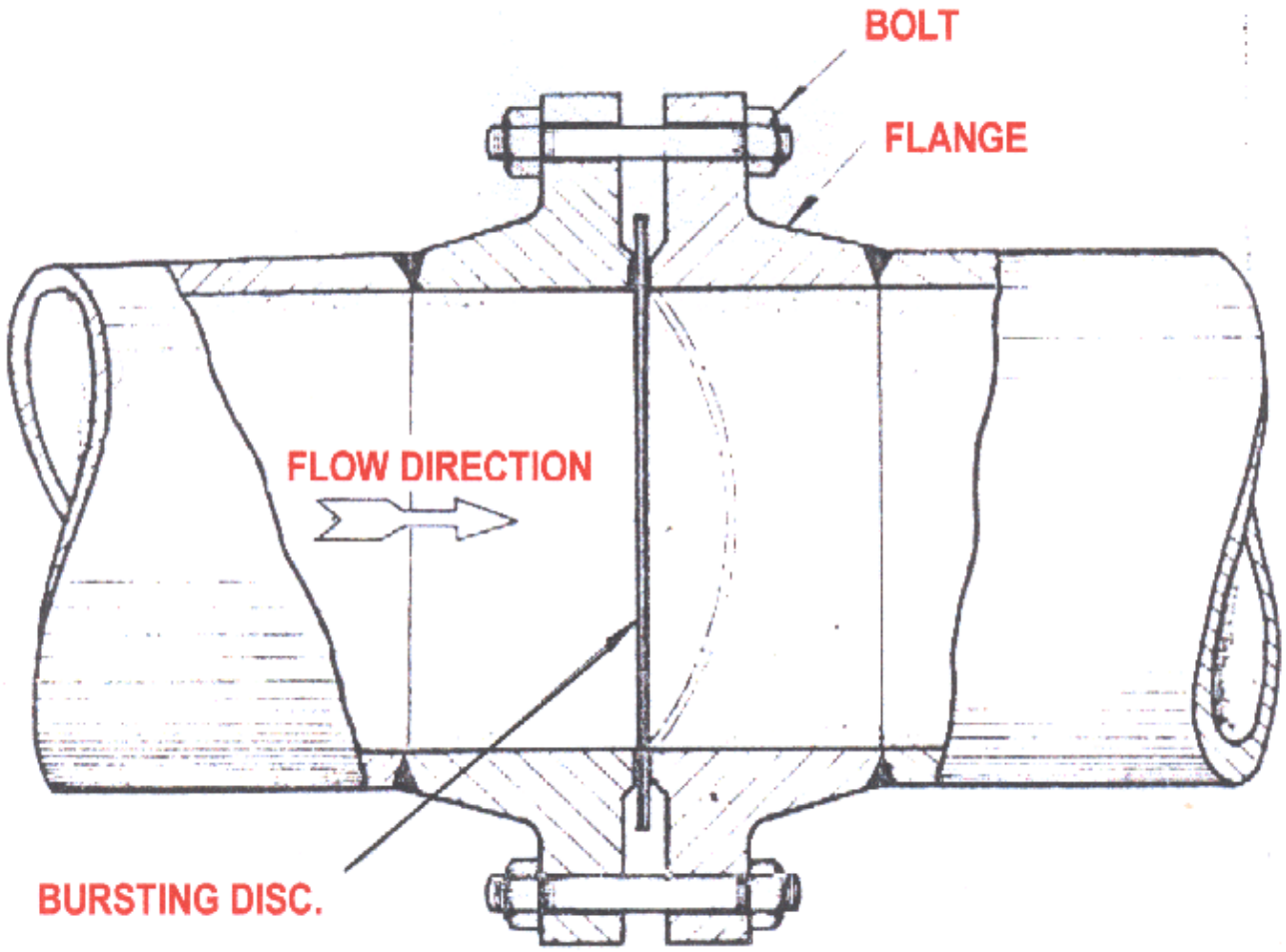
Typical ASME valve



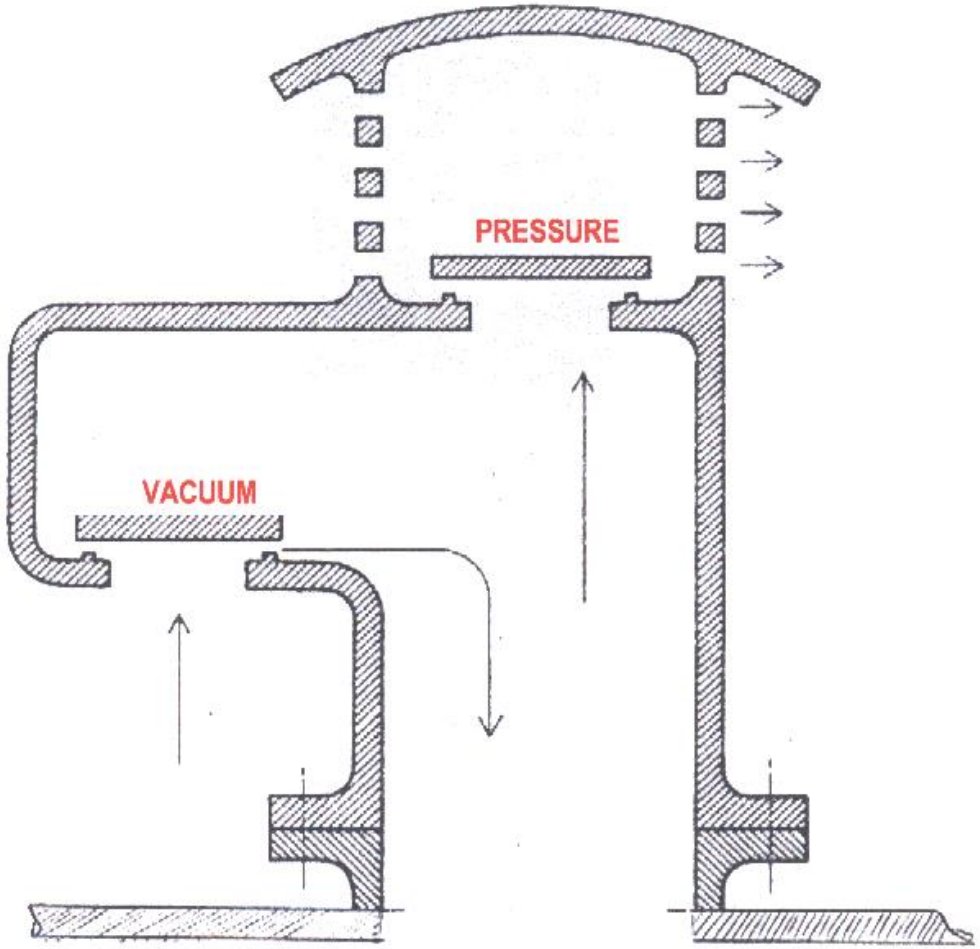
Typical DIN valve

Examples of safety valves

Examples of safety valves
BURSTING DISK



Examples of safety valves
VACUUM, PRESSURE RELIEF VALVE



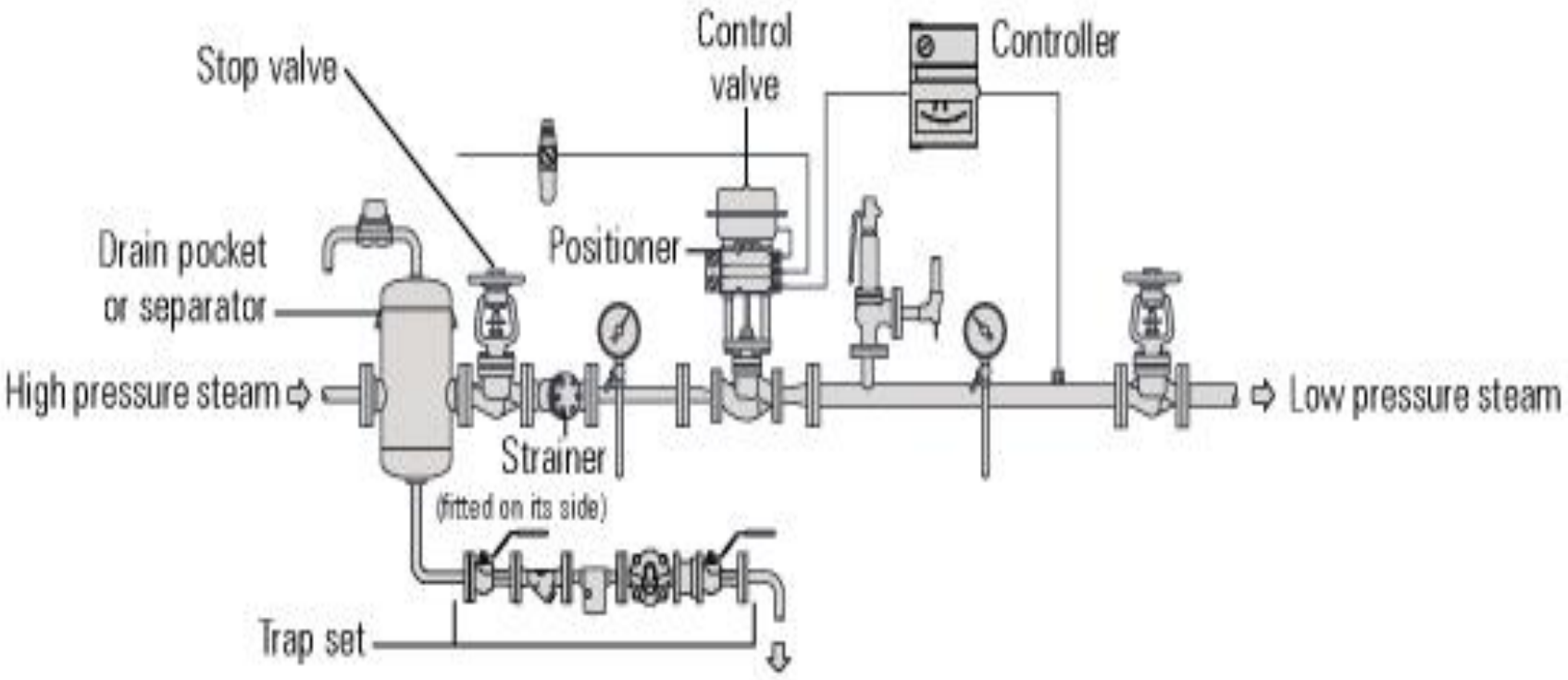
CONTROL VALVES

CONTROL VALVES

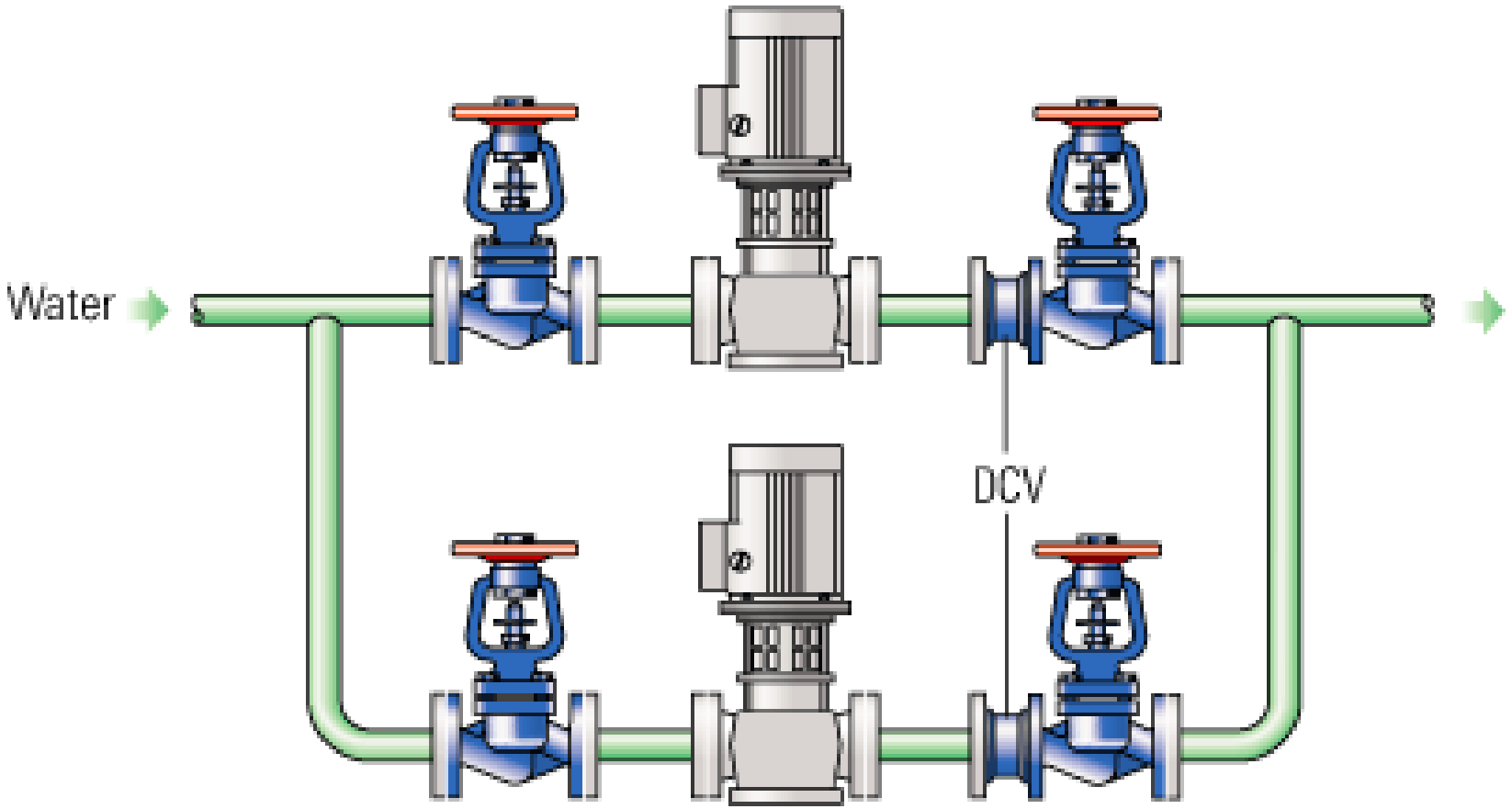
Control system would normally consist of the following components:

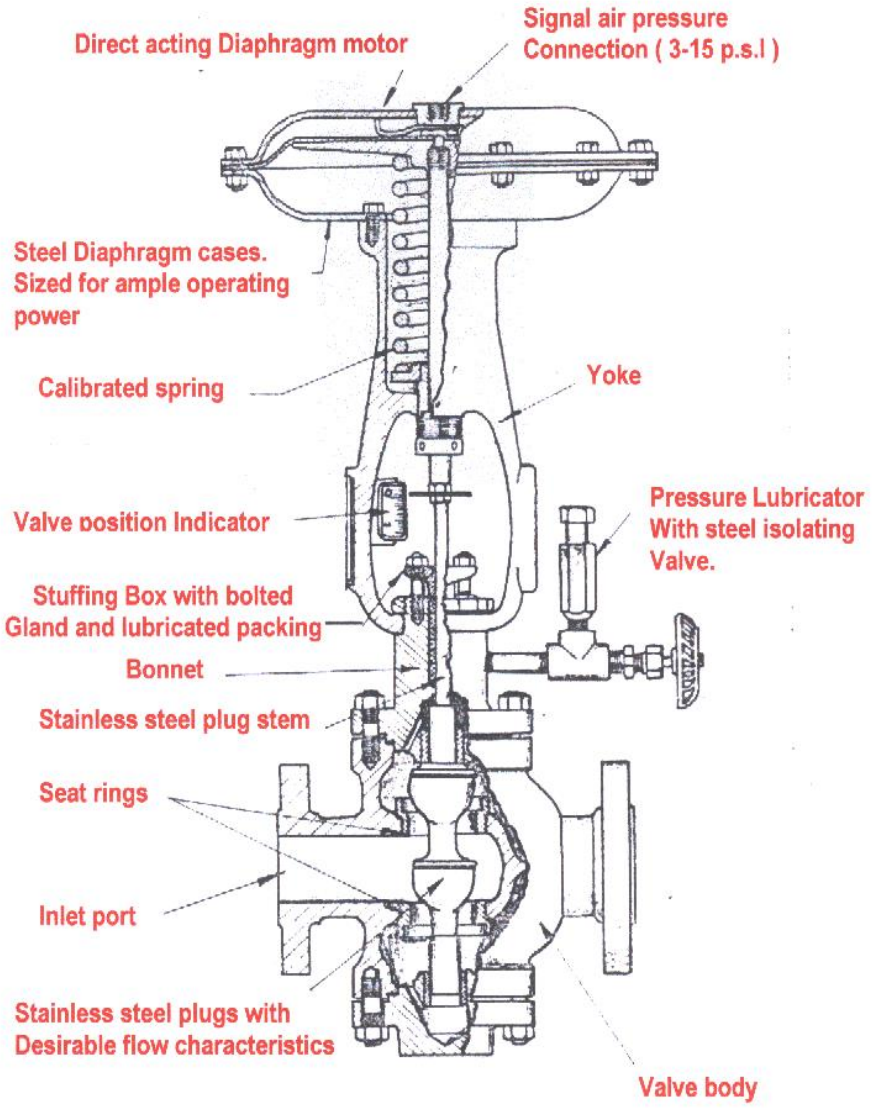
- Control valves.
- Actuators.
- Controllers.
- Sensors.

CONTROL VALVES

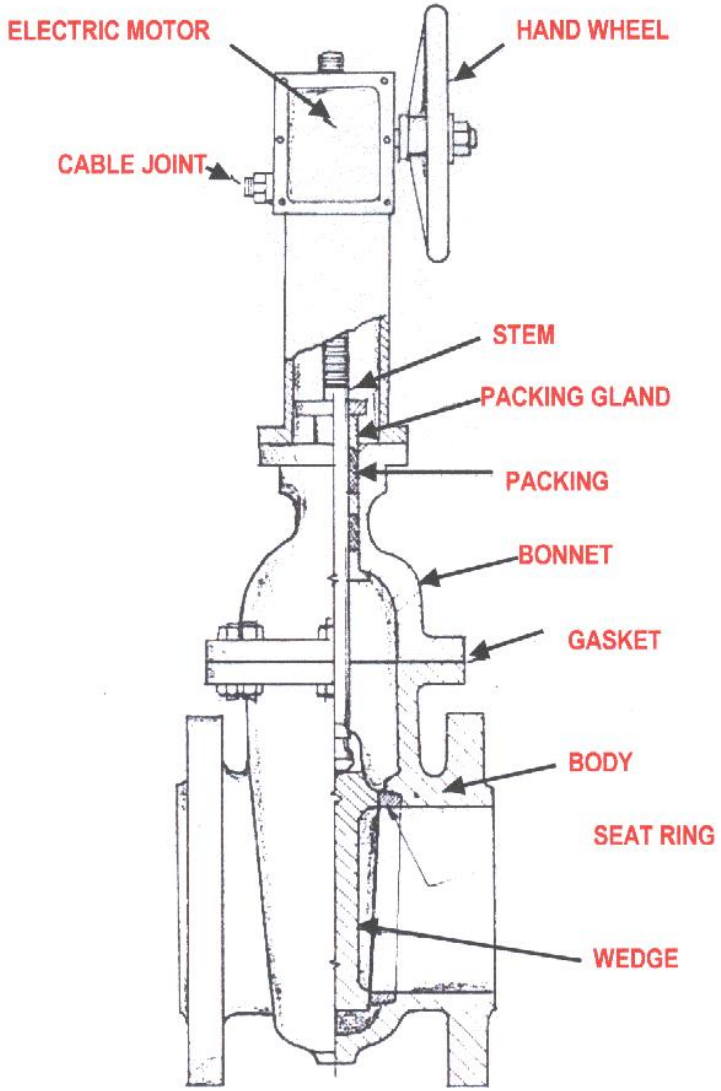


Valve positions





PNEUMATIC CONTROL VALVE

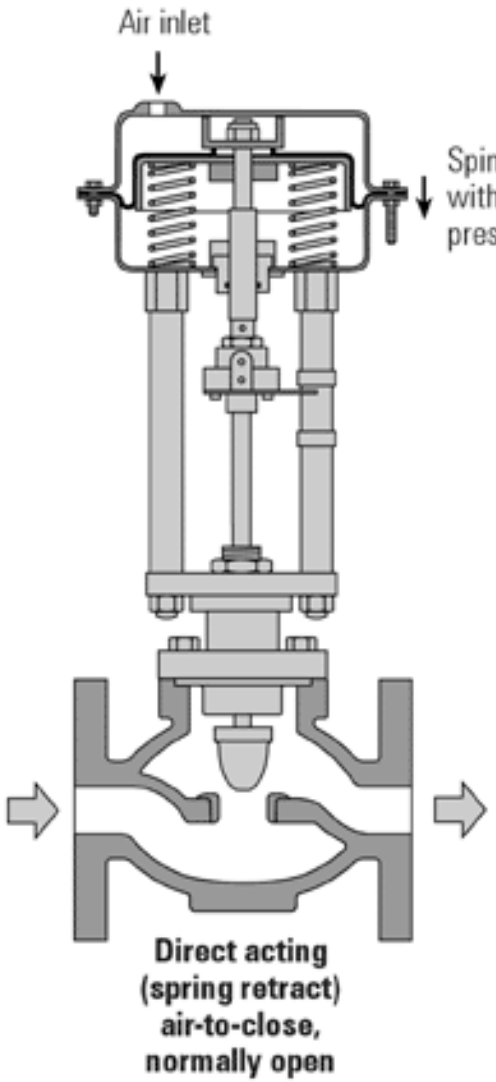


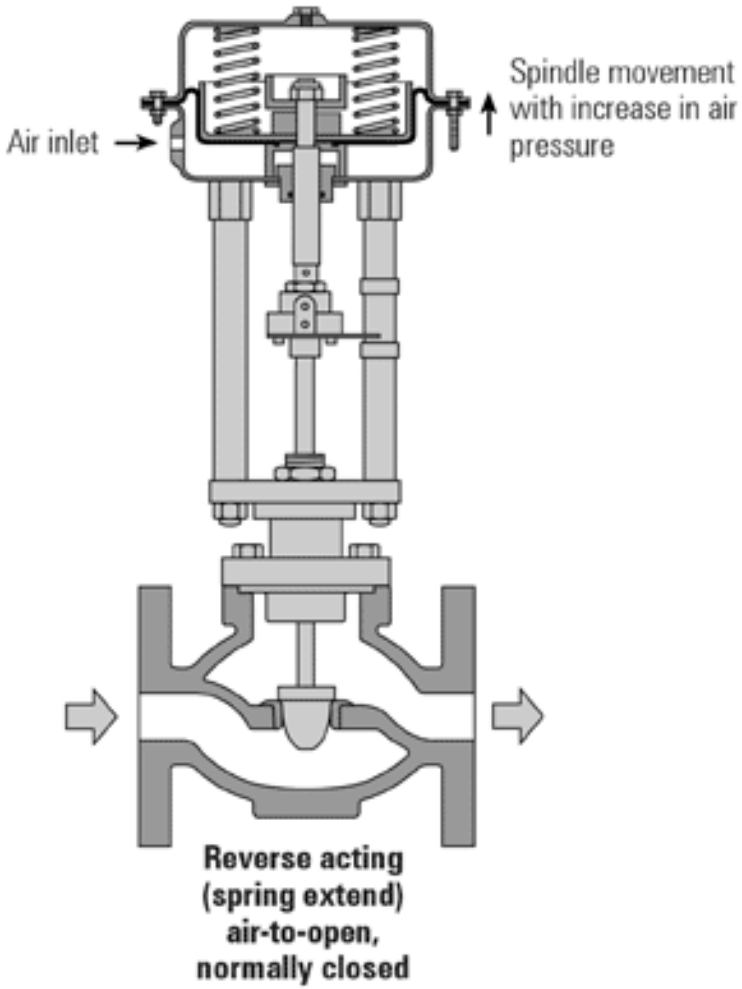
MOTORISED VALVE

MOTORISED VALVE

- The motorised valves are basically identical to the manually operated valves, except that the operation of opening and closing the valve is now performed by a motor..
- The motor is built integrally with the handwheel and is connected via a worm gear drive to the valve spindle. Motors give a wide range of output speeds.

PNEUMATIC CONTROL VALVE





PNEUMATIC CONTROL VALVE

PNEUMATIC CONTROL VALVE

- The equipment which measures the flow, level, pressure, or temperature being controlled sends out an air pressure signal, which varies usually in the range 3 to 15 p.s.i. The air signal is applied above the diaphragm. An increasing air signal will push the operator stem downwards against the force exerted by the spring on the diaphragm plate. As a result of the downward movement, the net area through which the flow passes will decrease gradually.

PNEUMATIC CONTROL VALVE

- An increase in air pressure is required to close the valve and a reduction to open the valve hence the name “Air off to open” (AFVO).
- The plug is constructed so that it can be removed from the valve stem, and refitted in reverse. The body can also be reversed. The action of the valve is thus reversed
- Air failure valve open (AFVO) or air failure valve closed (AFVC) are selected following consideration of plant requirements so that valves “fail safe” in event of air failure.

Types of Valves Summary

- **Gate valves** are generally used in systems where low flow resistance for a fully open valve is desired and there is no need to throttle the flow.
- **Globe valves** are used where good throttling and low seat leakage are desired and a relatively high head loss in an open valve is acceptable.
- **Ball valves** allow quick, quarter turn on-off operation and have poor throttling characteristics.
- **Plug valves** are often used to direct flow between several different ports through use of a single valve.

Types of Valves Summary

- **Diaphragm valves** are used where the entire operating mechanism to be completely isolated from the fluid.
- **Butterfly valves** provide significant advantages over other valve designs in weight, space, and cost for large valve applications.
- **Check valves** automatically open to allow flow in one direction and seat to prevent flow in the reverse direction.
- **Safety/relief valves** are used to provide automatic over pressurization protection for a system.

Water Hammer

- **Water Hammer occurs when the valve is close too quickly.**
- **Because the valves, fittings and lines are designed for specific working pressure, when the valve is closed too quickly the liquid flowing through it has to stop instantly, since the liquid is incompressible.**
- **Instantly stopping the flow produce high pressure in a system.**
- **This can do serious damage, and may rupture the line.**
- **Always close the valve slowly and gently.**

Cavitations of Valves

- When a liquid passes through a partially closed valve, the static pressure in the region of increasing velocity drops and may reach the vapor pressure of the liquid.
- The impinging of the opposing liquid particles of the collapsing vapor bubble produces locally high but short-lived pressures. If the implosions occur at or near the boundaries of the valve body or the pipe wall, the pressure intensities can match the tensile strength of these parts.

Cavitations of Valves

- The rapid stress reversals on the surface and the pressure shocks in the pores of the boundary surface lead finally to local fatigue failures that cause the boundary surface to roughen until, eventually, quite large cavities form.
- The development of cavitations can be minimized by letting the pressure drop occur in stages.

Presented by

Ahmed Yehia Mohamed

Process engineer,
Suez Oil Processing Company (SOPC)

+20 100 890 7 390
Che.Yehia@gmail.com