TRAINING MANUAL ON VALVES

COURSE NO. : SA-M-MP-2.8

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PREFACE

This training manual on Valves is intended to be used for basic skill training for Scientific Assistant trainees. This manual is prepared with a view of imparting training effectively on Function, Construction, Material of parts, and testing aspects of the valves to bring the competency in the new entrants so that they can ***do maintenance right at the first attempt.*** *This manual also meets training requirement for tradesman trainees.*

I express my sincere thanks to Shri C.M. Mishra, ENC(MT) for his guidance and encouragement to complete this task. I am also thankful to Shri N.Nagaich, Training Superintendent, RAPS-1 to 4 for his kind cooperation and motivation in preparation of this manual.

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CHAPTER - 1

GENERAL CONSIDERATION

1.1 INTRODUCTION

Valve is an equipment used as one of the critical organ of the process circuit of nuclear industry. Proper working of valves ensure better availability of unit, safety of the plant, equipment, processes and men. Passing or leaking of the fluid in valves lead to reduction in efficiency and consumption of excess costly fluids, resulting in higher production cost.

1.2 VALVE FUNCTIONS

Valves are used in piping systems and on processing vessels or tanks for a variety of reasons. General valve functions can be defined as follows :

1. On-off service
2. Throttling service
3. Prevention of reverse flow
4. Pressure control
5. Special functions
    - A. Directional flow control
    - B. Sampling service
    - C. Limiting flows
    - D. Sealing vessel and/or tank outlets nozzles
    - E. Other miscellaneous functions

1.3 VALVE SELECTION FACTORS

Usually more than one type of valve is suitable to perform a specific function. In order to narrow the selection down the one most applicable it is necessary to investigate the factors which affect the individual valve's performance and the effect that a particular valve has on the materials being handled.

Fluid Properties

The properties of the fluid being handled must be known. These properties include its specific gravity, viscosity, corrosiveness, and abrasiveness. Fluid, as used here, is a general term which can mean gas, vapor, or slurry, as well as a pure liquid material. All these properties relates for compatibility between fluid and valve material.

Fluid Friction Losses

The various types of valves exhibit pressure drops to varying degrees. A system requirement of limited available pressure drop can often influence a valve selection. This factor must be considered in valve selection.

Operating Conditions

Maximum and minimum pressures and temperatures must be known. A valve choice, particularly in a corrosion-resistant material of construction, can be influenced greatly by these factors. This is especially true when plastic or lined valves are under consideration.

Establishment of the actual operation condition of each valve will simplify the valve selection procedure.

Materials of Construction

This factor is directly related to the fluid properties of corrosiveness and abrasiveness. In dealing with extremely corrosive or abrasive materials the choice of valve may be limited by availability of valves in suitable materials of construction.

At times it is desirable to consider the material of construction of the body separately from the material of construction of the trim (stem, seat, ring, disc), in order to make the most economical selection. For certain types of lined valves, such as diaphragm valves, the lining material will normally be different from the elastomeric diaphragm.

The combination of operating pressure and operating temperature with influence the design criteria of the valve. The design temperature and pressure, along with the fluid characteristics, will determine the allowable materials of construction.

Valve Size

Because all types of valves are not available in a complete range of sizes, it is necessary to know what valve sizes will be required to perform each function. In addition, the economy of one type of valve over another can change as the valve size changes. The problem of available valve sizes is also prevalent in certain corrosion-resistant construction materials.

1.4 STANDARDS AND SPECIFICATIONS

Various technical societies, trade associations, and governmental agencies have established valve standards and specifications are recognized industry-wide by valve manufacturers, some are applicable only for specific valve services or uses, while others are applicable to all valves used within a specific industry. Most of these standards and/or specifications are designated by letters-the most common of which are listed below :

USASI (USAS) - United States of America Standards Institute - establishes certain basic dimensions on valves, fittings and threads.

ASTM - American Society for Testing Materials - establishes and writes chemical and physical requirements of all materials used in the manufacture of valves and fittings.

API - American Petroleum Institute - establishes purchasing standards on valves and fittings for the Petrochemical industry.

AWWA - American Water Works Association - establishes standards on iron gate valves to be used in a recognized water supply system.

MSS - Manufacturers Standardization Society of the Valves and Fitting Industry - maintains standards on dimensions, marking, locations for drains and bypasses, testing and other similar type standards.

NFPA - National Fire Protection Association - establishes design and performance standards on valves and fittings used in fire protection service.

ASME - American Society of Mechanical Engineers - establishes codes covering pressure -temperature ratings, minimum wall thicknesses, metal ratings, thread specifications, etc. for valves made of materials meeting ASTM specifications.

Metal and alloy Designations

As just explained, the ASTM establishes physical requirements and chemical composition of material which are used in the manufacture of the various valve components. Each of these materials is given an ASTM specification number. When valve construction is being compared between manufacturers, reference to the ASTM specification number is helpful. If the manufacturers supply the ASTM specification covering their valves (and most manufacturers do), a quick comparison and analysis of the valve material can be made.

1.5 ABBREVIATIONS AND TERMS

There are many standard abbreviations used to describe types of valves, features of valves, and the different valve parts. These abbreviations are used constantly and consistently by valve manufacturers and should be understood. The more common abbreviations with their meanings are listed below :

OS & Y	Outside Screw and Yoke - describes construction of a valve.
NRS	Non-Rising Stem - describes construction of a valve and operation of the valve stem.
RS	Rising Stem - describes construction of a valve and operation of the valve stem.
WOG	Water, Oil, Gas - pressure rating applying to relatively cool liquids and gases.
CWP	Cold Working Pressure
WSP or SP	Allowable Working Steam Pressure
“LPG”	Liquidified Petroleum Gas
IBBM	Iron Body - Bronze Mounted - describes valve construction
All iron	All Iron construction
TE or SE	Threaded End connection
FE	Flanged End connection
BWE or WE	Butt Welding End connection
SWE	Socket Welding End connection
SJ	Solder Joint End connection
SB	Silver Braze End connection
SIB	Screwed Bonnet
UB	Union Bonnet
BB	Bolted Bonnet
ISRS	Inside Screw Rising Stem
ISNRS	Inside Screw Non-Rising Stem
SW	Solid Wedge
DW	Double Wedge
DD	Double Disc
TD	TFE Disc (Teflon, Halon, etc.)
FF	Flat Face Flange
RF	Raised Face Flange
LFM	Large Male and Female Flange
SMF	Small Male and Female Flange
LF	Large Female Flange

SF	Small Female Flange
LM	Large Male Flange
SM	Small Male Flange
LTG	Large Tongue and Groove Flange
STG	Small Tongue and Groove Flange
LT	Large Tongue Flange
ST	Small Tongue Flange
LG	Large Groove Flange
SG	Small Groove Flange
RTJ	Ring Type Joint Flange
Int S	Integral Seat
Ren.S	Renewable Seat
IPS	Iron Pipe Size
PSI	Pounds per Square Inch.

These abbreviations will be used throughout this book.

Terms

There are many unique terms in valve design, operation and performance which are used in valve specification. These terms are defined and explained in this section.

Trim designates those parts of a valve which are replaceable and which usually take the most wear. The common trim parts are shown in Table 1-1 for various types of valves.

Table 1-1 Trim Parts on Common Valves

Type Valve	Gate	Globe	Swing Check	Lift Check
Trim parts	Stem Seat ring Wedge Pack under pressure bushing on steel valves	Stem Seat ring Disc Pack under pressure bushing on steel valves Disc nut	Disc Disc holder Disc carrier Disc nut Side plug Carrier pin or holder pin Disc nut pin Seat rings	Disc Disc guide Seat rings

Straight- Through Flow refers to a gate valve (or other type of valve) in which the wedge (or closure element) is retracted entirely clear of the waterway so that there is no restriction to the flow.

Full Flow refers to relative flow capacity of various valves.

Throttled Flow refers to the suitability of a valve for throttling service; that is, for service when the valve is not fully open, or more particularly, when the valve is nearly closed. In very close throttling there is danger of wire drawing. Gate valves are not recommended for throttling service since the accompanying turbulence will cause the wedge to vibrate against the seat with resulting damage.

Wire-Drawing means the premature erosion of the valve seat caused by excessive velocity between the seat surfaces. Excessive velocity can occur when a valve is not closed tightly. A WOG disc is the best defense against wire-drawing because its resiliency makes it easier to close tightly. Steam discs are harder materials and must be closed more carefully to prevent wire-drawing. Even closed tightly, a valve in steam service may start leaking later because of uneven cooling of its parts. These valves should be checked periodically until fully cooled as a precaution against leaking. Another protective measure against leaking is to install a globe valve with pressure over the seat whenever conditions permit. The pressure will act to maintain the closure of the valve if uneven cooling should occur.

Dirty or Abrasive Flow refers to flow conditions and the ability of a valve to function properly and remain usable when the fluid flowing through it contains solids or abrasives in suspension or entrainment. WOG disc material is least damaged by abrasives. Abrasive flow accelerates the wire-drawing effect.

Non-critical Applications are those applications in domestic water services, domestic heating systems, plant utilities and other systems where pipe or valve failure would not seriously endanger person or property or cause economic losses.

Critical Applications are a wide range of special or unusual applications where pipe or valve failure would seriously endanger person or property or cause economic loss. Appropriate pressure ratings and materials of construction should be used to satisfy the critical need of the application.

Frequent Operation refers to the cycle of operation of a valve. Globe valves may be operated thousands of times without severe wear because the sealing action primarily involves compression of the disc against the seat. Conventional gate valves close with a sliding action that causes wear on the seat, especially under abrasive conditions. Consequently, the life of a globe valve will be longer in the same service than a gate valve when there is frequent operation.

Replaceable Disc refers to the disc of any valve which can be replaced. In a gate valve the seats in the body undergo wear comparable to the wedge disc. Replacing a worn wedge disc will not, in most cases, result in a usable valve. Replacing the metallic disc in a globe valve may not result in a usable valve either, if the seat is damaged.

Replaceable Seat refers to any valve in which the seat can be replaced. There are many valve design having disc and body seat rings made of materials different from the valve body. These seating parts are used to gain greater wear resistance and extended life, not necessarily because of the “renewability” feature. However, the seats can be replaced when worn.

Metal-to-Metal Seats refer to a valve having a metal disc and metal seat. Valve constructions are available which utilize various materials for discs and/or seats other than metal. Included are materials such as Buna-N, TFE, Kel-F, etc. These composition disc materials tend to provide more positive closure for the valve than a metal-to-metal seated valve. Consequently, the metal-to-metal seat construction should only be specified when the fluid involved will damage the composition disc and/or pressure exceed the limitations of the composition material; or when the flow demands a gate valve.

Visual Indication of Valve Open or Closed is the degree of closure that a rising stem shows in gate or globe valves, or the position the handle indicates on plug cocks or ball valves.

On gate or globe valves a small amount or no stem showing between the packing nut and handwheel indicates the valve is closed or very nearly closed. Considerable stem showing indicates the valve is more or fully open. This is relative measure and varies with valves being observed. Some valves are equipped with an indicating device such as a pointer which rides up the stem and follows a scale graduated in percentage opening of the valve. Nonrising stem valves do not provide this indication.

Handles on plug cocks and ball valves are usually mounted so that the handle when at 90 degrees to the pipelines indicates the valve is closed. When the handle is oriented along the axis of the pipeline, the valve is full open.

Limited Installation Space refers to the space required for valve operation after installation. Check valves operate internally and therefore require no external operating space and can be installed in limited areas. Nonrising stem valves require little more than the space needed for installation. The handwheels rotate without rising. Rising stem valves require extra space after installation to accommodate the rising of the handwheel as the valve is opened fully.

Plug cocks and ball valves require space to permit operation of the handle across the pipeline.

Installation Position is the position of the valve stem when installed. Most valves are not limited as to the position of installation. However, all nonspring loaded check valves do depend upon gravity action to close when flow stops. Care in positioning should be taken in these cases.

TFE is the designation of polytetrafluoro-ethylene resin. This base resin is manufactured under the trade names of Teflon-TFE by E.I. duPont de Nemours & Co., Inc. and Halon-TFE by the Allied Chemical Corp. There are also other manufacturers. The chemical resistance of TFE is unique in comparison to other materials. It is virtually inert, chemically, to all commercially available chemicals and solvents with the exception of molten alkali metals, fluorine, and chlorine triflouride at high temperatures and pressures. This inertness exists throughout the entire allowable working temperature range.

Cv of Valve : Capacity factor (Cv) for control valve is defined as the gallons per minute of water at 60^0F that a control valve will pass with 1 pound per square inch pressure drop across the valve.

For control valve sizing purposes, process fluid flow rates are converted to equivalent flow rates of the proper reference fluids (water for liquid flows and air for vapour flows) because control valve capacities Cv are determined by tests using water and for air, the reference fluids, and are charted or tabulated on the basis.

CHAPTER - 2

VALVE DESIGN

The details of valve design can be divided into three individual design problems. Each phase or problem can be treated separately. Of primary importance to the proper operation of the valve is the design of the flow-control element. This is that portion of the valve, with its various components, which actually controls the flow of fluid through the valve.

Second, in logical sequence, is the design of the mechanism whereby the flow control element may be adjusted to permit control of the rate of flow through the valve.

The third area of consideration is the isolation of the mechanism governing movement of the flow control element from the fluid being handled in the valve (sealing methods).

When valve design is said to consist of the three areas just mentioned, it is understood that only the design of the operational portions of the valve are being considered. Other design problems can and certainly do exist - such as mechanical strength, dimensional arrangements, types of end connection, etc. However, this book is only concerned with the design of the operational portions of the valves.

2.1 FLOW CONTROL ELEMENTS

The four basic methods are employed to control flow through a valve are :

1. Move a disc or plug into or against an orifice such as is done in the globe, angle, Y, and needle valves.

2. Slide a flat, cylindrical, or spherical surface across an orifice such as is done in the gate, plug, ball, slide and piston valves.

3. Rotate a disc or ellipse about a shaft extending across the diameter of a circular casing as is done in butterfly valves and dampers.

4. Move a flexible material into the flow passage such as is done in diaphragm and pinch valves.

All valves, presently available, control flow by one or more of the above methods. Each type of valve has been designed for specific functions; and when used to meet these functions, the valve will give good service and have a long life.

2.2 MOVEMENT OF FLOW CONTROL ELEMENT

Movement of the flow control element is accomplished by means of a stem which is fixed to the flow control element and rotates, moves endwise, or combines both movements in order to set the position of the flow control element. In most types of valve the stem extends to the outside of the valve. Exceptions to this are check valves, and some safety and regulating valves which are operated by the force of the fluid within the pressure zone.

Rotating Stems

This type of movement will be found on nonrising-stem gate valves, rotating-disc gate valves, ball valves (usually quick opening), butterfly valves and most plug valves and cocks.

Endwise Stem Movement Without Rotation

This type of movement will be found on outside-screw and yoke gate valves (OS & Y); quick opening gate valves; globe and diaphragm valves; slide, piston and sleeve valves; and outside-spring safety and relief valves. On the OS & Y gate valves only the handwheel rotates with the valve stem raising through the handwheel. This is a somewhat awkward valve to operate in smaller sizes since the hand cannot be placed across the handwheel while it is turning.

Stem Rotates and Moves Endwise

Globe, angle, Y and needle valves; rising-stem gate valves; lift-type plug valves; and most diaphragm and pinch valves employ this type of movement.

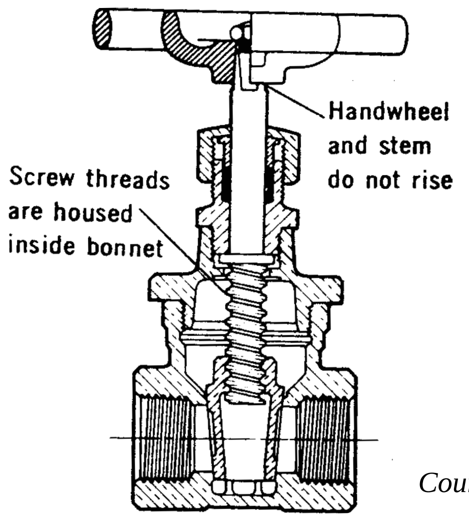
The majority of valves employ a threaded stem for the movement of the flow control element. Notable exceptions are butterfly valves, regulating valves, and check valves. When selecting valves with threaded stems, several factors must be considered, such as :

1. Corrosiveness of the fluid being handled
2. Corrosiveness of the surrounding atmosphere
3. Operating temperature
4. Available headroom
5. Desirability of having the stem position indicate the amount of valve opening.

Globe valves are available with either an inside or outside screw rising stem, which both rotates and moves endwise providing visual indication of the degree of valve opening.

Gate valves are available with an inside screw nonrising stem (Fig. 2.1) and an inside screw rising stem (Fig.2-2). The outside-screw gate valve has a threaded stem which moves endwise only.

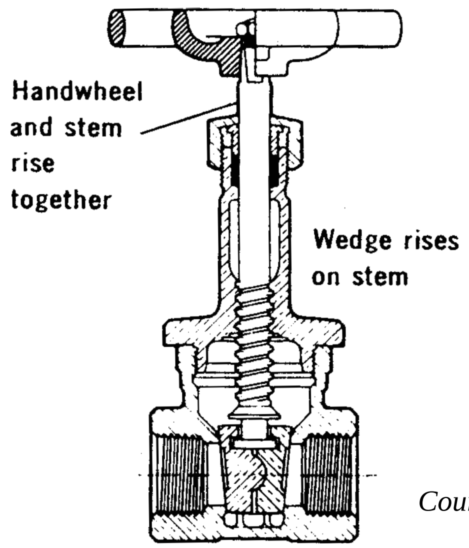
It can be seen from Fig. 2-1 and Fig. 2-2 that the stem threads on inside-screw valves are exposed to the process fluid being handled. Because of this feature this type of valve operation should not be used on lines handling corrosive materials slurries or where the operating temperature is elevated.



Courtesy of NIBCO Inc.

Fig. 2.1. Inside screw nonrising stem (ISNRS) gate valve.

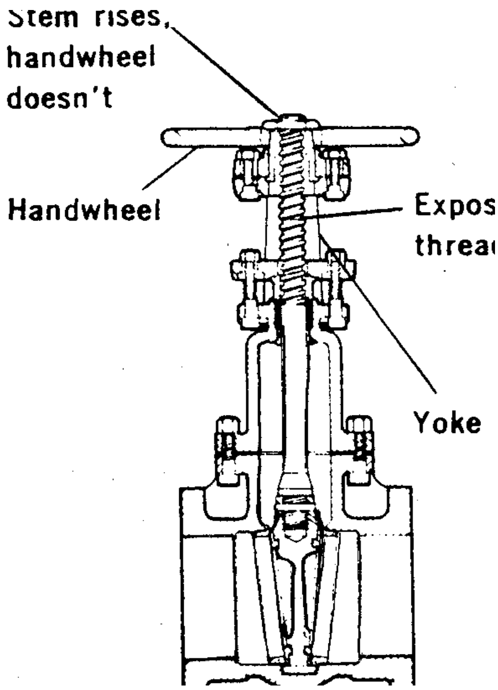
Rising-stem gate or globe valves of this design provide visual indication of the degree of the valve opening, but adequate headroom must be provided to allow for the rise of the stem to the fully opened position. A nonrising-stem gate valve is ideal for use in areas having limited headroom. Since only the spindle turns, stem wear is minimized. The wedge rises on the threaded portion of the stem.



Courtesy of NIBCO Inc.

Fig. 2.2. Inside screw rising stem (ISRS) gate valve.

In outside-screw and yoke (OS & Y) valves - refer to Fig. 2-3 - the spindle packing is between the threaded portion of the stem and the process fluid, preventing contact with the threads by the process fluid. Consequently this type of the valve is recommended for use on systems handling corrosive media, slurries, and systems operating at elevated temperatures. The position of the stem provides a visual indication of the degree of valve opening. In addition, the external screw also permits easy lubrication of the thread. Care should be taken to protect the exposed threads from damage and headroom must be provided to allow for the rise of the stem when the valve is in the fully opened position.



Courtesy of NIBCO Inc.

Fig. 2-3. Outside screw and yoke (OS&Y) gate valve.

Outside screws present a disadvantage when the external atmosphere contains corrosive fumes or vapors. Since the threads can be corroded, valve operation becomes difficult and at times impossible. In such cases an inside screw should be employed, providing the media being handled is not corrosive. There are many situations where both the external atmosphere and the internal media are corrosive. In such cases special bonnet seals must be employed. These are discussed in Section 2.3.

Ball valves, plug valves and butterfly valves usually control the flow by means of a rotating stem without the use of threads. As the stem is rotated, the flow-control element is similarly rotated providing a larger or smaller passage for the process fluid.

Gate and globe valves are also available with sliding stems where quick opening or quick closing is required.

Regardless of type of valve, if quick closing is a feature of operation, provision must be made in the piping system to compensate for hydraulic shock.

2.3 SEALING METHODS

There are four places in a valve where sealing is required. One, of course, is the prevention of leakage of the process fluid downstream when the valve is in the closed position. The remaining three are concerned with the leakage of the process fluid to the outside and/or the prevention of leakage of air into the system when the line is operating under vacuum. These latter seals must be made at the stem, the valve end connection, and where the bonnet joins the valve body. Because of the movement involved, stem sealing is more difficult to accomplish than the other two.

Since the valve end connections are actually external of the valve design itself, these seals will be considered in the section on valve connections.

Flow Seals

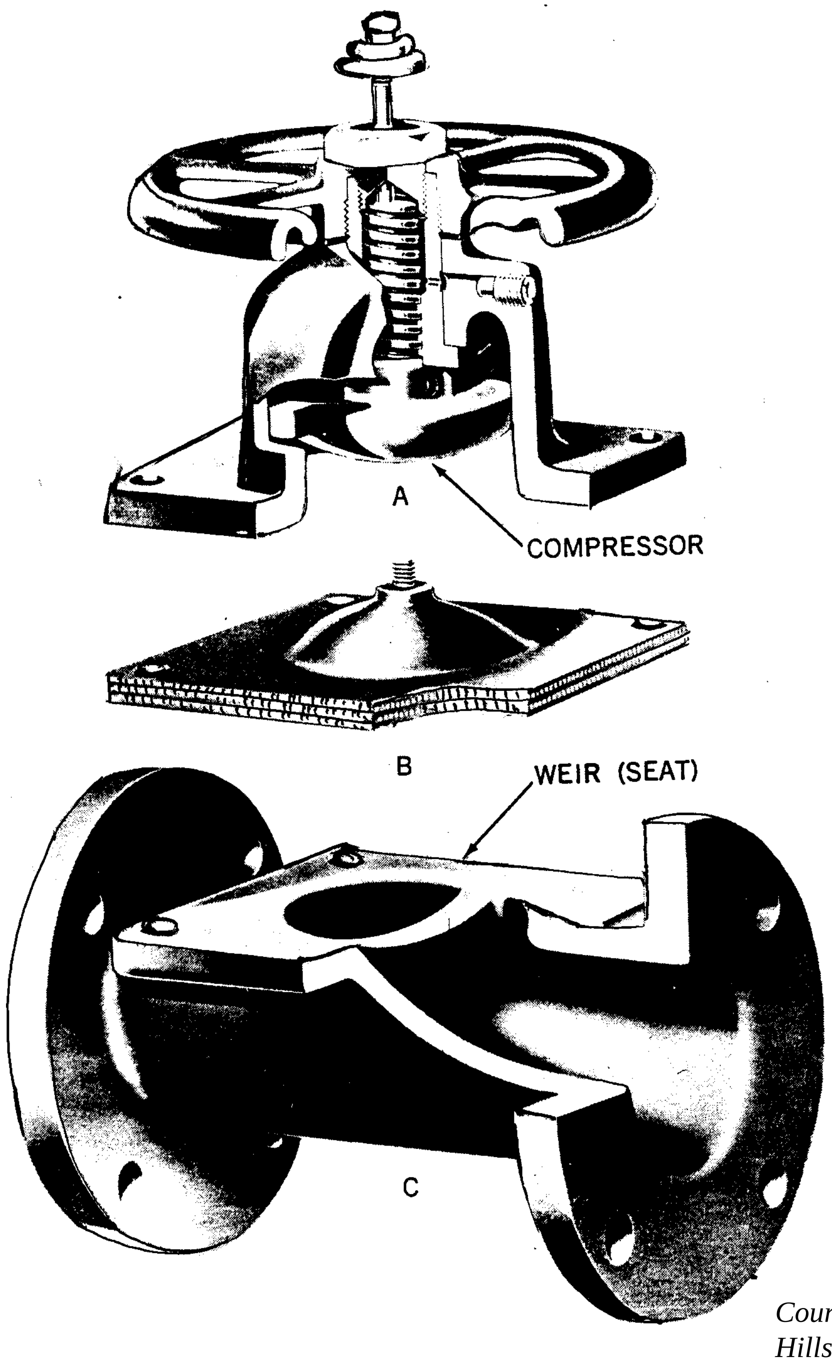
In order to provide an adequate seal against the flow of the process fluid when the valve is in the closed position, a tight closure must be provided between the flow control element and the valve seat. These components must be designed so that pressure and/or temperature changes, as well as strains caused by connected piping, will not distort or misalign the sealing surfaces.

In general, three types of seals are employed : a metal-to-metal contact; metal in contact with a resilient material; and metal in contact with metal containing a resilient material insert in its surface. With the advent of plastics, valves have become available in a variety of plastic formulations. The generalization of the three types of seals is still valid in plastic valves if plastic is substituted for metal in the above categories. The same analogy is applicable in valves having lined interiors - glass-lined, TFE-lined, rubber-lined, etc.

The greatest strength is obtained from a metal-to-metal seal, but metal seizing and galling may occur. A resilient seal is obtained by pressing a metal surface against a rubber or plastic surface. This type of seal provides a tighter shut-off and is highly recommended for fluids containing solid particles, although in general it is limited to less severe usage or to services where the pressure is not high. Solid particles, which may become trapped between the sealing surfaces, are forced into the soft surface and thereby do not interfere with the closure of the valve. A metal in contact with metal containing a resilient material inserted into its surface provides a primary resilient seal and a secondary metal-to-metal seal. This type of seal can be used at relatively high pressures.

Stem Seals

The most common method of stem sealing is the use of a stuffing box containing a flexible packing material such as graphic-asbestos, TFE-asbestos, TFE, etc. TFE is of particular importance for corrosive applications. The packing may be solid, braided or a loose fill of granulated TFE, asbestos fibers and TFE, as well as other compositions. Packing designs include square, wedge and chevron rings. Occasionally sealing is accomplished by means of “O” rings.



Courtesy of Hills-McCanna Div. Pennwalt Corp.

Fig. 2-4. Saunders patent diaphragm valve. A. Bonnet assembly; B. diaphragm; C. body.

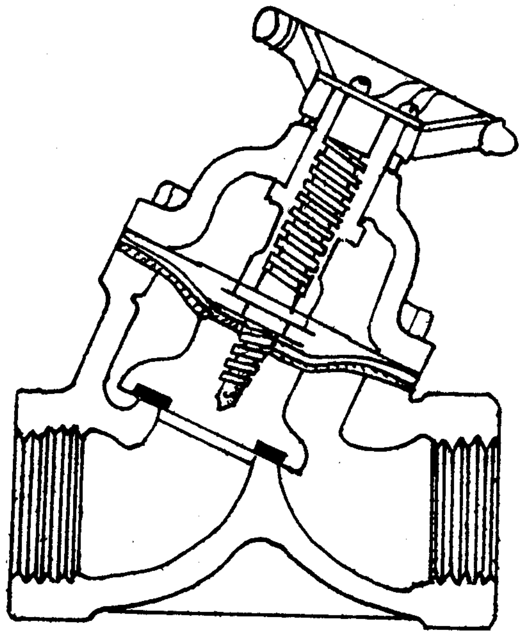


Fig. 2-5. Globe-type valve with diaphragm bonnet seal.

In order to retain the pressure of the fluids inside of the valve it is necessary to compress the packing. This is accomplished by means of a packing nut or gland which compresses the packing into the stuffing box and against the stem. On occasion a spacer or lantern gland is placed in the stuffing box to separate the packing into an upper and lower section.

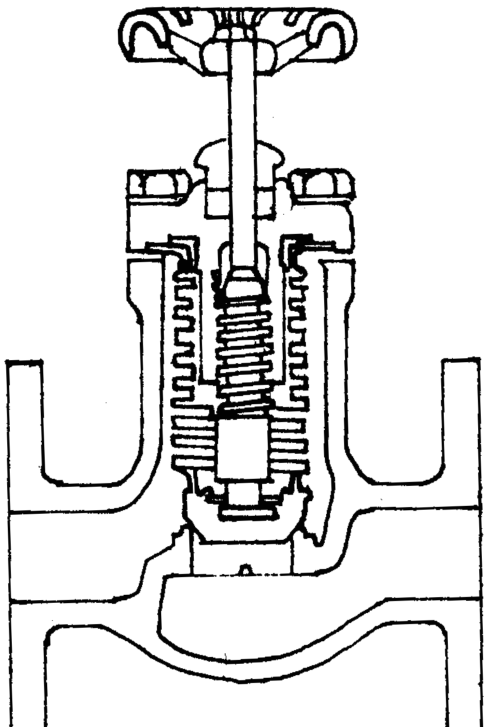


Fig. 2-6. Bellows Seal Globe Valve

This permits the introduction of lubricant or inert sealant into the stuffing box through the side. Such a sealing technique requires periodic inspection and maintenance. It is occasionally necessary to take-up (tighten) the stuffing box nut to maintain adequate packing compression to prevent leakage. Invariably if a valve has not been operated for a period of time, the stuffing box nut must be taken-up when the valve is operated since leakage will occur.

A conventional stem and stuffing box arrangement is unsatisfactory when there must be absolutely no leakage to the outside. Such would be the case when corrosive or extremely hazardous materials are being handled. For such applications a number of valves using packless methods are available.

One such group of valves employs an elastomeric diaphragm between the bonnet and the body. In most cases this diaphragm is pushed down into the flow path by a compressor component which is attached to the stem and thereby also acts as the flow control element. Such a valve is shown in Fig. 2-4.

A globe-type valve, shown in Fig. 2-5, is available with a diaphragm that isolates the working parts from the process fluid.

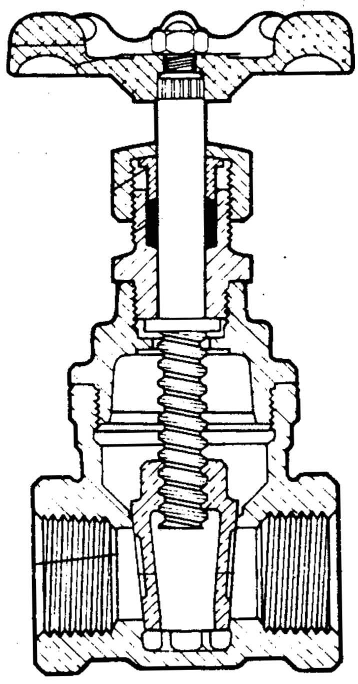


Fig. 2-7. Globe valve with screw-in bonnet.

Another type of packless valve employs a metallic bellows, rather than a flexible diaphragm. This construction is shown Fig. 2-6. These valves are especially good for operation under very high vacuum. A stuffing box is usually provided above the bellows to prevent leakage in the event of bellows failure. In nuclear power plant this type of value if used in PHT system.

PART
1. Set Screw
2. Handwheel
3. Yoke Bushing
4. Gland Bolts
5. Packing Gland
6. Packing
7. Bonnet
8. Stèm
9. Stem Collar
10. Wedge Pin
11. Wedge
12. Body

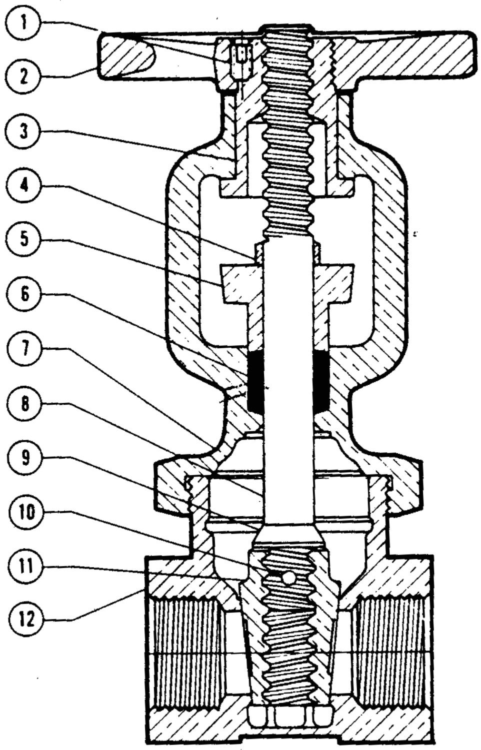


Fig. 2-8. Globe valve with screw-on bonnet.

Another design to prevent leakage to the atmosphere employs the use of a double stuffing box with a lantern ring in the middle and a piped drain.

Bonnet Seals

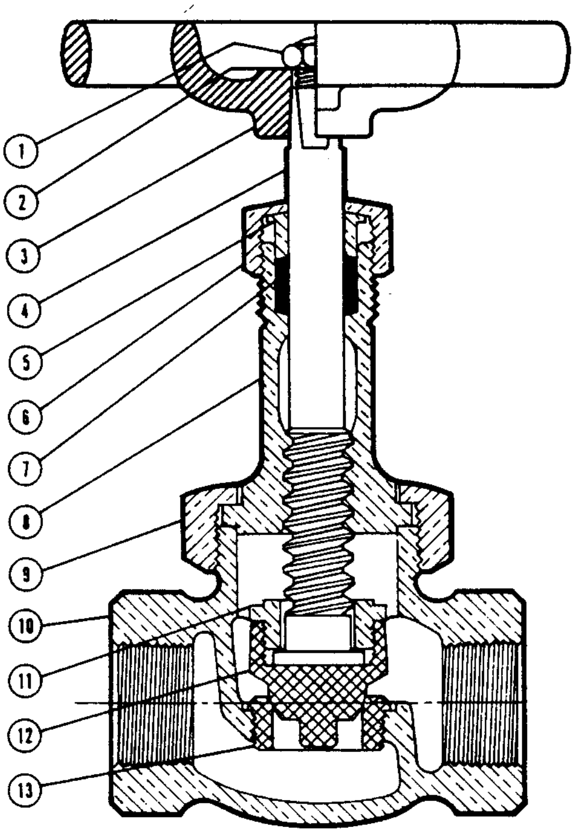
The bonnet is that component of the valve which provides a closure for the body. Normally it is necessary to remove the bonnet in order to gain access to the valve seat and flow control element for purposes of repair and/or replacement. There are three main types of bonnets - screwed, union and flanged (bolted) as well as several designs for specific applications.

Screwed Bonnet

There are two types of screwed bonnets - the screw-in bonnet (Fig. 2-7) and the screw-on bonnet (Fig. 2-8). These are the simplest and most economical types of bonnet designs and are usually found on the smaller valves and limited to low-pressure services.

The operation of screwing the bonnet firmly to the body neck to make a tight seal tends to distort the neck of the bonnet. Consequently it is difficult to make a tight seal again after the valve has been taken apart for maintenance purposes. In addition, it is possible to loosen this seal during normal valve operation or to accidently unscrew the bonnet. Therefore this type of construction should only be used where dismantling will be infrequent and where a minimum of shock and vibration will be encountered.

PART
1. Handwheel Nut
2. Identification Plate
3. Handwheel
4. Stem
5. Packing Gland
6. Packing Nut
7. Packing
8. Bonnet
9. Union Nut
10. Body
11. Disc Holder Nut
12. Seat Disc
13. Seat Ring



Courtesy of NIBCO I

Fig. 2-9. Globe type valve with union bonnet.

Union Bonnet

This style of bonnet, shown in Fig. 2-9, provides a quick, easy method of coupling and uncoupling the bonnet from the valve body. The bonnet is provided with a loose nut or union bonnet ring over the bonnet which is screwed onto the valve body while the bonnet is held securely in place. Since all parts are in compression and held firmly in place, distortion is unlikely and the bonnet can be detached and tightly resealed in place any number of times. Union bonnets are usually found on the smaller valves and are recommended for use where frequent dismantling of the valve is necessary for maintenance purposes. Because the union nut is separate from the bonnet, there is no danger of loosening the bonnet assembly accidently while operating the valve.

Bolted (Flanged) Bonnet

This type of bonnet connection is generally used in larger valves and in valves where corrosive media are being handled and/or where high temperatures or pressures will be encountered. Like a flanged piping joint, the bonnet flange is tightened to a similar body flange using a suitable gasket between the faces. The flange joint can be of the flat-faced, male and female or tongue and groove designs. A flat-faced bolted bonnet is shown in Fig. 2-10. Figure 2-11 shows the male and female joint.

PART
1. Handwheel Nut
2. Handwheel
3. Stem
4. Bonnet
5. Gland Nuts
6. Gland Studs
7. Gland
8. Packing
9. Hex Head Capscrew
10. Body Gasket
11. Disc Holder Nut
12. Disc Holder
13. Disc
14. Disc Plate
15. Seat Disc Nut
16. Seat Ring
17. Body

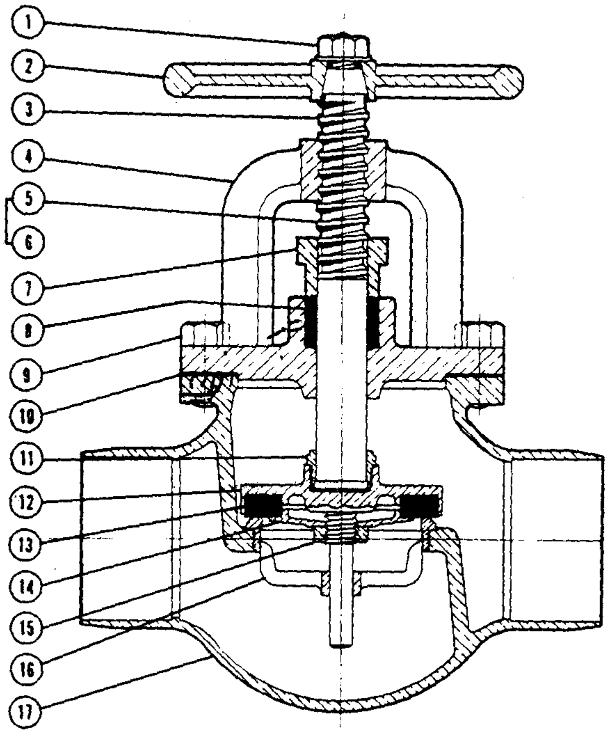


Fig. 2-10. Globe-type valve with flat-face bolted bonnet.

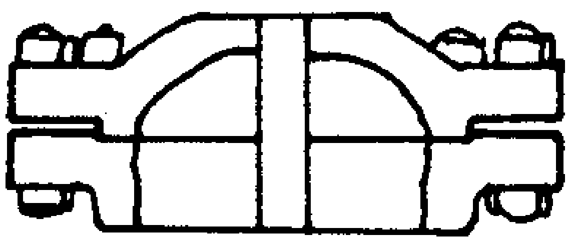


Fig. 2-11. Male and female face bolted bonnet.

In the smaller valves, where frequent disassembly is required for maintenance, the bonnet is often secured by a U-bolt that passes around the body as shown in Fig. 2-12.

These types of bonnets provide a strong connection yet can be easily disassembled and reassembled without causing any damage to the valve. Whenever the valve is disassembled it is good practice to use a new gasket on reassembly. It can be difficult to obtain a leak-tight joint when reusing the original gasket.

PART	
1	HANDWHEEL NUT
2	IDENTIFICATION PLATE
3	HANDWHEEL
4	STEM
5	YOKE BONNET
6	GLAND BOLT NUT
7	GLAND
8	GLAND BOLT
9	PACKING
10	BONNET GASKET
11	SOLID WEDGE
12	BODY
13	U-BOLT & NUT

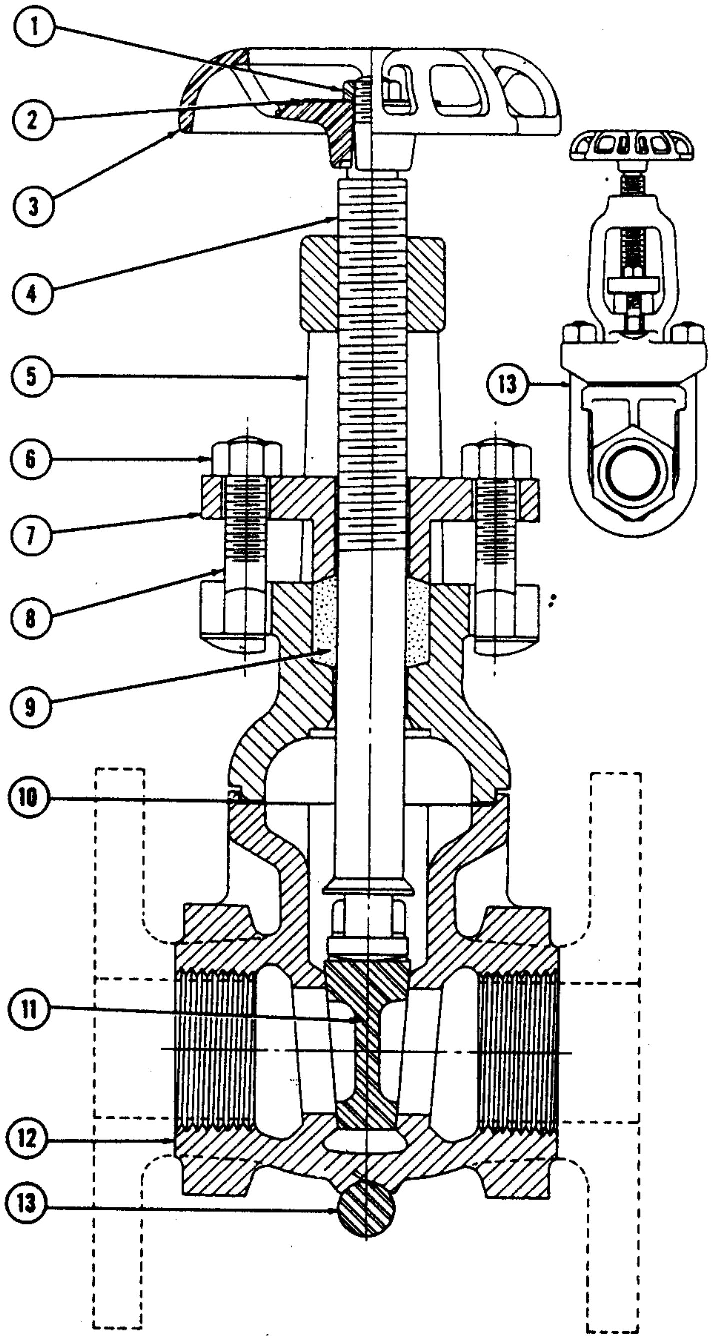


Fig. 2-12. U-bolt bonnet valve.

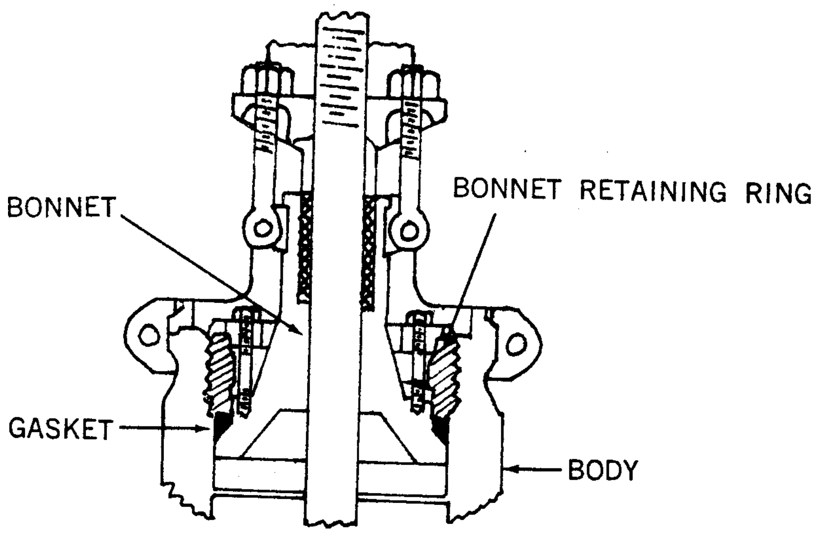


Fig. 2-13. Pressure-sealed bonnet.

Pressure-Sealed Bonnet

This is one of several types of bonnet seals available for high-pressure and high-temperature services. These assemblies offer a more compact and lightweight design than conventional flanged bonnets.

The pressure sealed bonnet, as shown in Fig. 2-13, uses the fluid pressure in the line to effect a seal. This technique involves fitting the bonnet into the body, followed by a ring gasket or ring seal that is retained within the body either by a segmented ring fitted into a groove in the body or by a retaining ring screwed into the body. The initial seal is obtained by lifting the bonnet upward against the gasket or seal ring by means of bolts. When in service, the internal fluid pressure acts on the underside of the bonnet, forcing it against the gasket or seal ring. As the fluid pressure increases, the tightness of the seal is increased. The bonnet can be removed for maintenance purposes.

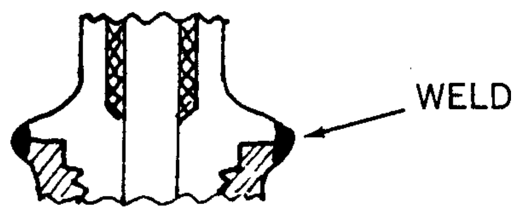


Fig. 2-14. Lip-sealed bonnet.

Lip-Sealed Bonnet

This style is also used where high pressures and/or high temperatures will be encountered. As shown in Fig. 2-14, the bonnet is screwed into the body until contact is made between the flat surfaces of the bonnet and the top of the body. A weld is then made around lips formed by the bonnet-body joint. The weld acts only as a liquid seal while the threads are carrying the entire mechanical load. Since the weld is laid on a flat surface, it can be ground off in order to remove the bonnet for maintenance purposes.

Breech-Lock Bonnet

This is another style bonnet for use where high pressures and/or temperatures will be encountered. Figure 2-15 illustrates such an assembly. The thrust on the bonnet is transmitted to the body through heavy interlocking breech lugs. The valve is assembled by lowering the bonnet into the body and rotating the bonnet 45 degrees to engage the body and bonnet lugs. The assembly is completed by making a small seal weld between the body and a flexible steel ring on the bonnet. By chipping out the welded joints the valve may be disassembled without removing the body from the line.

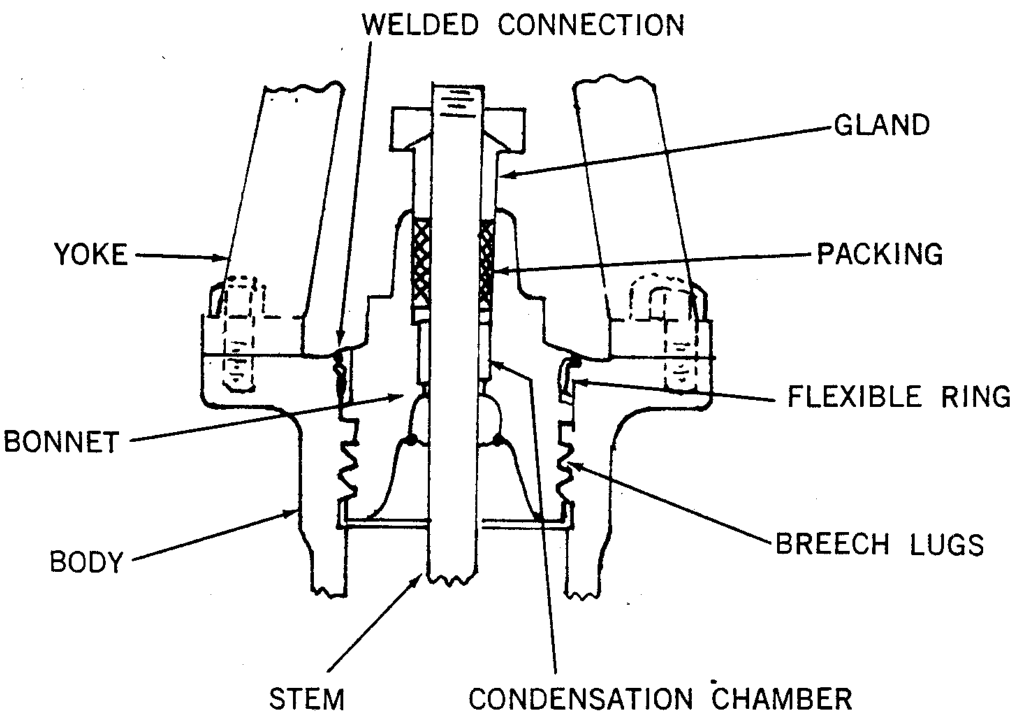


Fig. 2-15. Breech-lock bonnet.

2.4 METHOD OF VALVE OPERATION

Most valves are operated simply, by means of the handwheel or lever which is supplied with the valve. In order to meet these needs there are a variety of alternative methods of manual operation and a variety of automatic operators. These items are considered as valve accessories and can be supplied to fit most types or styles of valves.

Accessories for Manual Operation

The accessories for manual operation are usually supplied to solve one of two problems, namely :

1. Inaccessibility of the valve, thus preventing manual operation in the normal manner.

2. The valve is of such a size that a conventional handwheel will not provide sufficient leverage to permit an average man to open and close the valve.

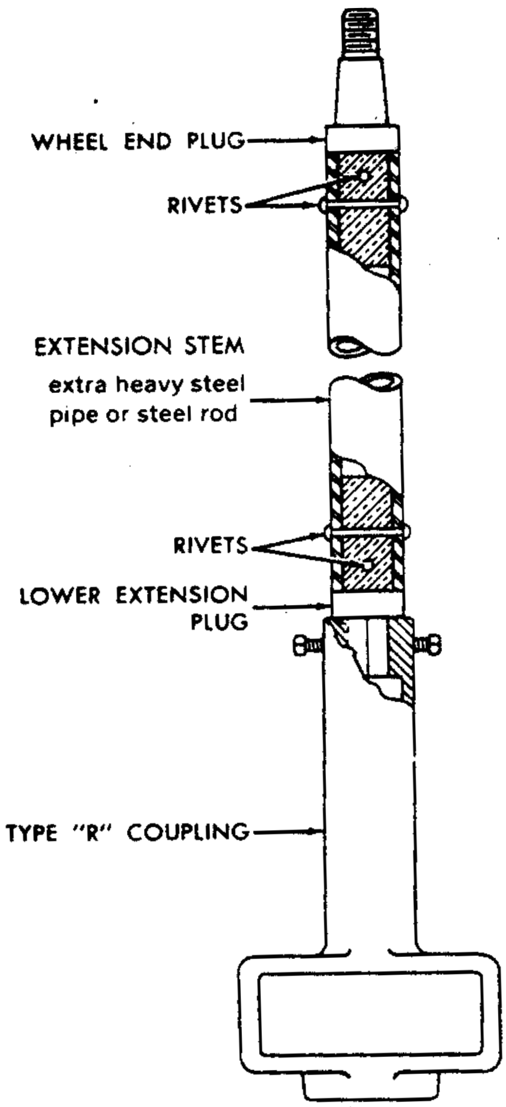


Fig. 2-16. Stem extension rod for rising stem valve.

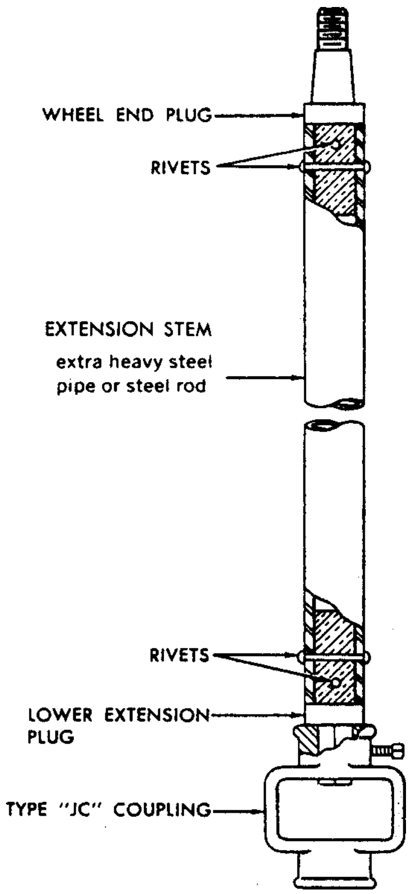


Fig. 2-17. Stem extension rod for nonrising stem valves.

Extension Stems

One of the most common problems encountered is the need to operate a valve which is located out of reach. It is not always possible or practical to place operating valves within reach. Consequently, valve manufacturers can and do supply extension stems.

Stem extension units permit remote operation of valves by providing a stem extension of any required length between the valve and the valve operating mechanism such as wheel, key or floor stand. The extension units usually consist of a cold rolled steel rod and a coupling for attaching to the valve stem. For a longer extension the rod is replaced with a heavy steel pipe , securely fastened to a wheel end plug and a lower extension plug, as shown in Fig. 2-16. A square hole wheel or operating nut fits the tapered square tip of the rod or wheel end plug. Adequate and rigid support must be provided for extra long stem extension units. Alternatively, a flexible metal shaft may serve as an extension stem.

The stem extension unit shown in Fig. 2-16 is used on rising stem valves. It is secured to the yoke sleeve of the valve by the yoke sleeve nut. The upper portion is hollow to receive the rising stem of the valve.

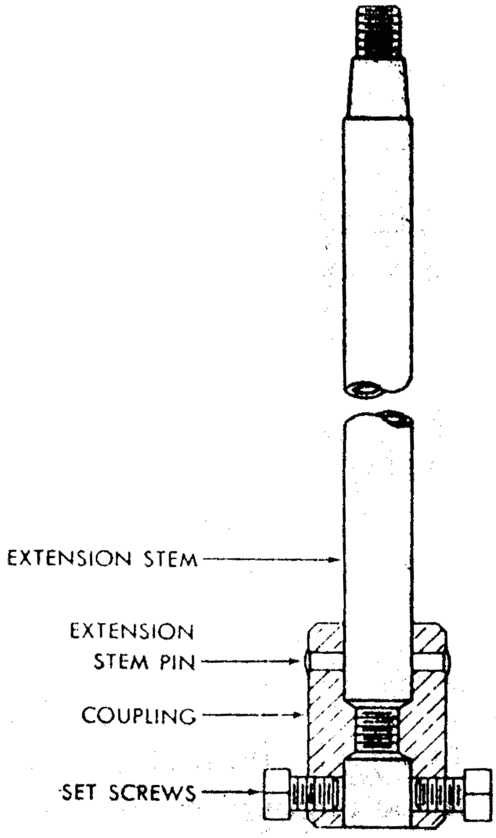


Fig. 2-18. Stem extension rod for nonrising stem valves.

A typical stem extension unit, shown in Fig. 2-17, is used for non-rising stem valves.

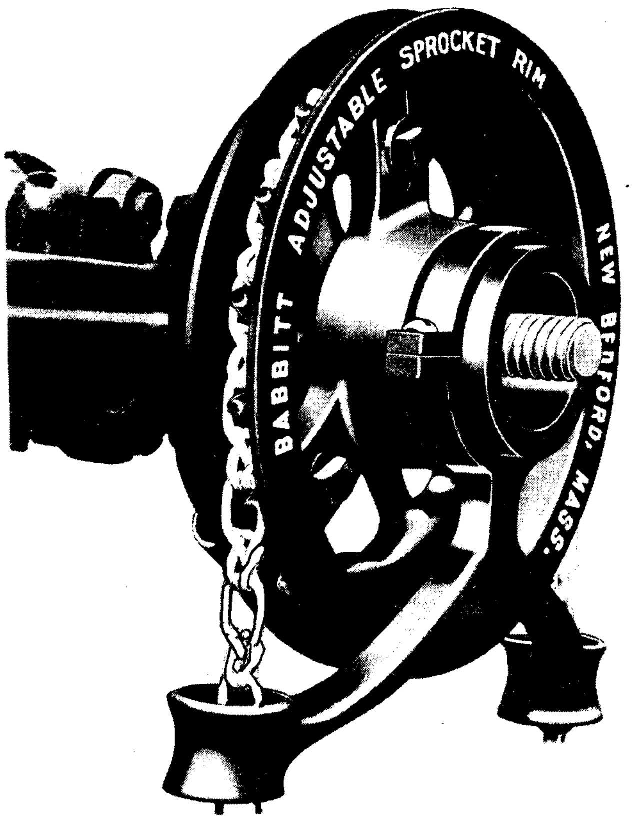


Fig. 2-19. Typical chain wheel operator.

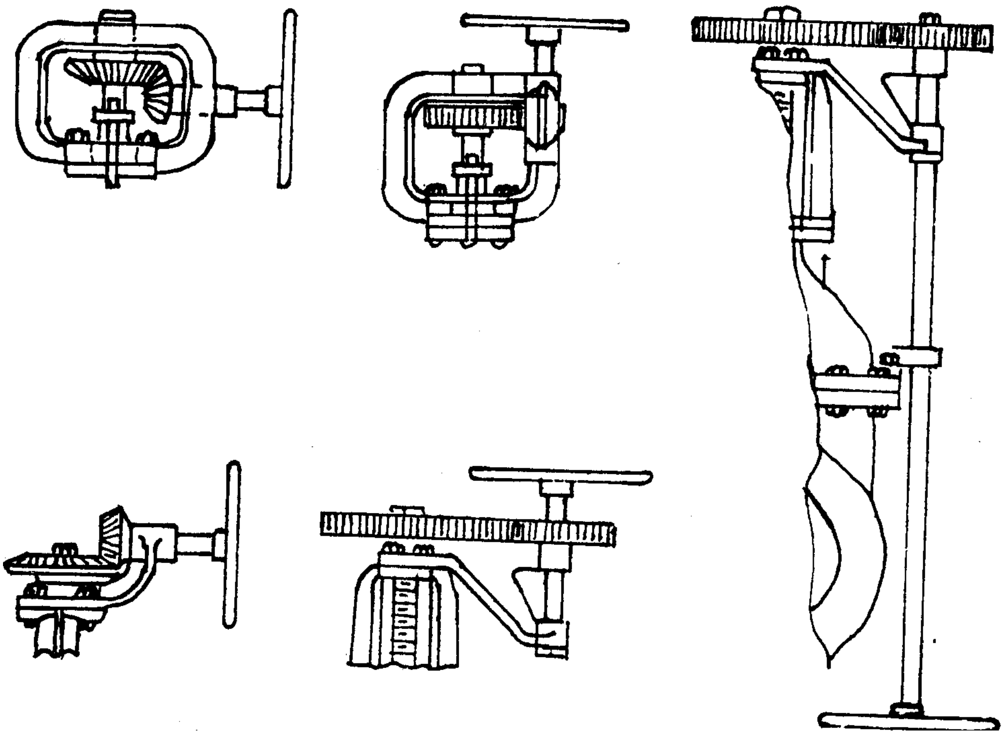


Fig. 2-20. Typical arrangements of geat operators.

Wheel Operators

Wheel operators are used to permit operation of overhead valves when an extension stem will not suffice, such as in a vertical pipeline or when the height makes an extension stem impractical. Figure 2-19 illustrates a wheel operator. These operators are easily attached to the rim of the valve wheel - never to the spokes. Adjust the hook bolts to the wheel rim, pass them through the slots in the lugs, center the sprocket rim on the wheel and tighten the nuts. When chain wheels are used on valves that have a handwheel mounted on the stem, make sure that the stem is strong enough to withstand the extra weight and pull. Valves can be ordered equipped with chain wheel operators.

Gear Operators

Gear operators are used to provide additional mechanical advantage in the opening and closing of larger valves. Operators can be mounted directly on the valve or remotely by means of extension stems. Several styles of gearing arrangements are shown in Fig. 2-20.

Hammer Blow Handwheel

Hammer blow handwheels are designed for use on large-size or high pressure valves where additional force is necessary for the initial effort is starting the disc or wedge or for the final effort in effecting tight seating. The hammer action is provided by two driving lugs cast on the underside of the wheel and the lug of the anvil which projects into the wide slot between the driving lugs.

At the full open or closed positions one of the driving lugs strikes the anvil with sharp impact, facilitating positive opening or closing of the valve. The hammer blow handwheels are usually of large diameters (24 inches or more) and are supplied as standard on some valves.

Position Indicators

Position indicators are used on nonrising stem valves to show the relative position of the flow control device. A typical unit is found in Fig. 2-21. An indicator travels up or down in the slot as the valve is opened or closed showing the relative position of the flow control element.

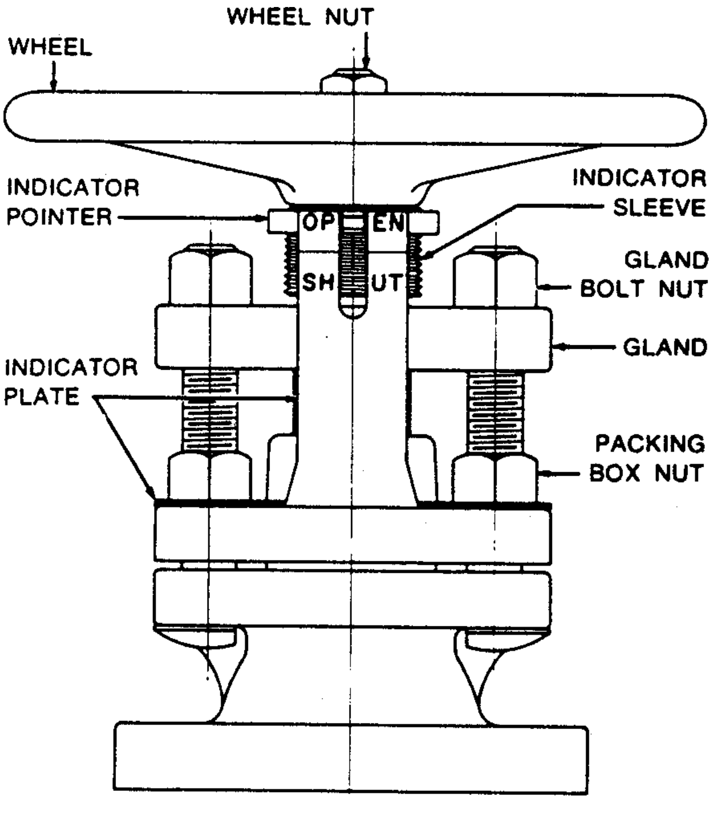


Fig. 2-21. Valve with position indicator.

Accessories for Automatic Operation

On occasion it may be necessary or desirable to have valves operate automatically. Such automatic operation may be of a throttling nature, or it can be a simple open and close operation. This can be accomplished by the addition to the standard valve of any of the following accessories :

1. Air (hydraulic) operator for throttling and/or open-closed operation.

2. Electric solenoid for open-closed operation.

3. Electric motor for throttling and/or open-closed operation.

Air (Hydraulic) Operators (Air Motors)

This type of operator, available with either a diaphragm or piston construction, is the most widely used. Regardless of style, the general method of operation is the same. In the diaphragm type two chambers are isolated one from the other by means of an elastomeric diaphragm. The diaphragm is connected to the valve stem, and as it is forced up or down it opens or closes the valve. The diaphragm can be positioned intermediately to permit a throttling action by the valve. The position is relative to the air pressure admitted to the valve operator.

In general, three types of air motors are available.

1. Air pressure to open - spring to close

2. Air pressure to close - spring to open

3. Air pressure to open and air pressure to close.

The reverse action of types 1 and 2 is accomplished by means of a spring which acts upon the diaphragm holding the valve in either the closed (type 1) or open (type 2) position. As air pressure is increased on the side of the diaphragm away from the spring, valve action takes place. In the event of an air failure the valve will return to its original open or closed position, which is usually referred to as the depressurized position. This is the valve position desired should there be a failure in the air supply. In this position no danger exists, and no damage can be caused as a result of the valve's position. This is known as the "fail-safe" position.

Since the force generated to operate the valve is a function of the area of the diaphragm and the operating air pressure, the higher the operating air pressure the smaller the area of the diaphragm required and consequently the lower the cost of the air motor.

Electric Solenoid Operators

Solenoid valves are designed for open and closed operation. They are available as either normally open (NO) or normally closed (NC). This designation refers to the position of the valve when installed before the coil is energized. When the coil of a normally open valve is energized, the valve will close. In the event of a power failure the valve will open and remain open. The converse is true of a normally closed valve.

Since solenoid valves are quick acting, provision should be made in the piping system to accommodate the hydraulic shock accompanying the operation of these valves. If not compensated for, such hydraulic shock can seriously damage the piping system.

Electric Motor Operators

Electric motor operation is similar to air operation in that the valve opening can be set in intermediate positions. The valve stem is connected to a small electric motor which positions the valve.

2.5 VALVE CONNECTIONS

Valves are furnished with end connections to accommodate all of the various conventional methods of joining pipe as below :

Threaded (Screwed) Ends

Threaded ends are usually provided with tapped female threads into which the pipe is threaded. Threaded-end valves are the least expensive, as less material and less finishing are required. This is especially true in higher alloy materials of construction. In addition, they can be quickly and easily installed in a line since no special pipe end preparation (other than threading) is required. However, when installing a threaded-end valve, two pipe unions should be installed - one on either side of the valve, fairly close to the valve - to facilitate valve removal for maintenance purposes.

Flanged Ends

Flanged ends make a stronger, tighter, more leak-proof connection than threaded ends. In certain alloy construction, such as stainless steel, it can be difficult to make a tight, leak-free, threaded connection. Where heavy viscous media are to be controlled, flanged-end valves should be specified. Because of the additional metal required by the flanges and the accurate machining required on the flanges, these valves will have a higher initial cost.

The different types of flanged ends available are shown in Fig. 2-25. Bronze and iron flat-face flanges have a machined finish.

Steel flat-face flanges and raised face flanges have a serrated finish of approximately 32 serrations per inch and may be either spiral or concentric. Steel, male and female and torque and grooved faces have either an RMS 64 finish for liquids or an RMS 32 finish for gases. The correct finish should be specified when ordering. The steel ring joint faces have similarly finished grooves of either RMS-64 or RMS-32 specification.

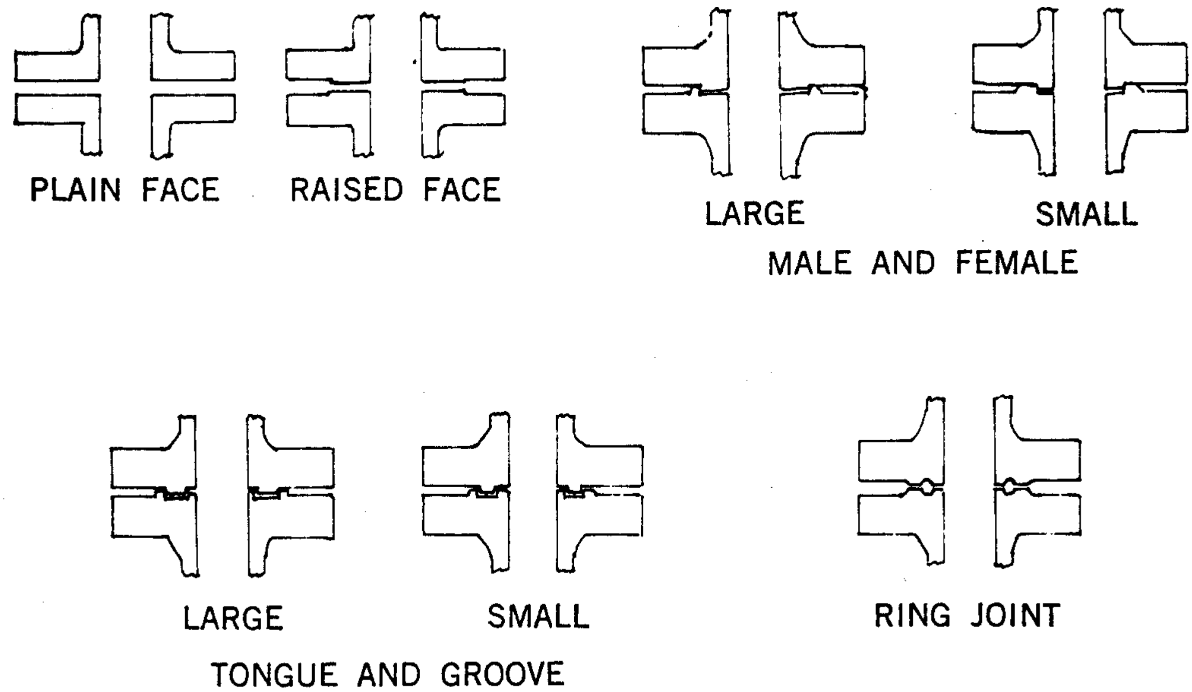


Fig. 2-25. Typical flange connections.

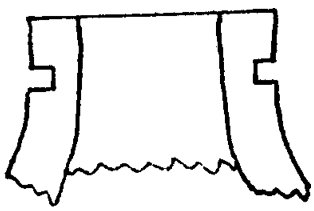


Fig. 2-26. Grooved-end connection.

Grooved Ends

The Victaulic Company of America provides a patented coupling for connecting grooved piping. Grooved end valves are available for installation in such a piping system. A typical end connection is shown in Fig. 2-26.

Since there are no end flanges, bolts and nuts, the valves are light in weight and can be quickly and easily installed or taken out of the line. The only tool required is an ordinary socket or speed wrench.

Solder End and Silver Brazing End

Valves are available with end connections to permit connection to pipe or tubing by means of soldering or silver brazing. Typical end connections are shown in Fig. 2-27. This provides a quick economical method of installation.

Socket or Butt Welding Ends

For installation in all welded piping systems valves are available with ends suitable for either socket or butt welding. Figure 2-28 shows typical valve ends for socket valve ends for socket welding and butt welding.

Fig. 2-27. Typical flange connections.

2.6 INSTALLATION TECHNIQUES

As stated previously, the most important decision in developing valve specifications is to fit the right valve location, and third is valve installation. All three steps are equally important if long satisfactory service is to be obtained from the valves.

Valve Location

Valves should be so located in a pipeline that they can be easily and safely operated. If remote operation (either manual or automatic) is not to be employed, the valves should be located so that the operator can exert just the right amount of force to open and close them properly. Overhead valves, with the handwheels facing down, are usually installed so that the handwheel is at an elevation of 6 feet 6 inches above the operating floor. This places the handwheel high enough so as not to present a head hazard and low enough so that an operator of average height can reach the handwheel easily and safely.

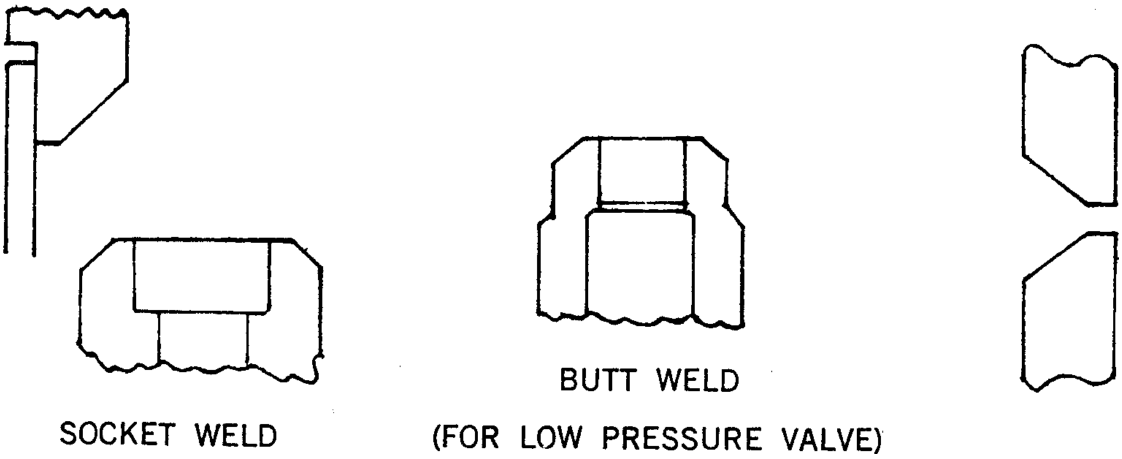


Fig. 2-28. End connections for socket weld and butt weld joints.

If the valve is installed higher (e.g., at operator fingertip height), the operator is forced to stretch to reach the handwheel. In this position he cannot close the valve tightly and eventually leakage occurs, which may cause abnormal wear on the seat and disc assemblies.

Valve Care Before Installation

Valves are generally wrapped and/or protected from damage during shipment by the manufacturer. This wrapping and/or protection should be left in place until the valve is to be installed. If the valves are left exposed, sand or other gritty material may get into the working parts. Unless all such foreign material is thoroughly cleaned out, it may cause trouble when the valve has been placed in service.

Valves should be stored where they are protected from corrosive fumes, and in such a manner that they will not fall or where other heavy material will not fall onto the valves.

Prior to installation it is advisable to have all valves either blown out with clean compressed air or flushed out with water to remove all dirt and grit. Piping should be cleaned out in the same manner, or swabbed out to remove dirt or metal chips left from threading operations or welding on the pipe.

Relieving Pipe Stresses

Pipe carrying high temperature fluids will be subjected to thermal stresses due to the thermal expansion of the piping system. Unless provision is made to take up the expansion of the pipe length involved, these stresses will be transmitted to the valves and pipe fittings.

The expansion of the pipe can be accommodated by installing either a "U" expansion bend or an expansion joint between all anchor points. Whichever method is used, care must be taken to insure that there is sufficient movement available to accommodate the expansion of the length of pipe involved. Note that the same condition exists, but in the opposite direction, on pipelines carrying extremely cold fluids. In these instances pipe contraction must be compensated for.

Installation of Valves

This section deals with the general installation procedures to be followed for all types of valves. Unique procedures for specific types of valves will be included in the section dealing with those valves.

When installing valves, make sure that all pipe strains are kept off the valves. The valves should not carry the weight of the line. Distortion from this cause results in inefficient operation jamming and the necessity of early maintenance. If the valve is of flanged construction, it will be difficult to tighten the flanges properly. Piping should be supported by hangers placed on either side of the valve to take up the weight. Large heavy valves should be supported independently of the piping system so as not to induce a stress into the piping system. When installing rising stem valves, be sure to allow sufficient clearance for operation and for removal of the stem and bonnet if necessary. Insufficient clearance will prevent the valve from being fully opened, which will result in excessive pressure drop, gate wedge erosion, chatter and wire drawing or seat wear.

It is better to install valves with the stem in the upright position. However, most valves may be installed with the stem at any angle. When installed so that the stem is in the downward position, the bonnet is under the line of flow, forming a pocket to catch and hold any foreign matter. (An exception to this are valves with a diaphragm which seals the bonnet from the material in the pipeline.) Foreign material, so trapped, can eventually cut and ruin the inside stem or threads.

Threaded End Valves

Avoid undersize threads on the section of pipe where the valve is to be installed. If the threaded section of pipe is too small, the pipe, when screwed into the valve to make a tight connection, may strike the diaphragm and distort it so that the disc or wedge will not seat perfectly. Undersize threads on the pipe also make it impossible to get a tight joint. A safe practice is to cut threads to standard dimensions and standard tolerances. All pipe threads in valve bodies are tapered and gaged to standard tolerances.

Paint, grease or joint sealing compound should be applied only to the pipe (male) threads - not to the threads in the valve body. This reduces the chances of the paint, grease or compound getting on the seat or other inner working parts of the valve to cause future trouble.

When installing screwed end valves always use the correct size wrenches with flat jaws (not pipe wrenches). By so doing there is less likelihood of the valve’s being distorted or damaged. Also, the wrench should be used on the pipe side of the valve to minimize the chance of distorting the valve body. This is particularly important when the valve is constructed of a malleable material, such as bronze. As a further precaution the valve should be tightly closed before installation.

Flanged End Valves

When installing flanged end valves, tighten the flange bolts by pulling down the nuts diametrically opposite each other and in the order numbered as shown in Fig. 2-29.

All bolts should be pulled down gradually to a uniform tightness. Make all bolts finger tight first, then take three or four turns with a wrench on bolt 1. Apply the same number of turns on each bolt, following the order shown in Fig. 2-29. Repeat the procedure as many times as required until the joint is tight. Uniform stress across the entire cross section of the flange eliminates a leaky gasket.

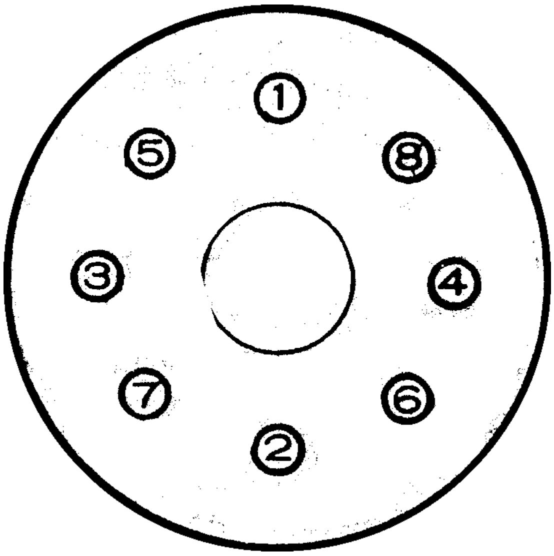


Fig. 2-29. Order of tightening flange bolts.

Socket Weld End Valves

The following procedure should be followed for the installation of valves having socket welding ends. It is recommended that the manufacturer be requested to weld 3-inch-long nipples in the valve bodies of all socket welding valves in sizes of 2 inches and smaller. This can be done before the interior of the valve is machined and reheat treated. By doing this, it will be possible to weld the nipples directly to the pipe and/or pipe fittings without distorting the valve body and seats.

- Cut the pipe end square, making sure that the diameter is not undersize or out of round. Remove all burrs.
- Clean pipe end (at least to depth of socket) and inside of socket with a degreasing agent to remove oil, grease and foreign matter.
- Insert pipe into valve socket and space as shown in Fig. 2-30 by backing off pipe 1/16 inch after it hits against the shoulder within the valve socket, or by using a removable spacing collar. This procedure is very important before welding. Tack weld in place.
- Make certain that valve is in open position before applying heat. Valve bonnets should be hand tight to prevent distortion or damage to threads. Valves having nonmetallic discs should have same removed before heat is

applied. Valve and pipe should be supported during socket welding process, and must not be strained while cooling.

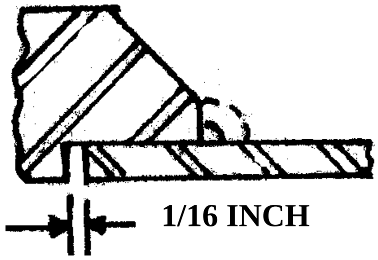


Fig. 2-30. Positioning for socket weld

- Preheat welding area 400^0 F to 500^0 F.

- For the highest-quality weld, the inert gas-arc method is recommended. Using the inert gas-arc method or metallic-arc method, a socket weld is normally completed in two or more passes. Make sure the first pass is clean and free from cracks before proceeding with the second pass. Excessive heat causes distortion and improper functioning of the valve.

- Discoloration may be removed by wire brushing.

Butt Weld End Valves

It is recommended that the manufacturer be requested to weld 3-inch long nipples on the valve bodies of all butt welding end valves in sizes 2 inches and smaller. This can be done before the interior of the valve is machined and reheat treated. By doing this it will be possible to weld the nipples directly to the pipe and/or pipe fittings without distorting the valve body and seats. The following procedure should be used for the installation of valves having butt welding ends.

- Machine pipe ends for butt welding joint. Remove all burrs.

- Clean pipe and valve joints with a degreasing compound to remove oil grease, and all foreign matter.

- Space joint as shown in Fig. 2-31. Align by means of fixtures. Take weld in place.

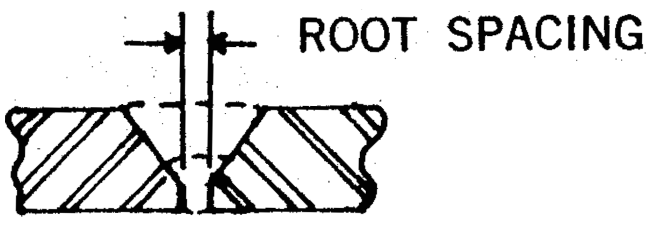


Fig. 2-31. Positioning for butt welding.

- Make certain valve is in open position before applying heat. Valve bonnet should be hand tight to prevent distortion or damage to threads, and valves having nonmetallic discs should have been removed before heat is applied. Valve and pipe should be supported during butt-welding process and must not be strained while cooling.

- Preheat welding area 400^0 F to 500^0 F.

- For the highest-quality weld, the inert gas-arc method is recommended. Using the inert gas-arc method or metallic-arc method, a butt weld is normally completed in two or more passes. The first pass should have complete joint penetration and be flush with the internal bore of the pipe. Make sure that the first pass is clean and free from cracks before proceeding with the second pass. The final pass should blend with the base metal and be flush with the external diameter. Indication of cracks, lack of fusion or incomplete penetration are causes for rejection.
  Excessive heat causes distortion and improper functioning of the valve.

- Discoloration may be removed by wire brushing.

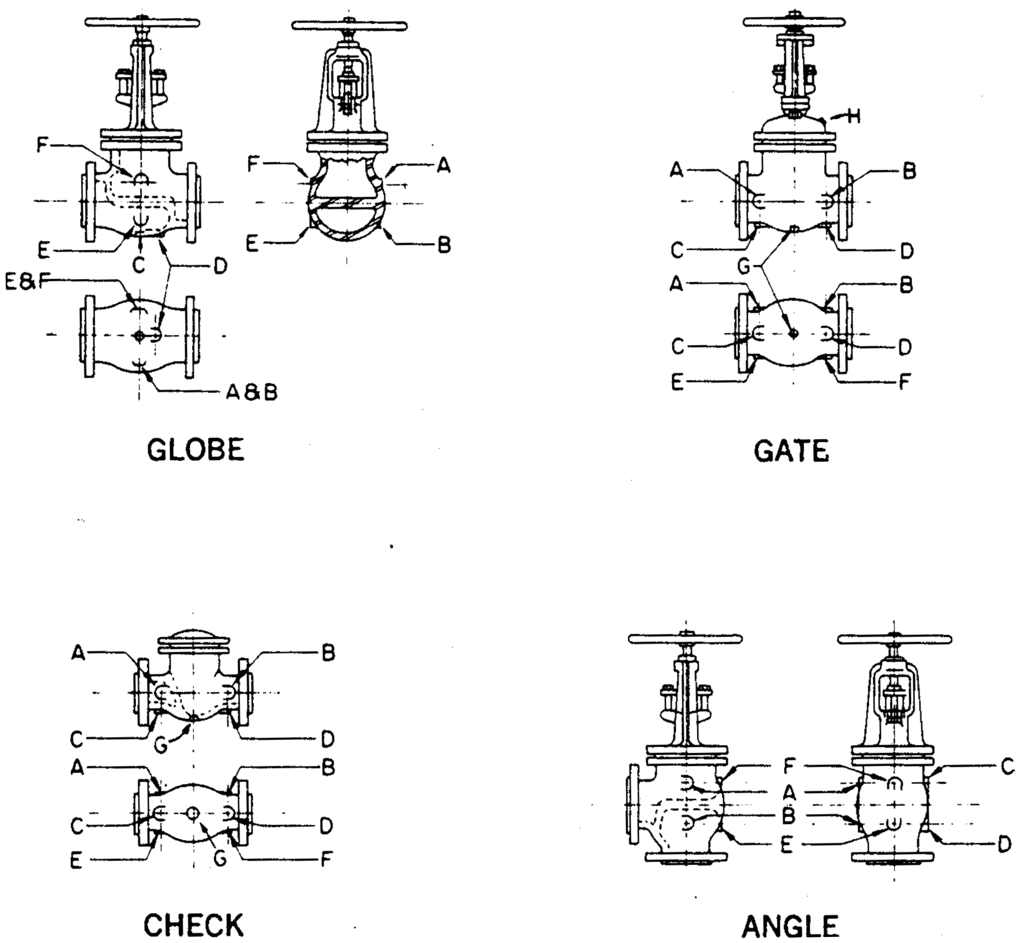


Fig. 2-32. Boss locations.

- After completion of the weld it should be subjected to one of the methods of nondestructive testing to insure a sound weld, with complete penetration of data.

2.7 DRAIN CONNECTIONS AND BYPASSES

A convenient means of draining a section of pipe between two block valves is to supply the valves with drain connections. Most bronze valves are available with optional feature which consists of the installation, by the manufacturer, of a 1/8 -inch drain cap.

Iron body valves are available with bosses which can be tapped in accordance with MSS Bypass and Drain Connection Standard SP-45. Standard tapping sizes are shown in Table 2-1.

Table 2-1. Standard Size of Tapping

Size of Valve Inches	2	3	4	5	6	8	10	12
Size of Drain Tapping Inches	1/2	1/2	1/2	3/4	3/4	3/4	1	1

Boss locations are standardized as are the boss symbols. These are shown in Fig. 2.32.

Bypasses are utilized to equalize pressure at inlet and outlet before opening main valve, thus facilitating easy valve operation. They may also be used for preheating the outlet lines and eliminate damage from too fast expansion. The standard bypass sizes, in accordance with MSS specification SP-45 Table 11 Series A for steam service are shown in Table 2-2.

Table 2-2. Sizes of Bypass Connections

Main Valve Size, Inches	4	5	6	8	10	12
Bypass Valve Size, Inches	1/2	3/4	3/4	3/4	1	1

CHAPTER - 3

GATE VALVE

3.1 GENERAL

Gate valves, being the simplest in design and operation of any valve, are the most widely used. The significant features of this type of valve is less obstruction to flow, with less turbulence within the valve and very little pressure drop. When the valve is wide open, the wedge or gate is lifted entirely out of the waterway, providing a straight-way flow path through the valve. Gate valves offer less resistance to flow because the seating is at right angles to the line of fluid flow.

These valves are normally used where operation is infrequent and the valve will be either fully closed or fully opened. They should not be used for throttling operations. Except in the fully opened or fully closed position the gate and seat have a tendency to erode rapidly. Close control of flow is practically impossible because a great percentage of the flow change occurs near shut-off at high velocity. If the valve is opened slightly in a throttle position, the seat and disc are subjected to severe wire drawing and erosion that will eventually prevent tight shut-off.

3.2 SERVICE RECOMMENDATIONS

- Fully opened or fully closed, nonthrottling service
- Minimum resistance to flow
- Minimum amount of fluid trapped in line
- Infrequent operation.

3.3 CONSTRUCTION OF VALVE

Gate valves are available with a variety of fluid control elements. Classification of gate valves is usually made by the type of fluid control element used. These elements are available as :

- Solid wedge
- Flexible wedge
- Split wedge
- Double disc (parallel disc).

Solid wedges, flexible wedges, and split wedges are employed in valves having inclined seats, while the double discs are used in valves having parallel seats.

Regardless of the style of wedge or disc used, they are all replaceable. In services where solids or high velocity may cause rapid erosion of the seat or disc, these components should have a high surface hardness and should have replaceable seats as well as discs. If the seats are not replaceable, damage to seats would require removal of the valve from the line for refacing of the seat, or refacing of the seat in place. Valves being used in corrosive service is specified with renewable seats.

3.3.1 Solid Wedge

The solid, or single wedge type, shown in Fig. 3-1 is recommended for use with oil, gas, air and is preferred for slurries and heavy liquids. It can also be used for steam service where a double or split disc would result in excessive rattle or chatter, although the flexible disc is better for this service. These valves can be installed in any position.

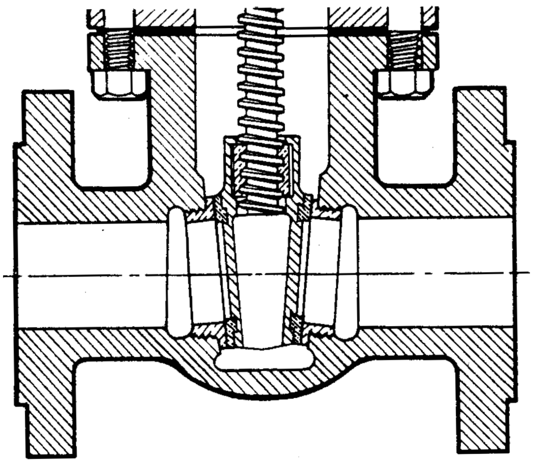


Fig. 3.1. Solid wedge.

3.3.2 Flexible Wedge

Flexible wedges (discs) are of one piece construction as shown in Fig. 3-2. The disc instead of being made completely solid with both seating surfaces rigid, is flexible. Thermal expansion and contraction entail no problems, as the flexible wedge is able to compensate for this and remain easy to open. These valves can be installed in any position.

3.3.3 Split Wedge

Split wedges, as shown in Fig. 3-3, are of the ball and socket design which are adjusting and self aligning to both seating surfaces. The disc is free to adjust itself to the seating surface if one-half of the disc is slightly out of alignment because of foreign matter lodged between the disc half and the seat ring. This type of wedge (disc) is suitable for handling noncondensing gases and liquids at normal

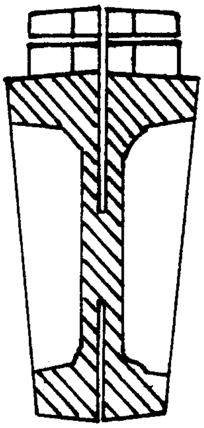


Fig. 3-2. Flexible wedge.

temperatures, particularly corrosive liquids. Freedom of movement of the discs in the carrier prevents binding even though the valve may have been closed when hot and later contracted due to cooling. This type of valve should be installed with the stem in the vertical position.

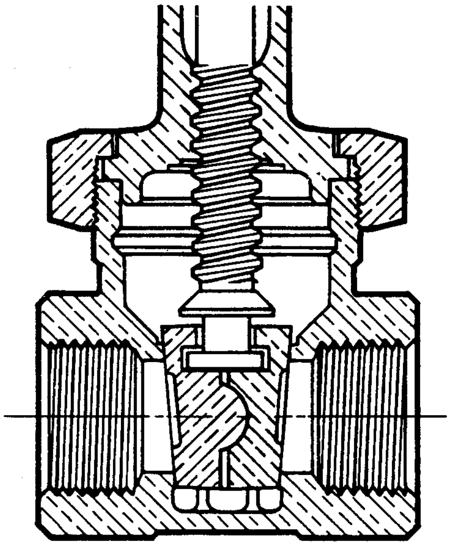


Fig. 3-3. Spilt wedge.

3.3.4 Double Disc or Parallel Disc

The double disc, or parallel disc, consists of two discs that are forced apart against parallel seats at the point of closure by a spring. See Fig. 3-4. This provides tight sealing without the assistance of fluid pressure. Hopkinson valve is trade name for parallel disc type valve in Nuclear power plant. Double disc arrangement provides various advantages such as self sealing, self cleaning. The gate assembly automatically compensates for angular misalignment of the seats or longitudinal shrinkage of the valve body on cooling. Specific shape of convergent divergent at inside of body adds more advantages such as less torque for operation, reduction in size of disc, less travel and disc material saving. Applications are much the same as

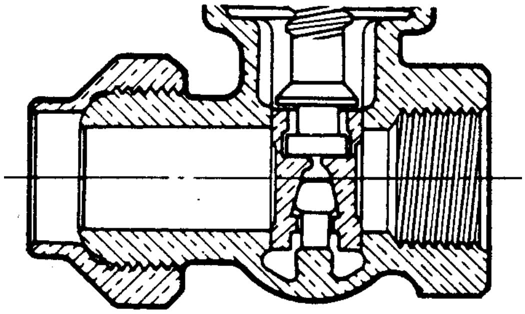


Fig. 3-4. Double disc.

for split wedges; i.e., for noncondensing gases, corrosive liquids and light oil services. These valves are recommended for installation in horizontal lines with the valve stem in the vertical position.

3.3.5 Seats

Seats for gate valves are either provided integral with the valve body, or in a seat ring type of construction. Seat ring construction provides seats which are either threaded into position or pressed into position and seal-welded to the valve body. The latter form of construction is recommended for higher temperature service.

Integral seats provide a seat of the same material of construction as the valve body while the pressed-in or screwed-in seats permit variation. Rings with hard facings may be supplied for the applications where they are required.

Screwed-in rings are considered replaceable since they may be removed and new seal rings installed.

3.3.6 Stem Assemblies

Gate valves are available with stem assemblies of the following types :

- Inside screw rising stem
- Outside screw rising stem
- Inside screw nonrising stem
- Sliding stems.

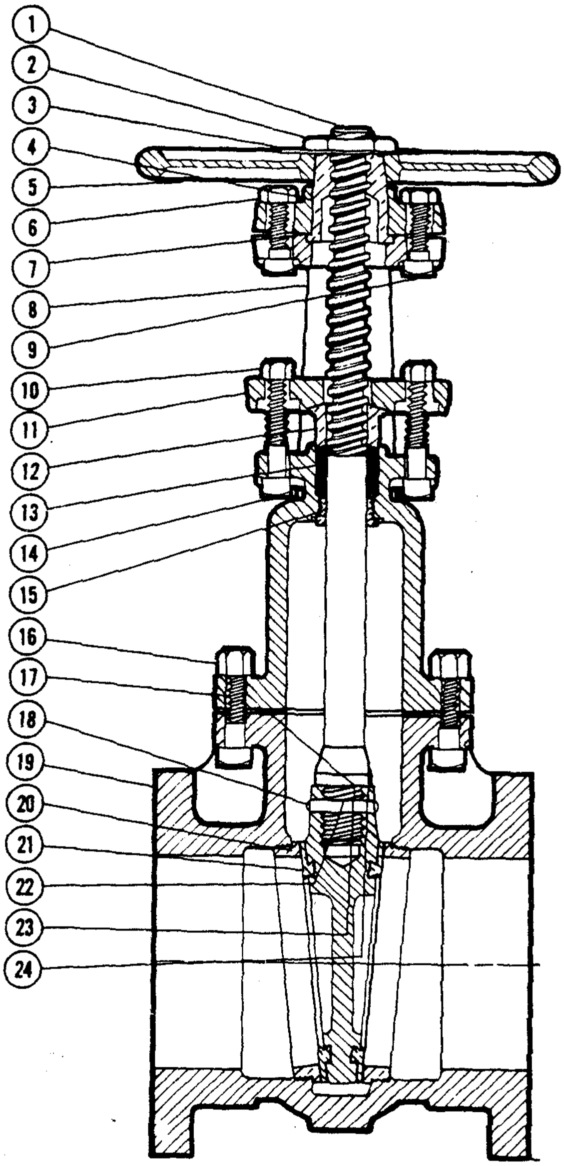
3.3.7 Stem Seals

Various methods are available to prevent leakage along the valve stem to the outside of the valve. These are discussed earlier however, gate valves are usually supplied with packing boxes.

3.3.8 Bonnet Construction

Gate valves are available with a variety of bonnet constructions. Those generally available are :

- Screwed-in bonnet
- Screwed-on bonnet
- Union bonnet
- Flanged bonnet
- U-bolt bonnet
- Pressure sealed bonnet
- Lip sealed bonnet
- Breech lock bonnet

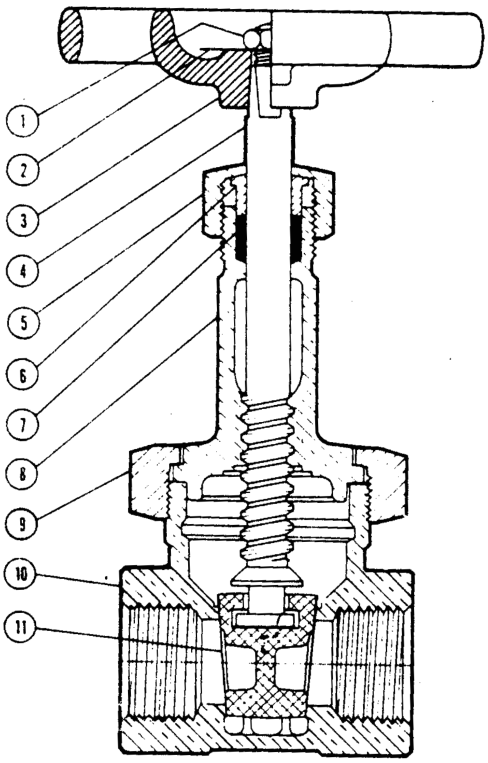


PART
1. Stem
2. Handwheel Nut
3. Identification Plate
4. Yoke Bushing
5. Handwheel
6. Bonnet Cap Nut
7. Bonnet Cap
8. Bonnet
9. Bonnet Cap Bolt
10. Gland Follower Nut
11. Gland Follower
12. Packing Gland
13. Packing
14. Gland Follower Bolt
15. Backseat Bushing
16. Body Nut
17. Body Bolt
18. Wedge Pin
19. Body
20. Seat Ring
21. Wedge Face Ring
22. Wedge
23. Body Gasket
24. Stem Collar

Fig. 3-5. Identification of gate valve parts.

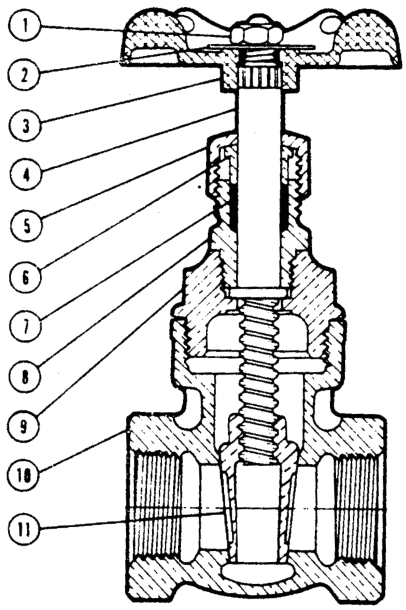
3.3.9 Identification of Parts

The nomenclature and identification of the different components and parts of gate valves with varying bonnet construction, stem assemblies, and styles of wedges are shown in Fig. 3-5.



PART
1. Handwheel Nut
2. Identification Plate
3. Handwheel
4. Stem
5. Packing Nut
6. Packing Gland
7. Packing
8. Bonnet
9. Union Nut
10. Body
11. Wedge

Rising Stem, Screw-in Bonnet



PART
1. Handwheel Nut
2. Identification Plate
3. Handwheel
4. Stem
5. Packing Nut
6. Packing Gland
7. Packing
8. Stuffing Box
9. Bonnet
10. Body
11. Wedge

Non-Rising Stem, Screw-in Bonnet

Fig. 3-5. (continued). Identification of gate valve parts.

3.4 AVAILABLE MATERIALS OF CONSTRUCTION

Gate valves are available in a wide range of materials of construction. Standard representative constructions include :

- Bronze
- All iron
- Cast iron
- Forged steel
- Monel
- Cast Steel
- Stainless Steel
- Polyvinyl chloride (PVC)

Various trims are available on the above valves. Other metallic constructions are also available, some as standards and some on special order, depending upon the specific manufacturer.

3.5 INSTALLATION, OPERATION AND MAINTENANCE

General installation procedures and care of valves prior to installation have been discussed earlier, some specified items unique to gate valves are as below :

Gate valves should only be used in services where they can always be either fully opened or fully closed. The bottom of the wedge (disc) or gate and seal will erode very rapidly if the gate is left in an intermediate position. In addition the wedge will tend to chatter and cause noise in the line.

Valves should be opened slowly to prevent hydraulic shock in the line. Closing the valve slowly will help to flush trapped sediment and dirt. Never force a valve closed with wrench or pry. When the valve has been fully opened, rotate the handwheel one quarter turn toward the closed position so as not to have the handwheel jammed in the open position.

When closing down a “hot” line, wait until the system has cooled, then recheck closed valves to insure shut-off.

Replacing wedges in a gate valve will rarely cure a leak because the seat will have worn comparably to the wedge. When reseating a gate valve, be sure to mark the disc so that the disc is inserted in the valve body the same way it was removed. Otherwise a tight closure may not be obtained.

Packing leaks should be corrected immediately by tightening the packing nut which compresses the packing. If left unattended long enough, corrosive fluids will ruin the stem. In addition, a leaking stem can lead to valve chatter in which the vibration will damage the working parts of the valve. This is true on both small and large-sized valves. If it is apparent that the packing gland has compressed the packing to its limit, replace with new packing. Make sure that the packing used is resistant to the materials being handled by the valve.

Lubrication of valves is especially important and should be done on an established schedule. Valves that are opened and closed frequently should be lubricated atleast once a month. On O.S. & Y. valves, when the stem is exposed, the screw threads should be kept clean and lubricated. Many valves are equipped with a lubricant fitting in the upper yoke to utilize pressure lubricant gun operation. Stem threads left dry and unprotected will become worn by grit and other abrasives threatening stem failure.

3.6 GATE VALVE SPECIFICATIONS

Once it has been decided that gate valves are to be used, a specification should be established that will provide a valve which will meet all of the requirements of the system. This specification should include the following items as well as the materials of construction of the various components :

- Type of end connection
- Type of wedge
- Type of seat
- Type of stem assembly
- Type of bonnet assembly
- Type of stem packing
- Pressure rating (operating and design)
- Temperature rating (operating and design)

CHAPTER - 4

GLOBE VALVES, ANGLE VALVES, NEEDLE VALVES

4.1 GENERAL

Globe valves are normally used where operation is frequent and/or primarily in throttling service to control the flow to any desired degree. The significant feature of this valve is efficient throttling, with minimum wire drawing or disc and seat erosion. Since the valve seat is parallel to the line of flow, globe valves are not recommended where resistance to flow and pressure drop are undesirable, because the design of the valve body is such that it changes the direction of flow causing turbulence and pressure drop within the valve. Globe valves have the highest pressure drop of any of the more commonly used valves. The shorter disc travel and the fewer turns to open and close a globe valve save time and wear on the valve stem and bonnet.

Angle valves, like globe valves, are used for throttling services. The flow on the inlet side is at right angles to the flow on the outlet side, making a 90-degree change in direction. The use of an angle valve eliminates the need for an elbow and extra fittings in the line. Basically the angle valve is a form of globe valve, having similar features of stem, disc and seat ring.

Needle valves are a form of globe or angle valve in that the seating is similar. These valves are generally used as instrument valves. They derive their name from the needle point of the stem. Very accurate throttling can be handled by this type of valve. However, these valves are not normally recommended for steam service or where high temperatures will be encountered.

4.2 SERVICE RECOMMENDATIONS

- Designed for throttling service or flow regulation
- Convenient for frequent operation - short stem travel of globe valves saves operator’s time.
- Positive shut-off for gases and air.
- Applied where some resistance in line can be tolerated.
- Used where some fluid trapped in line is not objectionable.

4.3 CONSTRUCTION OF VALVE

Globe valves are available with a variety of discs and seats. The shapes of the disc and seat can be altered to provide different flow characteristics. However, there are only three basic types of discs :

- Composition disc
- Metal disc
- Plug-type disc

Composition Disc

The composition-type disc, shown in Fig. 4.1 has a flat face that is pressed against a flat, annular, metal seating surface. It consists of a metal disc holder, a composition disc of some suitable nonmetallic material, and a retaining nut. Among the materials used for composition discs are various rubber compounds, polytetrafluorethylene (Teflon, Halon), Kel-F and others, depending upon the valve manufacturer.

Each valve manufacturer recommends the type of composition disc which is best suited for various fluid media.

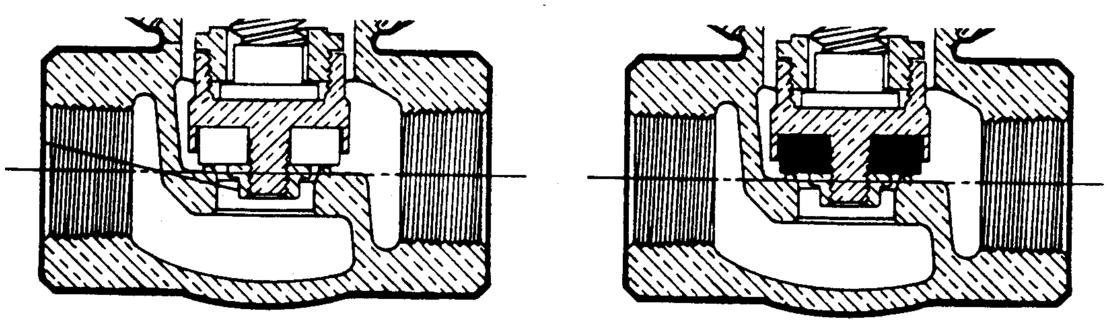


Fig. 4-1. Composition disc.

This type of disc is not recommended for throttling service but it does provide positive shut-off for gases and air. It also protects the valve seat from damage by dirt and scale, and the disc is quite easily and economically replaced.

Metal Disc

The metal disc, shown in Fig. 4-2, provides line contact against a conical seat with a tapered or spherical seating surface. When the proper materials are used for disc and seat, the line contact will break down deposits that may form on the seating surface. Soft materials, such as bronze, is used where the fluids are sediment free because they are easily damaged.

This type of disc is not recommended for throttling service but does provide positive shut-off for liquids.

Plug-Type Disc

The plug-type disc provides the best throttling service because of its configuration. It also offers maximum resistance to galling, wire drawing and erosion. Plug-type discs are available in a variety of specific configurations, but in general they all have a relatively long tapered configurations. Each of the variations have specific types of applications and certain fundamental characteristics. Figure 4-3 and figure 4-5 illustrates the various types.

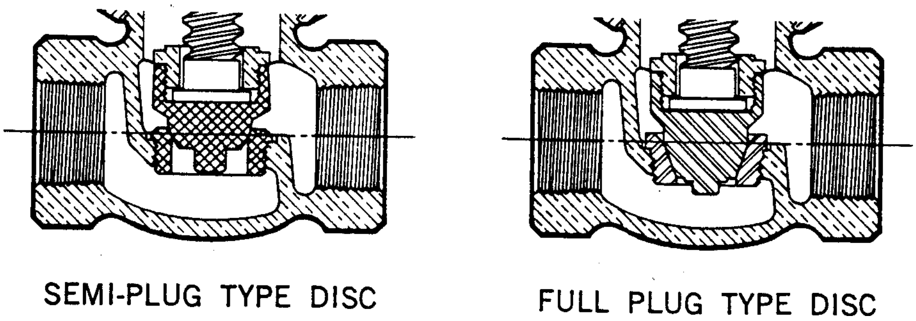


Fig. 4-2. Metal disc.

The equal percentage plug, as its name indicates, is used for equal percentage flow characteristic for predetermined valve performance. Equal increments of valve lift give equal percentage increases in flow.

Linear flow plugs are used for linear flow characteristics with high pressure drops.

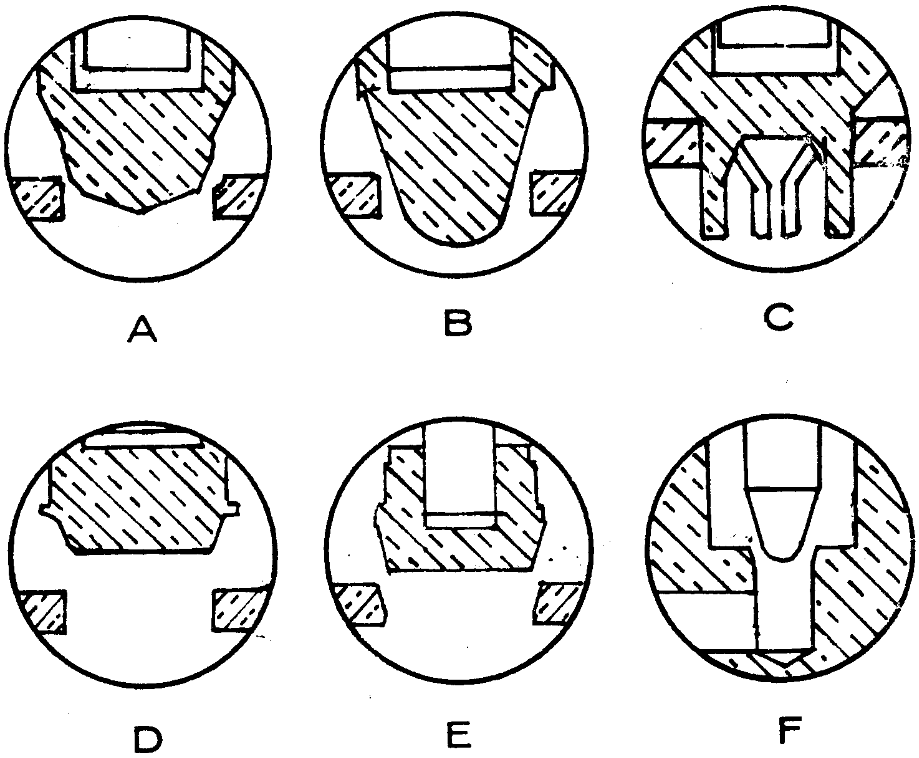


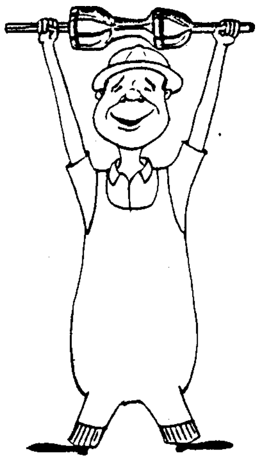
Fig. 4-3. Plug-type discs. A. Equal pcecentage plug; B. linear flow plug; C. "V" port plug; D. plug; E. semicone plug; F. needle plug.

"V" port plugs provide linear flow characteristics with medium and low pressure drops. This type of design also prevents wire drawing during low flow periods by restricting the flow, when the valve is only partially open, through the orifices in the "V" plug.

Needle plugs are used primarily for instrumentation applications and are seldom available in valves over 1 inch in size. These plugs provide high pressure drops and low flows. The threads on the stem are usually very fine; consequently, the opening between the disc and seat does not change rapidly with stem rise. This permits closer regulation of flow.

4.4 VALVE PLUG CHARACTERIZATION (refer figure 4.4)

4.4.1 Linear Flow Characteristic



The ideal linear flow characteristic equation expresses flow rate to be directly proportional to valve travel.

At 50% maximum valve travel the flow rate is 50% of maximum; at 80% travel, the flow rate is 80% of maximum; etc. Change of flow rate with respect to valve travel is constant.

The linear characteristic may be expressed mathematically as follows :

$Q=kL$ $\quad dQ/dL=k$

Q=flow rate; L=valve travel;

k=constant of proportionality

4.4.2 Equal Percentage Flow Characteristic

The ideal equal percentage flow characteristic equation expresses flow rate as an exponential function of valve travel. For equal increments of valve travel, the change in flow rate with respect to valve travel may be expressed as a constant percent of the flow rate at a time of change. The change of flow rate with respect to valve travel will be relatively small when the valve plug is near its seat and relatively high when the valve plug is nearly wide open.

The equal percentage characteristic may be expressed mathematically as follows :

$Q=Q_0 e^{nL}$ $\quad dQ/dL=nQ$

Q=flow rate; L=valve travel;

e=2.718; Q_0=minimum controllable flow; n=constant

4.4.3 Modified Parabolic Flow Characteristic

The modified parabolic flow characteristic is selected to provide fine throttling action at low valve travels and approximately a linear characteristic for upper portions of valve travel. When the valve plug is near its seat, the change in flow rate with respect to valve travel will be relatively small. At upper portions of valve travel, change in flow rate will be relatively large and constant.

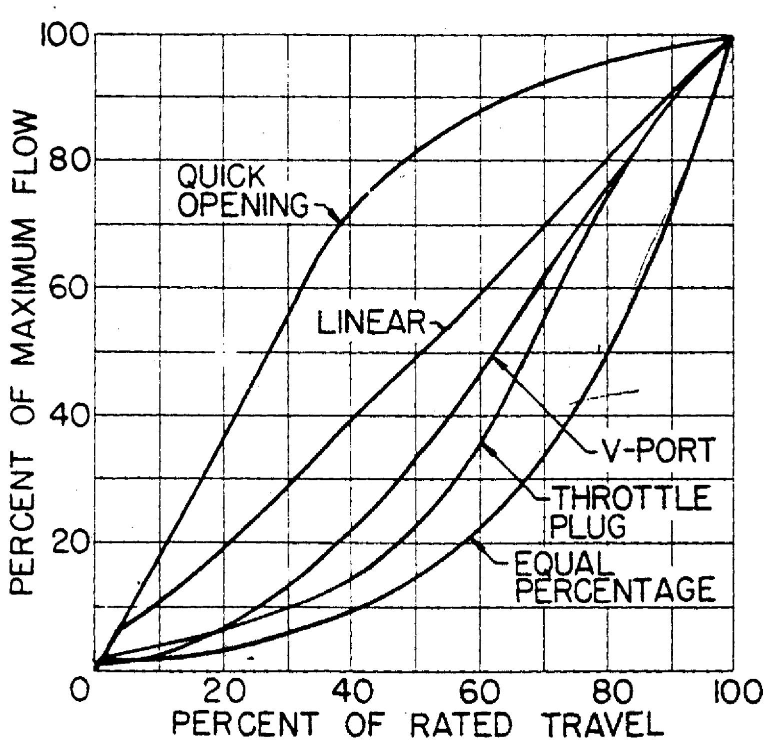


Fig. 4-4. Flow characteristic curves for various valve plugs. Throttle Plug and V-port plugs have a modified parabolic flow characteristic.

4.4.4 Quick Opening Flow Characteristic

The quick opening flow characteristic provides for maximum change in flow rate at low valve travels. The characteristic is essentially linear throughout the first 65% to 70% of valve travel. Additional increases in valve travel give sharply reduced changes in flow rate. When the plug is near its wide open position, the change of flow rate with respect to valve travel approaches zero.

All of the plug configurations are available in either a conventional globe valve design or the angle valve design. Only when the needle plug is used is the valve name changed (needle valve). In all other cases the valves are still referred to as globe or angle valves with a specific type of disc.

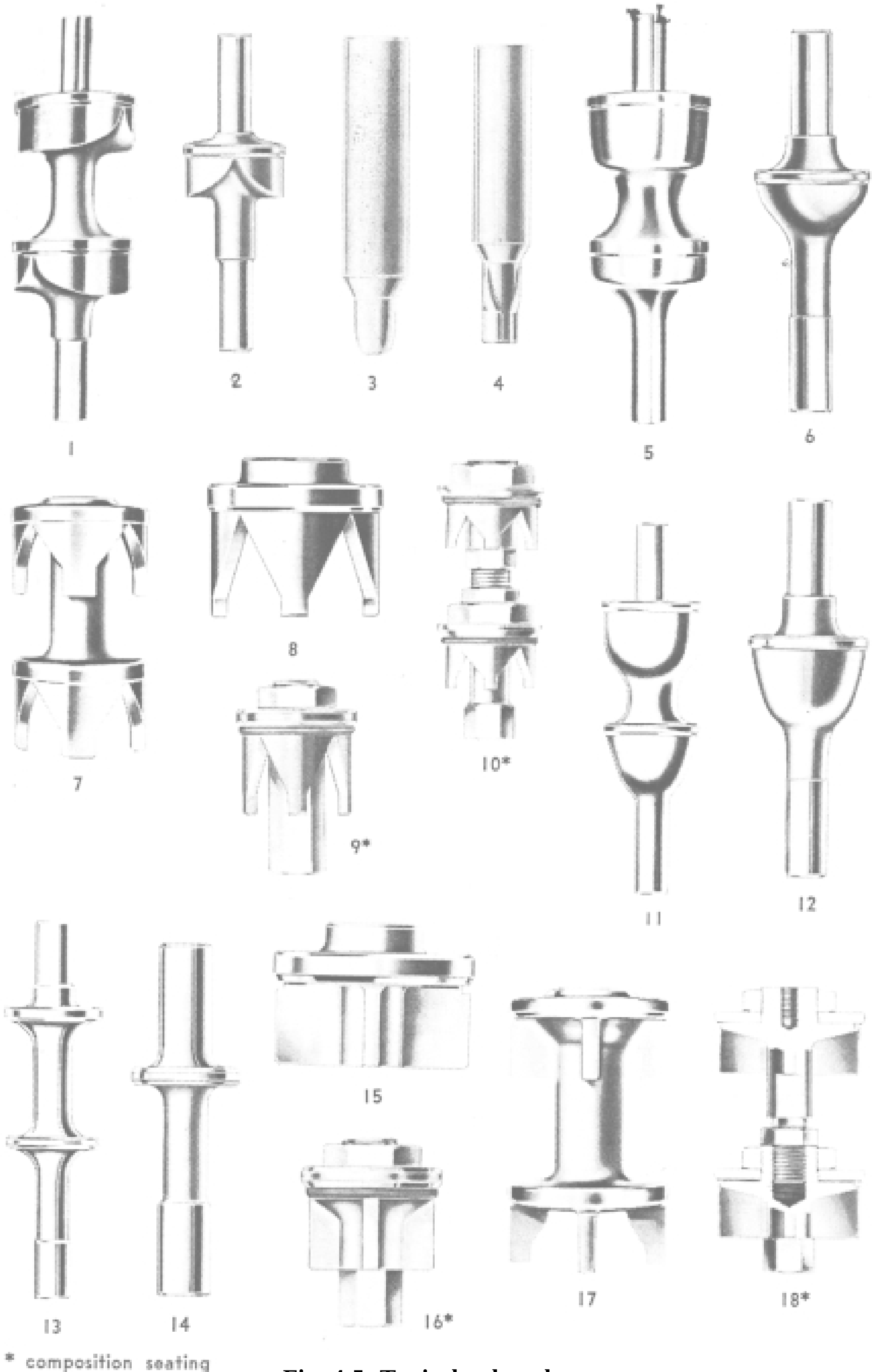


Fig. 4-5. Typical valve plugs.

TYPICAL VALVE PLUGS FOR CONTROL VALVES (Refer figure 4.5)

Illustration Key	Valve Plug Style	Flow Characteristic	Application	Remarks
1	V-Pup	Equal Percentage	Used where large percentage of pressure drop is absorbed by system it-self. Also used where highly varying pressure drops can be expected.	Very popular for throtting applications. Generally top or top and bottom guided.
2				
3	Micro-Form			
4	Micro-Flute			
5	Throttle Plug	Modified Parabolic	Used on pressure and flow control applications where the major system pressure drop is available at the control valve.	Top and bottom or port guided. Metal or composition seating.
6				
7	V-Port			
8				
9				
10				
11	Linear	Linear	Flow is directly proportional to travel. Used wherever true linear relationship is desired.	Top and bottom guided.
12				
13	Quick Opening	Quick Opening	Used for two-position (on-off) service where the valve is required to be in one of two positions with not throtting of the flow.	Top and bottom or port guided. Metal or composition seating.
14				
15				
16				
17				
18				

4.5 SEAT

Globe valve seats are either furnished cast integrally with the valve or furnished as seat rings which are screwed-in, pressed-in or tackwelded in place. Seat rings with TFE inserts can also be supplied.

Integral seats provide a seat of the same material of construction as the valve body, while the other types permits a variation. This ability to vary the materials of construction of the seat from that of the valve body is advantageous in corrosive services.

The screwed-in seats are considered replaceable since they may be removed and new seat rings installed. This is an advantage in valves of expensive alloy construction in that it is not necessary to scrap the complete valve because of a damaged seat which cannot be repaired.

4.6 STEM ASSEMBLIES

Globe valves are available with stem assemblies of the following types :

- Inside screw rising stem
- Outside screw rising stem
- Sliding stem.

4.7 STEM SEALS

Various methods are available to prevent leakage along the valve stem to the outside of the valve which have been discussed earlier.

4.8 BONNET CONSTRUCTION

Globe valves come with a variety of bonnet constructions. Those generally available are :

- Screwed-in bonnet
- Screwed-on bonnet
- Union bonnet
- Flanged bonnet
- Pressure sealed bonnet
- Lip sealed bonnet
- Breech lock bonnet.

4.9 IDENTIFICATION OF PARTS

The nomenclature and identification of the different components and parts of globe valves with valves with varying bonnet construction, stem assemblies, and types of discs are shown in figures 4.6, 4.7 & 4.8.

4.10 AVAILABLE MATERIALS OF CONSTRUCTION

Globe valves are available in a wide range of materials of construction. Standard representative constructions include :

- Bronze
- All Iron
- Cast Iron
- Forged steel
- Monel
- Cast steel
- Stainless steel

Various trims are available on the above valves. Other metallic constructions are also available, some as standards and some on special order, depending upon the specific manufacturer.

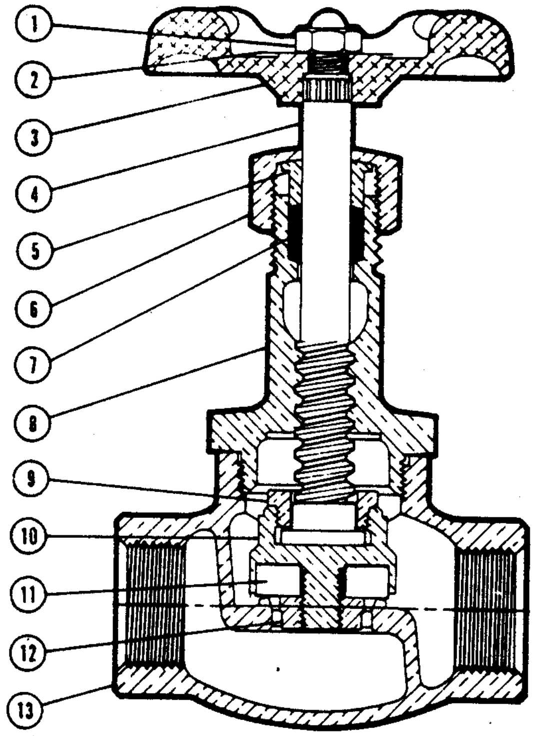
Angle valves and needle valves can also be found in a variety of plastic materials, including :

- Polyvinyl chloride (PVC)
- Polypropylene
- Penton
- Impervious graphite

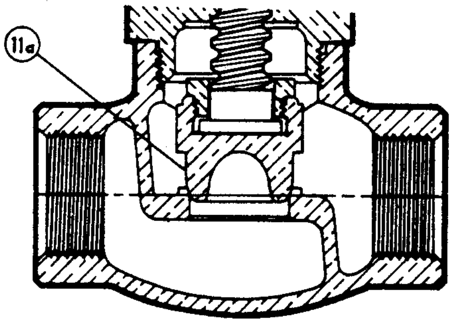
4.11 INSTALLATION, OPERATION AND MAINTENANCE

General installation procedures and care of valves prior to installation have been discussed earlier. Covered here are the items unique to globe valves.

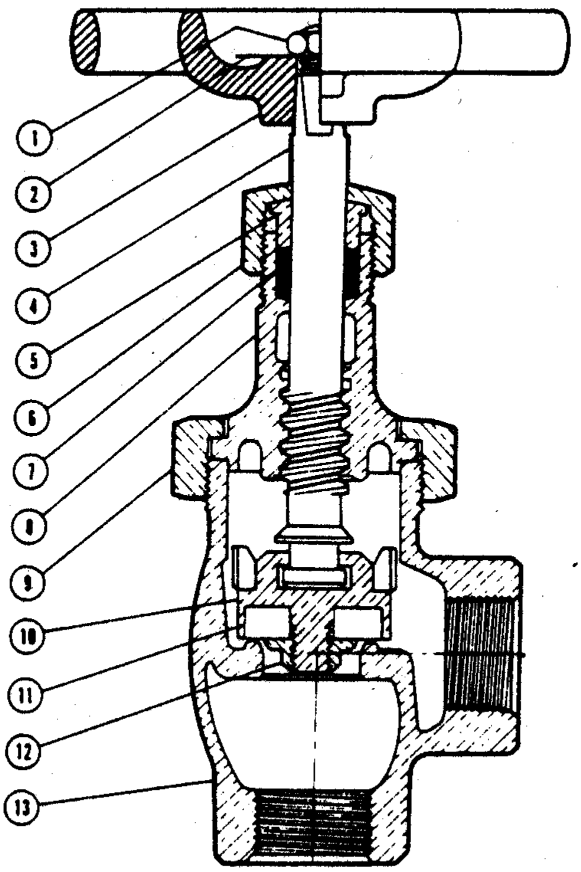
Globe and angle valves should ordinarily be installed so that the pressure is under the disc. This promotes easy operation. It also helps to protect the packing and eliminates a certain amount of erosive action on the seat and disc faces. However,



A

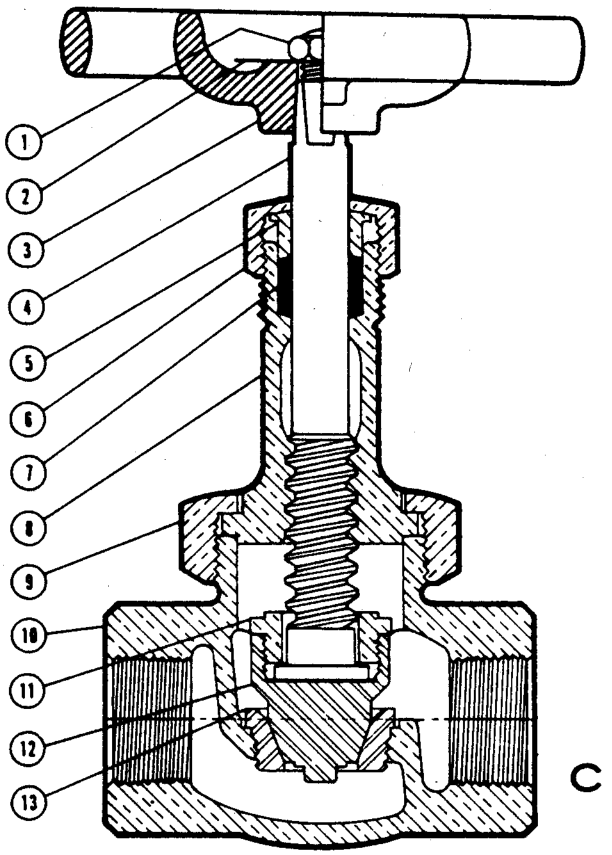


1. Handwheel Nut
2. Identification Plate
3. Handwheel
4. Stem
5. Packing Gland
6. Packing Nut
7. Packing
8. Bonnet
9. Disc Holder Nut
10. Disc Holder
11. Seat Disc
11a. Seat Disc
12. Disc Nut
13. Body

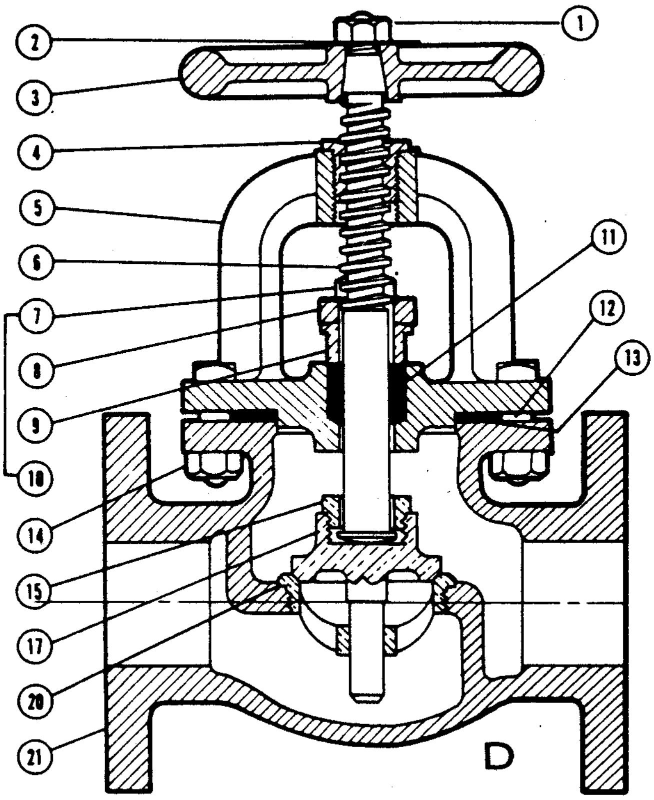


B

Fig. 4-6. Identification of globe valve parts. A Screw-in bonnet composition disc; B. union bonnet composition disc angle body.

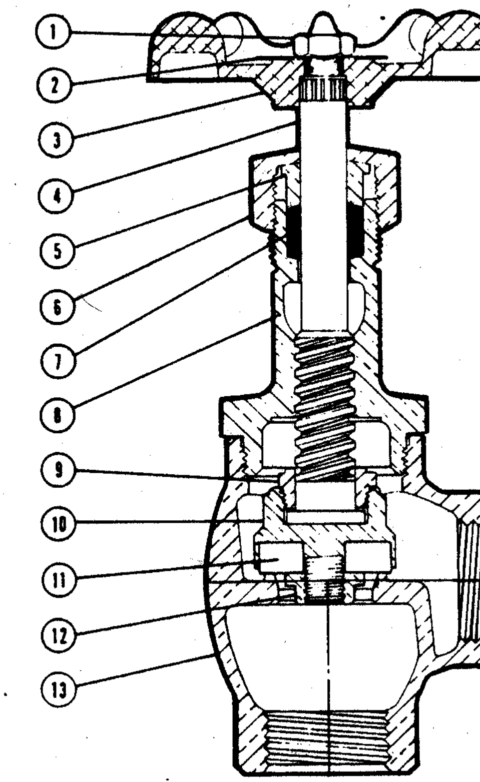


1. Handwheel Nut
2. Identification Plate
3. Handwheel
4. Stem
5. Packing Gland
6. Packing Nut
7. Packing
8. Bonnet
9. Union Nut
10. Body
11. Disc Holder Nut
12. Plug Disc
13. Seat Ring



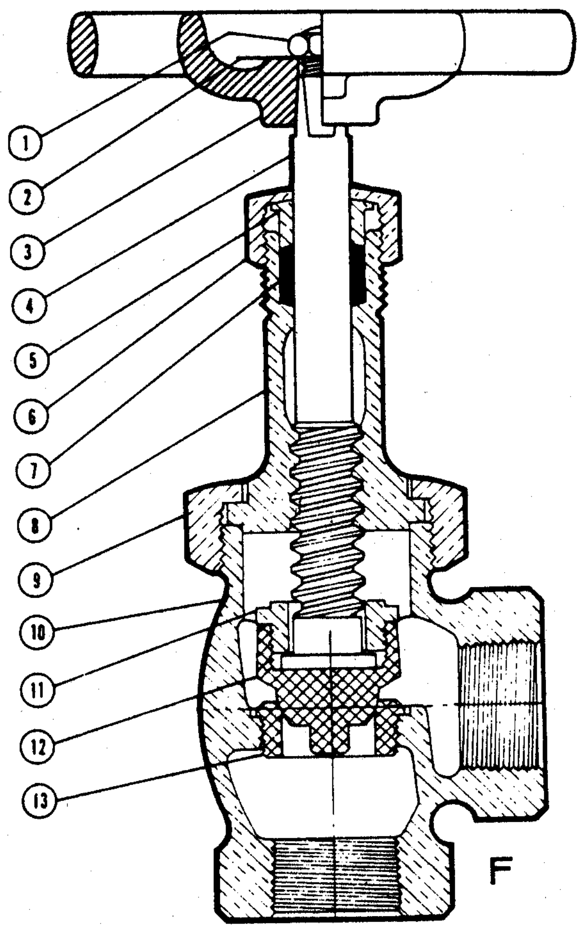
1. Handwheel Nut
2. Identification Plate
3. Handwheel
4. Yoke Bushing
5. Bonnet
6. Stem
7. Gland Follower Nut
8. Gland Follower Stud
9. Gland Follower
10. Packing Gland
11. Packing
12. Body Bolt
13. Body Gasket
14. Body Nut
15. Swivel Nut
16. Disc Cage
17. Disc
18. Disc Plate
19. Disc Nut
20. Seat Ring
21. Body

Fig. 4-7. (Continued) c. Union bonnet plug disc; D. bolted bonnet renewable seat and disc.



E

1. Handwheel Nut
2. Identification Plate
3. Handwheel
4. Stem
5. Packing Gland
6. Packing Nut
7. Packing
8. Bonnet
9. Disc Holder Nut
10. Disc Holder
11. Seat Disc
12. Seat Disc Nut
13. Body



F

1. Handwheel Nut
2. Identification Plate
3. Handwheel
4. Stem
5. Packing Gland
6. Packing Nut
7. Packing
8. Bonnet
9. Union Nut
10. Body
11. Disc Holder Nut
12. Seat Disc
13. Seat Ring

Fig. 4-8. (Continued) E. Screw-in bonnet composition disc angle body; F. union bonnet semi-plug disc angle body.

when high temperature steam is the medium being controlled, and the valve is closed with the pressure under the disc, the valve stem, which is now out of the fluid, contracts on cooling. This action tends to lift the disc off the seat, causing leaks which eventually result in wire drawing on seat and disc faces. Therefore, in high-temperature steam service, globe valves should be installed so that the pressure is above the disc.

Lubrication of the valves is especially important and should be done on a strict schedule. Valves that are opened and closed frequently should be lubricated at least once a month. On OS & Y valves where the stem is exposed, the screw threads should be kept clean and lubricated. Many valves are equipped with a lubrication fitting in the upper yoke to utilize pressure lubricant gun operation. Stem threads left dry and unprotected will become worn by grit and other abrasives, threatening stem failure.

Foreign matter on the seat of a globe valve can usually be flushed off the seat by opening the valve slightly, which creates a high rate of flow through the small opening provided.

If valves do not hold tight, do not use extra leverage, or wrenches on the handwheel, as a valve is easily ruined this way. Instead, take the valve apart and inspect the seat and disc to locate the trouble.

Packing leaks should be corrected immediately by tightening the packing nut which compresses the packing. If left unattended long enough, corrosive fluids will ruin the stem. This is true on both small and large valves. In addition, a leaking stem can lead to valve chatter in which the vibration will damage the working parts of the valve. If apparent that the packing gland has compressed the packing to its limit, replace with new packing, making sure that a packing is selected which is compatible with the materials being handled by the valve.

Regrindable seat valves should have a union-type bonnet construction for easy access, although bolted bonnet and screwed-in bonnet valves can also be reground. Remove the bonnet, by unscrewing the bonnet ring, or by removing the body bolts on a bolted bonnet. Place an ample amount of grinding compound on the disc, insert a pin in the groove of the disc holder and the hole in the stem, then reassemble bonnet to the body, screwing the union bonnet ring to hand tightness. Then back off one complete turn. Now the stem can be used as your regrinding tool. By reversing union bonnet ring only one complete turn, you assure yourself of the stem's being vertical and the disc and seat in perfect alignment. If the disc is off-center or cocked, the new reground seat will not be true. Do not overgrind, as unnecessary grinding on a seat and disc defeats the purpose of regrinding a renewable seat valve. When regrinding is completed, remove bonnet ring and bonnet and thoroughly clean the regrinding compound from the seat and disc. Also, remove any scale or corrosive deposits which may have formed in the valve body or bonnet ring and body for easy removal the next time.

4.12 GLOBE VALVE SPECIFICATIONS

The specification should include the following items as well as the materials of construction of the different components.

- Fluid to be handled
- Type of end connection
- Type of disc
- Type of seat
- Type of stem assembly
- Type of stem seal
- Type of bonnet assembly
- Type of Pressure rating
- Type of Temperature rating.
- Specific feature if needed

4.13 Y-TYPE VALVES

Y-pattern valves are a modification of the globe valve but have features of the gate valve. They offer the straight way passage and unobstructed flow of gate valve and the throttling ability of the globe valve. They have a lower pressure drop across the valve than the conventional globe valve. Such a valve is shown in Fig. 4.9.

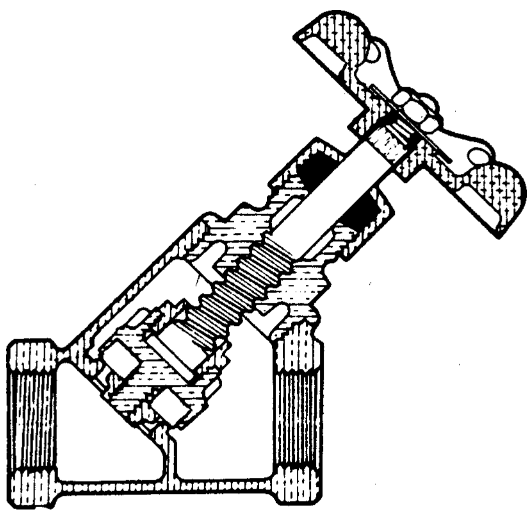


Fig. 4-9. Y-valve.

All of the variations of disc and seat design available in the globe valve are also available in the Y-pattern valve. In general, any specification established for a conventional globe valve can be met by the Y-pattern valve except pressure drop, which is considerably lower is the Y-pattern valve. These valves are also available in the same materials of construction as the conventional globe valve.

CHAPTER - 5

PLUG VALVE

5.1 GENERAL

The advantages of the plug valve are : minimum amount of installation space, simple operation, quick action (a 90-degree rotation of the plug opens and closes the fluid flow path), relatively little turbulence within the valve, and low pressure drop across the valve.

Plug valves (cocks) are normally used for nonthrottling on-off operations, particularly where frequent operation of the valve is necessary. These valves are not normally recommended for throttling service because, like the gate valve, a great percentage of flow change occurs near shut-off at high velocity. However, a diamond-shaped port has been developed for throttling service.

Another important characteristic of the plug valve is its easy adoption to multiport construction. Multiport valves are widely used. Their installation simplifies piping and they provide a much more convenient operation than multiple gate valves would. They also eliminate pipe fittings. The use of a multiport valve eliminates the need of two, three or even four conventional shut-off valves, depending upon the number of ports in the plug valve.

Plug valves are available in either a lubricated or nonlubricated design and with a variety of styles of port openings through the plug as well as a number of plug designs.

5.2 SERVICE RECOMMENDATIONS

- Fully opened or fully closed nonthrottling service, except for valves.
- Minimum resistance to flow
- Minimum amount of fluid trapped in line
- Frequent operation
- Low pressure drop
- Use as a flow-diverting valve.

5.3 CONSTRUCTION OF VALVE

The basic components of the plug valve are the body, plug and gland. In addition to those with a conventional straight-through body, these valves are also used as :

- Short pattern valves with compact face-to-face dimensions used as a on-off valve. Port openings can be either full or reduced but are usually rectangular in shape.
- Multiport valves which have bodies with three or more pipe connections and are used for transfer or diverting services.
- Venturi design which is a reduced area, round or rectangular port with Venturi flow through the body. Usually the minimum port opening is 40 percent.

Multiport Valves

This body style is particularly advantageous on transfer lines and for diverting services. A single multiport valve may be installed in lieu of three or four gate valves, or other type of shut-off valves. One word of caution is that many of the multiport configurations do not permit complete shut-off of flow. In most cases one flow path is always open. These valves are intended to divert the flow to one line while shutting off flow from the other lines. If complete shut-off of flow is a requirement, it is necessary that a style of multiport valve be used which permits this, or a secondary valve to permit complete shut-off of flow.

In some multiport configurations, flow to more than one port simultaneously is also possible. Great care should be taken in specifying the particular port arrangement required to guarantee that proper operation will be possible.

Figure 5.1 shows typical port arrangements on multiport valves.

Plug

Plugs are either round or cylindrical with a taper. They may have various types of port openings, each with a varying degree of free area relative to the corresponding pipe size. Port types are as follows :

- Rectangular port is the standard shaped port with a minimum of 70 percent of the area of the corresponding size of standard pipe.
- Round port means that the valve has a full round opening through the plug and body, of the same size and area as standard pipe.
- Full port means that the area through the valve is equal to or greater than the area of standard pipe.
- Standard opening means that the area through the valve is less than the area of standard pipe, and therefore these valves should be used only where restriction of flow is unimportant.

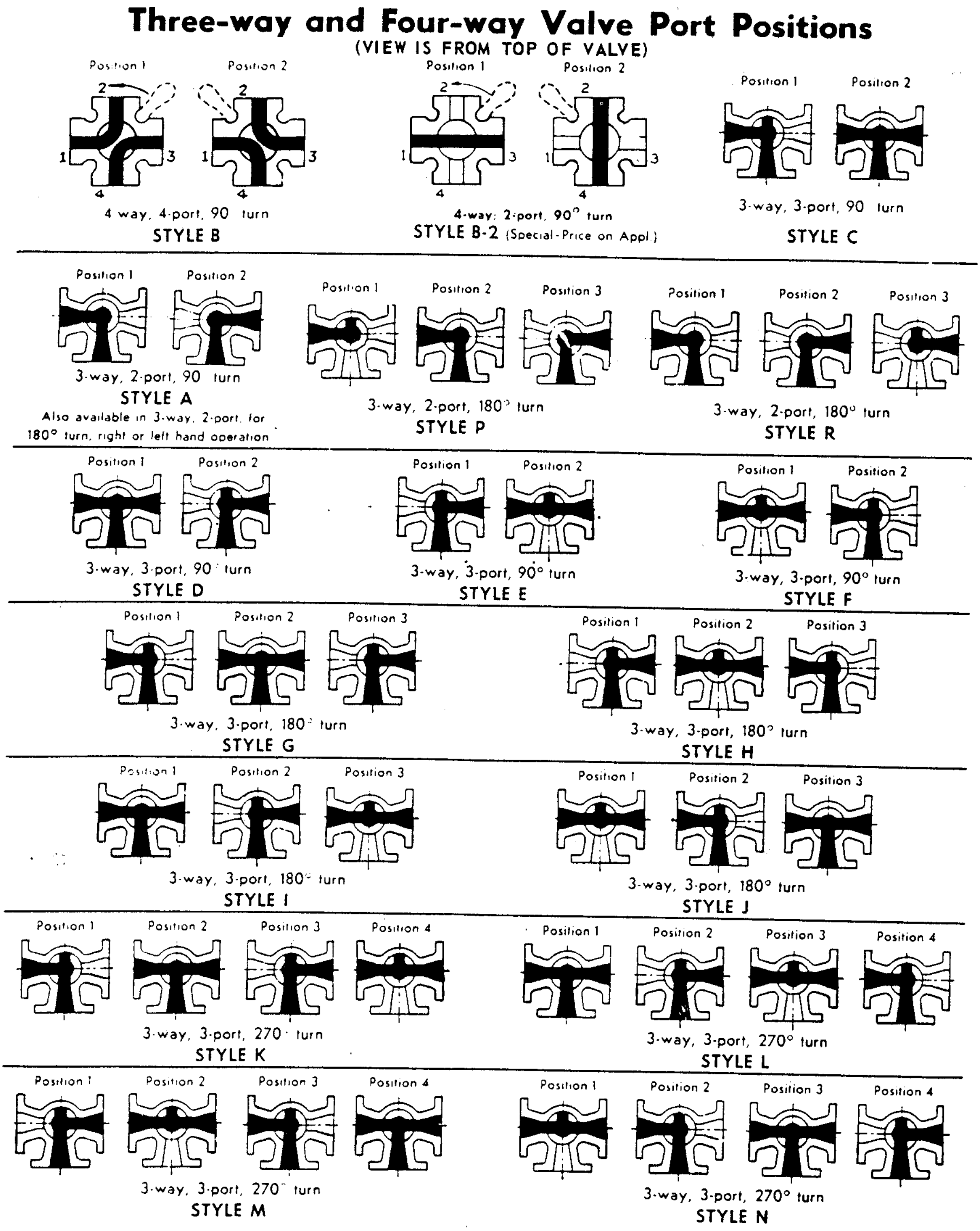


Fig. 5-1. Typical multiport arrangements.

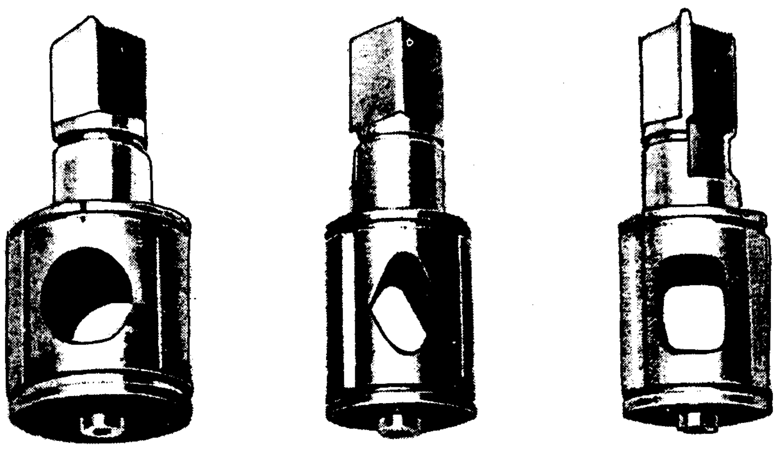


Fig. 5-2. Typical plug openings.

- Diamond port means that the opening through the plug is diamond-shaped. This has been designed for throttling service. All diamond port valves are venturi restricted flow type.

Figure 5.2 shows typical plug openings.

5.4 LUBRICATED PLUG VALVES

Lubricated plug valves have certain advantages over other conventional types of valves. These valves have the ability to give tight shut-off on hard-to-hold substances. A quarter turn of the plug allows the valves to be opened or closed. The plug is the only moving part of the valve when in operation, and its tapered configuration assures positive seating.

The plug is designed with grooves which permit a lubricant to seal and lubricate the valve as well as to function as hydraulic jacking force to lift the plug within the body, thus permitting easy operation. The straight-way passage through the port offers no opportunity for sediment or scale to collect. The valve plug, when rotated, wipes foreign matter from the plug. However, these valves must be kept lubricated at all times to maintain a tight seal between the plug and body.

Lubricated plug valves have these distinct characteristics :

- Tight shut-off if proper lubrication is used
- Quick operation
- Shearing action of plug, which wipes off scale and foreign matter
- Lubrication necessary to prevent galling and sticking

l Not recommended for low or high temperature service.

The correct choice of lubricant is extremely important for successful lubricated plug valve performance. In addition to provide adequate lubrication to the valve, the lubricant must not react chemically with the material passing through the valve nor must the lubricant contaminate the material passing through the valve because of solubility. All manufacturers of lubricated plug valves have developed a series of lubricants which are compatible with a wide range of media. Their recommendation should be followed as to which lubricant is best suited for the service.

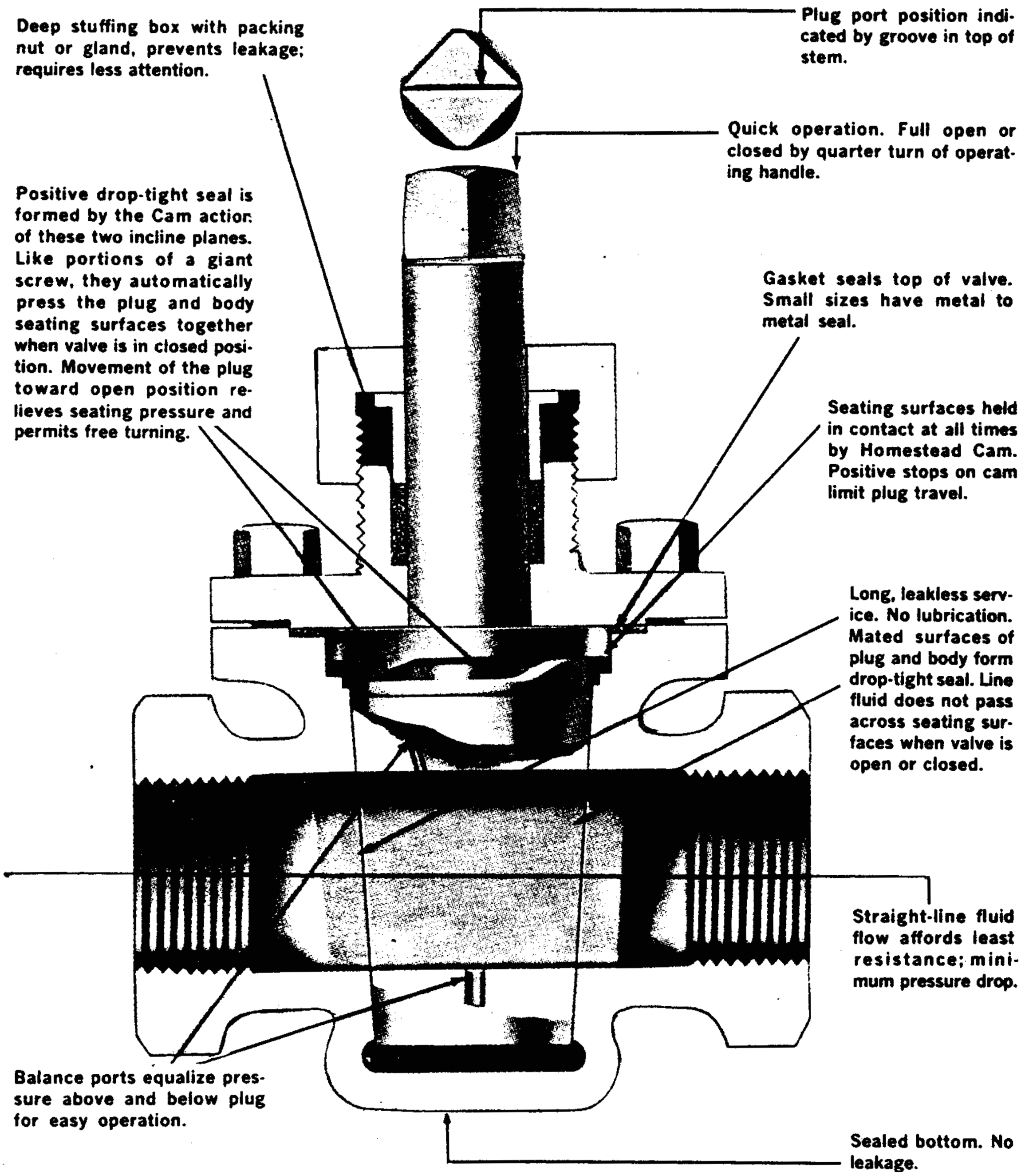


Fig. 5-3. Cam-operated nonlubricated plug valve.

5.5 NONLUBRICATED PLUG VALVES

In order to overcome the disadvantages of the lubricated plug valves, in so far as their need of lubrication, two basic types of nonlubricated plug valves were developed. The nonlubricated valve may be either a lift-type or have an elastomer sleeve or plug coating that eliminates the need to lubricate the space between the plug and seat.

Lift-type valves provide a means of mechanically lifting the tapered plug slightly to disengage it from its seating surface to permit easy rotation. The mechanical lifting can be accomplished through either a cam, as shown in Fig. 5.3, or by means of an external lever as shown in Fig. 5.4.

A typical nonlubricated plug valve with an elastomer sleeve is shown in Fig. 5.5. In this particular valve a sleeve of TFE completely surrounds the plug. It is retained and locked in place by the metal body. This results in a continuous primary seal being maintained between the sleeve and the plug at all times, both while the plug is rotated and when the valve is in either the open and closed position. The TFE sleeve is durable and essentially inert to all but a few rarely encountered chemicals. It also has a low coefficient of friction and therefore is self-lubricating.

Nonlubricated plug valves have the following characteristics :

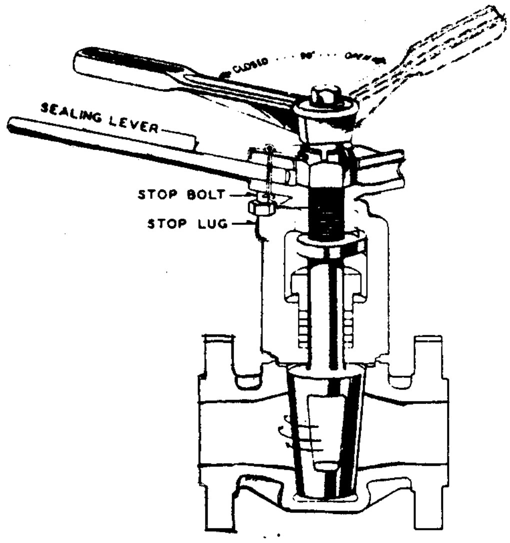
- Absolute shut-off - can use resilient seats
- Quick operation
- Suitable for wider temperature ranges than lubricated plug valves
- Products handled not subject to contamination by a lubricant
- Best for handling slurries - will not stick
- Not necessary to lubricate valve - low maintenance cost.

5.6 GLAND

The gland of the plug valve is equivalent to the bonnet of a gate or globe valve. It is that portion of the valve assembly which secures the stem assembly to the valve body. There are three general types of glands - single gland, screwed gland and bolted gland.

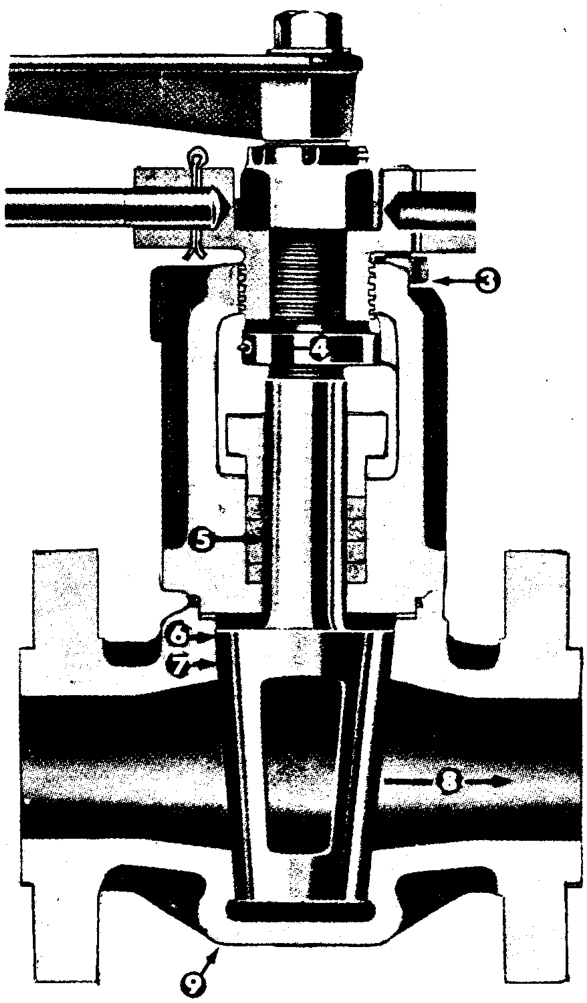
5.7 IDENTIFICATION OF PARTS

The nomenclature and identification of the different components and parts of plug valves are shown in Fig. 5.6.



Position of sealing-lever stop bolt shows whether sealing pressure has, or has not, been relieved. Sealing pressure has been relieved when stop bolt rests against lug. Do not attempt to operate valve if sealing-lever stop bolt is in any other position. Sealing pressures must be restored after each operation

Features



1. Plug lever. Quarter-turn to open or close.
2. Sealing lever. Valve cannot stick. The powerful lever and screw principle assures positive operation. It is part of the valve and always ready for instant use.
3. Positive stop allows seating pressure to be relieved only enough to overcome friction between plug and body and permit easy turning of the plug.
4. Visible outside stop limits plug travel to quarter-turn, and assures alignment of plug and body ports. Plug level lines up with groove on top of stem on indicate port openings.
5. Deep stuffing box and gland. No leakage of valuable fluids.
6. "Lever-seald" action presses mated metal surfaces firmly together to form perfect seal against leakage.
7. Protected seating surfaces. No fluid or grit passes across seating surfaces in either open or closed position. Maximum valve life and lowest cost-per year service.
8. Straight-line fluid flow. Low pressure drop.
9. Sealed bottom prevents leakage.

Fig. 5-4. Lever-operated nonlubricated plug valve.

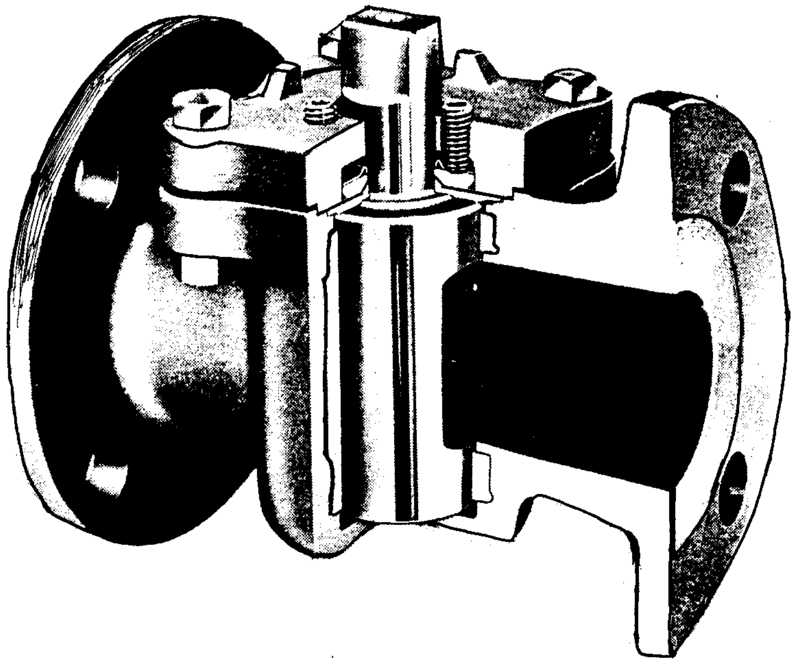


Fig. 5-5. Plug valve with elastomeric sleeve.

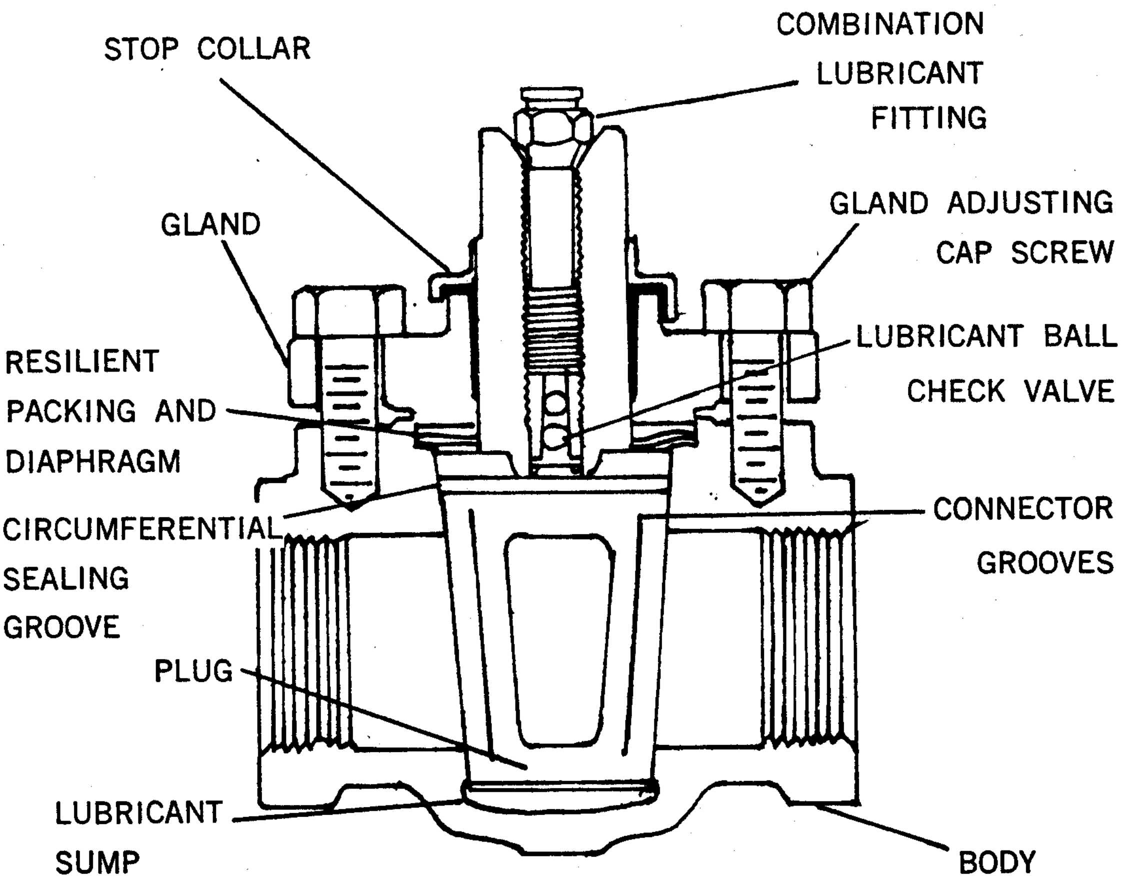


Fig. 5-6. Identification of plug valve parts.

5.8 AVAILABLE MATERIALS OF CONSTRUCTION

Plug valves are available in a wide range of materials of construction including solid plastics and many lined configurations. Among the more readily available materials of construction are :

Bronze	Polyvinylchloride (PVC)
Steel	TFE-lined
Stainless steel	Ni-rest
Brass	Penton

5.9 INSTALLATION, OPERATION AND MAINTENANCE

General installation procedures and care of valves prior to installation have been already discussed. Covered here are the specific items unique to plug valves.

When installing plug valves, care should be taken to allow room for the operation of the handle (lever, wrench). The handle is usually longer than the valve, and it rotates to a position parallel to the pipe from a position 90 degrees to the pipe.

Lubricants are available in stick form, in tubes and in bulk. Stick lubrication is usually employed when a small number of valves are in service or when they are widely scattered throughout the plant. However, for a large number of valves gun lubrication is the most convenient and economical solution. Tube lubrication is used as stick lubrication. Not all types of lubricants are made in stick form.

All valves are usually shipped with an assembly lubricant. This assembly lubricant should be removed by completely relubricating with the proper lubricant before being put into service.

Gun Lubrication

- Valve should be in fully open or fully closed position. The best results are obtained with the valve in the fully open position.
- Connect high-pressure lubricant gun to combination lubricant fitting and pump lubricant into valve until resistance is felt.
- Rotate plug back and forth during final strokes of lubricant gun to spread lubricant evenly over the plug and body seating surfaces.

Stick Lubrication

- Valve should be in the fully open or fully closed position. The best results are obtained with the valve in the fully open position.

- Remove lubricant fitting and insert proper size stick of lubricant.
- Replace fitting. Lubricant will be forced into the valve by turning the fitting.
- Repeat, adding additional sticks of lubricant until increased resistance is felt on fitting, which indicates that the lubricant system is full and under pressure.
- Rotate plug back and forth while turning in last stick of lubricant to spread the lubricant evenly over the plug and body seating surfaces.

  Regular periodic lubrication is a must for best results. Extreme care should be taken to prevent any foreign matter from entering the plug when inserting new lubricant.

Gland Adjustment

To insure a tight valve the plug must be seated at all times. Gland adjustment should be kept tight enough to prevent the plug from becoming unseated and exposing the seating surfaces to the live fluid. Care should also be exercised so as not to overtighten the gland, which will result in a metal-to-metal contact between the body and the plug. Such a metal-to-metal contact creates an additional force which will require extreme effort to overcome when operating the valve.

Hard Operation

- Lubricate valve thoroughly with the proper lubricant. Hard operation can sometimes result from using the improper lubricant.
- Should valve remain difficult to operate after lubrication, loosen gland (or bonnet) slightly and relubricate valve thoroughly.
- If gland (or bonnet) has been loosened to the extent that the valve operates freely, retighten gland (or bonnet) until the proper operation is obtained. Freely operating valves require an ample amount of lubricant to keep them from leaking.
- If the above operations do not free the plug, it will be necessary to disassemble the valve and clean it thoroughly. Be sure that all hardened lubricant is removed from the lubricant system. Reassemble and lubricate thoroughly.

Leakage

- Lubricate valve thoroughly.

- If grease backpressure fails to buildup while lubricating, the valve is out of adjustment. The plug is not seated in the body and the lubricant that is added will be dispersed into the line.

- Tighten gland (or bonnet) while operating the plug back and forth to work out the excess lubricant. Gland (or bonnet) should be tightened so that valve operates with moderate effort.

5.10 PLUG VALVE SPECIFICATION

A specification for plug valves should include, besides basic materials of construction, the following terms :

- Type of plug

- Type of gland

- Lubricant to be used (if lubricated valve)

- Port arrangements if multiport design

- Temp. rating

- Pressure rating

CHAPTER -6

BALL VALVE

6.1 GENERAL

The ball valve, in general, is the least expensive of any valve configuration. In early designs having metal-to-metal seating the valves could not give bubble-tight sealing and were not firesafe. With the development of elastomeric materials and with advances in the plastics industries, the original metallic seats have been replaced with materials such as fluorinated polymers, nylon, neoprene and buna-N.

The ball valve is basically and adaptation of the plug valve. Instead of a plug it uses a ball with a hole through one axis to connect the inlet and outlet ports in the body. The ball rotates between resilient seats. In the open position, the flow is straight through. When the ball is rotated 90 degrees the flow passage is completely blocked.

In addition to quick, quarter-turn on-off operation, ball valves are compact, easy-to-maintain, require no lubrication and give tight sealing with low torque.

Since conventional ball valves have relatively poor throttling characteristics, they are not generally satisfactory for this service. In a throttling position the partially exposed seat rapidly erodes because of the impingement of high-velocity flow. However, a ball valve has been developed with a spherical surface-coated plug which is off to one side in the open position and which rotates into the flow passage until it blocks the flow path completely. Seating is accomplished by the eccentric movement of the plug. The valve requires no lubrication and can be used for throttling service.

6.2 SERVICE RECOMMENDATIONS

- Designed primarily for on-off service
- For minimum resistance to flow
- Quick opening
- Low maintenance cost
- Limited to moderate temperature services.

6.3 CONSTRUCTION OF VALVE

Ball valves are designed on the simple principle of floating a polished ball between two plastic O-ring seats, permitting free turning of the ball. Since the plastic O-rings are subjected to deformation under load, some means must be provided to hold the ball against at least one seat. Normally this is accomplished through spring pressure, differential line pressure, or a combination of both.

With a soft seat on both sides of the ball, most ball valves give equally effective sealing of flow in either direction. Most designs permit adjustment for wear.

Ball valves are available in the venturi, reduced and full port patterns. The latter has a ball with a bore equal to the inside diameter of the pipe. Balls are usually metallic in metallic bodies with trim (seats) produced from elastomeric materials. Also, all-plastic designs are available. Seats are replaceable, as are the balls.

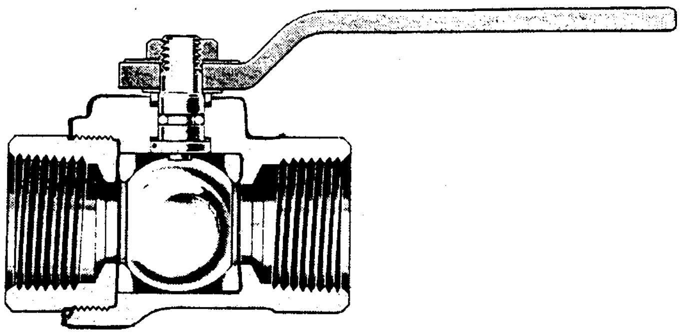


Fig. 6-1. End entry ball valve.

Balls valves are available in top entry and split body (end entry) types. In the former, the ball and seats are inserted through the top, while in the latter, the ball and seats are inserted from the ends as shown in Fig. 6.1.

Another design of ball valve provides for the interchangeability of the end pieces in various materials of construction. This permits the changing of the end pieces, if necessary, as long as galvanic action will not present a problem.

Ball valves are also available in multiport configurations in the same manner as plug valves. The typical port arrangements are the same as shown in Fig.5.1 for plug valves. These valve bodies are usually larger than the equivalent straight-way valve since a larger diameter ball must be provided to permit the multiple port drilling.

When closed, many ball valves trap the fluid between the seats and in the hole in the ball, which may be objectionable in some cases. This type of the valve is limited to temperatures and pressures allowed by the seat material.

Seats

The resilient seats for ball valves are made from various elastomeric materials. The most common seat materials are TFE (virgin), filled TFE, Nylon, Buna-N, Neoprene and combinations of the foregoing. Because of the elastomeric materials these valves cannot be used at elevated temperatures. Typical average maximum operating temperatures at full pressure rating of the valves are shown in Table 6.1 for various seat materials. In order to overcome this disadvantage a graphite seat has been developed which will permit operation up to 1000^0 F.

Table 6.1 Maximum Operating Temperature of Ball Valve Seats

Seat Material	TFE(Virgin)	Filled TFE	Buna-N	Neoprene
Oper. Temp ^{0}F*	280	325	180	180

* These are average values and will vary between valve manufacturers.

Care must be used in the selection of the seat material to insure that it is compatible with the materials being handled by the valve, as well as its temperature limitation.

Stem and Bonnets

The stem in a ball valve is not fastened to the ball. It normally has a rectangular portion at the ball end which fits into a slot cut into the ball. This engagement permits rotation of the ball as the stem is turned.

A bonnet cap fastens to the body which holds the stem assembly and ball in place. Adjustment of the bonnet cap permits compression on the packing which supplies the stem seal. Packing for ball valve stems is usually in the configuration of die-formed packing rings normally of TFE, TFE-filled or TFE-impregnated materials. Some ball valve stems are sealed by means of O-rings rather than packing.

Some ball valve stem are equipped with stops which permit only a 90-degree rotation, while others do not have stops and may be rotated 360 degrees. In the latter valves a 90-degree rotation is still all that is required for closing or opening of valve. Position of the handle indicates valve ball position. When the handle lies along the axis of the valve, the valve is open; when the handle lies 90 degrees across the axis of the valve, the valve is in the closed position.

In addition to the handle position as an indicator of the valve setting, some ball valve stems have a groove cut in the top face of the stem which shows the flow path through the ball. Observation of the groove position indicates the position of the port through the ball. This feature is particularly advantageous on multiport valves. Figure 6.2 shows two such stem grooves, one for a straight through valve and one for a multiport valve.

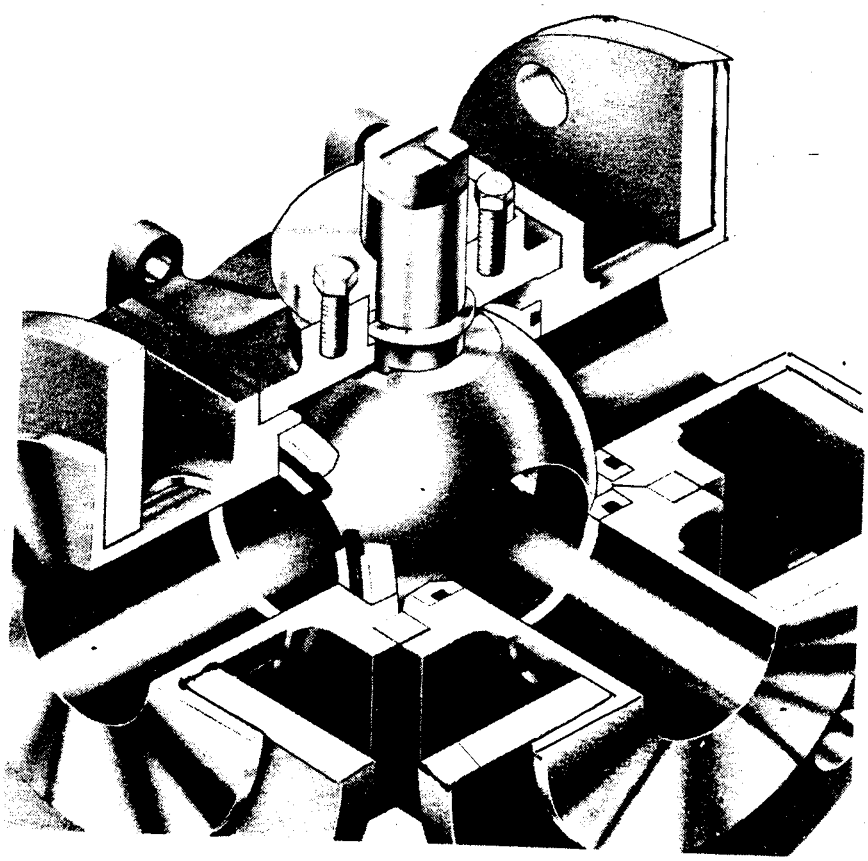


Fig. 6-2. Grooves in ball valve stem.

6.4 IDENTIFICATION OF PARTS

The nomenclature and identification of the components and parts of ball valves are shown in Fig. 6.3.

6.5 AVAILABLE MATERIALS OF CONSTRUCTION

Ball valves are available in an extremely wide range of materials of construction including :

cast iron	aluminium	borosilicate glass
ductile iron	carbon steel	impervious graphite
bronze	stainless steels	polypropylene
brass	titanium	polyvinylchloride
zirconium	tantalum	

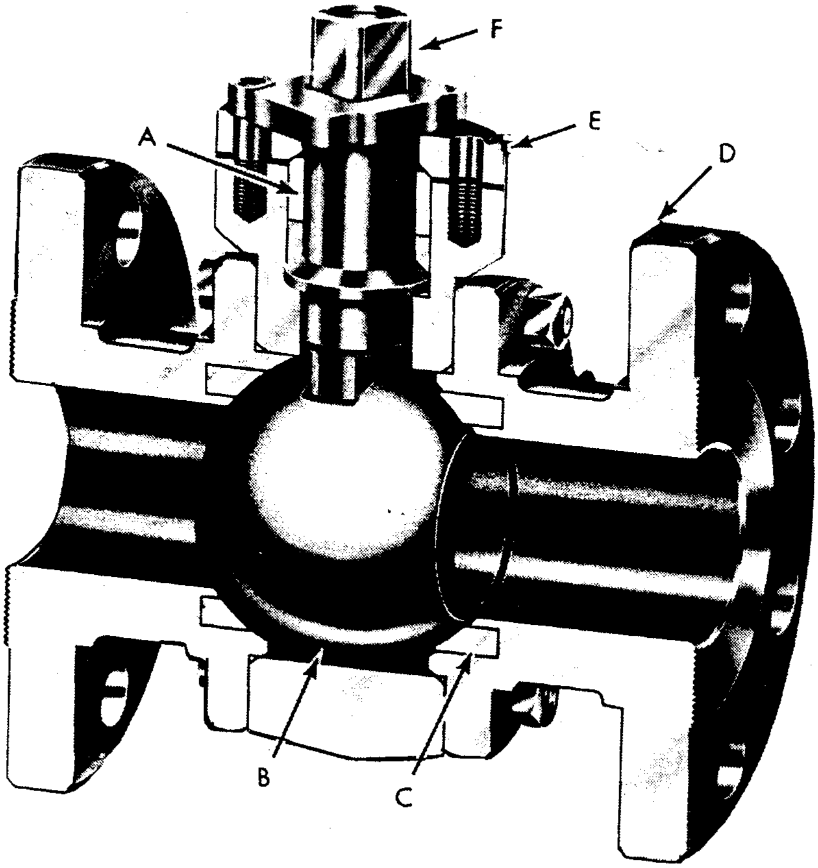


Fig. 6-3. Identification of ball valve parts. A. Packing, B. ball, C. seat, D. body, E. bonnet cap, F. stem.

6.6 INSTALLATION, OPERATION AND MAINTENANCE

General installation procedures and care of valves prior to installation have been already discussed. Covered here are the specific items unique to ball valves.

When installing ball valves, care should be taken to allow sufficient room for the operation of the valve handle. The valve handle is usually larger than the valve body, and it rotates from a position parallel to the pipe to a position 90 degrees across the pipe. Conventional ball valves should not be used for throttling service.

Weld End Valves

To prevent damage to the ball and seats due to excessive heat or weld slag, the following procedure is recommended for welding ball valves into pipelines :

- Place the ball in the fully open position before starting to weld.
- Use an internal welding back-up ring where practical.
- Avoid rapid application of excess welding material.

- Do not permit the temperature of valve body-seat area to exceed 250^0F, to prevent seat and seal damage. (Check with Temperature Stick.)

- Before turning valve to the closed position clean the pipeline and valve bore of weld slag. This can be done by pigging and flushing the line.

- Alternative to this procedure is to remove the ball and seats, weld the valve in place, clean the pipeline of weld slag, and reassemble the ball and seats.

Sockets Weld-End Valves

In addition to the foregoing standard welding procedure, the following special procedure should also be followed for socket weld-end valves :

- Provide adequate support to the pipe on each side of the valve prior to welding.

- Use an electric welding rod (maximum 1/8-inch diameter). Weld each end of valve with a continuous bead. Do not apply excessive weld metal.

- If multiple passes are necessary, make certain that the interpass temperature does not exceed 250^0F in the body seat area. (Check with Tempil stick.)

If it is necessary to disassemble a ball valve in order to replace one or more portions the following procedure should be adhered to on the reassembly :

- Ball should be in the closed position.

- If the top of the stem is slotted, the slot should line up with the port in the ball.

- Inspect the seats and make sure that they are not damaged or scored.

- Torque up the bolts or cap screws evenly, alternating back and forth across the valve. Also use a feeler gage if necessary to obtain a uniform gap between end fitting and body.

- Rotate ball back and forth while torquing up on bolts or cap screws, to avoid getting it too tight.

Packing leaks should be taken care of immediately by tightening the gland which compresses the packing. The gland must be tightened uniformly alternating back of forth across the valve. Do not overtighten. Rotate the ball back and forth while tightening to prevent getting it too tight. If it is necessary to tighten excessively, it is an indication that the packing should be replaced. Overtightening can damage and deform the elastomeric seats.

6.7 BALL VALVE SPECIFICATIONS

A ball valve specification should include, besides the basic materials of construction of the body, the following items :

- Operating temperature
- Operating pressure
- Type of port in ball and whether full port or reduced port is required.
- Material of construction of seat.
- Whether ball is to be top entry or end entry

CHAPTER - 7

BUTTERFLY VALVE

7.1 GENERAL

Butterfly valves possess many advantages over gate, globe, plug and ball valves in a variety of installations, particularly in the larger sizes. Savings in weight, space and cost are the most obvious advantages. Maintenance costs are low since there is a minimum number of moving parts and there are no pockets to trap fluids.

This type of valve is suitable for throttling as well as open-closed applications. Operation is easy and quick because a 90-degree rotation of the handle moves the flow control element from the fully closed to the fully opened position. These valves may also be equipped for automatic operation.

Butterfly valves are especially well suited for the handling of large flows of liquids or gases at relatively low pressures and for the handling of slurries or liquids with large amounts of suspended solids.

7.2 SERVICE RECOMMENDATIONS

1. Fully opened, fully closed or throttling service
2. Low pressure drop across the valve
3. Minimum amount of fluid trapped in the line
4. Frequent operation
5. Positive shut-off for gases or liquids
6. Handling of slurries.

7.3 CONSTRUCTION OF VALVE

Butterfly valves are built on the principle of a pipe damper. The flow control element is a disc of approximately the same diameter as the inside diameter of the adjoining pipe, which rotates on either a vertical or horizontal axis. When the disc lies horizontally, the valve is fully opened, and when the disc approaches the vertical position, the valve is shut. Intermediate positions, for throttling purposes, can be secured in place by handle-locking devices.

Stoppage of flow is accomplished by the valve disc sealing against a seat which is on the inside diameter periphery of the valve body. Metal disc can also be used to seal against a metal seat but does not provide a leak-tight closure. Valves of this design are still available.

With the advent of the newer elastomeric materials most butterfly valves are now produced with an elastomeric seat against which the disc seals. This arrangement does provide a leak-tight closure.

Body construction varies. The most economical is the wafer type which simply fits between two pipeline flanges. Another type of lug wafer valve is held in place between two pipe flanges by bolts that join the two flanges and pass through holes in the valve's outer casing. Valves are also available with conventional flanged ends for bolting to pipe flanges and in a screwed end construction. These various configurations are shown in Fig. 7.1. Butterfly valves are also available in sanitary construction.

Disc

Discs for butterfly valves are available in a wide range of materials of construction, including practically all metals. Metal discs are also available with many types of coverings such as TFE, Buna-N, Neoprene and other corrosion-resistant elastomers. Discs are replaceable.

Seat

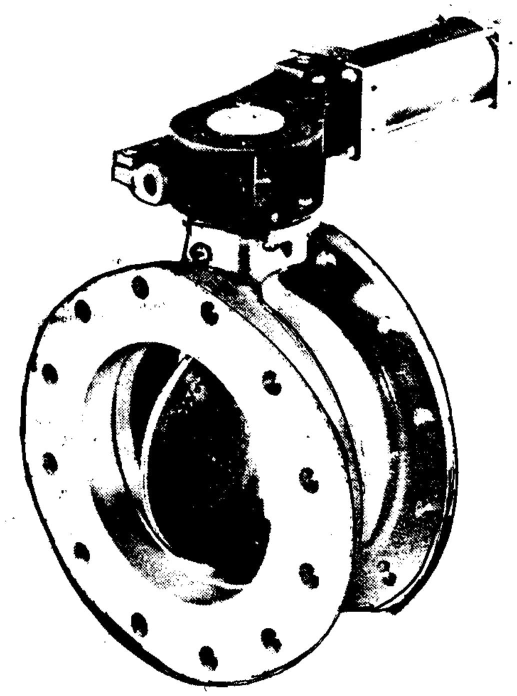
Butterfly valve seats can be of metal or resilient liner types. The former do not give a leak-proof closure, while the resilient liner types do provide a leak-proof closure. In most valves the resilient liner is an elastomeric material which is replaceable. Typical materials used as seats are as follows :

Buna-N	Neoprene
Viton	Natural Rubber
TFE	White Butyl
Polyurethane	

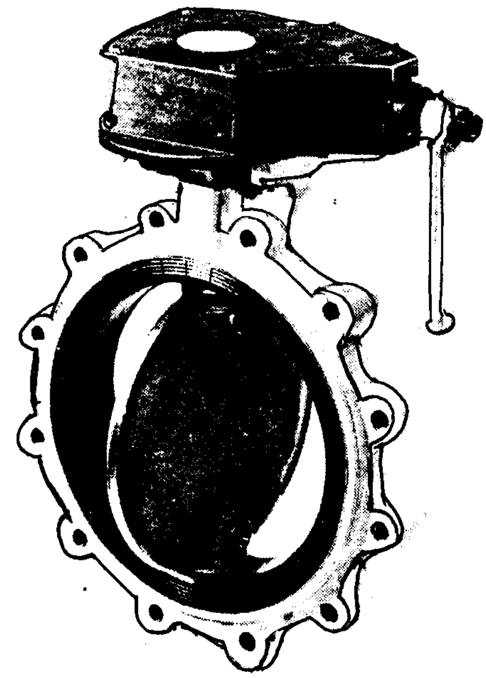
Stem and Gland Assembly

The stem and disc are separate pieces. The disc is bored to receive the stem. Two methods are used to secure the disc to the stem so that the disc rotates as the stem is turned.

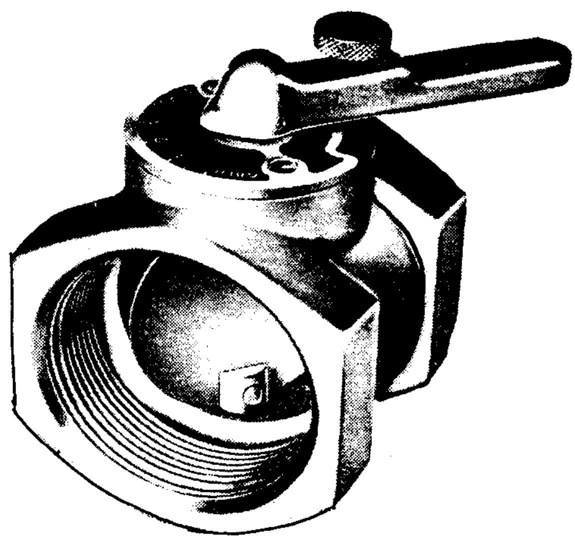
In the first method the disc is simply bored through and the disc secured to the stem by means of bolts or pins which pass through the stem and disc as shown in Fig. 7.1. The alternate method, also shown in Fig. 7.2, involves boring the disc as before, then broaching the upper stem bore to fit a squared stem. This method allows the disc to "float" and seek its center in the seat. Uniform sealing is accomplished and external stem fasteners are eliminated. This is advantageous in the case of covered discs and in corrosive applications.



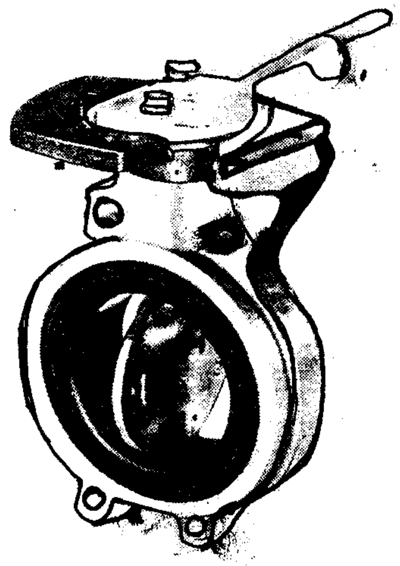
TWO-FLANGE BODY



LUG WAFER BODY



SCREWED END VALVE WITH LEVER AND INDICATION DIAL PLATE



WAFER BODY

Fig. 7-1. Types of butterfly valve bodies.

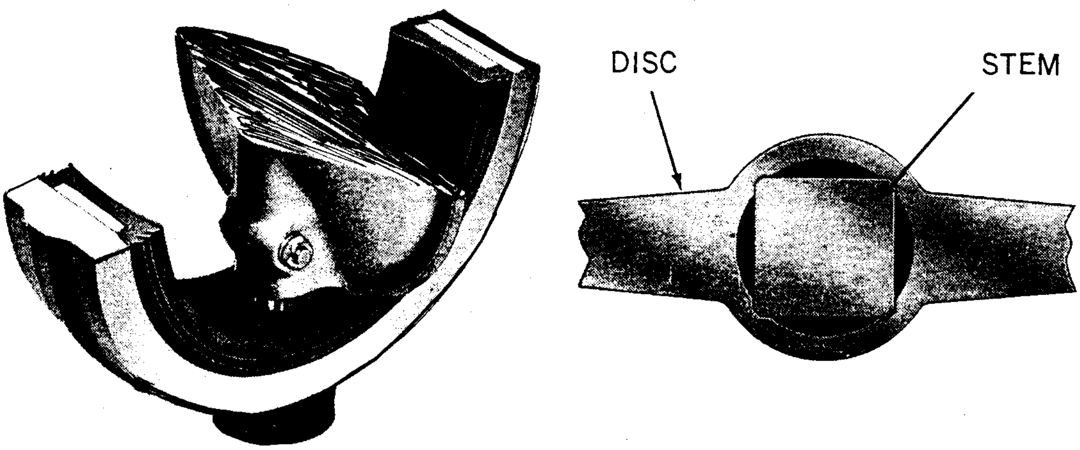


Fig. 7-2. Connection of stem to disc.

In order for the disc to be held in the proper position, the stem must extend beyond the bottom of the disc and be fitted into bushing in the bottom of the valve body. One or two similar bushings are also necessary along the upper portion of the stem as well. These bushings must either be resistant to the media being handled or they must be sealed so that the corrosive media cannot come into contact with them. Both methods are employed, depending upon the valve manufacturer.

Stem seals are effected either with packing in a conventional stuffing box or by means of O-ring seals. Some valve manufacturers, particularly those specializing in the handling of corrosive materials, effect a stem seal on the inside of the valve so that no material being handled by the valve can come into contact with the valve stem. If a stuffing box or external O-ring seal is employed, the material passing through the valve will come into contact with the valve stem. Different types of sealing arrangements are shown in Fig. 7.3.

7.4 IDENTIFICATION OF PARTS

The nomenclature and identification of parts of butterfly valves are shown in Fig. 7.4.

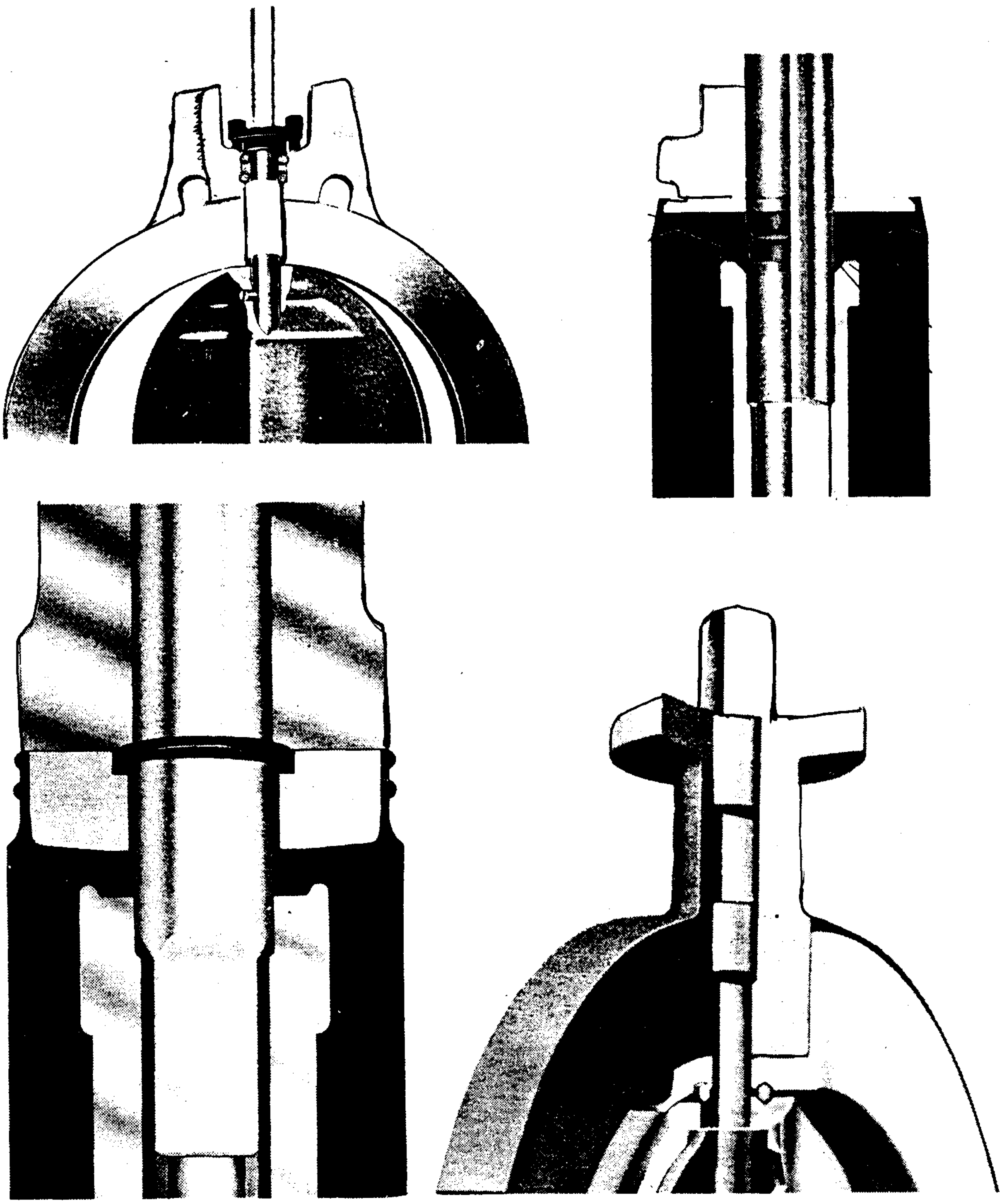
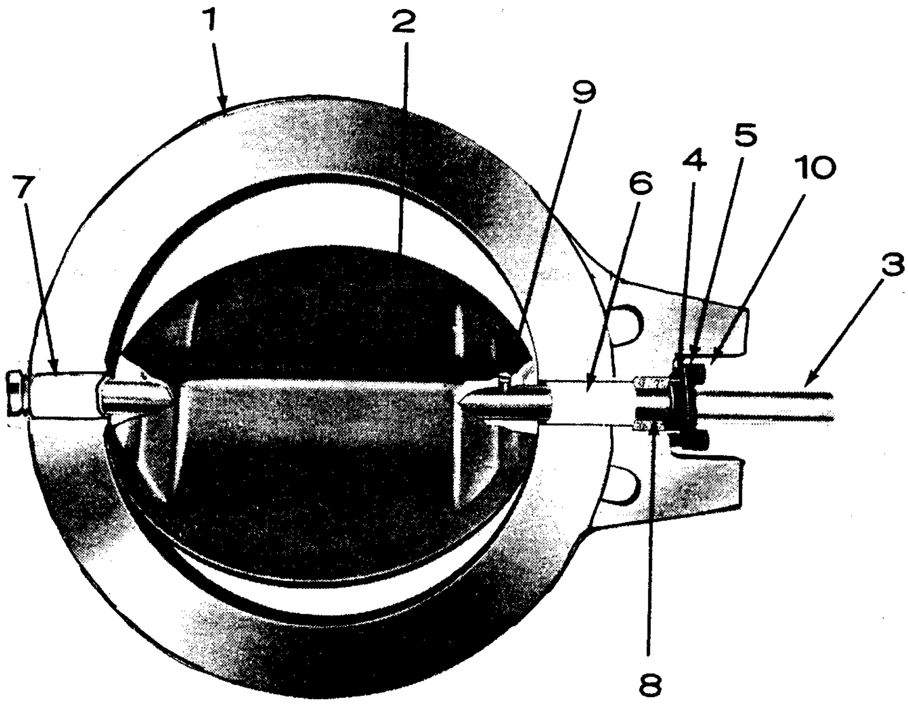


Figure 7-3.

STEM-SEALING ARRANGEMENTS.



1. Body	6. Upper bearing
2. Disc	7. Lower bearing
3. Shaft	8. Packing
4. Gland	9. Pin
5. Gland retainer	10. Gland screws

Fig. 7-4. Identification of butterfly valve parts.

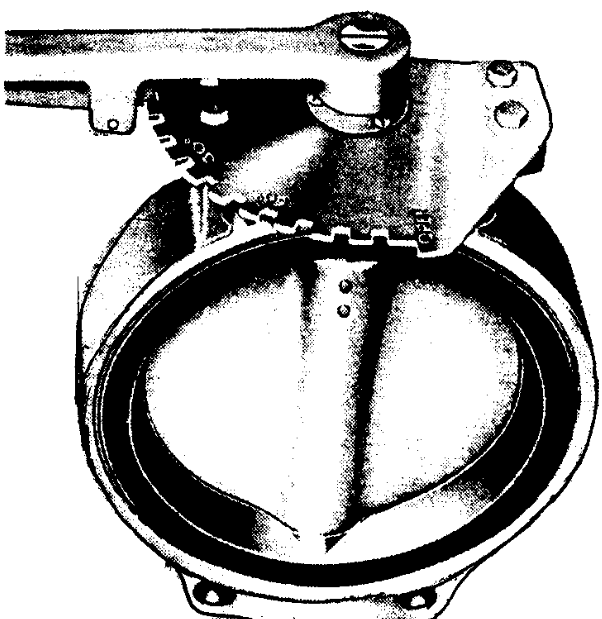


Fig. 7-5. Lever-actuated butterfly valve.

7.5 TYPES OF BUTTERFLY VALVE

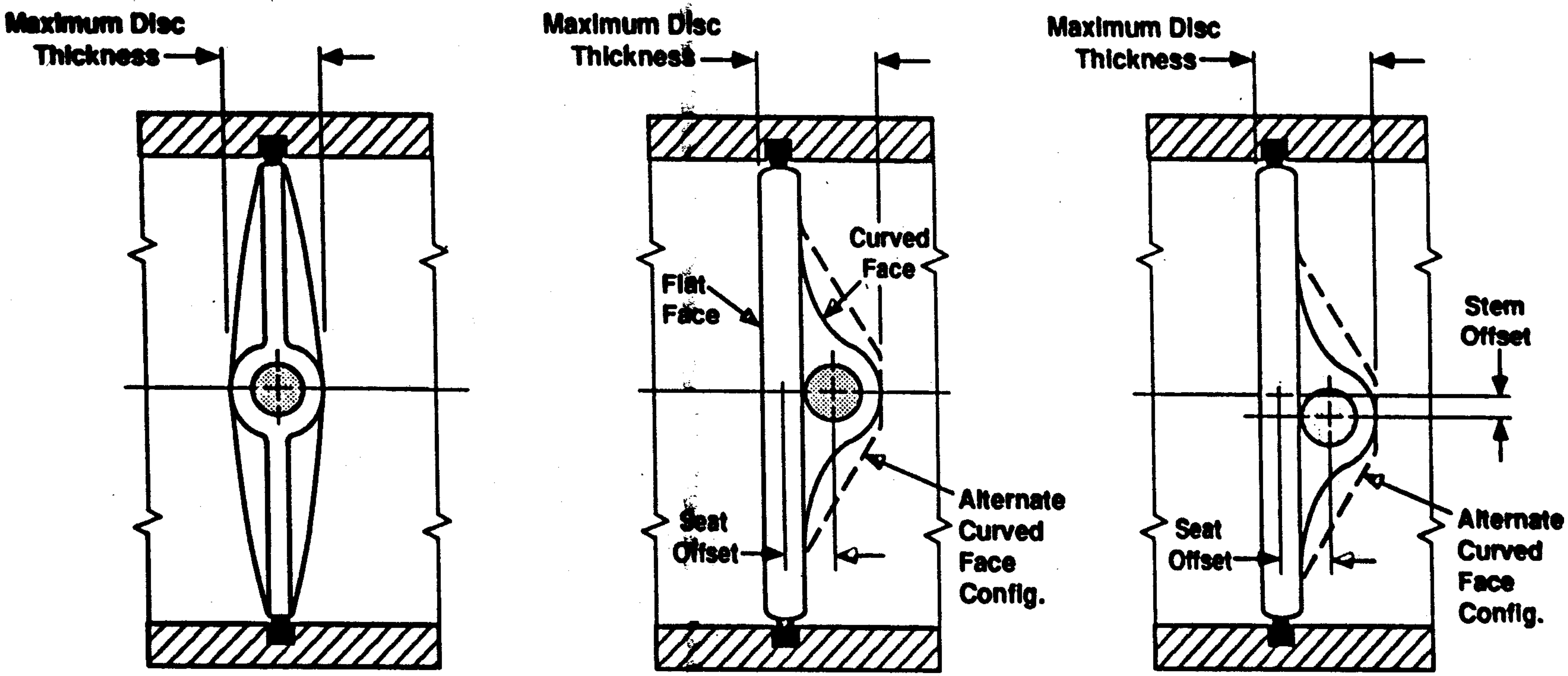
a. According to stem offset :

1. Symmetric (lens type) disc with concentric stem (Figure 7.6a) : The symmetric disc type design is generally referred to as the standard disc, conventional disc. Flow and torque characteristics of a symmetric disc valve do not depend on the flow direction, and the valve has no preferred flow direction. Symmetric disc design is typically furnished with a rubber lined body to provide a seal in the fully closed position. In this design, the stem penetrates the rubber liner and an enlarged hub area around the stem is provided with interference against the rubber liner to prevent leakage around the stem in the fully closed position. The disc hub area maintains a continuous contact against the body liner throughout the disc rotation, which has a tendency to cause higher wear in this region.

2. Nonsymmetric disc with single offset stem (Figure 7.6b) : In the single offset nonsymmetric disc design, stem centerline (and the center of disc rotation) is offset axially from the plane of the valve seat along the pipe centreline. In this stem/disc design, the valve seat is continuous and the stem does not penetrate the seat. This design is available in resilient as well as metal-to-metal seat. The disc face away from the stem is typically flat or has a small curvature, and is commonly referred to as the flat face. The other disc face is generally convex and contoured to accommodate the stem. This face is generally referred to as the curved face.

   Flow and torque characteristics of the valve depend on the flow direction with respect to the disc. When the shaft is on the downstream side (or the flat face of the disc is on the upstream side) of the flow direction, the installation is commonly referred to as shaft downstream or flat face forward (Figure 7.7). Similarly, when the shaft is on the upstream side (or the curved face of the disc faces the upstream flow direction), the installation is referred to as shaft upstream or curved face forward.

3. Nonsymmetric disc with double offset stem (Fig.7.6c) : In this disc design the stem has a seat offset (similar to the single offset design) and a relatively small lateral stem offset. The magnitude of the stem offset in typical high performance valves varies from 1/32-inch to 1/8-inch. This design is available with resilient seats as well as metal seats. The double offset provides a cam like action that is claimed to reduce seat wear and enhance sealing capability in certain applications. In double offset design, the resultant force due to differential pressure across the disc in the closed position does not pass through the stem centerline. A external torque may be required to prevent disc opening due to differential pressure in double offset designs that have large disc offset.



(a)
Symmetric Disc Design

(b)
Single Offset Design

(c)
Double Offset Design

Fig. 7-6. Typical Variation in Butterfly Disc Designs.

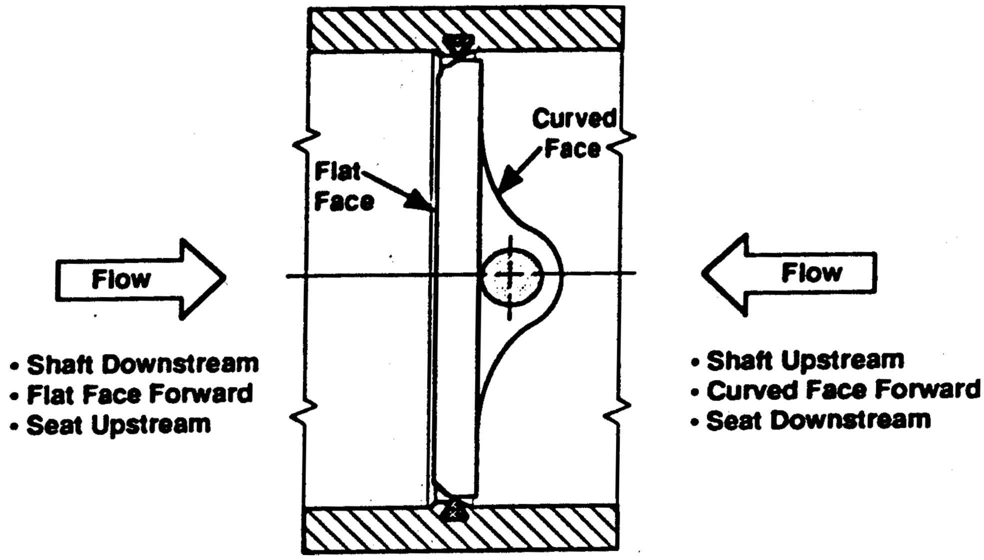


Fig. 7-7. Valve disk flow orientation terminology.

Another variation in disc design that is relatively uncommon in nuclear power plants is the triple offset seat design, shown in Fig. 7.8. The main feature of this design is that, in addition to the seat and stem offsets described above, the stem has an additional (third) offset with respect to the disc centerline.

This geometry provides a stronger camming action between the disc and seat, which provides a tight metal-to-metal seal, even in large valves. The triple offset design is torque seated, as contrasted to the other three disc designs shown in Figure 7.6, which are position seated.

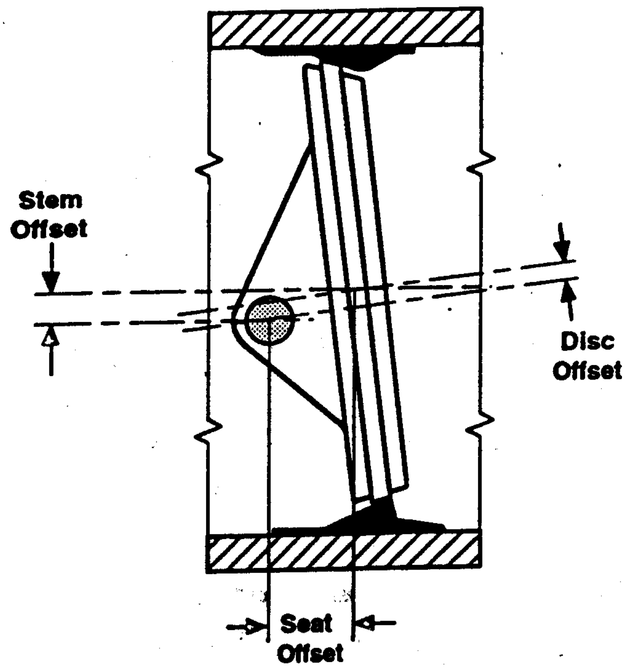


Fig. 7-8. Triple offset butterfly valve.

b. **According to Valve Seat Design :**

A large number of combinations of valve seat designs and materials are available to meet the variety of applications and operating conditions. Based on seat leakage and seat torque requirements, valve seats may be divided into nominal leakage seats, low leakage seats and tight shut-off seats. Except for externally pressurized elastomer seats of inflatable designs (Figure 3.8) which are not commonly used in nuclear power plants, tight shut-off seats require higher seating/unseating torque than the nominal leakage seat designs. In some throttling and modulating applications in which small leakage is tolerable, a clearance is provided between the disc OD and the seat ID. In such designs, the seat does not add any component to the total torque requirements.

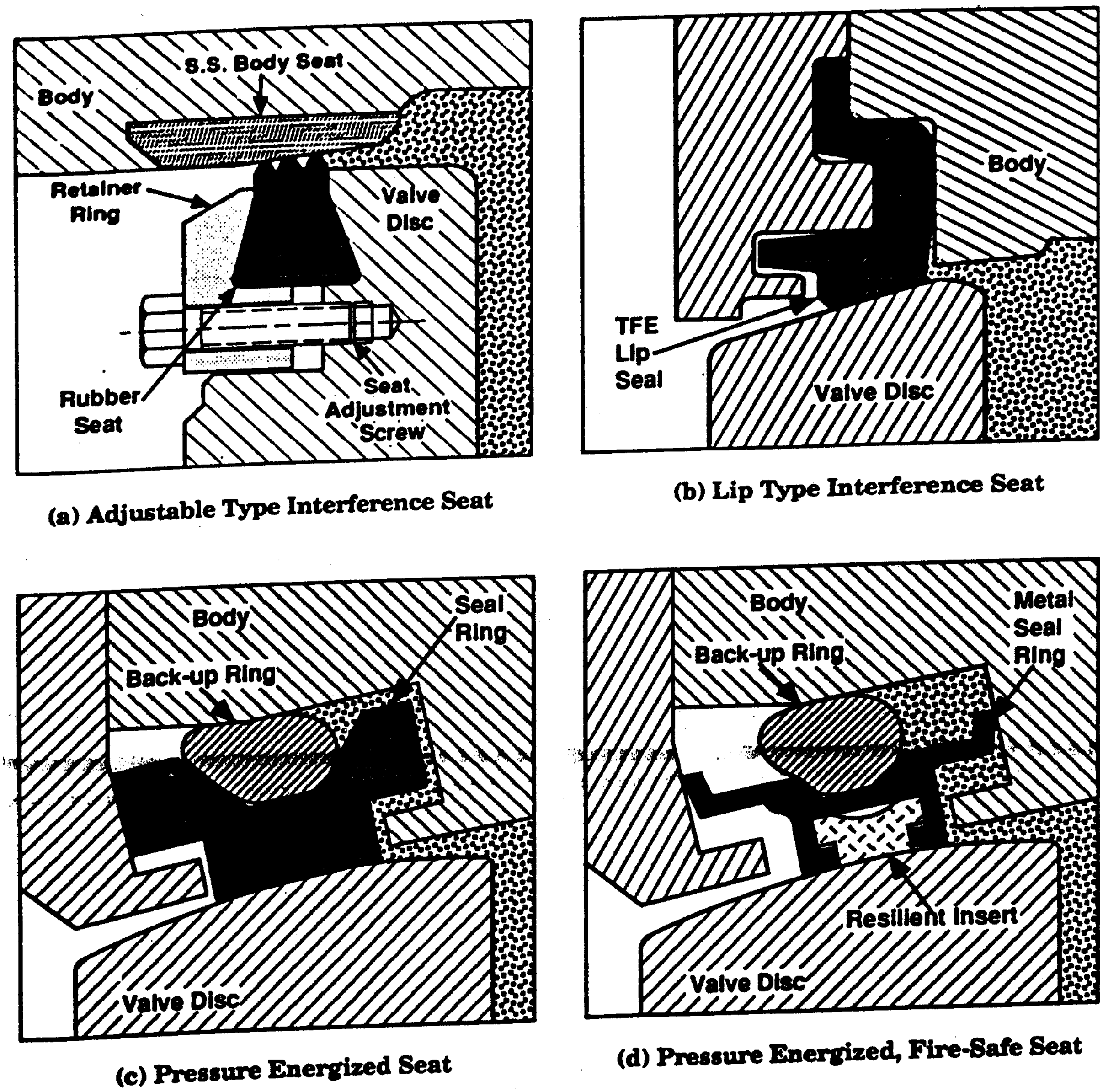


Fig. 7-9. Typical seat designs.

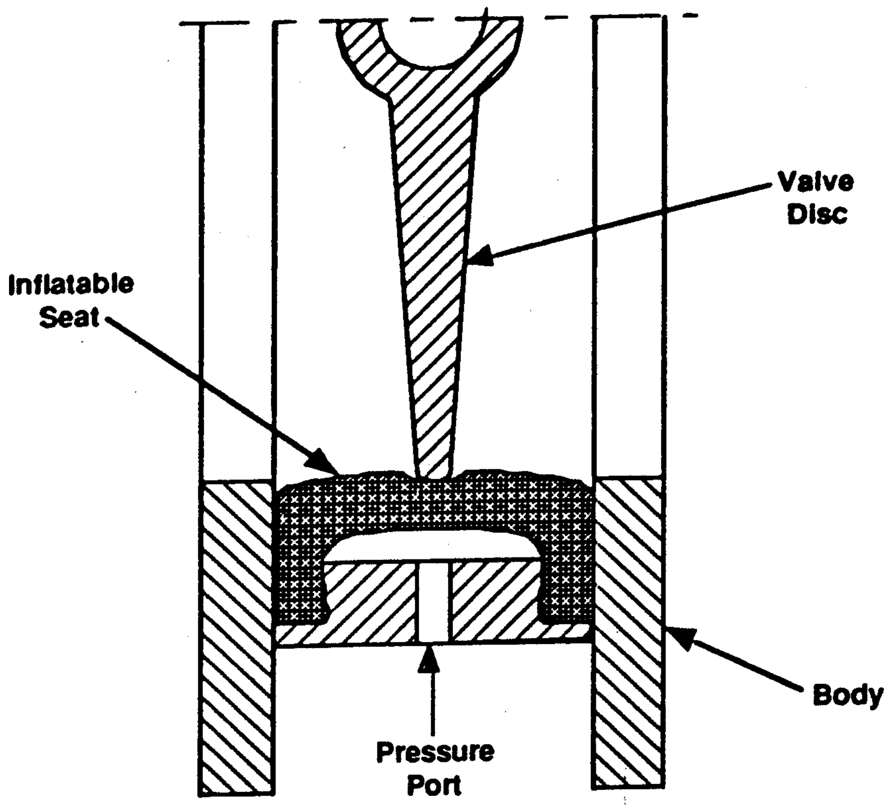


Fig. 7-10. Inflatable seat butterfly valve.

The valve seat may be disc-mounted or body-mounted. Seat design may be metal-to-metal seal or soft seal using elastomers or plastics against metal. Stainless steel or nickel-copper alloy seating surfaces are recommended for frequently operated valves (more than once a month). Even though a desirable feature for any size valve, standard for rubber-seated butterfly valves requires that rubber seats be replaceable at the installation site for valves 30 inches and larger. Rubber seats should be resistant to microbiological attack and ozone attack. Provisions should be made for ease of maintenance, e.g., adjustment or replacement of seats, by providing proper access to the MOV.

Sealing in the fully closed position is achieved by intimate contact between the sealing surfaces on the disc and body. The most commonly used methods of effecting this intimate contact are described below.

1. Interference type seats : In interference type seats, sealing is achieved by elastically deforming the seat. The amount of interference is preset to ensure sealing under the design differential pressure. In the elastomer-lined body design in which the liner also acts as the interference type seat. This is the most commonly used design in symmetric disc butterfly valves. Figure 7.9a and 7.9b show the adjustable type and lip type variation of the interference

seat designs, respectively. The adjustable type seat design requires a controlled magnitude of torque (specified by the valve manufacturer) on the seat retainer ring adjustment screws. This seat design offers the advantage of being easily replaceable in the field.

2. Pressure-energized or self-energized type seats : In pressure-energized type seats, the line differential pressure at the fully closed position is used to generate intimate contact between the seat and its mating surface. Figures 7.9c and 7.9d show two commonly used designs of pressure-energized seats. The seal ring is typically made of reinforced Teflon or other composite plastic material and has a shape that permits the upstream high pressure fluid to increase the contact pressure at the sealing interface. Figure 7.9d shows a pressure-energized metal seat design that provides a tight shut-off and meets the fire safe sealing requirements.

3. Inflatable type seat : In inflatable type seat designs, external pressure is applied to the resilient seat member after seating and removed before unseating the disc. Figure 7.10 shows an inflatable type elastomer seat design for a symmetric disc valve.

   Increase in seating/unseating torque. Valve manufacturers provide recommendations for the seat replacements frequency to ensure satisfactory seal performance.

   The valve seat design or the actuator torque requirements indictate a preferred flow direction for the valve. The shaft upstream (seat ring downstream) is the preferred direction from a sealing standpoint because elastic deflections due to the differential pressure across the disc tend to close up the clearances between the disc and seat mating surfaces, thus providing a tighter seal. The shaft downstream direction exhibits lower dynamic torque and is the preferred direction from an actuator size standpoint.

7.6 CHARACTERISTIC CURVE FOR BUTTERFLY VALVE

7.6.1 Flow Characteristic Curve

Fig. 7.12 indicate flow characteristic of the "swing-thru" butterfly valve which is shown by a plot of Percent of Maximum Flow versus Valve Travel (valve opening). (A "swing-thru" valve is one in which the disc could rotate through 360^0 but this is prevented from happening by either actuator travel or external travel stops on the body.)

Note that 100% flow is shown at the 60^0 opening since it is a general practice to size butterfly control valves at this angle of opening. Note also that beyond 60^0

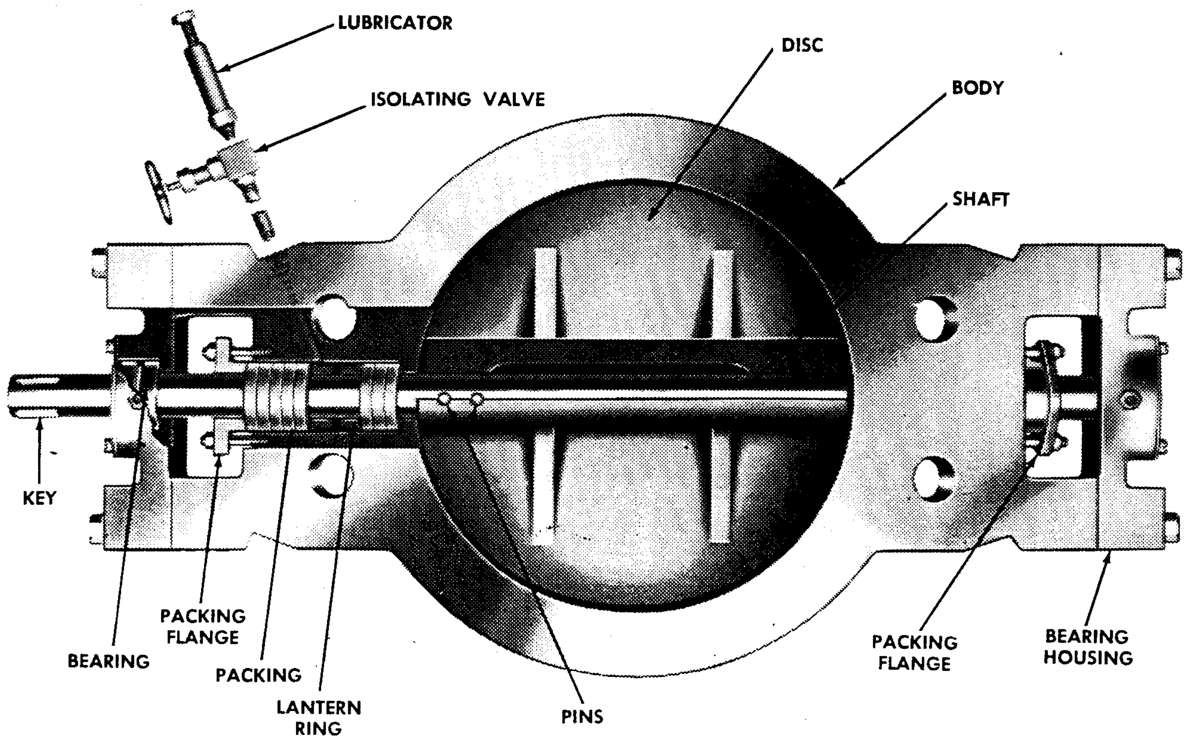


Fig. 7-11. Typical heavy pattern butterfly valve showing names of various parts.

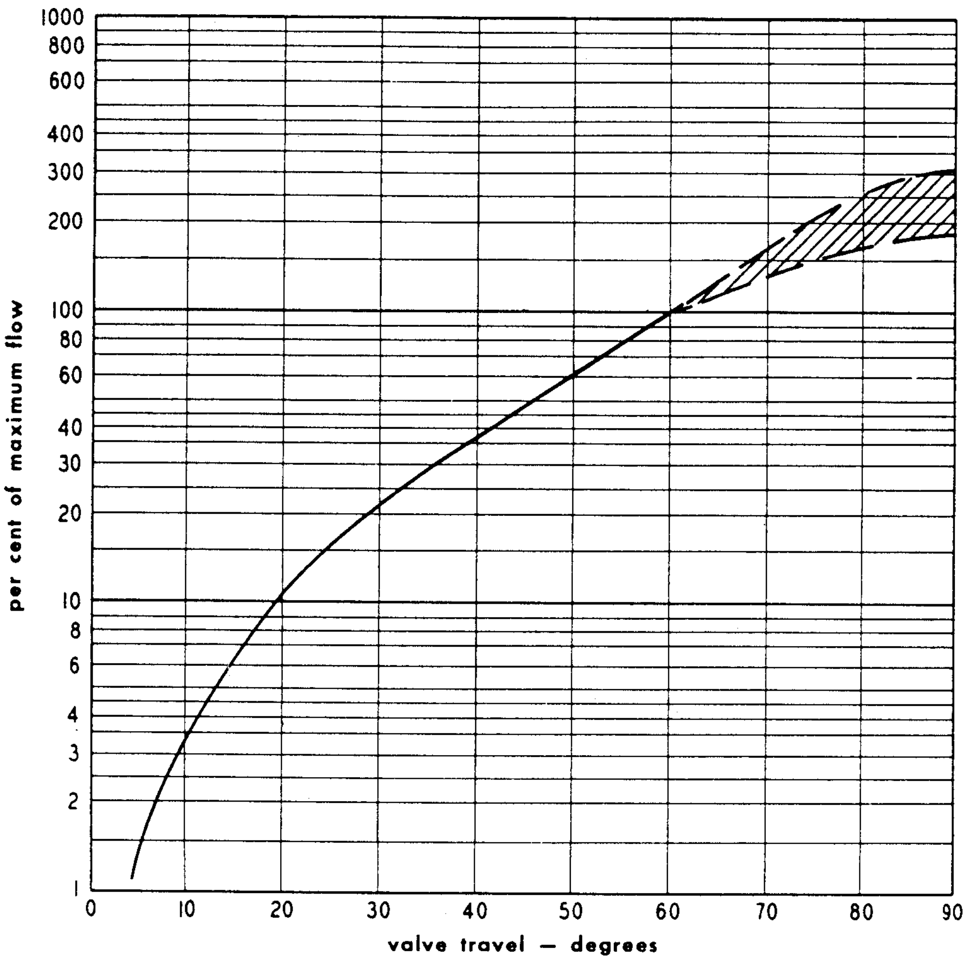


Fig. 7-12. Flow characteristic of a butterfly valve.

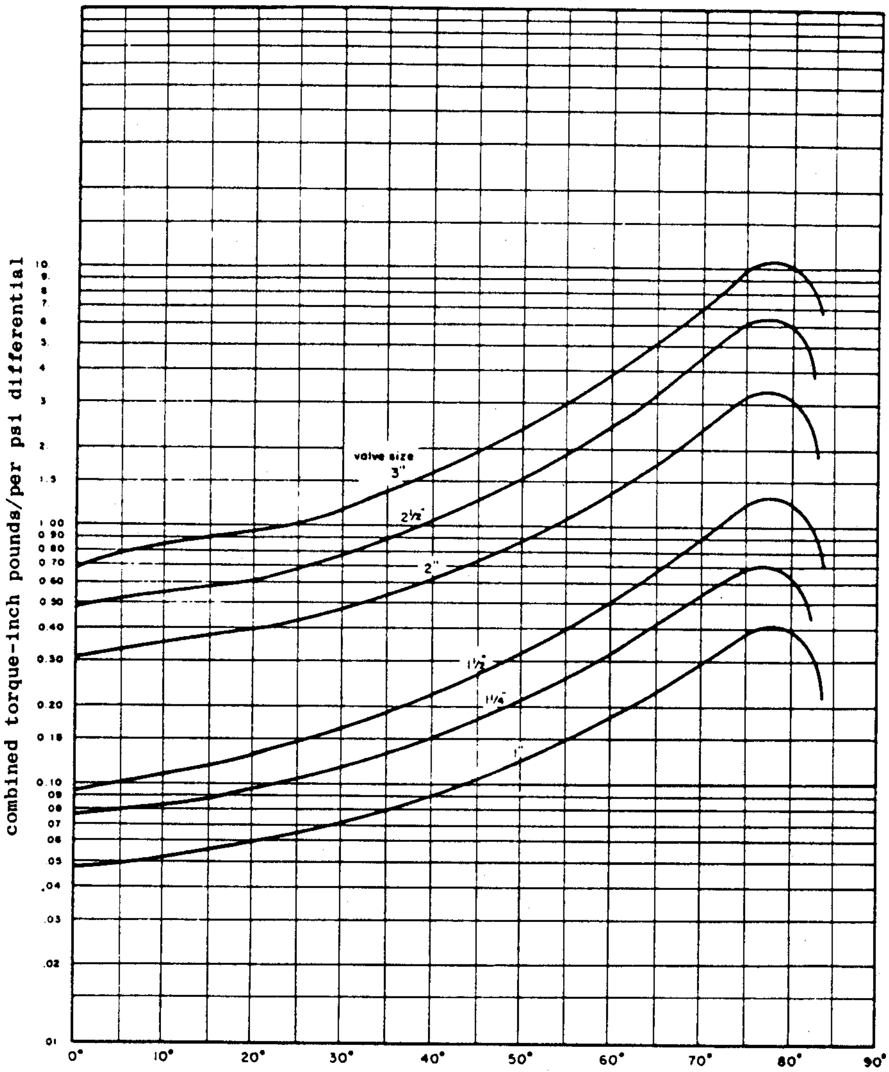


Fig. 7.13 - Combined torque curves for butterfly valves, size 1" through 3".

open, the curve is shaded. The reason for this is that a butterfly valve is designed around its main shaft. The diameter of the shaft will dictate the minimum thickness through the center or hub of the disc. This thickness also determines the maximum open area and it varies in proportion to the size and the class design of the valve. As the wings of the disc move to open position, they are gradually disappear. Butterfly valves are not recommended for good throttling control below 10^0 open since the change in percent of flow is much greater than an equal change is disc travel. Above approximately 70^0 open, control of flow is also poor due to the eclipse of the wing behind the hub.

7.6.2 Combined torque chart

The curves in Figures 7.13, show the amount of torque required to operate various size butterfly valves for each psi of pressure differential. This torque is referred to as "combined torque" since it is a sum of the hydraulic and static torques. Hydraulic torque is the unbalance torque due to the dynamic forces of the fluid acting on the disc which tends to close the valve. Static torque is the frictional torque in packing and bearing which resist movement of the shaft in either direction. Since the "combined torque" from the curve is a direct function of the static pressure drop, the correct torque values are obtained by multiplying values from the curves by the actual static pressure differential for the desired disc angle. In all cases, the torque should be figured both for the closed position and the maximum required angle of opening. For throttling service, the maximum angle of opening should be 60^0. For 90^0 on-off service, the value of the torque curve at 78^0 should be used.

7.7 Installation, Operation and Maintenance

General installation procedures and care of valves prior to installation have been already discussed. Covered here are the specific items unique to butterfly valves.

Butterfly valves can be operated manually by lever (handle), handwheel or chainwheel. Figure 7.5 shows a lever actuator. A steel or ductile iron handle with a spring-loaded locking trigger is secured to the stem. The position indicator has increments for variable control between 0 to 90 degrees nonadjustable travel stops. Usually lever actuators are not recommended on valves above 10 to 12 inches in size because of the high torque required for operation.

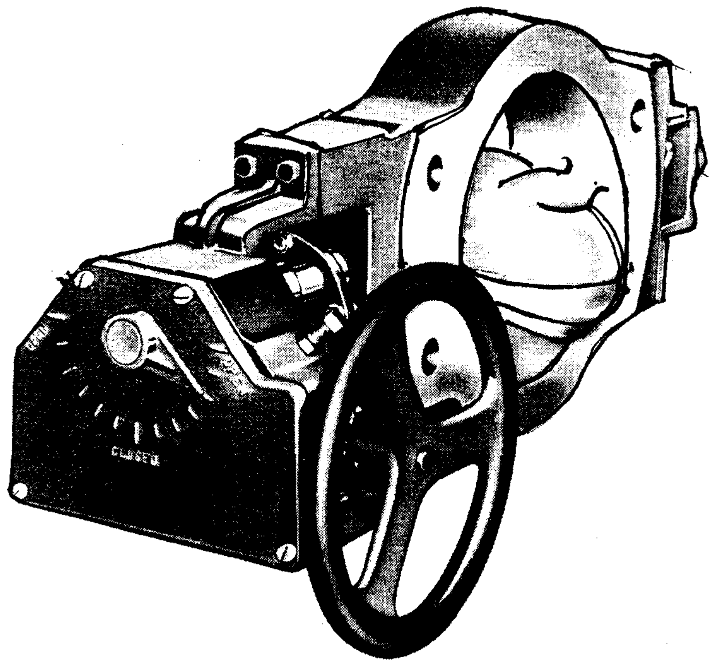


Fig. 7-14. Handwheel-actuated butterfly valve.

A handwheel actuator is shown Fig. 7.15. A totally enclosed screw and lever mechanism imparts handwheel movement to the butterfly valve disc for variable settings between full open and full closed positions. The disc position indicator consists of shaft mounted pointer and cast-in increment scale on housing cover plate. This type of actuation is recommended for high torque conditions and corrosive atmospheres. It should be noted that this type of actuator is self locking in any

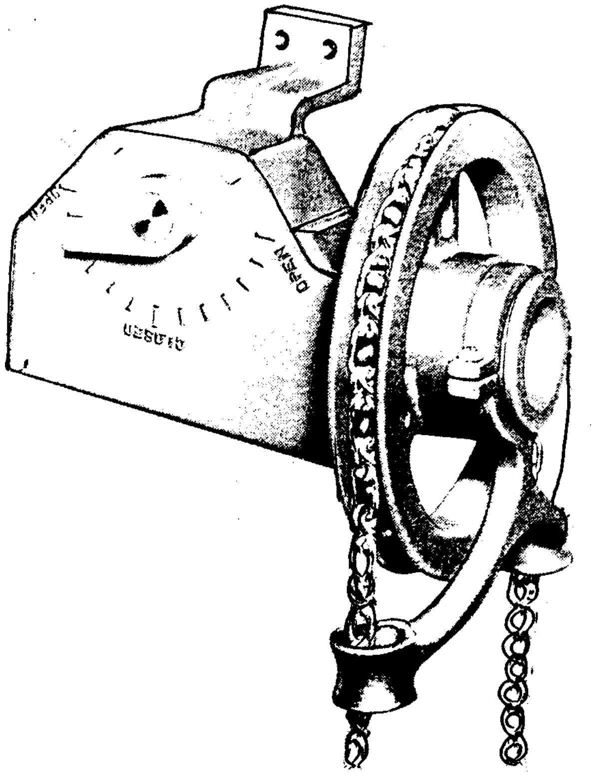


Fig. 7-15. Chainwheel-actuated butterfly valve.

position. Extensions handles and floor stand handwheels may also be used on these handwheel actuators.

Chainwheel actuators are modifications of the handwheel actuators in which the chainwheel operator has been incorporated into the assembly rather than using the handwheel itself. Such a unit is shown in Fig. 7.15.

In addition to manual operation, butterfly valves may also be operated by means of air or fluid power and electricity. Available for this type of operation are cylinder actuators, diaphragm actuators, piston P.O.P. actuators and electric actuators. These are shown in Fig. 7.16.

Operating torques required for specific valves and services should always be checked with the valve manufacturer before sizing the automatic operating accessory. Most manufacturers will supply the valve with the automatic operation if specified.

Care should be taken in planning the piping layout to allow sufficient room for operation of the handle (if lever-actuated).

Most butterfly valves are designed for installation between ANSI 150-pound flanges in schedule-40 piping systems. All flange types are permissible provided the inside diameter of the flange at the face does not differ significantly from the pipe inside diameter. Wall sections heavier or lighter than schedule 40 may require spacers in order to provide adequate disc clearance or support for the valve seat or liner.

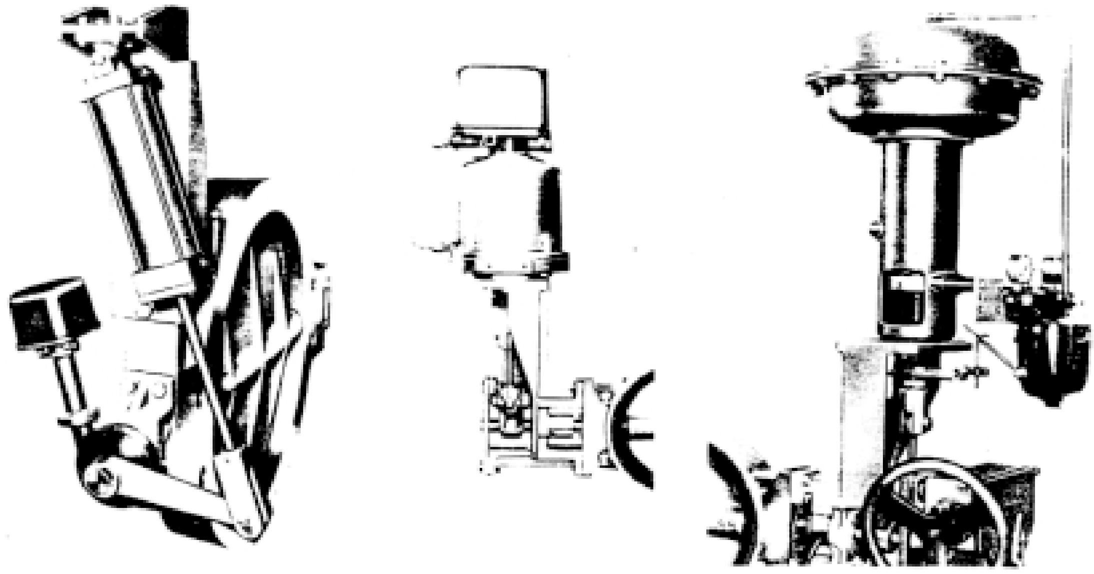


Fig. 7-16. Automatic actuators for butterfly valves.

Special care should be taken in checking these dimensions when a lined piping system is being used. Valve manufacturers can supply the dimensional limitations on pipe dimensions and the proper spacer dimensions. Spacers, when required, must be installed on both sides of the valve.

Gaskets are not normally required on valves having resilient seats since the elastomeric material which forms the valve liner usually forms a gasket on both flange faces. Gaskets may be used, and are recommended, for protection of the liner, where frequent disassembly of the associated piping may be required. Gaskets should be used when the valve is to be installed between smooth face (ground or rigid plastic) or glass-lined pipe flanges.

Valves should remain in the closed position during all handling and installation operations. This is necessary to protect the disc edge or sealing surface from nicks and scratches. Such damage would impair the bubble-tight seal of the valve.

Care should also be taken to protect the valve liner from damage during handling. Severe scratches or damage to the liner may not be overcome by the flange pressure, making a gasket seal impossible. When slipping the valve between flanges, it is very important that the liner not be allowed to catch on the pipe I.D. and fold over. This will cause flange leakage and severe damage to the liner.

When tightening flange bolts, normal wrench torques may be used without fear of damage to the valve or liner.

After the valve has been installed between flanges and all flange bolts have been tightened, slowly turn the disc and check for freedom of disc movement.

If the valve is to be removed from the pipe line for any reason, the valve should be closed before the flange bolts are loosened and remain closed until removed from the pipeline. Do not run sharp instruments between the valve and the liner or between the liner and the pipe flanges. This practice will result in severe liner damage.

Adjustment

Adjustment of the valve disc to engage the seal properly is important for bubble tight shut-off. The means of making this adjustment varies between valve manufacturers and should be checked before an attempt is made to make any adjustment.

Normally butterfly valves do not require any maintenance other than checking to see that there is no stem leakage. If there is stem leakage it should be corrected as soon as possible. The steps to take will vary depending upon the style of stem seal and the manufacturer. Instructions should be followed which are supplied by the manufacturer.

7.8 BUTTERFLY VALVE SPECIFICATIONS

Specifications established for butterfly valves should include the following items :

- Type of body
  - A.Wafer
  - B. Lug Wafer
  - C. Flanged
  - D. Screwed
- Type of seat
  - A. Metal
  - B. Resilient
- Material of construction
  - A. Body
  - B. Disc
  - C. Seat
- Type of actuation
- Operating pressure
- Operating temperature

CHAPTER - 8

DIAPHRAGM VALVES

8.1 GENERAL

Diaphragm valves are particularly suited for the handling of corrosive fluids, sticky and/or viscous materials, fibrous slurries, sludges, etc. which require high purity and must remain free from contamination. The operating mechanism of a diaphragm valve is not exposed to the media within the pipeline. Sticky or viscous fluids cannot get into the bonnet to interfere with the operating mechanism. Many fluids that would clog, corrode or gum up the working parts of most other types of valves will pass through a diaphragm valve without causing problems. Conversely, lubricants used for the operating mechanism cannot contaminate the fluid being handled. There are no packing glands to maintain and there is no possibility of stem leakage.

Diaphragm valves can be used for on-off service and throttling service. There are two general body types :

a. Weir type (Saunders patent), which is the most widely used. It gives tight shut-off with relatively low thrust and a shorter stroke that reduces the flex required for diaphragm. Less flex increases diaphragm life. The valve body is widened at the weir to provide an opening area approaching the cross sectional area of pipe. The weir type is better throttling valve but has a limited range. Its throttling characteristics are essentially those of a quick-opening valve because of the large shut-off area along the seat.

b. Straight through type : It has same inside diameter and shape as the pipe. It is therefore, particularly suited for viscous substances, slurries and fibrous suspensions. It is limited by elastomers because the plastics now available are not sufficiently flexible to accommodate the long stroke.

8.2 SERVICE RECOMMENDATIONS

- Fully opened, fully closed or throttling service
- Handling of slurries, highly corrosive materials or materials to be protected from contamination.
- Service with low operating pressures.

8.3 CONSTRUCTION OF VALVE

Diaphragm valves are, in effect, simple “pinch clamp” valves. A resilient, flexible diaphragm is connected to a compressor by a stud molded into the diaphragm. The compressor in moved up and down by the valve stem. Thus the diaphragm is lifted high when the compressor is raised. As the compressor is lowered, the diaphragm is pressed tight against the body weir (in the weir-type valve) or the contoured bottom in the straight-through valve.

The major components of the diaphragm valve are the body, the diaphragm, and the stem and bonnet assembly. There are no seats as such in a diaphragm valve since the body itself acts as the seat.

Body

Of the two the weir type is the most widely used, primarily because of the wider range of diaphragm materials available.

Bodies are available in an extremely wide range of materials of construction, including lined constructions. Table 8.1 shows the materials in which the bodies of diaphragm valves may be had .

Table 8.1 Body Materials for Diaphragm Valves

	METALLIC BODIES	
Cast iron	Alloy 20	Aluminium
Cast steel	Bronze	Leaded red brass
Stainless steel	Ductile Iron	Titanium
Hastelloy A,B,C	Monel	
	SOLID PLASTIC BODIES	
Polyvinylchloride	Polyvinylidene	Chlorinated polyethene
(PVC)	(Saran)	(Penton)
Polypropylene	Blue asbestos reinforced epoxy	Blue asbestos reinforced phenolic
	(Chemtite EB)	(Chemtite PB)
Vinylidene fluoride	ABS	
	LINED BODIES	
Hard natural rubber	Soft natural rubber	Chlorinated polyethene
Glass	Lead	(Penton)
Polyvinyl chloride	Polyvinylidene chloride	Heresite
(PVC)	(Saran)	Polypropylene
Lithcote	Porcelain	Fluorinated ethylene
Butyl	Titanium	propylene (FEP)
	Buna-N	Ethylene propylene (EPT)
		Neoprene

Table 8.2 Diaphragm Materials

Valve Type	Material	Temperature Range, ^0F Min.	Max.
Weir	Soft natural rubber	-30	180
	Natural rubber	-30	180
	White natural rubber	0	160
	Pure gum rubber	-30	160
	Neoprene	-30	200
	Hi-temp black butyl	-20	250
	Hi-temp white butyl	-10	225
	Black tygon	0	150
	Clear tygon	0	150
	TFE	-30	350
	Kel-F	60	250
	Polyethylene	10	135
	Ethylene propylene copolymer	-60	300
	Viton	-20	350
Straight way	Natural rubber	-30	180
	Neoprene	0	180
	Hycar (Buna-N)	10	180
	Hi-temp black butyl	0	225
	Hi-temp white butyl	0	200

Operating temperature depending on its corrosion resistance. This should be checked from a corrosion table.

Stem and Bonnet Assembly

Diaphragm valves are available with indicating and non indicating stem assemblies. Stems in diaphragm valves do not rotate. The handwheel rotates a stem bushing which engages the stem threads moving the stem up and down, raising and lowering the compressor which is pinned to the stem. The diaphragm in turn is secured to the compressor.

The indicating stem valve is identical to the non indicating stem valve except that a longer stem is provided to extend up through the handwheel. See Fig. 8.1

A quick opening bonnet, with lever operation, is also available. This bonnet is interchangeable with the standard bonnet on conventional.

Diaphragms

Just as there is a wide choice of body materials there is also a wide choice of available diaphragm materials. Diaphragm life depends not only upon the nature of the material handled but also upon the temperature, pressure and frequency of operation. In screw arrangement diaphragms are molded with a stud in the center which is used for connection to the compressor or the valve stem. This imparts the flexing motion to the diaphragm as the valve stem is raised and lowered.

When plastic diaphragms such as TFE or Kel-F are used, a special compressor assembly is necessary because of the mechanical properties of these plastics. Table 8.2 shows the diaphragm materials available.

Some elastomeric diaphragm materials may be unique in their excellent resistance to certain chemicals at high temperatures. However, the mechanical properties of any elastomeric material will be lowered at the higher temperature with possible destruction of the diaphragm at high pressures. Consequently, the manufacturer should be consulted for his recommendation of allowable operating pressures when the operating temperature is above ambient.

All elastomeric materials operate best below 150^0 F, though some will function at higher temperatures. Viton, for example, is noted for its excellent chemical resistance and stability at high temperatures. However, when fabricated into a diaphragm, Viton is subject to lowered tensile strength just as any other elastomeric material would be at elevated temperatures, and in the case of Viton, temperatures may be reached where the bond strength would become critical.

Fluid concentrations will also affect the diaphragm selection. Many of the diaphragm materials exhibit satisfactory corrosion resistance to certain corrodents up to a specific concentration and/or temperature. The elastomer may have a maximum

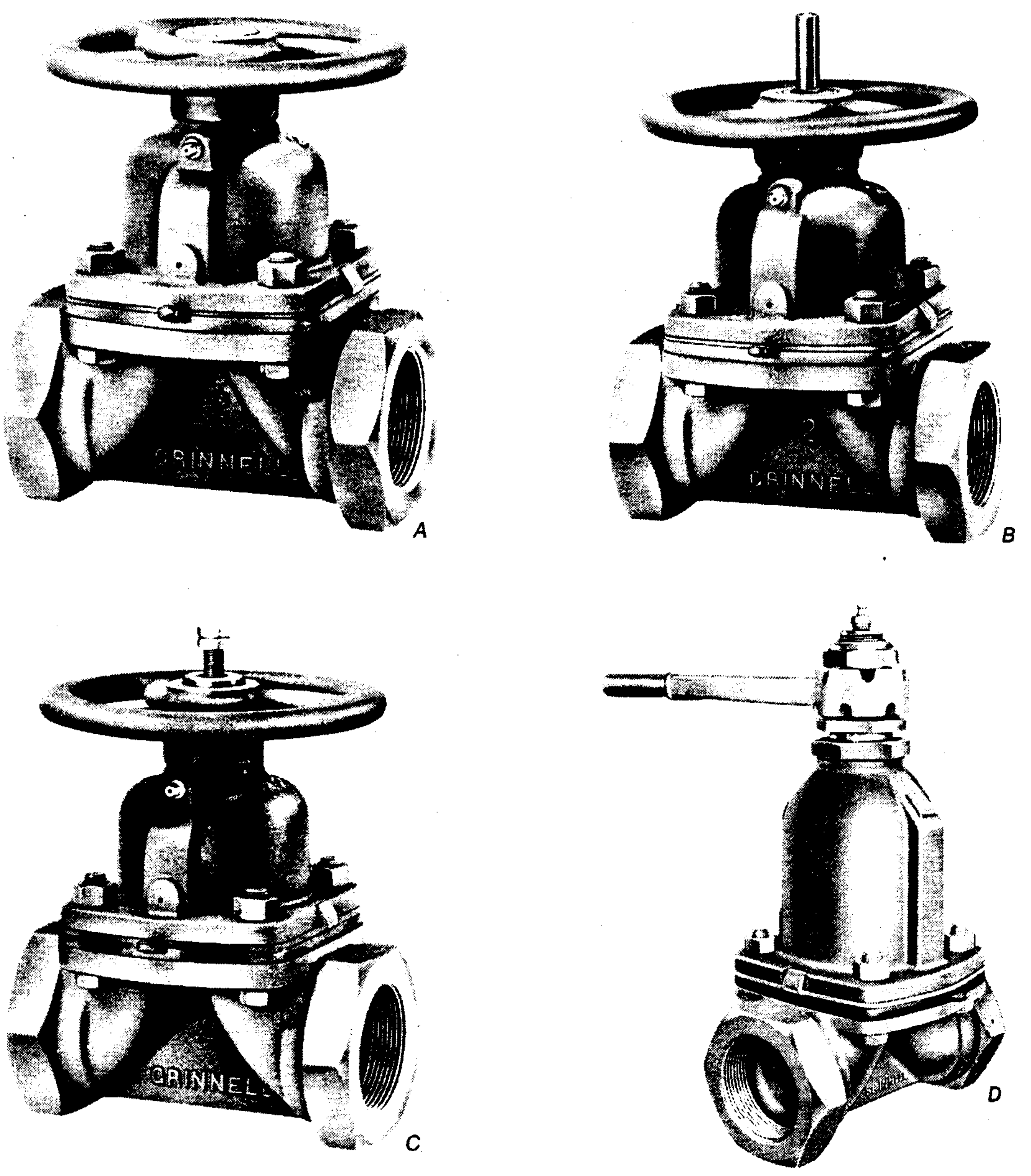


Fig. 8-1. Diaphragm valve stem assemblies :A. Nonindicating stem; B. indicating stem; C. travel stop and indicating stem; D. lever operated.

temperature limitation based on mechanical properties which could be in excess of the allowable weir-type bodies. A 90-degree turn of the lever moves the diaphragm form full open to full closed.

Many diaphragm valves are used in vacuum service. Standard bonnet construction can be employed in vacuum service on valves through 4 inches in size. On valves 6 inches and larger a sealed bonnet should be employed and evacuated. This is recommended to guard against premature diaphragm failure.

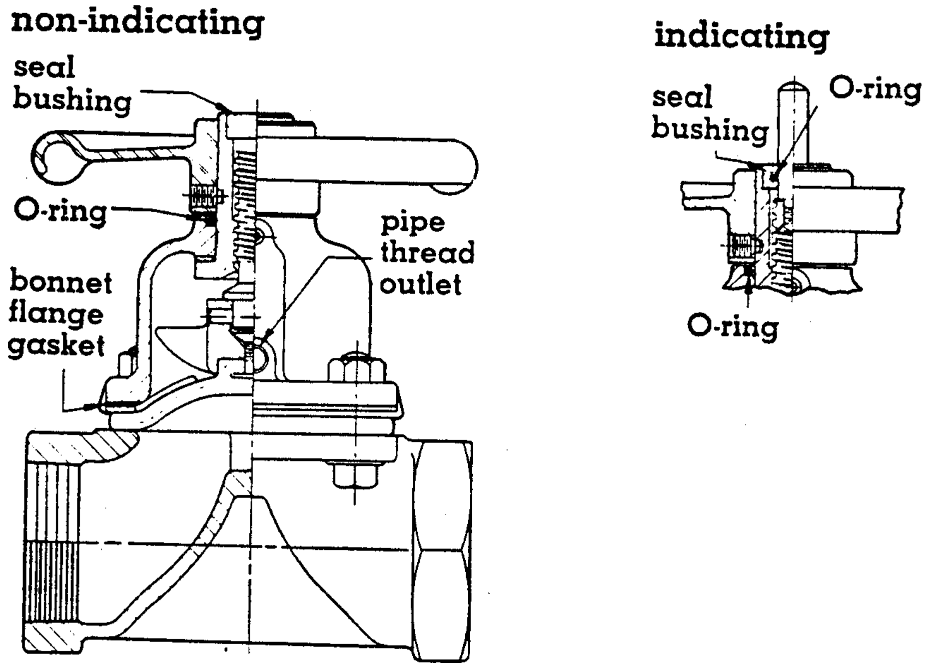


Fig. 8-2. Sealed bonnet construction.

Sealed bonnets are supplied with a seal bushing on the non indicating types and a seal bushing plus O-ring on the indicating types. Construction is shown in Fig.8.2.

This design of bonnet is also recommended for valves that are handling dangerous liquids and gases. In the event of a diaphragm failure the hazardous materials will not be released to the atmosphere. If the materials being handled are extremely hazardous, it is recommended that a means be provided to permit a safe disposal of the corrodents from the bonnet.

Diaphragm valves may also be equipped with chain wheel operators, extended stems, bevel gear operators and air or hydraulic operators.

8.4 IDENTIFICATIONS OF PARTS

The nomenclature and identification of the components and parts of the diaphragm valves are shown in Fig. 8.3.

8.5 INSTALLATION, OPERATION AND MAINTENANCE

General installation procedures and care of valves prior to installation have been already discussed. Covered here are the specific items unique to diaphragm valves.

When a diaphragm valve is used as an "unloading" valve (working pressure upstream and atmospheric or low pressure downstream), operation of the handwheel is relatively easy. On a "live line" application, where the back pressure on the valve is high, the valve becomes very difficult to operate, because of the thrust developed

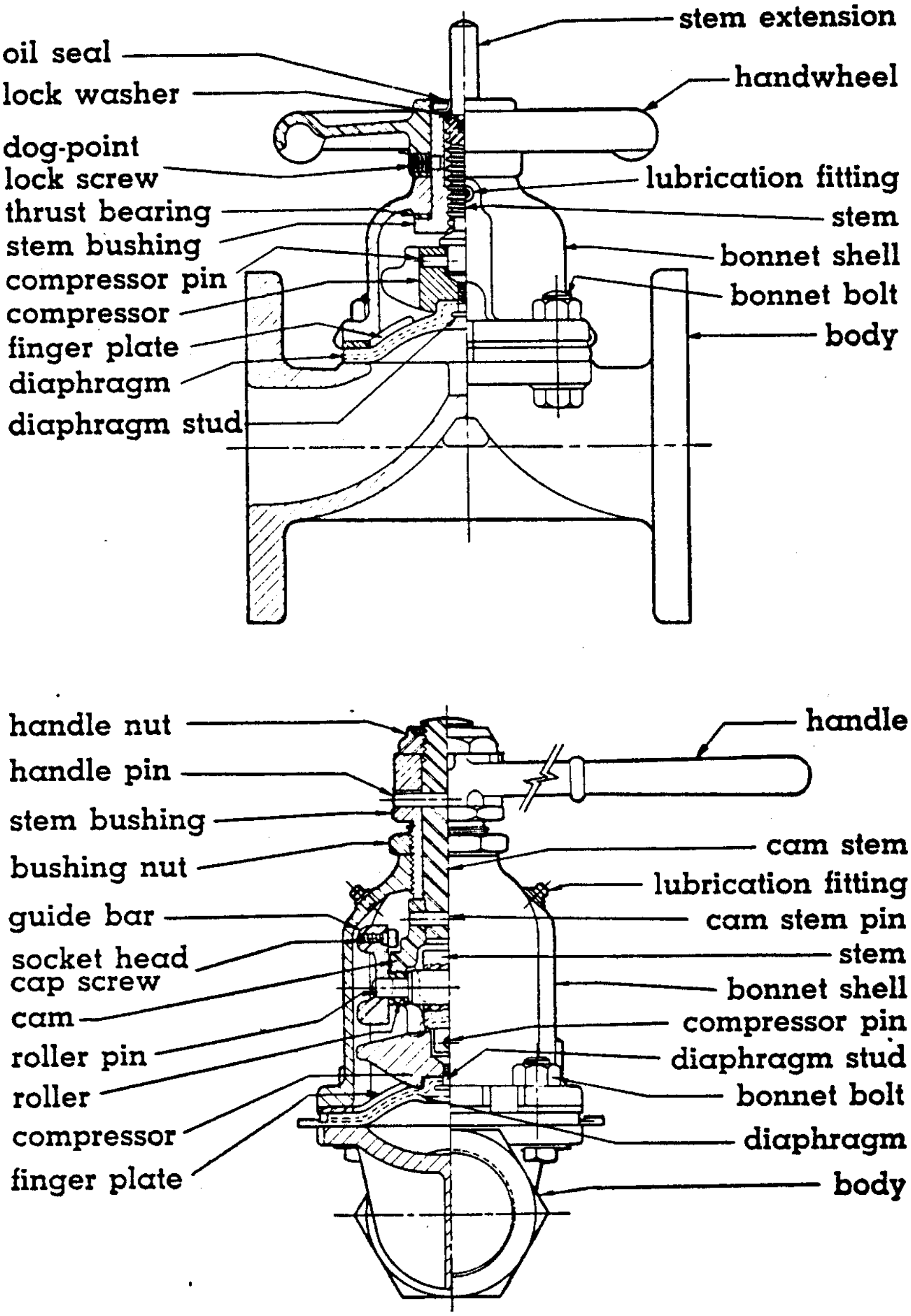


Fig. 8-3. Identification of diaphragm valve parts.

by the pressure acting over the entire diaphragm surface, which tends to reduce diaphragm life.

For larger valves where one man operation is required, the valve should be furnished with a manual gear operator. Under live-line closure, the diaphragm is being excessively worked, resulting in shortened diaphragm life.

The diaphragm valve is a "positive" displacement valve, which displaces a volume of fluid equal to that volume swept by the diaphragm by closure. If the valve is in a portion of the line with valves shut off on both sides of the diaphragm valve, it is impossible to close the valve without damage. If this condition is not avoided through proper piping, and provisions made to prevent the condition, an operator may inadvertently apply a pipe wrench to the valve handwheel. As a result, the excessive internal pressure increases to a point where the diaphragm will rupture, or the compressor pin, stem or sleeve may shear or bind. This possibility must be given particular thought where the valve utilizes solid plastic diaphragms in service, since the solid plastic diaphragms are limited in pressure rating and are more susceptible to failure from this type of abuse.

It is not necessary to apply bars, wrenches, "cheaters" or other aids in closing a diaphragm valve. A diaphragm valve is inherently a soft seating valve, and it is not necessary to grind hard, metal-to-metal seats together under peak torque in order to secure closure. In fact, the opposite is true, in that the resilient diaphragm is specifically designed for ease of seating to give satisfactory closure and to promote diaphragm life.

In many cases an operator will apply torques far in excess of those required to effect valve closure. This results in shortened diaphragm life and unnecessary expenses incurred in premature diaphragm replacements. If operating personnel are not familiar with diaphragm valves, or if they tend to be heavy handed in applying torques, the incorporation of travel stops is recommended during valve closure. These adjustable metal-to-metal travel stops, an optional feature available from the valve manufacturers, prevent the application of excessive torque on diaphragm closures.

Diaphragm valves are frequently used on services where a highly corrosive atmosphere is encountered. To resist atmospheric attack on the cast iron bonnets and handwheels, these parts are available with various protective coatings. The small extra cost for these coatings will be quickly recovered on savings over frequent paint maintenance that normally is required and/or bonnet replacements if a continuing preventative maintenance program is not conducted.

In some applications the atmosphere may be particularly corrosive, which results in attack of the exterior and interior of the bonnet assembly, as well as on the valve lubricant. In such cases the bonnet assembly must be frequently maintained and lubricated. Alternatively, it is possible to specify plastic-coated or stainless steel stems and sleeves. Such special bonnet assemblies can be lubricated with chemically inert grease such as the silicone lubricants or fluorocarbon lubricants.

Despite the fact that the diaphragm valve has an upstanding weir, it can be effectively drained for all intents and purposes if the valve is mounted so that the angle between the center line of the stem and the horizon is 15 to 18 degrees positive, depending upon the valve manufacturer. This brings the side tip of the weir down to a point where it nearly coincides with the floor of the pipe. At this point there is retained, at the most, 1 or 2 cubic centimeters of fluid. Alternatively, where installation will permit, the valve can be installed vertically, where it will drain, except for fluid that has wetted the valve surfaces because of liquid surface tension.

Pressure grease fittings are supplied on diaphragm valve bonnets. It is recommended that a regular program of lubrication, four times a year, be carried out. It is important that valve bonnets be kept greased and in good working order to prevent the handwheel or sleeve assembly from "freezing". Such freezing may lead to the inadvertent application of large over-torque by the use of wrenches to operate the valve. This could result in broken bonnet flanges, broken handwheels, or seized stem and sleeve. Grease should be applied sparingly to keep the back of the diaphragm free of grease. Most elastomeric materials and polyethylene may be adversely affected by grease.

Only one part, the diaphragm, is normally subject to wear and needs replacement. Depending upon the type of service, it may last indefinitely.

If it is necessary to replace the diaphragm, the following steps should be followed :

Weir-Type Valves

- Remove bonnet bolts and lift valve bonnet off body.
- Remove diaphragm from compressor. (Follow manufacturer's instruction.)
- Install new diaphragm. (Follow manufacturer's instructions.)
- Replace bonnet on body and tighten bolts hand tight.
- Close valve fully, back off one-quarter turn of handwheel, then tighten bolts with wrench.
- Open valve and if necessary retighten bonnet bolts.

Straightway Valves

- Remove bonnet bolts and lift bonnet off body.
- Remove diaphragm from compressor. (Follow manufacturer's instruction.)
- Install new diaphragm. (Follow manufacturer's instructions.)
- With compressor holding diaphragm in slightly open position (one or two turns open from molded position), replace complete bonnet and tighten bolts securely.

8.6 DIAPHRAGM VALVE SPECIFICATIONS

A diaphragm valve specification should include the following items :

1. Body material
2. Diaphragm material
3. End connections
4. Type of stem assembly
   A. Non indicating
   B. Indicating
5. Type of bonnet assembly
6. Type of operation
7. Operating pressure
8. Operating temperature.

CHAPTER - 9

CHECK VALVES

9.1 GENERAL

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 the foregoing.

Basic styles of check valves have been designed for use with specific types of flow control valves, but do not necessarily have to be used with the corresponding flow control valve. When used with the corresponding flow control valve, the effect on flow of the check valve will be very similar to the effect on flow of the corresponding flow control valve.

The general types of check valves are :

- Swing check valve
  - A. Y-pattern
  - B. Straight-through pattern
- Tilting-disc check valve
- Lift check valve
- Piston check valve
- Butterfly check valve
- Spring-loaded check valve
- Foot valve
- Stop check valve

Some check valves have been designed for specific applications, not necessarily related in any way to flow control valves. These conditions will be discussed under the heading of each specific valve. Table 9.1 lists the types of check valves and the corresponding style of flow control valve with which it is normally used.

Table 9.1 Check Valve — Flow Control Valve Combinations

Type of Check Valve	Flow Control Valve Normally Used with :
Swing Check	Gate; Y-Pattern; Plug; Ball; Diaphragm
Tilting Disc	Gate; Y-Pattern; Plug; Ball; Diaphragm; Pinch
Lift Check	Globe, Angle
Piston Check	Globe, Angle
Butterfly Check	Butterfly; Plug; Ball; Diaphragm; Pinch
Spring Loaded*	Globe, Angle
Foot Valve	See note
Stop Check	See note

* These valves are designed for specific applications.

The considerations given to the selection of the check valve are very similar to the considerations given to the selection of a flow control valve. An analysis of the features of each check valve indicates a parallelism to the analysis of the features of a particular flow control valve which permits the formulation of the corresponding recommendations found in Table 9.1.

The size ranges and operating ranges of the different types of check valves are summarized in Table 9.2. The ranges shown are average and will vary among manufacturers. Maximum figures shown may not be attainable in all sizes and in all materials of construction.

9.2 GENERAL INSTALLATION AND MAINTENANCE

The general procedure for the care of valves prior to installation, has been already discussed, applies to check valves.

When installing check valves, make sure that all pipe strains are kept off the valves. The valves should not carry the weight of the line. Distortion from this cause results in inefficient operation and early maintenance. If the valve is of flanged construction it will be difficult to tighten the flanges properly. Piping should be supported by hangers placed on either side of the valve to take up the weight. Large heavy valves should be supported independently of the piping system so as not to induce a stress into the piping system.

Table 9.2. Sizes and Operating Ranges of Check Valves

Check Valve	Size, Inches		Operating Ranges Temp., ^0F		Operating Ranges Pressure, Psig	
	Min.	Max.	Min.	Max.	Min.	Max.
Swing Check						
Y-Pattern	1/4	6	0	1250	0	2500
Straight Through	1/4	24	0	1250	0	2500
Tilting Disc	2	30	-450	1100	0	1400
Lift Check	1/4	10	0	1250	0	2500
Butterfly Check	1	72	0	500	0	1200
Spring Loaded	1	24	0	500	0	2500

Threaded-End Valves

Avoid undersize threads on the section of pipe on which the valve is to be installed. If the threaded section of pipe is too small, the pipe, when screwed into the valve to make a tight connection, may strike the seat and distort it so that the disc will not seat properly. Undersize threads on the pipe also make it impossible to get a tight joint. Safe practice is to cut threads to standard dimensions and standard tolerances. All pipe threads in valve bodies are gauged to standard tolerances.

Paint, grease, or joint-sealing compound should be applied only to the pipe (male) threads — not on the threads of the valve body. This reduces the chances of the paint, grease or compound getting on the seat or other inner working parts of the valve to cause future trouble.

When installing screwed end valves always use the correct size wrenches with flat jaws (not pipe wrenches). By so doing there is less likelihood of the valve's being distorted or damaged. Also, the wrench should be used on the pipe side of the valve to minimize the chance of distorting the valve body. This is particularly important when the valve is constructed of a malleable material, such as bronze.

Flanged-End Valves

When installing flanged-end valves, tighten the flange bolts by pulling down the nuts diametrically opposite each other. All bolts should be pulled down gradually to a uniform tightness. Make all bolts finger tight first, then take three or four turns with a wrench on bolt number 1. Apply the same number of turns on each bolt, following the order. Repeat the procedure as many times as required until the joint is tight. Uniform stress across the entire cross section of the flange eliminates a leaky gasket.

Socket-Weld End and Butt-Weld End Valves

The procedures for installing these check valves are the same as for installing the corresponding flow control valve as discussed in individual topics.

9.2 TYPES OF CHECK VALVE

9.2.1 SWING CHECK VALVES

General

Swing check valves allow full unobstructed flow, opening with line pressure and automatically closing as pressure decreases, being fully closed when the line pressure reaches zero and thus preventing back flow. Turbulence and pressure drop within the valve are very low. Consequently, this style of check valve is normally recommended for use in systems employing gate valves.

Swing check valves can be installed in a horizontal line or vertical line with flow upward. In all cases the check valve must be installed with the flow pressure under the disc.

Service Recommendations

- For minimum resistance to flow
- For liquid service (low velocities)
- For infrequent change of direction
- For service in lines using gate valves.

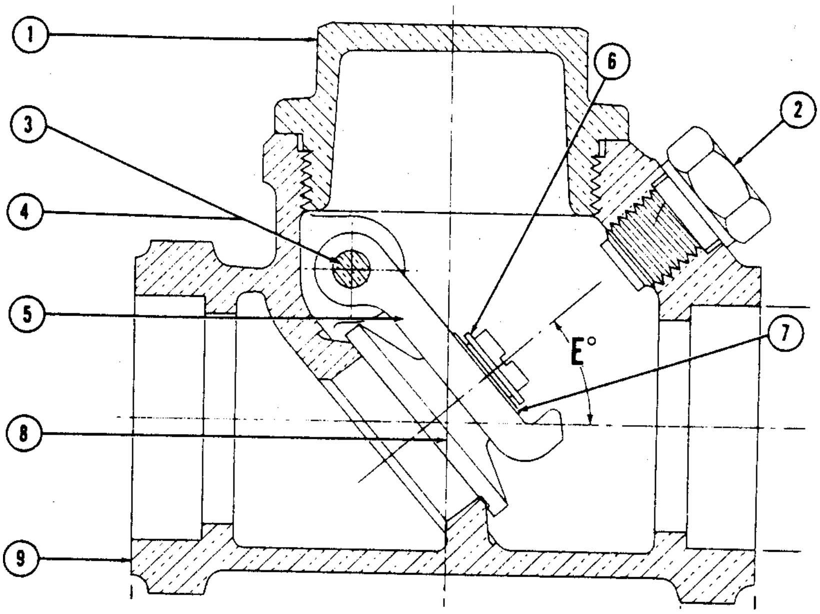
Construction of Valve

Swing check valves are available in either a Y-pattern or straight through body design. In either style the disc and hinge are suspended from the body by means of a hinge pin. Seating is either metal-to-metal or metal seat and composition disc. Composition discs are usually recommended for services where dirt or other particles may be present in the fluid, where noise is objectionable, or where positive shut-off at low pressure is required.

Y-pattern check valves are designed with an access opening in line with the seat, which is integral with the body. (Refer to Fig.9.1) This permits the disc to be rotated with a screwdriver to regrind the seating surfaces (on metal-to-metal seated valves) without removing the valve from the line.

Straight-through pattern check valves contain a disc that is hinged at the top (see Fig.9.2). The disc seals against the seat which is integral with the body. This type of check valve usually has replaceable seat rings. The seating surface is placed at a slight angle to permit easier opening at lower pressures, more positive sealing and less shock when closing under higher pressures.

When swing check valves are used in systems having frequent flow reversals, the valves may have a tendency to chatter. This can be corrected by equipping the valve with an outside lever and weight as shown in Fig. 9.3. The outside weight and lever serve a threefold purpose :

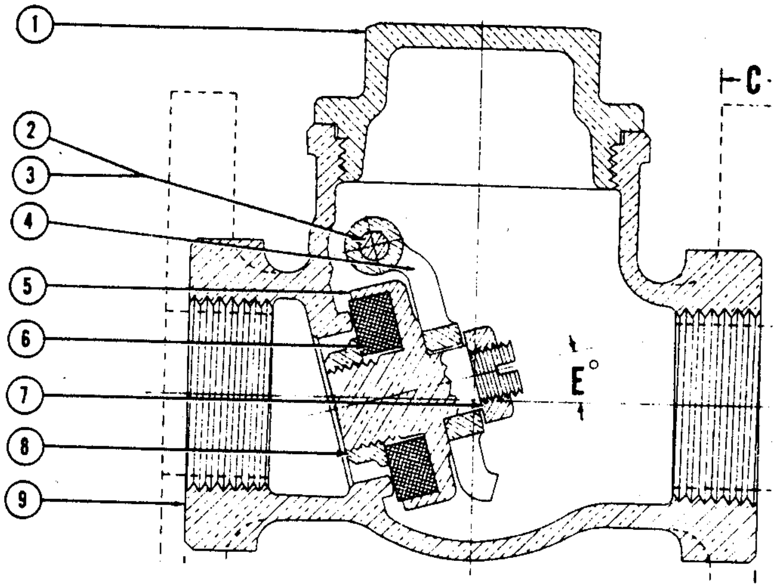


PART
1. CAP
2. STOP PLUG
3. SIDE PLUGS
4. HANGER PIN
5. HANGER
6. RETAINING RING
7. WASHER
8. DISC
9. BODY

Fig. 9-1. Y-pattern swing check valve.

- Weight is added to the disc for quicker closing against back flow, which prevents water hammer and excessive shock pressure.
- Check valve cannot open until desired pressure is reached.
- Operating sensitivity of the disc can be controlled.

When a check valve is operating properly there will normally be fluid trapped downstream of the valve. This is one purpose of installing a check valve. Such fluid can present a problem should maintenance have to be performed on the line, unless the fluid can be drained. To permit drainage of the line, most check valves can be supplied with a boss which may be drilled and tapped for a drain.



PART
1. CAP
2. SIDE PLUG
3. HANGER PIN
4. HANGER
5. DISC HOLDER
6. DISC
7. HANGER NUT
8. DISK NUT
9. BODY

Fig. 9-2. Straight-through swing check valve.

For use in vertical lines for upward flow

For use in horizontal lines.

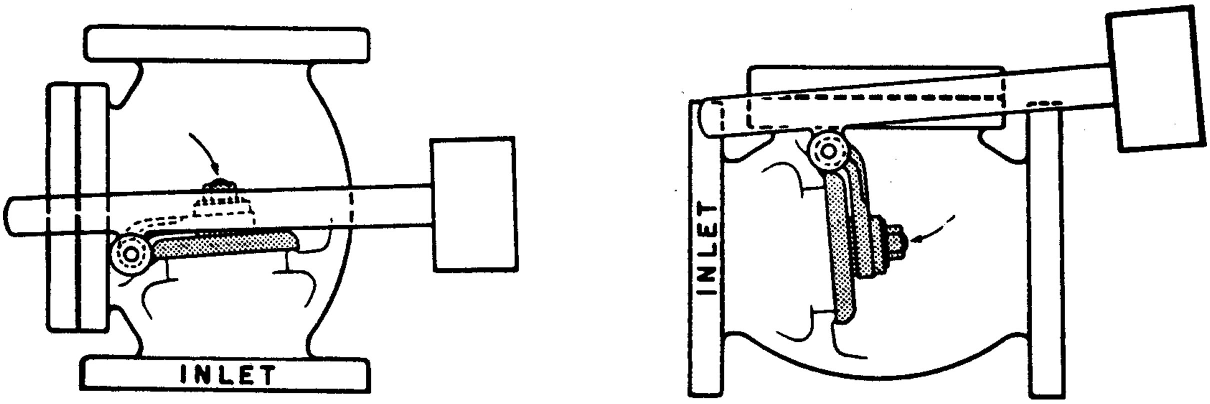


Fig. 9-3. Swing check valve with outside lever and weight. Right : Lever and weight are mounted to assist disc in closing.

Identification of Parts

The nomenclature and identification of the components and parts of swing check valves are shown in Fig.9.1 for the Y-pattern; in Fig. 9.2 for the straight-through pattern. Figure 9.3 illustrates the straight-through pattern with an outside lever and weight.

Available Materials of Construction

Swing check valves are available in a wide range of materials of construction. Included are the following body materials :

- Bronze
- All iron
- Cast iron
- Forged steel
- Monel
- Cast steel
- Stainless steel

Various trims are available, to meet the specific requirement.

Installation and Maintenance

Swing check valves are usually installed in a system having gate valves because they provide comparable free flow. They are recommended for lines having low velocity flow and should not be used on lines with pulsating flow when the continual flapping or pounding would be destructive to the seating elements. This condition can be partially corrected by utilizing an external lever and weight as described previously.

Swing checks should be installed in horizontal lines or in vertical lines having upward flow. Pressure should always be under the seat. Be careful when installing a swing check valve. If you examine a swing check valve, you will notice that it has a plug on each side. These two plugs are your guide to correct installation. They hold in place the hanger pin which permits the disc to swing. The direction of swing is upward from the end of the valve opposite the plugs. Therefore, when installing a swing check valve, connect the end to which the side plugs are nearest to the inlet flow so that the incoming fluid will open the valve and the reverse flow will close the valve. If a swing check valve is installed in reverse position it will stop the flow. Some swing check valves have an arrow cast on the body to indicate the direction of flow. If this is the situation, pay attention to the arrow and the valve will be installed correctly.

If a swing check valve fails to seal against reverse flow, check the seating surfaces. Make sure that the line has been completely drained before removing the valve bonnet. If the seat is damaged or scored, it should be reground, or replaced if it is of the seat ring design. Inspect the disc. If the disc is of the composition type, verify that the disc material is compatible with the fluids being handled. Replace the composition disc with the correct materials. Before reassembling the valve, clean the internal portions thoroughly, being careful to remove all grinding compounds that may have been used if the seat was reground.

Other general instruction to be followed as discussed earlier in previous chapters.

9.3 TILTING DISC CHECK VALVE

The tilting-disc check valve is similar to the swing check valve. Like the swing check, the tilting-disc type keeps fluid resistance and turbulence low because of its straight-through design.

Tilting-disc check valves can be installed in horizontal lines and vertical lines having upward flow. Some designs simply fit between two flange faces providing a compact, lightweight installation, particularly in the larger diameters.

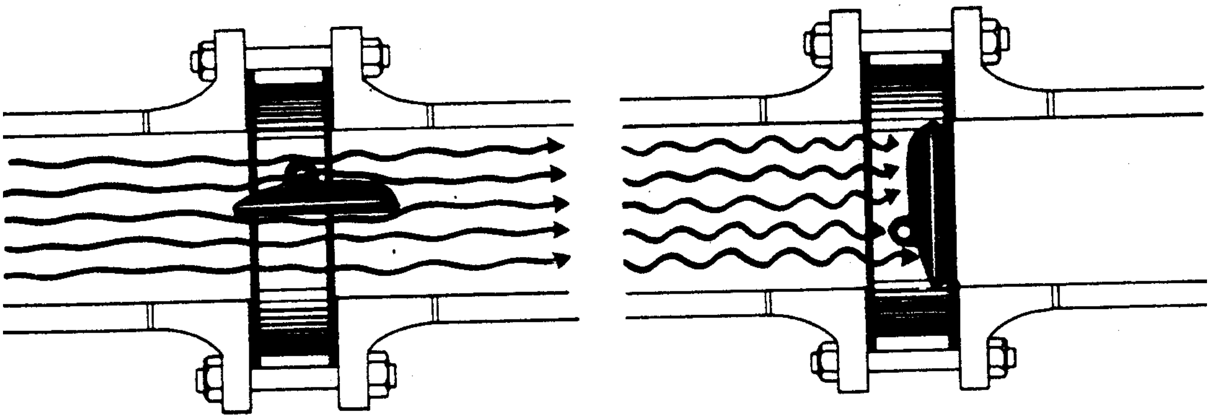
Service Recommendations

- For minimum resistance to flow
- For liquid or gas service
- For frequent change of direction
- For service in lines using gate valves.

Construction of Valve

The disc lifts off of the seat to open the valve. The airfoil design of the disc allows it to "float " on the flow. Disc stops built into the body position the disc for optimum flow characteristics. A large body cavity helps minimize flow restriction. As flow decreases, the disc starts closing and seals before reverse flow takes effect. Back pressure against the disc moves it across the soft seal into the metal seat for tight shut-off, without slamming. If the reverse flow pressure is insufficient to effect a seal the valve may be fitted with an external lever and weight. Figure 9.4 illustrates the operation of the tilting-disc check valve.

These valves are available with either a soft seal ring (of an elastomeric or plastic material) and metal seat seal; or a metal-to-metal seal. The latter is recommended for high-temperature operation. The soft seal rings are replaceable, but the valve must be removed from the line to make the replacement. The larger valves have an insert valve seat also.



Valve Open

The contoured disc lifts easily off the seat to open the valve. The airfoil design of the disc allows it to “float” on the flow. Rugged disc stops built into the body position the disc for optimum flow characteristics. Large body cavity helps minimize flow restriction. The valve functions smoothly and silently in both horizontal and vertical up-flow lines.

Valve Closed

The disc has definite design advantages. It is counterweighted, mounted eccentrically and spring-loaded. As flow decreases, the disc starts closing and seals before reverse flow takes effect. Back pressure against the disc moves it accross the soft seal into the metal seat for tight shutt off.

Fig. 9-4. Operation of tilting-disc check valve.

Identification of Parts

The nomenclature and identification of the components and parts of the tilting-disc check valve are shown in Fig. 9.5.

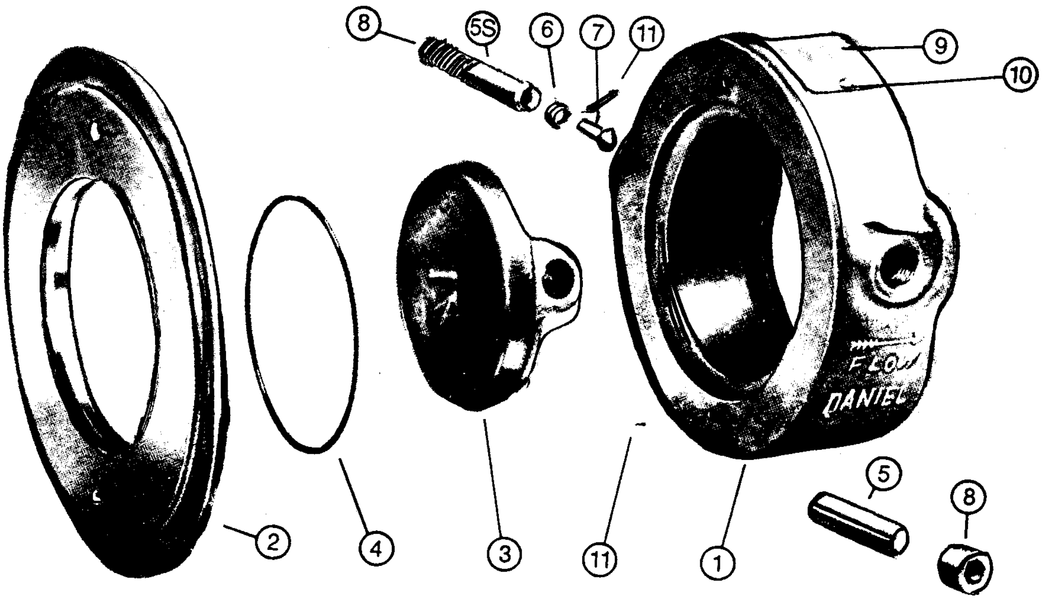


Fig. 9-5. Identification of parts of tilting-disc check valve : 1. Body, 2. seal housing, 3. disc, 4. soft seal, 5. hinge pin (without spring), 5S. hinge pin (slotted for spring), 6. spring, 7. spring retainer, 8. locking plug. 9. name plate, 10. name plate drive screw, 11. roll pin.

Available Materials of Construction

Tilting-disc check valves are available in the following materials of construction :

- Carbon steel
- Cast Iron
- Stainless Steel
- Aluminium
- Bronze.

Seal rings are available in Buna-N and TFE as standards, with other elastomeric materials available on order.

Installation and Maintenance

General installation instructions will be found on page 40.

Care should be taken when installing these valves that the inlet flow side is opposite the direction of the disc travel; otherwise the flow will be stopped. Arrows are usually cast on the body, and some valves have the word “inlet” cast on the inlet side of the disc.

These valves can be installed in horizontal lines or in vertical lines having upward flow.

If the valve is not sealing against reverse flow, drain the line, remove the valve and inspect the seal ring and the seat. If necessary, replace the seal ring, being sure that the material of construction of the seal ring is compatible with the materials being handled and the operating temperature.

9.4 LIFT CHECK VALVES

General

Lift check valves are commonly used in piping systems in which globe valves are being used as the flow control valve, since they have similar seating arrangements. Valves are available for installation in horizontal or vertical lines with upward flow.

They are recommended for use with steam, air, gas, water and on vapor lines with high flow velocities.

Service Recommendations

- For frequent change of directions
- For steam, gas or vapor service

- Composition disc for air service
- For use with globe and angle valves.

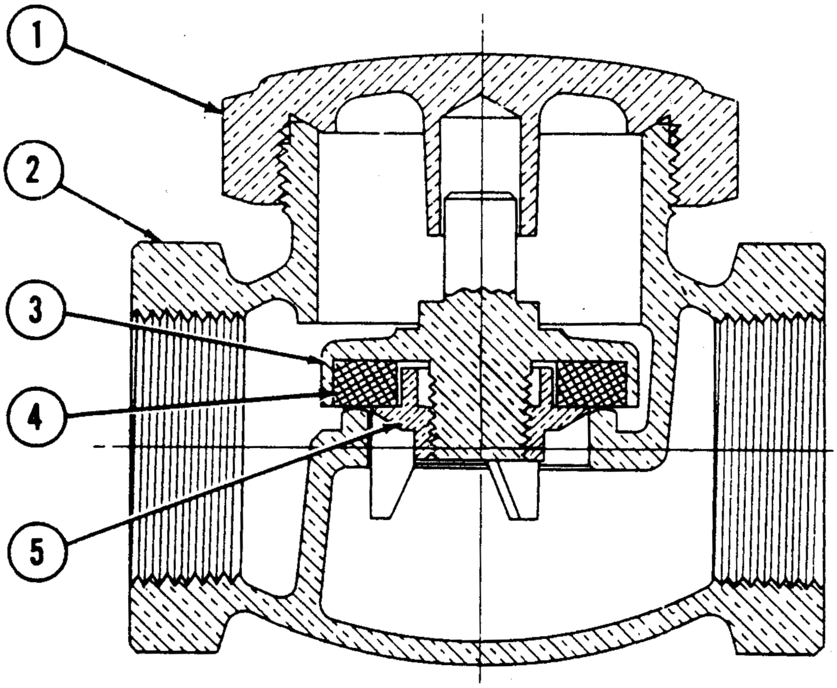
Construction of Valve

Lift check valves are available in three body patterns :

- Horizontal
- Angle
- Vertical.

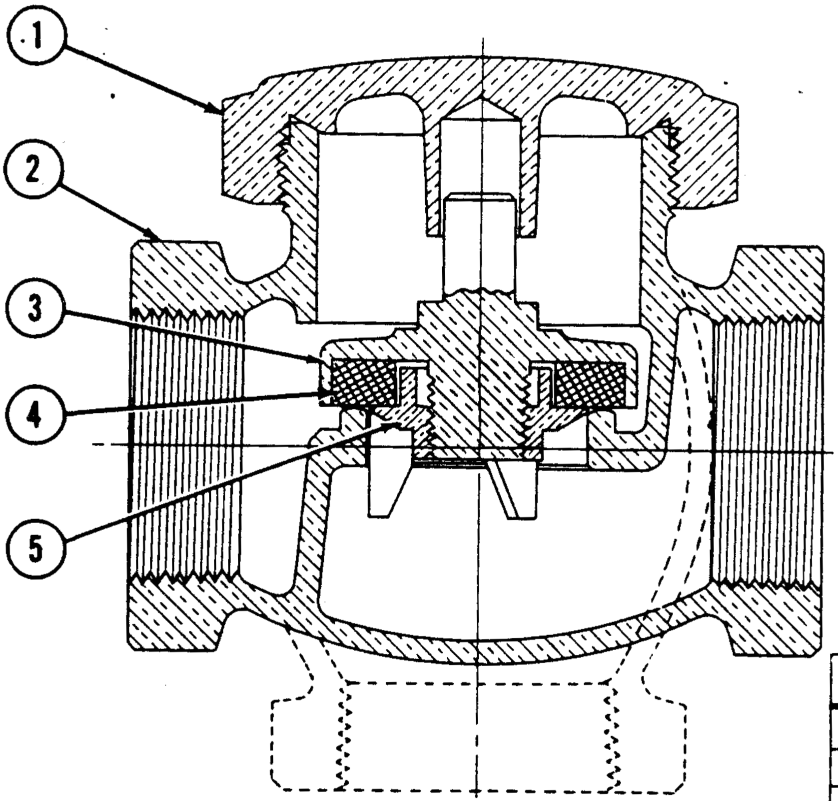
In design, the seat and disc configurations are very similar to the seat and disc configurations of globe valves, with the exception of the ball check valves which employ a ball as the disc. Flow to lift check valves must always enter below the seat. As the flow enters, the disc or ball is raised within guides from the seat by the pressure of the upward flow. When the flow stops or reverses, the disc or ball is forced onto the seat of the valve by both the backflow and gravity, effecting a seal. Some types of ball check valves may be installed horizontally. In this design the ball is suspended by a system of guide ribs. This type of check valve design is generally employed in all plastic check valves and/or impervious graphite check valves.

The seats of metallic body lift check valves are either integral with the body or contain renewable seat rings. Disc construction is similar to the disc construction of globe valves with either metal or composition discs. Metal disc and seat valves can be reground, the same as globe valves. Ball discs are generally recommended for the handling of viscous liquids.



PART
1 SCREW-OVER CAP
2 BODY
3 DISC HOLDER
4 DISC
5 DISC GUIDE NUT

Fig. 9.6 : Horizontal lift check valve.



PART
1 SCREW-OVER CAP
2 BODY
3 DISC HOLDER
4 DISC
5 DISC GUIDE NUT

Fig. 9-7. Angle lift check valve.

Identification of Parts

The nomenclature and identification of parts and components of lift check valves are illustrated in Fig. 9.6 for horizontal lift check valves, Fig. 9.7 for angle lift check valves, and Fig. 9.8 for vertical lift check valves.

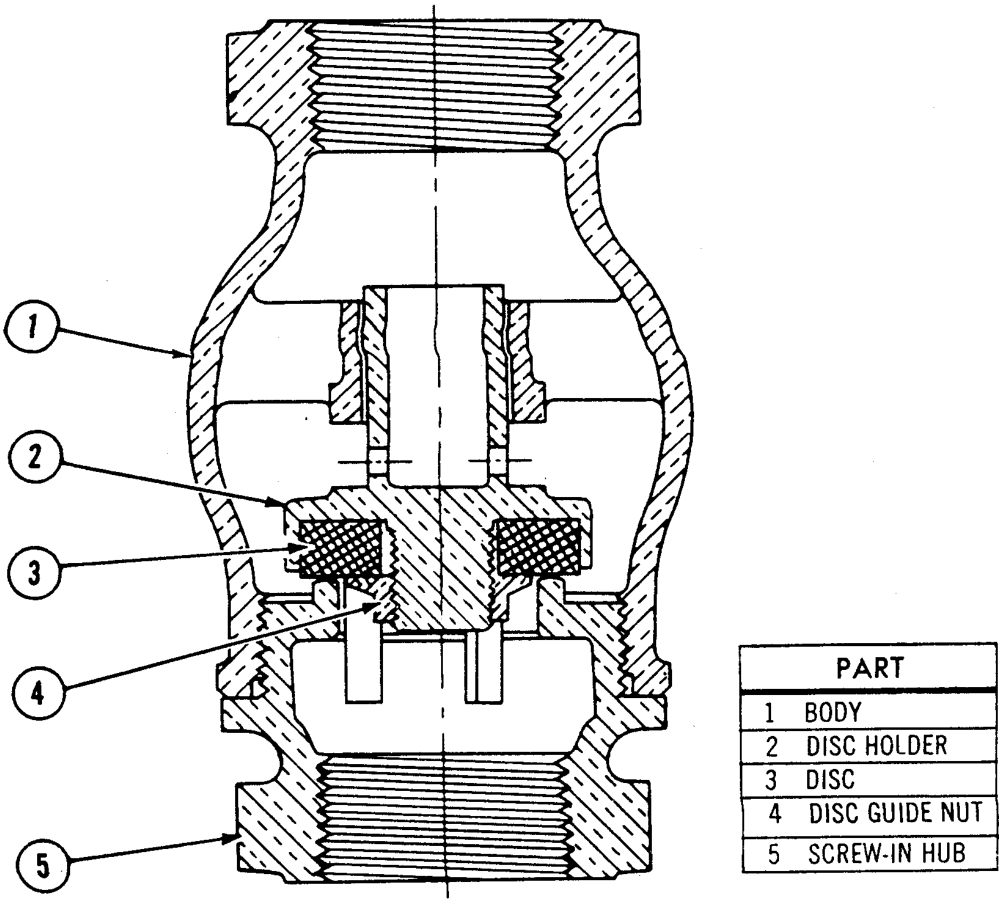


Fig. 9-8. Vertical lift check valve.

Available Materials of Construction

Lift check valves are not only available in a wide range of metallic constructions but also in various plastics and other materials. A representative list of standard materials of construction in which lift check valves are available includes :

Bronze	Polyvinyl chloride (PVC)
All Iron	Chlorinated polyethene (penton)
Cast iron	Impervious graphite
Forged steel	Borosilicate glass—TFE
Monel	TFE-lined
Stainless steel	

with a variety of trim combinations.

Installation and Maintenance

General installation procedures to follow for check valves have been already discussed. when installing lift check valves, certain other factors must be taken into consideration.

Horizontal life checks should be installed in horizontal lines with operating parts in the vertical position and pressure under the seat, assuring the return of the disc to its seat for positive closing.

The angle pattern must be installed with flow upward from beneath the seat. The vertical pattern is for use on vertical pipes only and must also have the flow upward from beneath the seat.

If the valves do not prevent backflow, drain the line, dismantle the valve, and inspect the seat and disc. Replace damaged or scored parts and reinstall. On valves with regrindable seats and discs, regrind. Make sure that all grinding compound is removed from the valve before reinstalling. Clean the interior of the valve body whether the seat has been reground or not. If composition discs are being replaced, make sure that the composition disc is compatible with the media in the pipeline.

9.5 PISTON CHECK VALVES

General

Piston check valves are essentially lift check valves, with a dashpot consisting of a piston and cylinder that provides a cushioning effect during operation. Because of the similarity in design to lift check valves, the flow characteristics through a piston check valve are essentially the same as through a lift check valve.

Installation is the same as for a lift check in that the flow must enter from under the seat. Seat and disc construction is the same as for lift checks.

Piston checks are used primarily in conjunction with globe and angle valves in piping systems experiencing very frequent changes in flow direction.

9.6 BUTTERFLY CHECK VALVES

Butterfly check valves have a seating arrangement similar to the seating arrangement of butterfly valves. Flow characteristics through these check valves are likewise similar to the flow characteristics through butterfly valves. Consequently, butterfly check valves are quite frequently used in conjunction with butterfly valves. In addition the construction of the butterfly check valve body is such that ample space is provided for unobstructed movement of the butterfly valve disc within the check valve body without the necessity of installing spacers.

As with butterfly valves the basic body design lends itself to the installation of seat liners of many materials of construction. This permits the construction of a corrosion-resistant valve at less expense than would be encountered where it necessary to construct the entire body of the higher alloy or more expensive metal. This is particularly true in constructions such as those of titanium.

Since the flow characteristics are similar to the flow characteristics of butterfly valves, applications of these valves are much the same. Also, because of their relatively quiet operation they find application in the air conditioning and heating systems of high rise buildings. Simplicity of design also permits their construction in large diameters — up to 72 inches.

Service Recommendations

1. For minimum resistance to flow
2. For frequent change of direction
3. For liquid or gas service
4. For use in lines using butterfly valves.

Construction of Valve

The butterfly check valve design is based on a flexible sealing member sealing against the bore of the valve body at an angle of 45 degrees. The short distance the discs must move from full open to full closed inhibits the "slamming" action found in some other types of check valves. Figure 9.9 shows the internal assembly of the butterfly check valve.

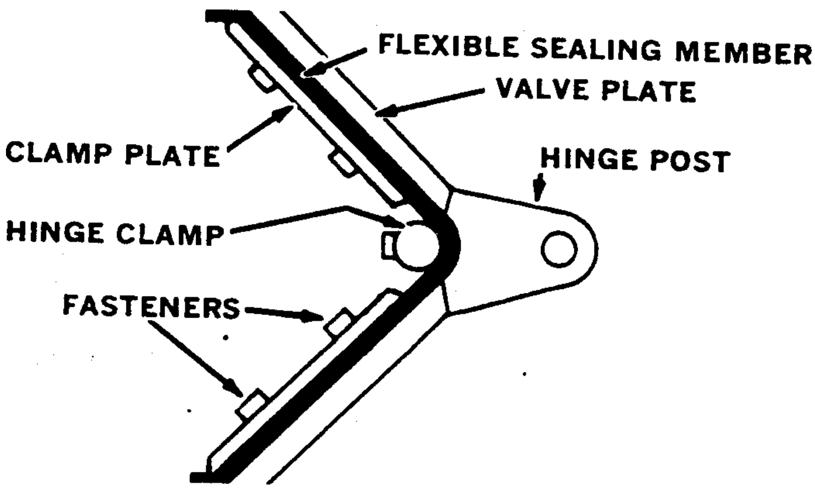


Fig. 9-9. Internal assembly of butterfly check valve.

Flexible sealing members are available in Buna-N, Neoprene, Viton, Urethane, Butyl, Silicone and TFE as standard, with other materials available on special order.

The valve body essentially is a length of pipe which is fitted with flanges or has threaded, grooved or plain ends. The interior is bored to a fine finish. The flanged end units can have liners of various metals or plastics installed depending upon the service requirement. Internals and fasteners are always of the same material as the liner. Figure 9.10 illustrates such a lined valve.

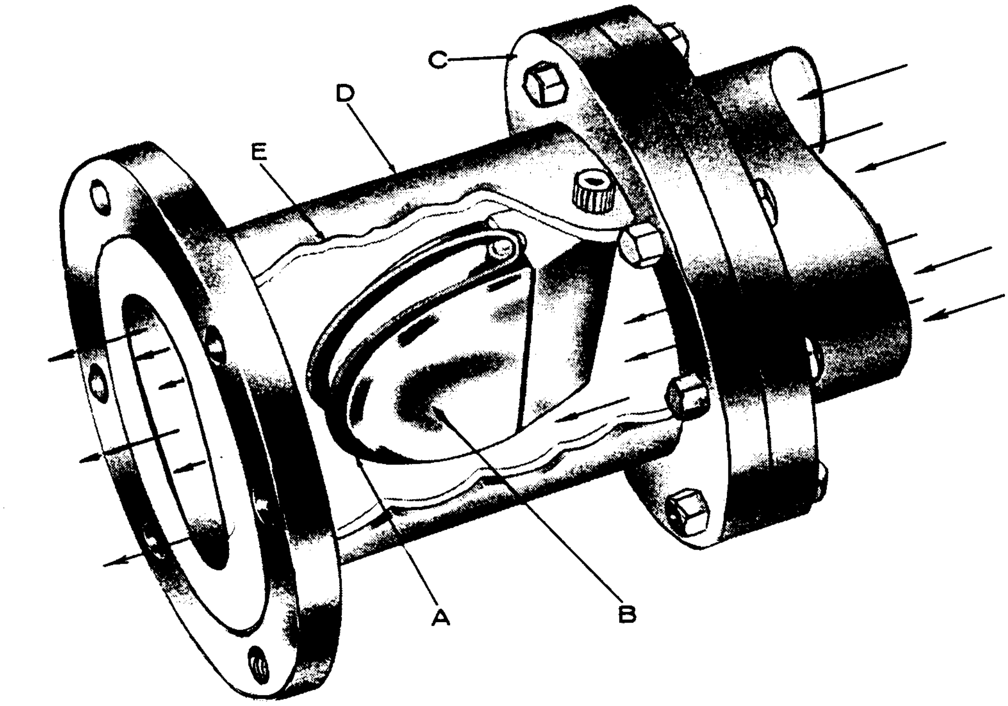


Fig. 9.10. Lined butterfly check valve. A. Sealing member as required, B. internals to match liner, C. ASA flanges, D. steel or iron body, E. liner.

A short form of this check valve is also available which fits between pipe flanges in the same manner as the wafer butterfly valve. See Fig. 9.11

Available Material of Construction

These valves are available in a fairly wide range of materials of construction, particularly in the lined styles. Standard body fluid contact parts (either in lined or solid construction) include :

Steel	Polyvinyl chloride (PVC)	Cast iron
Stainless steel	Polyvinyl dichloride (CPVC)	Monel
Titanium	Polyethylene	Bronze
Aluminium	Polypropylene	

Flexible sealing members are available in the following materials as standard, with others available on special order:

Buna-N	Neoprene	
Viton		
Butyl	Urethane	Silicone
TFE		

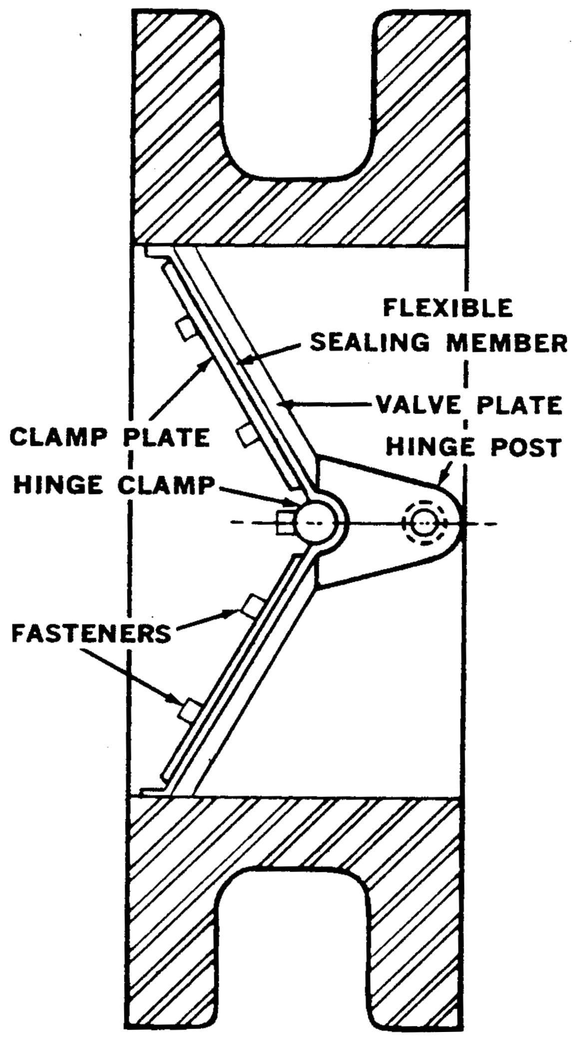


Fig. 9-11. Wafer-type butterfly check valve.

Installation and Maintenance

Butterfly check valves may be installed in any position — horizontal or vertical with the vertical flow either upward or downward. On lined valves care should be taken to protect the valve liner from damage during handling. Severe scratches or damage to the liner on the flange face may not be overcome by flange pressure, making a gasket seal impossible.

Care should be taken to insure that the valve is installed so that the entering flow comes from the hinge post end of the valve; otherwise all flow will be stopped. General installation procedure has been discussed earlier.

9.7 SPRING-LOADED CHECK VALVES

General

Spring-loaded check values are actually a form of vertical lift check valves — the difference being that a spring is employed to effect the sealing. Advantages of spring actuation are : more rapid response to reversal of flow (usually closes as soon as the fluid velocity has reached zero and before reverse flow has actually commenced) and the ability to be installed in any position vertical or horizontal. Because of their rapid closing action they are more effective in controlling hydraulic shock in a piping system than some other types of check valves.

This type of construction also permits the furnishing of check valves in materials of construction that would not be possible if it were necessary to rely upon gravity and liquid head to effect the seal.

Service Recommendations

- For frequent reversal of flow
- For liquid or gas service
- For positive sealing
- For controlling hydraulic shock in a pipeline.

Construction of Valve

Details of construction vary somewhat among valve manufacturers, but in general the seat and disc configuration resembles that of a globe valve with a spring arrangement to hold the disc on the seat until sufficient pressure is developed to open the valve. Seats and discs are replaceable.

Available Materials of Construction

Spring-loaded check valves are available with body materials of practically any material of construction, including bronze, steel, stainless steel, borosilicate glass, TFE-lined, various plastic materials, etc. There is a wide choice of trim materials, including bronze, stainless steel, TFE, various plastics, etc.

Fig. 9.12 illustrates a steel valve with stainless steel trim; and Fig. 9.13 shows spring-loaded check valves with a borosilicate glass body and a TFE-lined body, both with TFE trim.

GLOBE-TYPE
for 3” to 24” line sizes :
ASA Drillings 125# to 600#

FLAT-TYPE
for 1” to 10” lines sizes :
ASA Drilling 125# to 2500#

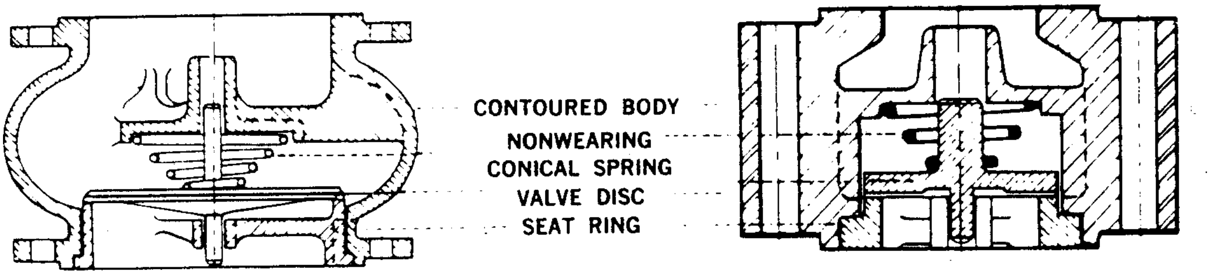


Fig. 9-12. Steel-body spring-loaded check valve.

Installation and Maintenance

The spring-loaded check valves can be installed in horizontal, angular or vertical lines. The flow must enter under the seat but these valves can be installed in vertical downflow as well as vertical upflow positions.

Seats and discs are replaceable; therefore in the event of leakage the seats and discs should be inspected for damage and replaced if necessary.

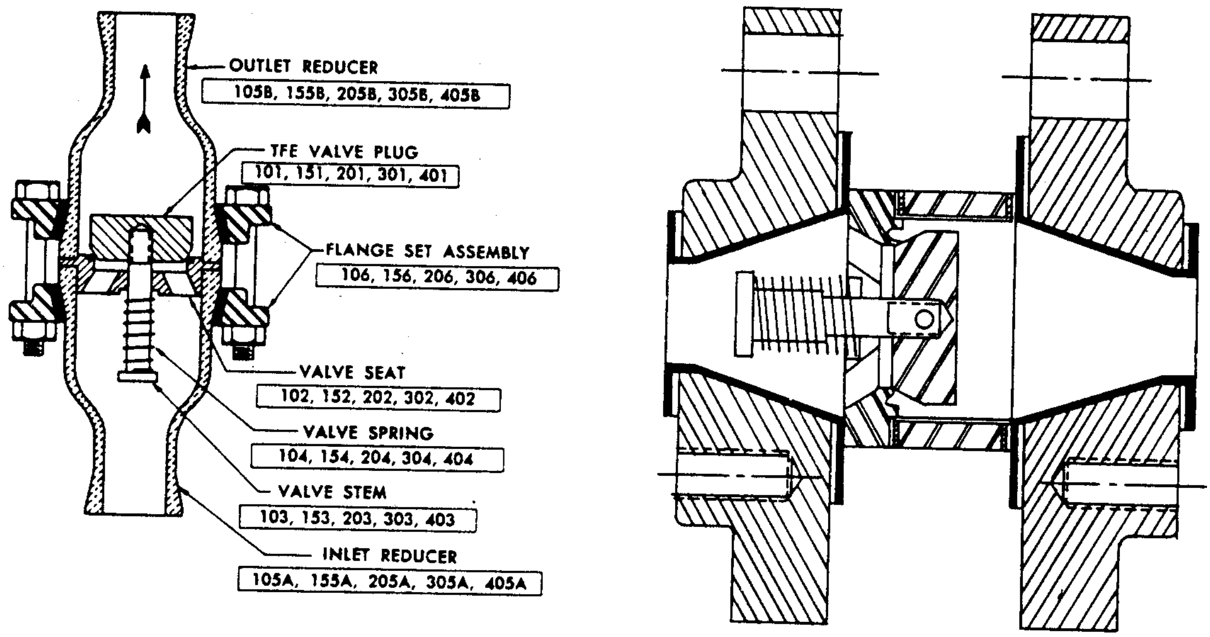


Fig. 9-13. Borosillicate glass and TFE-lined spring-loaded check valve.

9.8 STOP CHECK VALVES

The stop check valve is a check valve which can manually or through a motor-operated stem tightly seal the check valve or limit its opening. The valve stem is not connected to the disc. When the stem is in the open position, such a valve operates as a conventional lift check valve. However, the stem feature permits shutting off, or throttling of, the normal flow through the valve. The closure against reverse flow feature is always present. Figure 9.14 illustrates such a valve.

9.9 FOOT VALVES

Foot valves basically lift check valves which are used on the bottom of a suction line to maintain the pump's prime. They may be of the lift check or ball check variety and are usually fitted with a strainer. The head of liquid above the valve holds the valve closed and keeps the suction pipe full. As suction is created when the pump starts up, the check valve opens and permits flow to the pump.

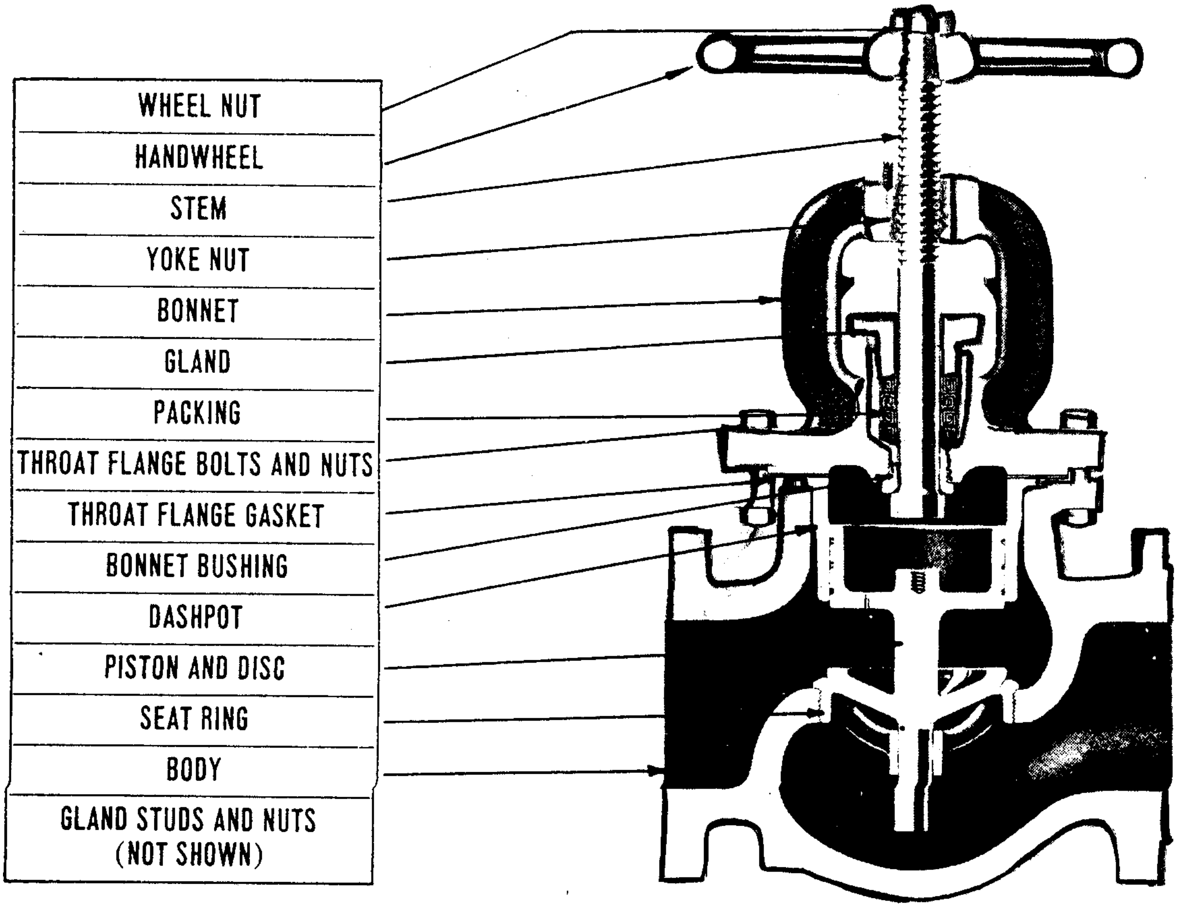


Fig. 9-14. Stop check valve.

CHAPTER - 10

PRESSURE RELIEVING DEVICES

10.1 PURPOSE

Pressure relieving devices are installed for one or more of the following reasons :

- To provide safety for operating personnel.
- To conserve material loss that might occur with overpressure.
- To prevent downtime that might result from overpressure.

10.2 DEFINITIONS OF TERMS

To ensure a proper understanding of the various pressure-relieving devices and their associated terms, the following definitions are given.

Relief valve : An automatic pressure-relieving device actuated by the static pressure upstream of the valve; it opens in proportion to the increase in pressure over the opening pressure. It is used primarily for liquid service.

Safety valve : An automatic pressure-relieving device actuated by the static pressure upstream of the valve and characterized by rapid full opening or pop action. It is used for gas or vapor service. In the petroleum industry, it is used normally for steam or air.

Safety relieve valve : An automatic pressure-relieving device suitable for use as either a safety or relief valve, depending on application. In the petroleum industry, it is normally used in gas and vapor service or for liquid.

Pressure relief valve : A generic term applying to relief valves, safety valves or safety relief valves.

Rupture disc : Consists of a thin metal diaphragm held between flanges. Its purpose is to fail at a predetermined pressure, serving essentially the same purpose as a pressure relief valve.

Maximum allowable working pressure : The maximum allowable working pressure depends on the type of material, its thickness and the service conditions set as the basis for design. The vessel may not be operated above this pressure or its equivalent at any metal temperature. It is the highest pressure at which the primary pressure relief valve is set to open.

Operating pressure : The pressure, in pounds per square inch gauge, to which the vessel is usually subjected in service. A processing vessel is usually designed for a maximum allowable working pressure, in pounds per square inch gauge, which will provide a suitable margin above the operating pressure in order to prevent an undesirable operation of a relief device. It is suggested that this margin be as great as possible consistent with economical design of the vessel and other equipment, system operation and the performance characteristics of the pressure-relieving device.

Set pressure : The inlet pressure, in pounds per square inch gauge, at which the pressure relief valve is adjusted to open under service conditions. In a relief or safety relief valve on liquid service, the set pressure is to be considered the inlet pressure at which the valve starts to discharge under service conditions. In a safety or safety relief valve on gas or vapor service, the set pressure is to be considered the inlet pressure at which the valve pops under service conditions.

Cold differential test pressure : In pounds per square inch gauge, the pressure at which the valve is adjusted to open on the test stand. The cold differential test pressure includes the corrections for service conditions of back pressure and/or temperature.

Accumulation : Pressure increase over the maximum allowable working pressure of the vessel during discharge through the relief valve, expressed as a percent of that pressure, or in pounds per square inch.

Overpressure : Pressure increase over the set pressure of the primary relieving device. It is the same as accumulation when the relieving device is set at the maximum allowable working pressure of the vessel. Note from this definition, that when the set pressure of the first (primary) safety or relief valve to open is less than the maximum allowable working pressure of the vessel, the overpressure may be greater than 10% of the set pressure of the safety valve.

Blowdown : The difference between the set pressure and the reseating pressure of the relief valve, expressed as percent of the set pressure or in pounds per square inch.

Lift : The rise of the disc in a pressure relief valve.

Back pressure : Pressure on the discharge side of safety relief valves.

Superimposed back pressure : The pressure in the discharge header before the safety relief valve opens.

Built-up back pressure : The pressure in the discharge header which develops as a result of flow after the safety relief valve opens.

Conventional safety relief valves : Designed to have their bonnets closed (Fig. 10.1). Their operating characteristics (set pressure, blowdown, capacity) are directly affected by the back pressure on the valve. Their performance, therefore is normally unsatisfactory under back pressure because of unbalanced forces acting on the disc and affecting the set pressure.

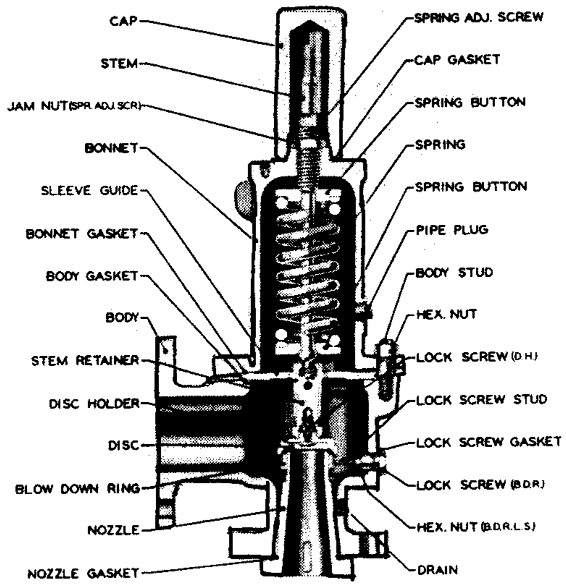


Fig. 10-1. A conventional full nozzle safety relief valve. Note that the bonnet is plugged and it not open to the atmosphere. (Courtesy of Teledyne Farris Engineering)

Balanced safety relief valves : Designed to have their bonnets vented to the atmosphere or to a safe location. They are constructed so that back pressure has little or no effect on their operation at set pressure. There are two types : the piston (Figure 10.2) and the bellows (Figure 10.3). The piston type is designed so that the back pressure acts on both sides of the disc, cancelling out its effect. The bellows type is designed so that the back pressure is prevented from acting on top of the disc in the seat area while acting on both sides of the disc where the disc extends beyond the seat area.

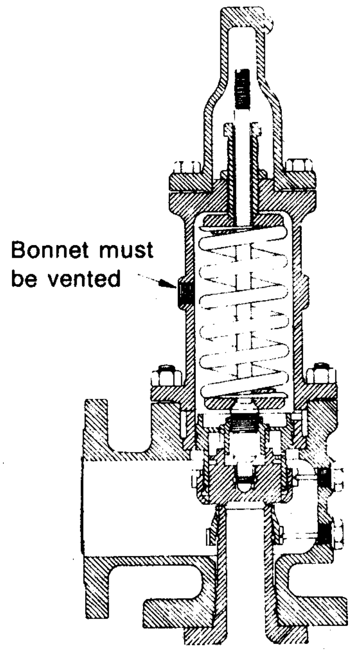


Fig. 10-2. Piston balance safety relief valve with vented bonnet.

10.3 TYPE AND FUNCTION OF RELIEF VALVES

10.3.1 Relief valves

Relief valves (see figure 10.4) have spring-loaded discs that close the inlet opening in the valve against the pressure source. The lift of the disc is in direct proportion to the overpressure above the set pressure. When the inlet pressure equals the set pressure, the disc may rise slightly from the seat and permit a small amount of fluid to pass. As the higher pressure accumulates at the inlet, the spring is further compressed, permitting the disc to rise; thus, it provides additional area so as to allow an increasing flow of fluid.

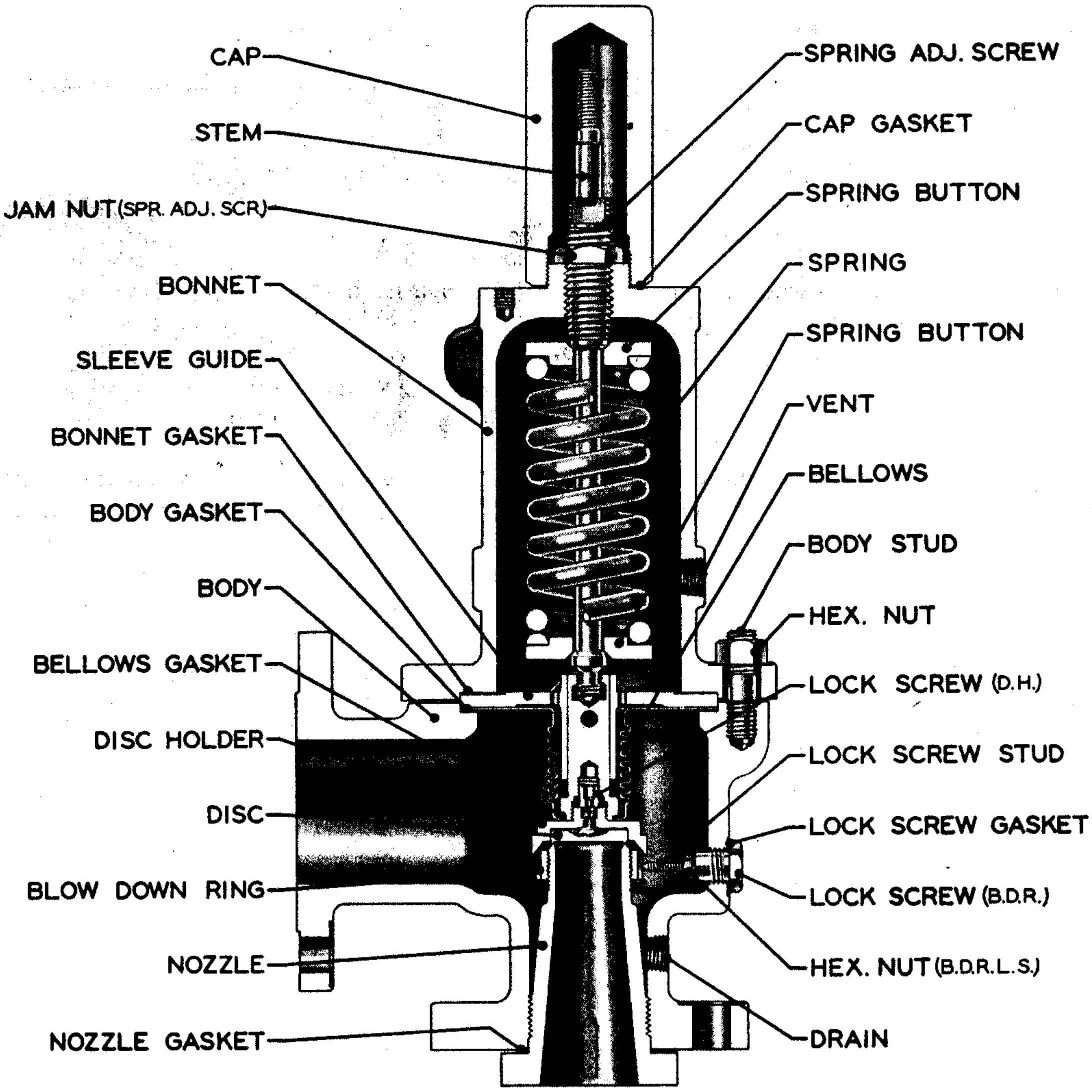


Fig. 10-3. A bellows balance safety relief valve prevents back pressure from acting on top of disc to affect opening at set pressure. Bonnet vent is open to atmosphere.

The gradual rising of the disc with increasing upstream pressure throughout its useful range and the attainment of full rated discharge capacity at 25% overpressure are characteristics of the relief valve. These features distinguish it from a safety valve whose disc attains its rated lift with low overpressure. It is further distinguished by not having a blowdown ring and a huddling chamber. It is used primarily for liquid service.

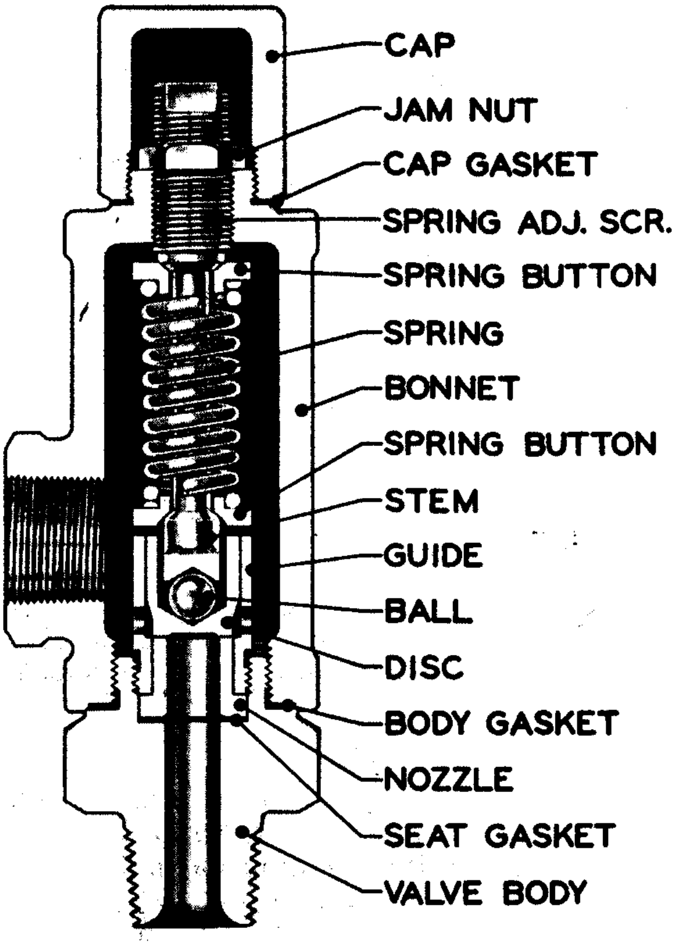


Fig. 10-4. Typical spring-loaded relief valve whose lift (or opening) is directly proportional to the overpressure above set pressure.

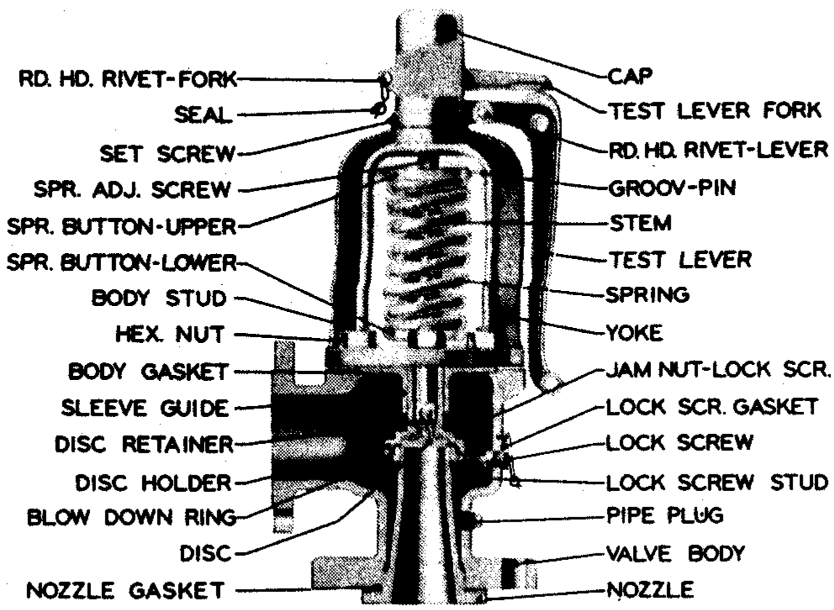


Fig. 10-5. Safety valve - an increased disc and seat area exposed to inlet pressure produces pop action characteristic of safety valves.

10.3.2 Safety Valves

Safety valves (and safety relief valves) are designed specifically to give full opening with little overpressure. They have spring-loaded discs that close the inlet opening in the valve against the upstream pressure and are characterized by rapid full opening, or pop action, produced by a huddling chamber which at set pressure, increases the disc and seat area exposed to inlet pressure to a point where the spring force can no longer overcome the inlet force (see Figure 10.5).

The flowing medium is directed to react against the disc and the spring force. This action utilizes kinetic energy (i.e. high velocity mass changing direction) to keep the valve in the open position. When the rate of flow is less than 25% of the valve capacity, the kinetic energy (mass) is not sufficient to keep the valve in its full open position, and the spring pushes the valve closed. Static pressure again pops the valve open, and again the low volume of flowing mass allows the valve to close. This repetition of opening and closing is characteristic of safety valves and is called **chattering**. It is an objectionable feature and occurs frequently when relief valve are oversized.

Properly sized, the relief valve continues to discharge until the inlet pressure recedes to 4 to 5% below the set point before reseating. The difference between set pressure and reseating pressure is known as **blowdown**. Safety valves have an adjustable ring or rings for controlling blowdown.

Safety valves that meet the Power Boiler Code usually have body pressure limits equal to the inlet flange series, i.e. 300 psig for 300-psig inlet flanges, 600 psig for 600-psig flanges, etc.

10.3.3 Safety Relief Valves

The safety relief valve is a unique and extensively used relieving device in oil refineries and chemical process plants. It may be described as a safety valve with a plugged bonnet (Figure 10.1). Therefore, all the characteristics of the safety valve are inherent in the safety relief valve.

As the name implies, it may be used in either service — as a relief or safety valve. When used as a relief valve, the blowdown ring is backed off so that the huddling chamber effect is absent— the pop action is avoided— and the valve functions strictly as a relief valve. It may be used as a safety valve, except in situations where the temperature is high enough to alter the spring characteristics.

The versatility of the safety relief valve accounts for its extensive use, particularly in services where fluids must be contained or emission closely controlled.

10.3.4 Pilot-Operated Relief Valves

The functions of pilot-operated safety valves are the same as for spring-loaded valves. They operate quite differently, however. The pilot-operated valve uses a floating piston as a main valve with process pressure on both sides. It is held closed by a larger area on top of the piston than on the bottom (Fig. 10.6). When the set pressure is reached, a pilot valve relieves the pressure from the top of the piston, allowing quick action. Closure of the valve is accomplished by the pilot operator, which diverts pressure to the top of the piston whose greater area provides the necessary alosing force at pressure close to the set pressure. Both the opening and closing of pilot-operated valves occur quickly and positively as opposed to direct spring-operated valves where process pressure first approaches the set pressure of the opposing spring force, then is equally balanced with that force and finally overcomes it and starts relieving. Firm closure of safety valves is accomplished by adjustment of blowdown rings which, although providing good closing forces, prevent closures close to the set pressure.

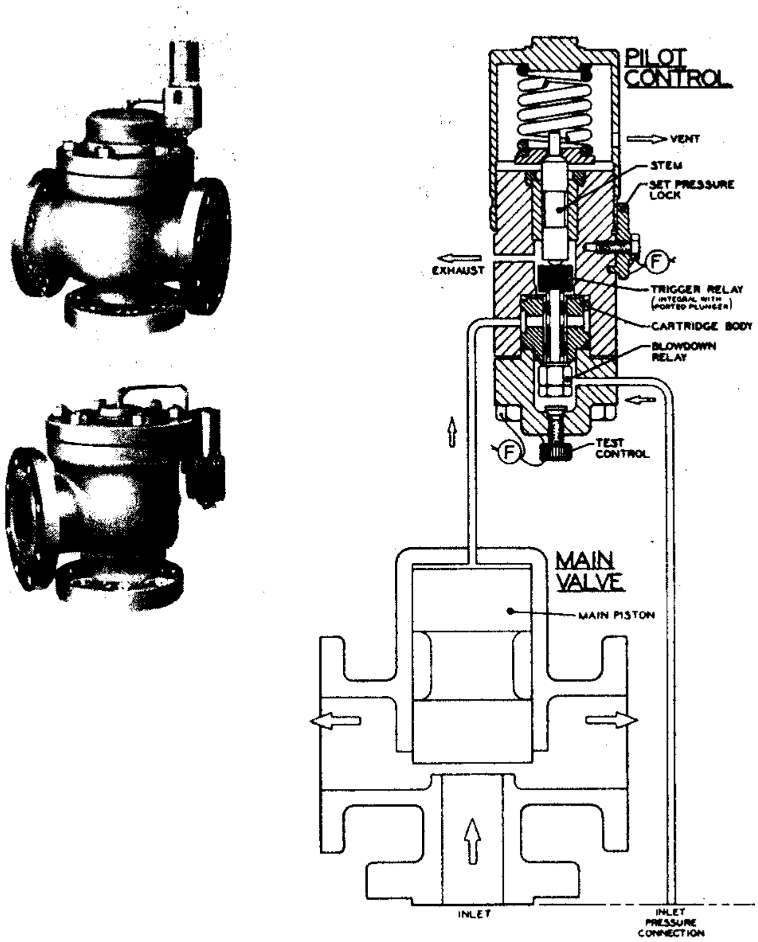


Fig. 10-6. Pilot-operated relief valve has floating piston as main valve, with process pressure on both sides, held close by virtue of larger area on top of piston.

Since pilot-operated relief valves have more parts that are subject to failure (refer again to Figure 10.6 for a typical system), their acceptance has been slow. Proper evaluation of conditions where they may safely be applied, however, will lead to an increasing awareness of their economy and safety. They are acceptable for many clean services in gas transmission, at compressor stations and on unfired pressure vessels.

10.3.5 Rupture Discs

A rupture disc in an intentionally designed “weak spot” within a pressure system. Thus, it is expected to fail before other, more valuable equipment is damaged or destroyed. Requiring no moving parts, rupture discs are fabricated from carefully selected pieces of metal. They have defined limitations basic to their ultimate tensile or compressive strength and to creep, fatigue or corrosion resistance.

There are primarily five points to consider : type and thickness of metal, mechanical method of construction, operating margin, temperature and the types of loads the pressure system will impose on the disc during operation.

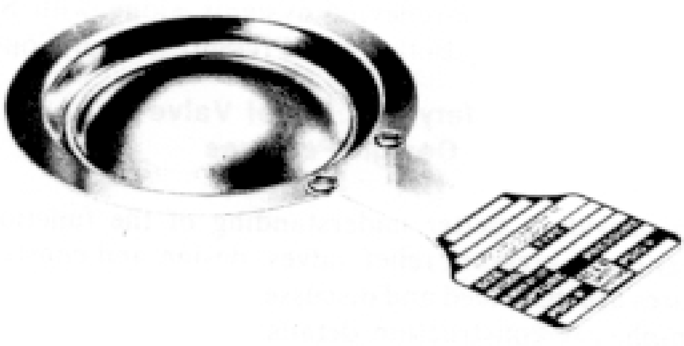


Fig. 10-7. A solid metal rupture disc. (Courtesy of BS & B Safety Systems)

Fig. 10-8. A composite rupture disc has a weakened metal disc backed by another metal or plastic disc that performs the sealing function.

Rupture discs may be grouped into different design types : solid metal (Figure 10.7), composite (Figure 10.8), reverse-buckling (Figure 10.9).

The most commonly used construction materials for rupture discs are aluminium, nickel, Monel, Inconel and austenitic stainless steel; however, discs are sometimes constructed from copper, silver, gold, platinum, tantalum and titanium. Metal foils, strips and sheets in soft, annealed condition are required. Today's wide variety of requirements necessitates the use of many increments of metal thicknesses ranging from approximately 0.002 to 0.060 inch. At least 70% of all metal rupture-disc applications involve the use of metal foil less than 0.010 inch thick.

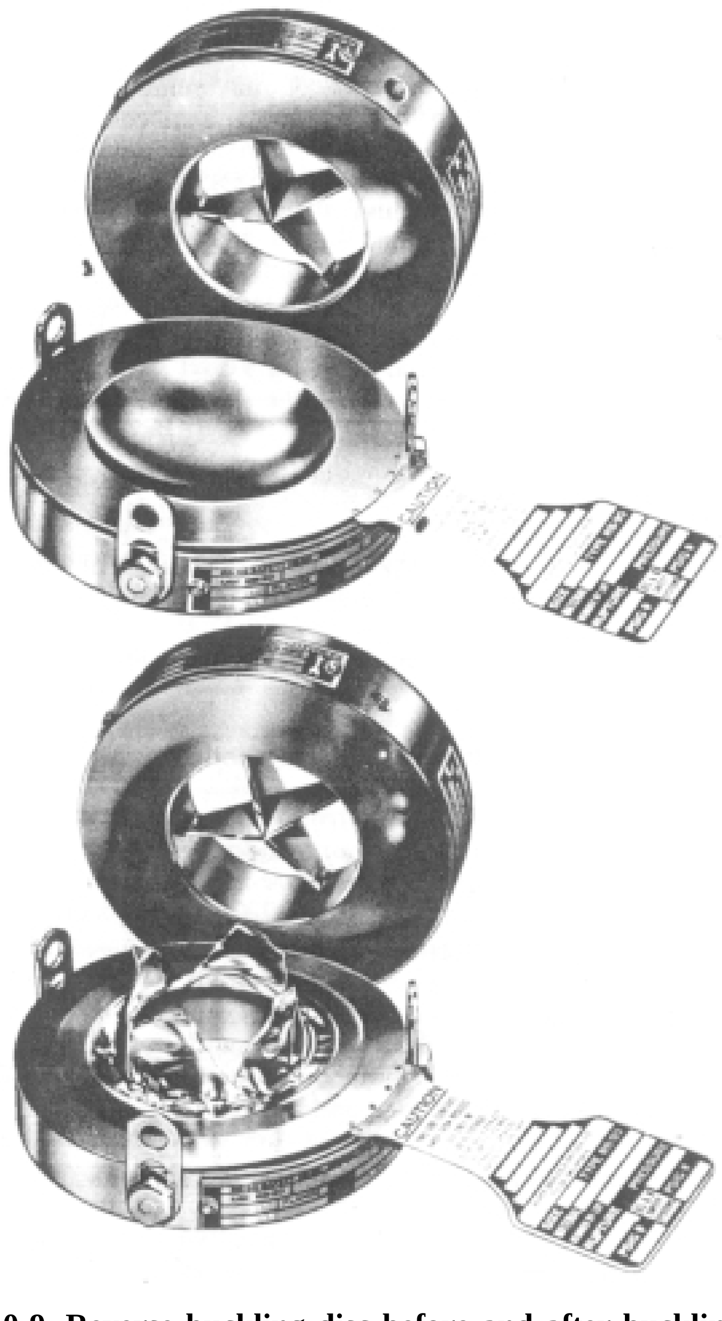


Fig. 10-9. Reverse buckling disc before and after buckling. Knife action is used to shear disc when rupture is reached.

Rupture discs are used for a variety of reasons, some of which are given below.

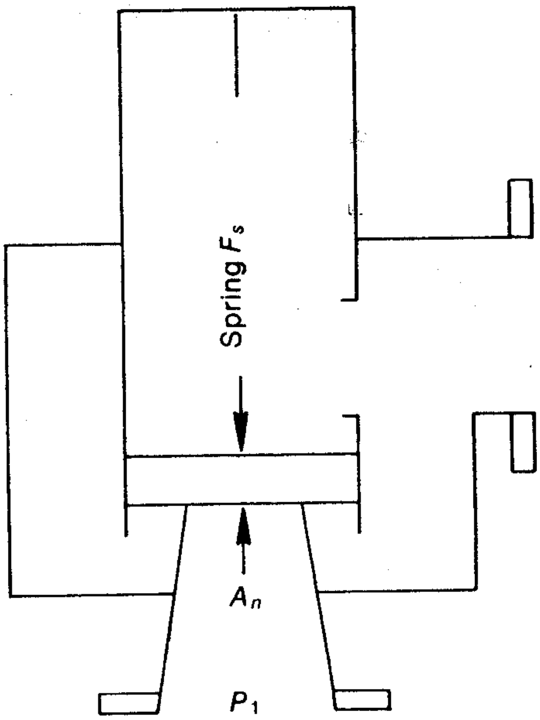
- In polymer and slurry services (or other highly viscous materials) where material accumulation, plugging or freezing would make the use of safety valves impractical.)
- As secondary relief devices to release large volumes of fluids under fire or other emergency conditions after primary devices have been actuated.
- As explosion protectors— they open a large area in a fraction of a second.
- In series with relief valves to prevent leaking, to protect against corrosion or to avoid plugging or freezing of the relief valve.
- Because they are more economical, especially in services requiring alloy materials.

10.4 SAFETY AND RELIEF VALVE DESIGN FEATURES

The basic purpose of a relief device is to relieve an overpressure condition of a system automatically and do it as economically and efficiently as practicable. The purpose also is to contain the pressure system as soon as the overpressure condition is relieved back to the normal condition. This is accomplished by a force-balance system acting on the closure of the relieving area (Fig. 10.10). The orifice area of the pressure relief valve is selected to pass the required flow at specified conditions. This area is closed by a disc (Fig. 10.11) until the set pressure is reached. The contained system pressure acts on one side of the disc and is opposed by a spring force on the opposite side. To complete this direct spring-loaded pressure-relieving valve, there must be a suitable body with inlet and outlet connections, a disc holder and other accessories to provide the performance characteristics desired.

10.4.1 Bodies

The valve body, usually an angle type (Fig 10.12), generally has the outlet sized larger that the inlet. This is necessary for expanding fluids such as gases, vapors, etc. A safety or relief valve must always relieve to a lower pressure (usually atmosphere for cheap, non poisonous fluid). This lower outlet pressure requires an increase in pipe size sufficient to keep the back pressure under the allowable 10% of the inlet pressure which is necessary to ensure that the valve opens at its set pressure.



$Fs>P_1An$ at normal operating condition.
$Fs=P_1An$ when valve starts to open.
$Fs<P_1An$ at relieving condition.

$Fs>P_1An$ at normal operating condition.
$Fs=P_1An$ when valve starts to open.
$Fs<P_1An$ at relieving condition.

Fig. 10-10. Pressure balance of a relief valve is determined by the spring (Fs), the inlet pressure (P_1) and the nozzle area (An).

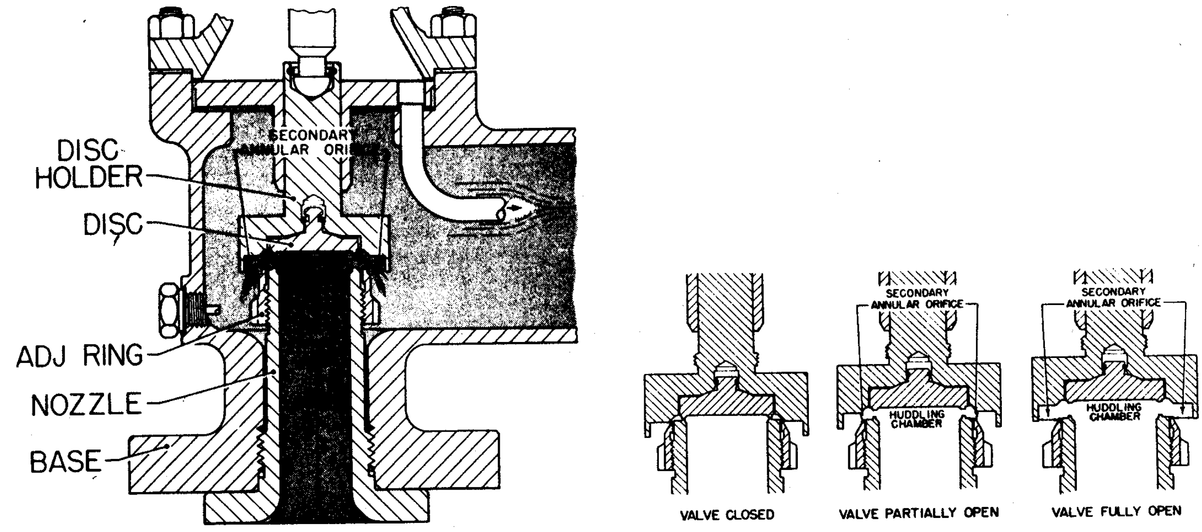


Fig. 10-11. The valve disc seating against the nozzle closes the valve.

The valve body must have an inlet connection capable of withstanding the pressure and temperature to which it will be subjected, not only under normal operating conditions but also at relieving conditions, which may be appreciably different. The body outlet connections and the bonnet assembly are likely to be designed for the lower pressures to which the valve will relieve.

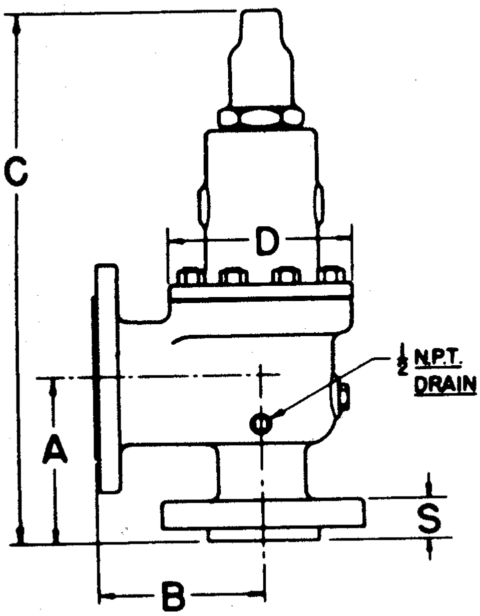


Fig. 10-12. Relief valve body is normally an angle with larger outlet than inlet connection.

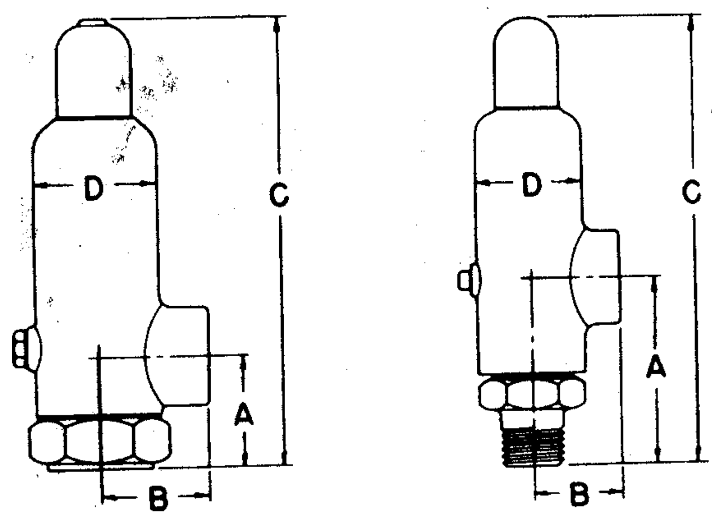


Fig. 10-13. Inlet connections of screwed valves may be male or female; outlets are usually female.

Body connections may be screwed, flanged or welded. Screwed connections (Figure 10.13) are available in sizes up to 3 x 4 inches. Inlets may be male or female; outlet connections are usually female. Although the larger sizes (3 x 4) inches are also available and used in some industries.

10.4.2 Nozzles

The arrangement of the nozzle in a pressure relief valve falls broadly into two types : full nozzle and semi nozzle construction. Except when discharging, the only parts of a full nozzle valve that are wetted by the contained fluid are the nozzle and disc or disc insert (Figure 10.14). In many applications that require special alloy materials, only the nozzle and disc are made of the special alloy.

Seminozzle construction (Figure 10.15) is such that other parts of the valve are in contact with the line or vessel fluid. In most instances valves of standard material and construction are satisfactory.

10.4.3 Nozzle Orifice Sizes

Safety relief valve manufacturer have adopted standard orifice sizes to simplify relief valve selection and designation. Between 0.110 and 26.00 square inches are 15 different sizes designated by the letters D through T with the exception of I, O and S. Table 10.1 lists sizes and alphabetical codes.

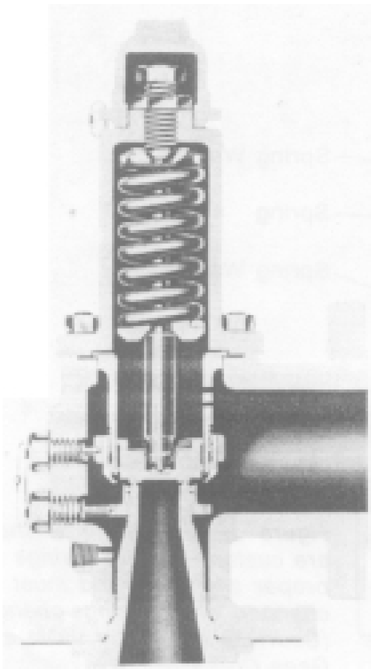


Fig. 10-14. The nozzle and disc or disc insert are the only wetted parts of the valve until it relieves.

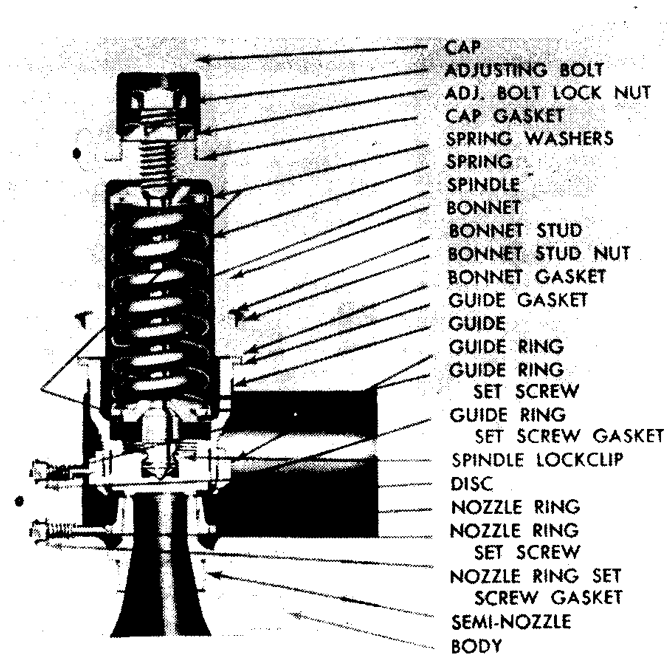


Fig. 10-15. The inlet flange in the body of a seminozzle valve is wetted by the process fluid.

Table 10.1 Standard Relief Valve Orifice Sizes and Their Designation

EFFECTIVE ORIFICE AREA SQ.IN.	ORIFICE DESIGNATION
0.110	D
0.196	E
0.307	F
0.503	G
0.785	H
1.287	J
1.838	K
2.853	L
3.60	M
4.340	N
6.380	P
11.050	Q
16.0	R
26.0	T

10.4.4 Springs

Standard springs for relief valves are normally carbon steel or alloy (tungsten) steel. Carbon steel springs are furnished for temperatures to 450^0F and alloy (tungsten) steel springs for temperatures over 450^0 on closed bonnet valves. For steam (open spring) valves, the dividing point is 650^0 F.

For temperatures lower than —20^0 F, alloy steel springs (and bodies) are recommended to prevent breakage from impact.

For corrosive service, either alloy steel springs or special coating is advisable to prevent stress corrosion which might result in broken springs. Balanced bellows can be used to protect springs so that carbon steel springs and bonnets are satisfactory when bellows valves are used.

Valve springs are adjustable within a narrow range of settings. The adjustment may be 30% or more on low range springs and as little as 5 % on higher spring ranges. This does not mean, however, that a valve setting may be changed that much on a particular valve for the original setting might have been at the very top or bottom of the spring range. It is likely that a new spring will be required when a valve set pressure is changed.

Spring washers (Figure 10.16) are fitted to a particular spring for proper alignment so that their change is also necessary when springs are changed.

The two important factors to remember in spring selections are temperature and corrosion.

10.4.5 Trim and Other Internal Parts

Some manufacturers consider that the term trim applies only to nozzle and disc. Others include the disc holder in the term. Where full nozzle valves are not used, the base would be included in the term (Figure 10.17). Standards materials for nozzle disc and for other internal parts (disc holder, sleeve guide, stem retainer and blowdown ring) are alloy or stainless steels (Figure 10.18). During relieving conditions, these parts are subjected to the flowing medium, and corrosive applications may require Monel or Hastelloy.

10.4.6 Seating

As pressure relief valves approach their set pressure, there is increasing tendency for them to leak. This is inherent in their design as force balance mechanisms—the internal forces on the underside of the disc area approaches the opposing spring force on the top of the disc. The proneness to leak is overcome primarily by :

- Precision machining of seating surfaces and aligning as accurately as possible. Surface finishes can be produced that deviate less than 5 microinches from a perfect finish.
- The use of O-ring seat seals (Figure 10.19) which allows complete tightness at pressures much closer to the set pressure than is possible with standard metal-to-metal seats (see figure 10.20).

The difficulty with the use of resilient seating material is its tendency to "cold flow" under the seat load imposed by the spring force. This gradually lowers the set pressure as the valve spring relaxes under these circumstances.

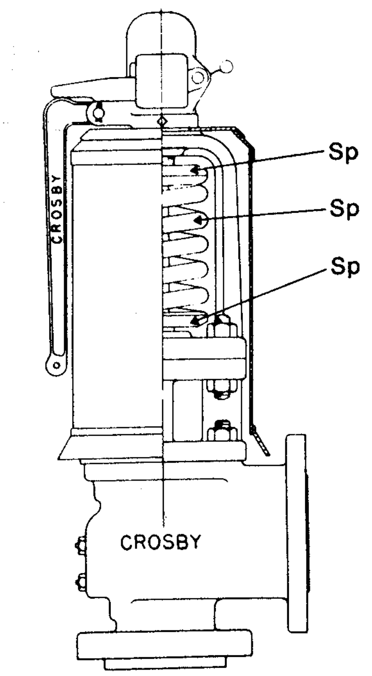


Fig. 10-16. Spring washers are custom fitted to springs for proper alignment and must be changed when springs change.

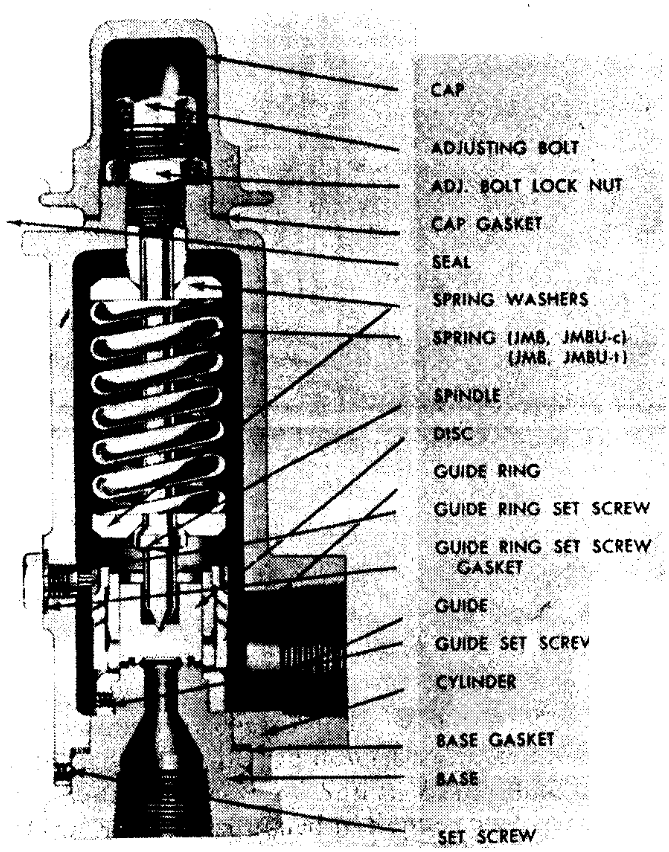


Fig. 10-17. The base is considered as trim in the semi-nozzle or modified nozzle valves.

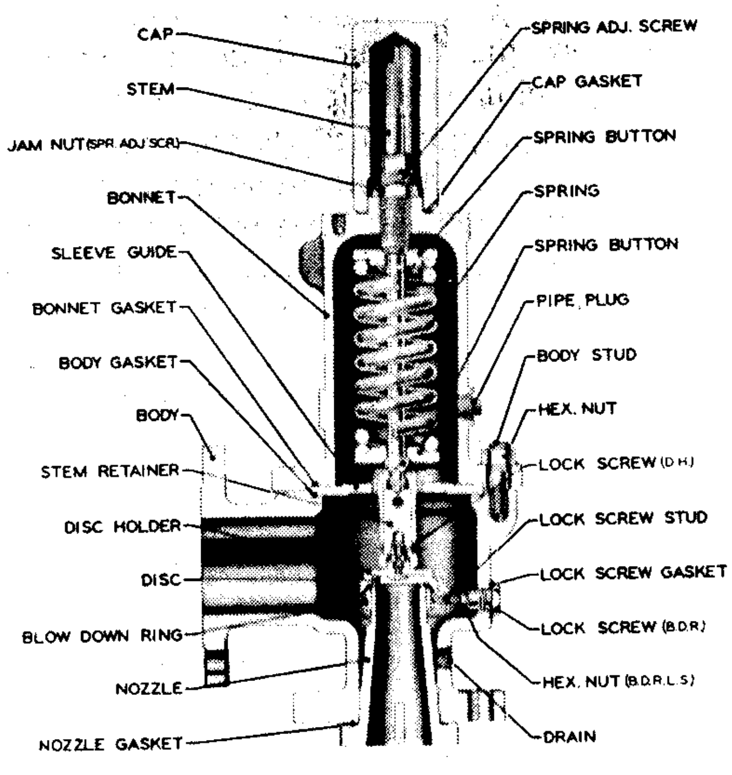


Fig. 10-18. Internal parts such as disc holder, sleeve guide, stem retainer and blowdown ring are made of stainless steel or other alloy.

The use of an O-ring seat seal allows relief valves to maintain the set pressure and the desired tightness by using relatively rough metal-to-metal seating surfaces to carry the spring force while the O-ring is pressure loaded against a specially curved seating surface. With this construction, the resilient O-ring does not carry the seat load imposed by the spring force and is not subject to cold flow; yet it provides a high degree or tightness over an extended period of time.

10.4.7 Tightness

The terms used to define tightness are commercial and bubble. Bubble tightness means no leakage or bubbles of air at specified percentages of set pressure. Commercial tightness permits a stipulated maximum leakage at specified percentages of set pressure.

The test apparatus and procedures under which commercial tightness tests may be made are described in API RP 527, Commercial Seat Tightness of Safety Relief Valves with Metal-to-Metal Seats, Figure 10.21 shows the acceptable test arrangement.

Table 10.2 shows the maximum leakage rates permissible for conventional and balanced bellows valves. Tests are determined with the valve mounted vertically and the relief valve inlet held at 90% of set pressure immediately after the valve has popped. An exception to the above percentage is that for any valve set below 50 psig, the pressure shall be required to hold at 5 psig below the set pressure immediately after popping. In both cases sited above, the test pressure must be applied for a maximum of 1 minute for valve sizes through 2 inches; 2 minutes for $2^{1/2}$-, 3- and 4-inch sizes; and 5 minutes for 6 and 8-inch sizes. Air at approximately atmospheric temperature is used as the pressure medium.

API RP 527 applies only to relief valves with set pressures up to 1,000 psig. No leakage rates have been defined as permissible under this procedure for pressures above that. When there is a need for specifying tightness on valves of higher settings, complete specifications should be agreed upon between the customer and the manufacturer.

When better than commercial tightness is desired, this may also be specified by the customer. The same rate of leakage might be allowed at 95 % of set pressure, for example, or a lesser leakage rate at the specified 80% of set pressure. Greater demands relative to tightness incur greater cost for the purchased item.

10.4.8 Common Causes of Leakage

Listed below are circumstances under which excessive valve leakage is likely to occur.

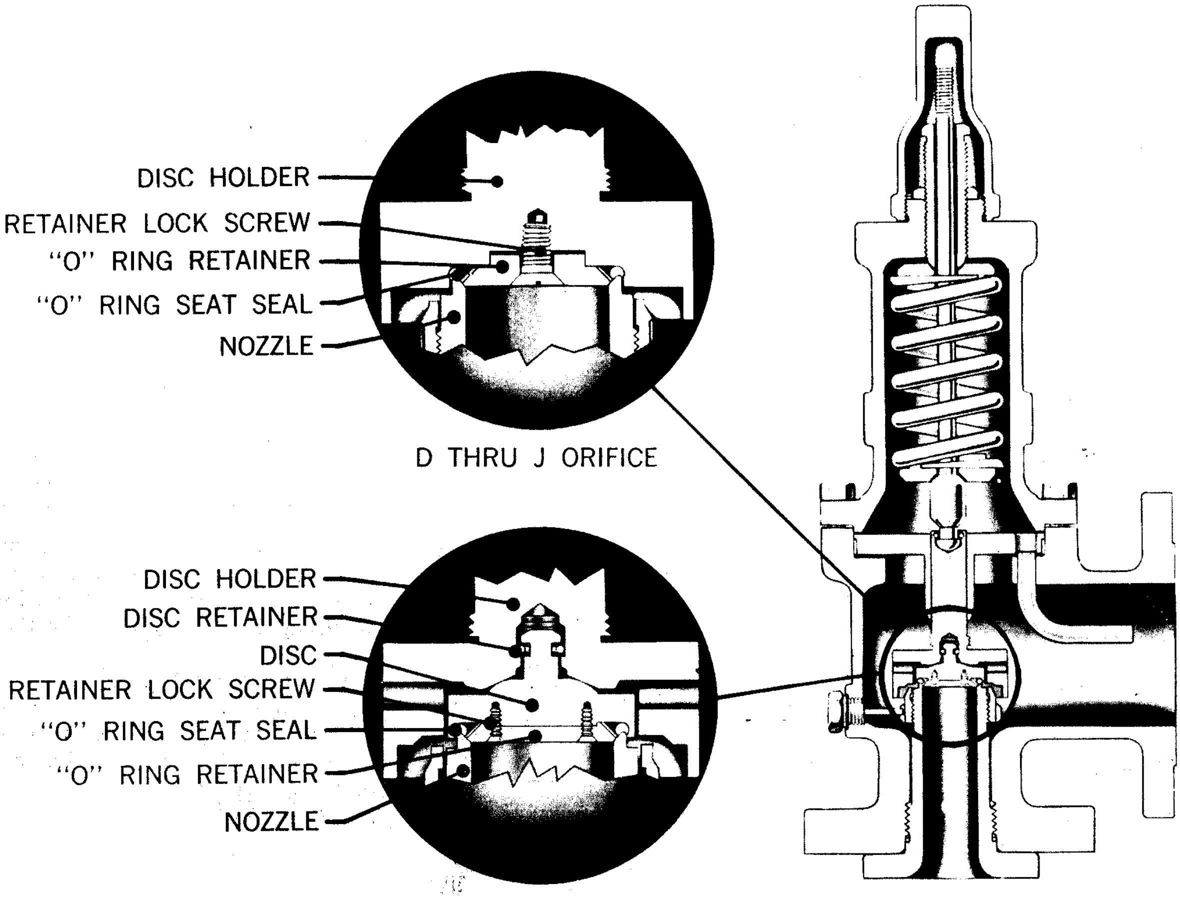


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Fig. 10-19. The use of O-ring seat seals reduces leakage problems considerably in comparison with metal-to-metal seats.

- Set pressure too close to the normal operating pressure. As the differential between the operating and set pressure decreases, the force between the seating surface decreases also. Pressure peaks at these conditions produce leakage.

- Failure of the valve to reseat properly after it has popped or after "simmering" occurs. A characteristic of a safety relief valve is that it must lift off the seat slightly and "simmer" before pressure is built up in the huddling chamber to cause the valve to pop. In many cases, the valve simmer takes care of the excessive pressure and the valve does not pop at all. At the simmer point, the seat load is zero between the seating surfaces, and the valve disc can float out of alignment. When the pressure goes down, the valve continues to leak until a high differential force causes it to seal more tightly.

- The scratching of the metal-to-metal seating surfaces by foreign material such as pipe scale, welding beads, sand, dust, etc. when a valve is open and flowing.

- Corrosion of the seating surfaces.
- Piping strains caused by normal thermal expansion or by incorrect pipe installation.

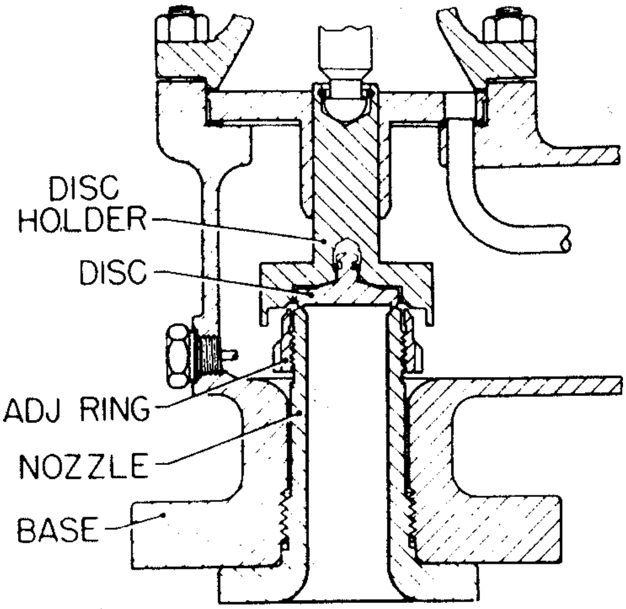


Fig. 10-20. Metal-to-metal seats must be machined precisely and aligned accurately to seal properly.

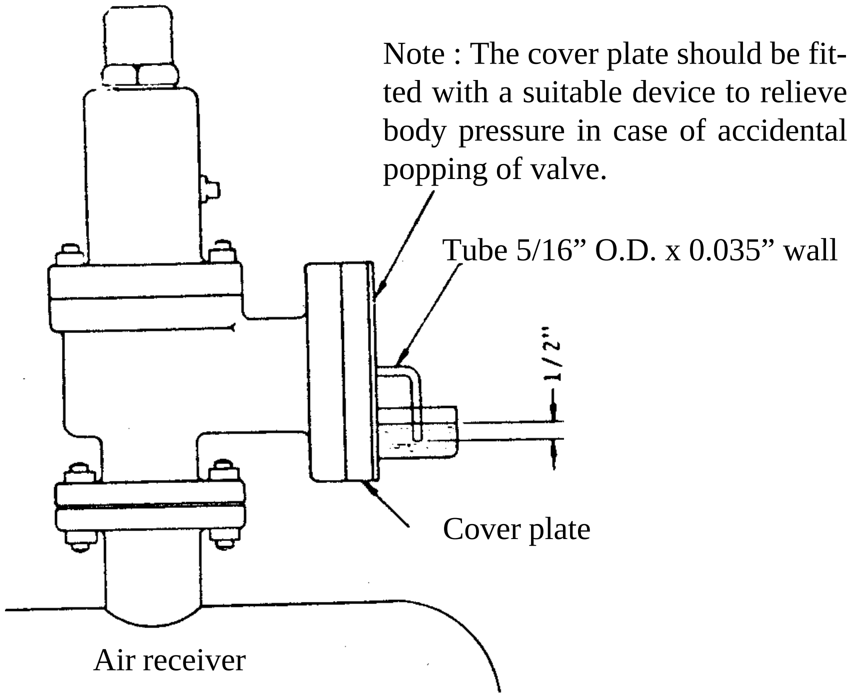


Fig. 10-21. Test apparatus for seat tightness as specified in API RP 527.

Table 10.2 Maximum Permissible Leakage Rates for Relief Valves

Type of Valve	Manufacturer's Orifice Size	Max. Leakage Rate (bubbles/ min.)	App. Leakage Rate (SCF/24 hr)
Conventional	F and smaller	40	0.60
	G and larger	20	0.30
Balance bellows	F and smaller	50	0.75
	G and larger	30	0.45

- Applications where heavy vibrations occur. Vibrations cause the spring force to increase and decrease alternately. On the decrease part of the cycle, the differential force between the contained medium and spring may actually approach zero, resulting in leakage.

- Nozzle icing conditions resulting from the refrigerant effect of the flowing fluid when a valve relieves. Ice sometimes actually forms on the seat. Reseating is improper. For valves subject to frosting when discharging, a knife seat is advisable. (Knife seats are satisfactory also for fluids containing fine solids in suspension.)

10.4.9 Bellow Seals

Bellow seals (Figure 10.22) are used to overcome the effect that back pressure exerts on the valve set pressure in pressure-relieving systems. A secondary advantage is that they also protect valve moving parts from corrosion.

When variable back pressure exists, it is not possible for a conventional valve to relieve consistently at any set pressure. The relieving pressure varies with the magnitude of the back pressure.

Figure 10.23 shows how back pressure (downstream pressure) acts on a disc to effectively increase the pressure of the valve. It can be seen clearly that the pressure opposing the process pressure P_1, is the spring force F_s , plus, the downstream (back) pressure. Conventional valves may be used when the back pressure is constant or when the variation in back pressure does not exceed 10% of set pressure. When back pressure is constant, it is simply subtracted from the set pressure to determine the net spring setting.

When back pressure is variable or when its value exceeds 10% of the setting, balancing bellows should be used. The inside of the bellows remains atmospheric at all times, keeping the back pressure from exerting its force on the unbalanced seat area. When balanced bellows are used, the bonnet should be vented to the atmosphere so that the bellows can breathe freely; otherwise (with plugged vent), pressure buildup in the bonnet and bellows restricts bellows movement.

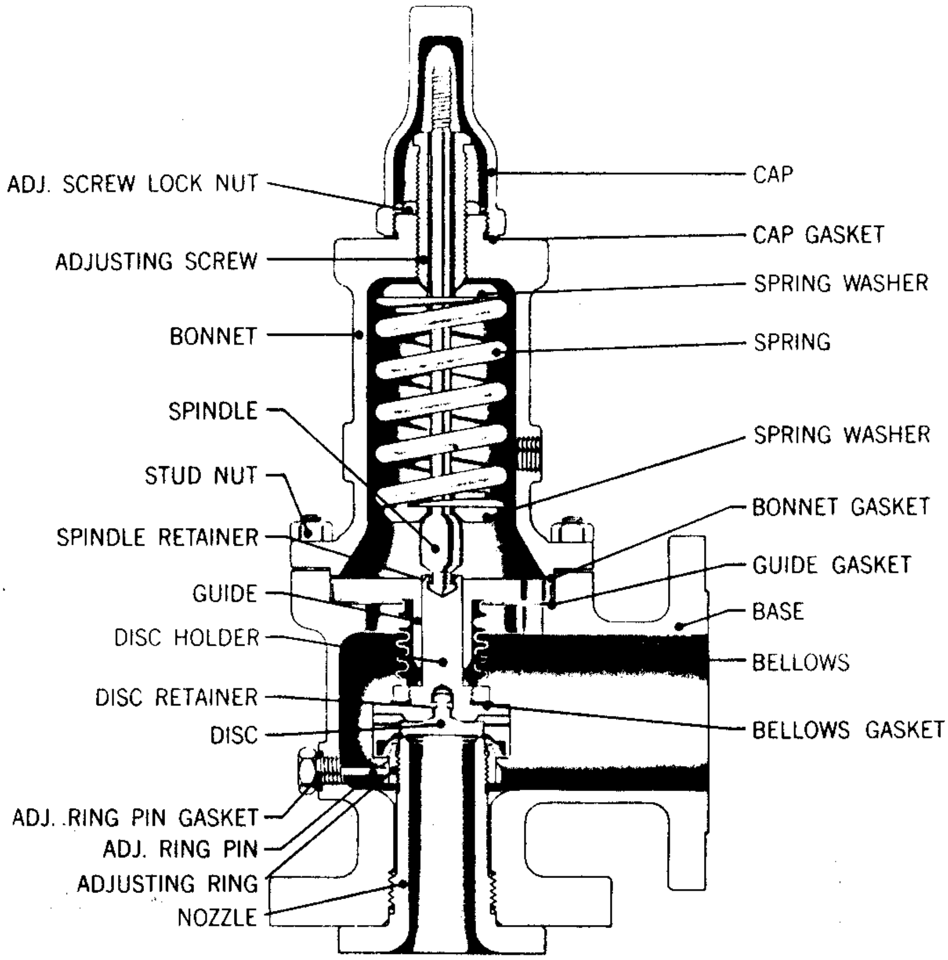


Fig. 10-22. Bellows seals overcome the effect of back pressure on the set pressure of relief valves by covering the disc whose area the back pressure would affect.

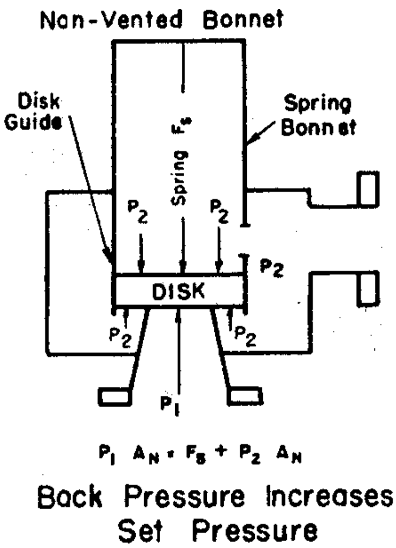


Fig. 10-23. Effect of back pressure of conventional safety relief valves.

10.4.10 Blowdown Rings

Blowdown rings accomplish two basic purposes :

1. Along with the disc holder (Figure 10.24) they form a “huddling” chamber that provides the “pop” action necessary for safety valves.

2. Adjustment of the blowdown ring(s) varies the difference between the set pressure and reseating pressure of the valve.

Pop action on safety valves is needed to prevent the condition known as chattering which occurs when the valve starts to open. Where a relief valve on liquid service opens slightly and the pressure drops sharply with the release of the relatively small volume of fluid, safety valves in vapor service exhibit different characteristics. There is a tendency for the valve to cycle, alternately opening and closing. This often causes damage to the valve seats resulting in leakage.

The solution was the design of the disc holder and blowdown rings to take advantage of the stream pressure and kinetic forces to obtain a greater lifting force as soon as the valve started opening. The resulting “pop” action is the distinguishing characteristic between relief and safety valves.

Blowdown is defined as the percentage difference between the pressure at which the valve starts to open (set pressure) and the pressure at which it reseats. Maximum blowdown occurs when the blowdown ring(s). (there may be one or two) are brought toward the disc (Figure 10.25). As the blowdown ring is adjusted away from the disc, blowdown decreases.

Normal blowdown on a valve is 5% of set pressure. It is normally set by bringing the ring all the way up to the disc, then backing off the number of turns suggested by the vendor. This recommendation comes from the vendor because there are few test facilities where it may be checked by customers. Blowdown per turn is usually based on tests using methane. Other fluids have different blowdown characteristics.

10.4.11 Bonnets and Yokes

Bonnets are housings around the springs of relief, safety and safety relief valves. The valves spring may or may not be in the relieving stream. Fig. 10.26 shows the bonnet for a screwed safety valve where the spring is in the flowing stream. Fig. 10.27 shows the bonnet enclosing a spring that is outside the flowing stream.

Bonnets are not necessary where there is no need to contain escaping fluids to prevent their release in a particular area. In the petroleum and related industries, it is usually necessary to contain the liquids and vapors that might escape and direct their flow to specific area of release.

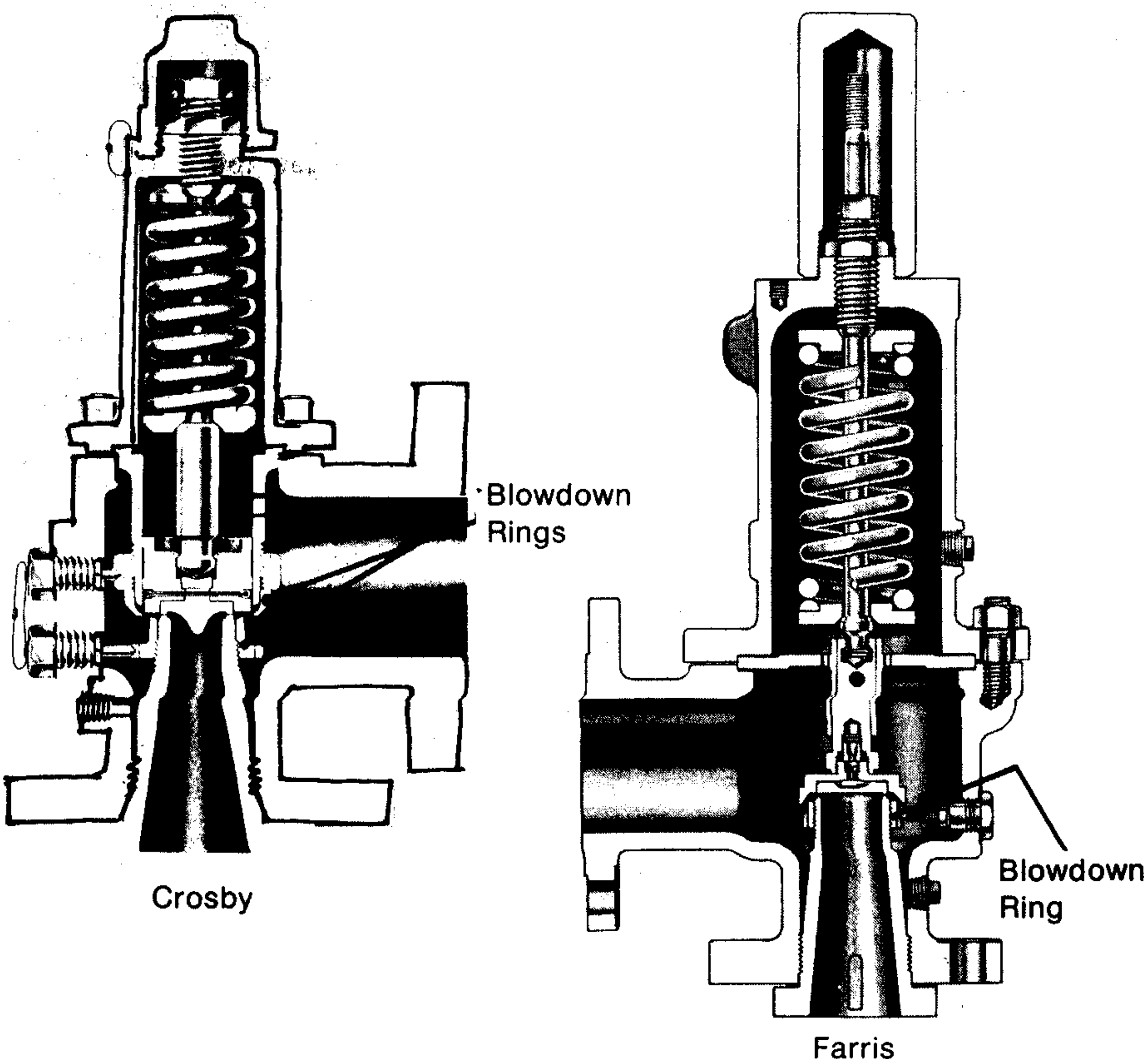


Fig. 10-24. The valve on the left uses two blowdown rings and right valve one to form the "huddling" chamber that produces the "pop" action required by safety and safety relief valves.

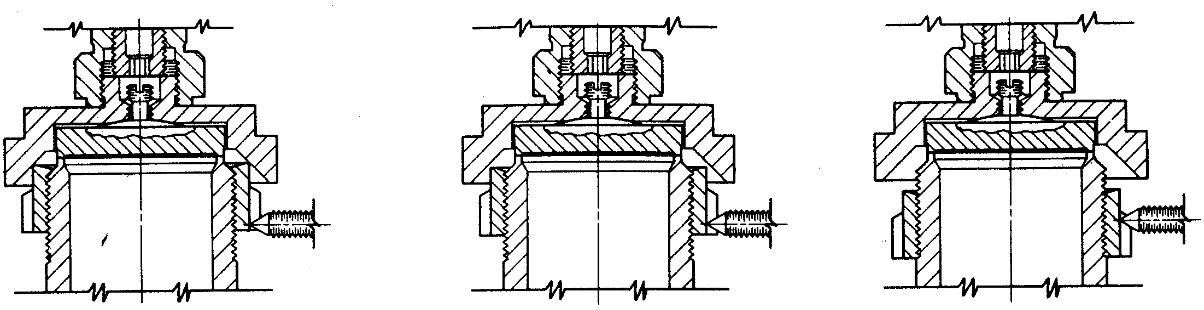


Fig. 10-25. From left to right, the blowdown ring is brought completely up to the disc, backed away to provide "pop" naction for vapor services and backed away completely for liquid relief service.

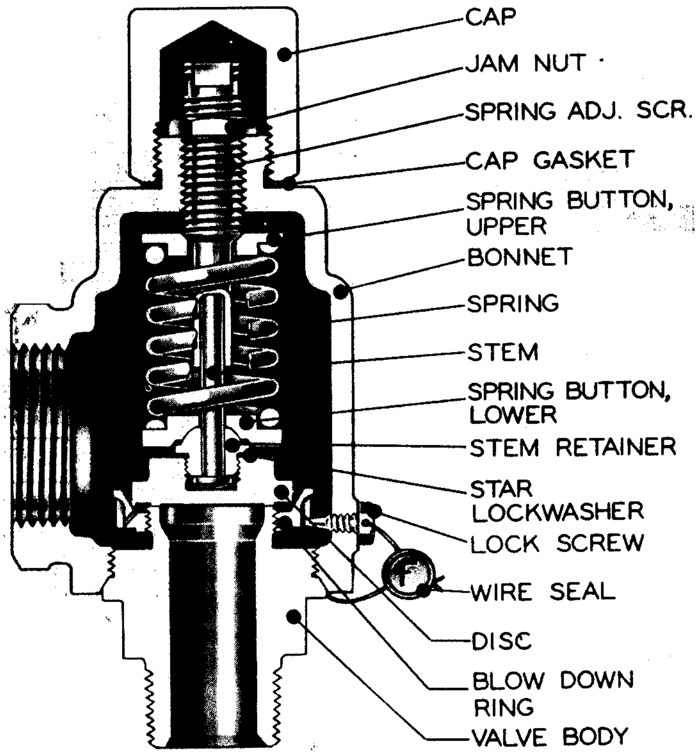


Fig. 10-26. Relief valve bonnet encloses the spring inside the flowing relief stream.

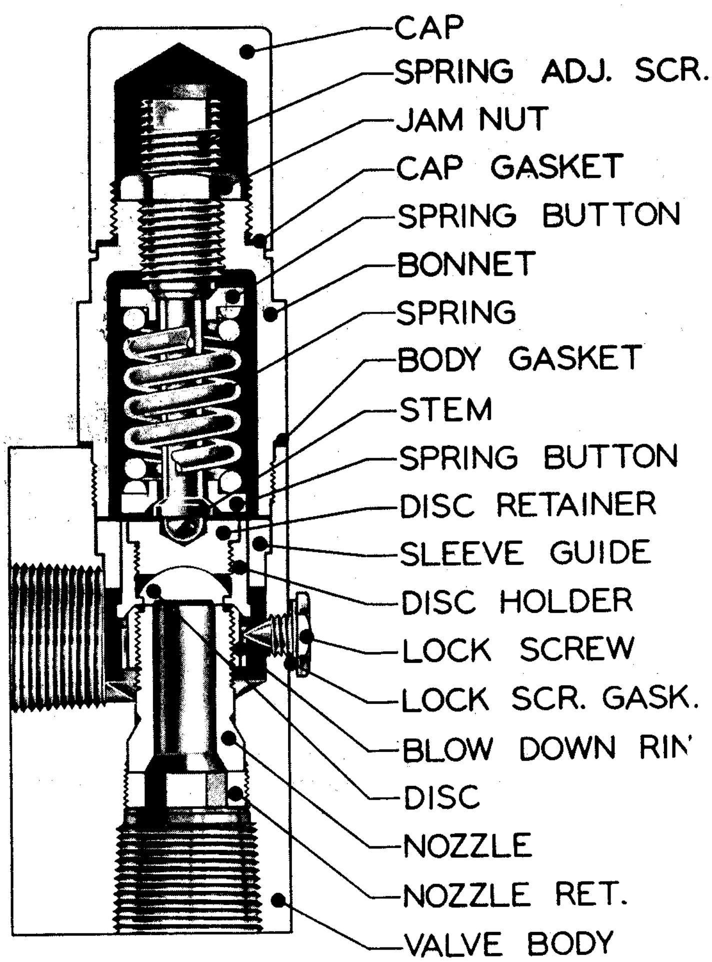


Fig. 10-27. Relief valve bonnet encloses the bonnet outside the flowing relief stream.

The majority of valves used in the processing industry are provided with bonnets. When balanced bellows valves are used, no leakage to the bonnet occurs; the bonnet vent in this case is left open so the bellows may "breathe" properly. On conventional valves, bonnet vents are plugged to contain flowing fluids.

Safety valve applications that do not require fluid containment use an open spring arrangement (Figure 10.28) which uses a yoke mount for spring mounting. It is a simple, economical design that is satisfactory for clean, nontoxic, nonflammable services.

10.4.12 Lifting Mechanisms

The purpose of a lifting mechanism is to open a valve when the pressure under the valve is lower than the set pressure. Lifting levers are supplied when periodic testing of the relief valve is desirable or mandatory. They are required on steam boilers and on air compressors and are quite common on other steam and air services. Their use on other process services varies with user practices.

Lifting mechanisms are furnished in three basic types : plain lever, packed lever and air-operated devices.

The plain lever (Figure 10.29) can be used where no back pressure is present and where the escape of discharging vapors is not objectionable.

Packed levers (Figure 10.30), as the name implies, are used on applications where leakage around the shaft cannot be permitted and where back pressure is present.

In addition to its use for periodic testing, lifting mechanisms may also be used :

1. To lift the disc from the valve seat periodically to make sure the disc is not frozen as a result of corrosion, caking or other flowing media deposits.

2. To remove foreign particles which are sometimes trapped under the seat as the valve closes. This sometimes stops leaks by immediate cleansing of the flowing fluid, lowers maintenance cost and avoids shutdowns.

3. For venting purposes—piping and/or equipment.

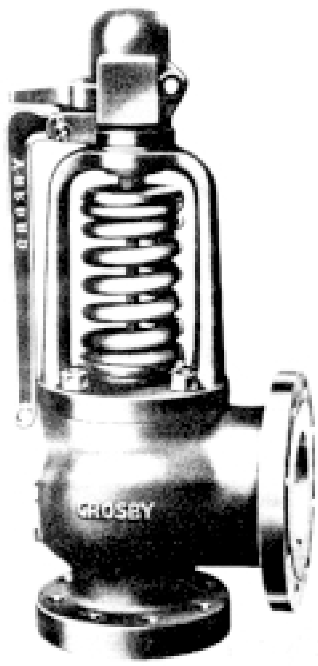


Fig. 10-28. Enclosed valve bonnet are not necessary for clean services that may be released safely to the atmosphere.

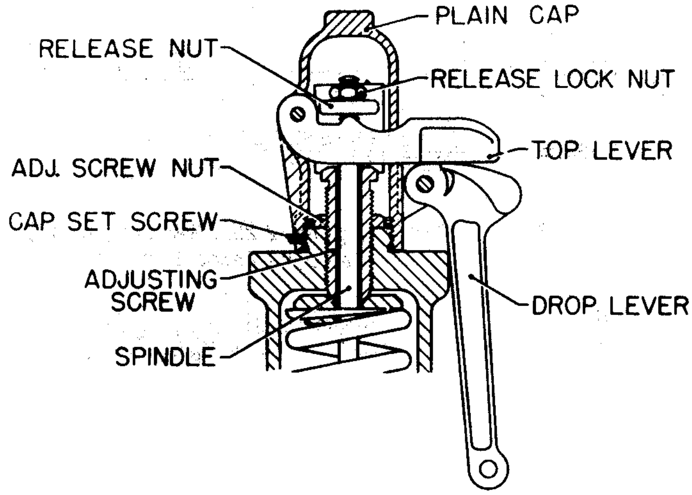
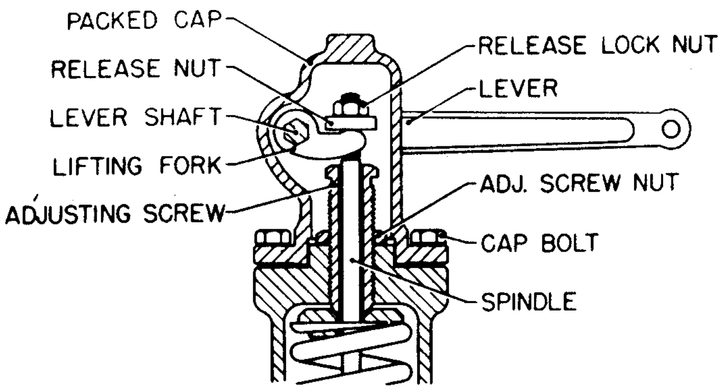
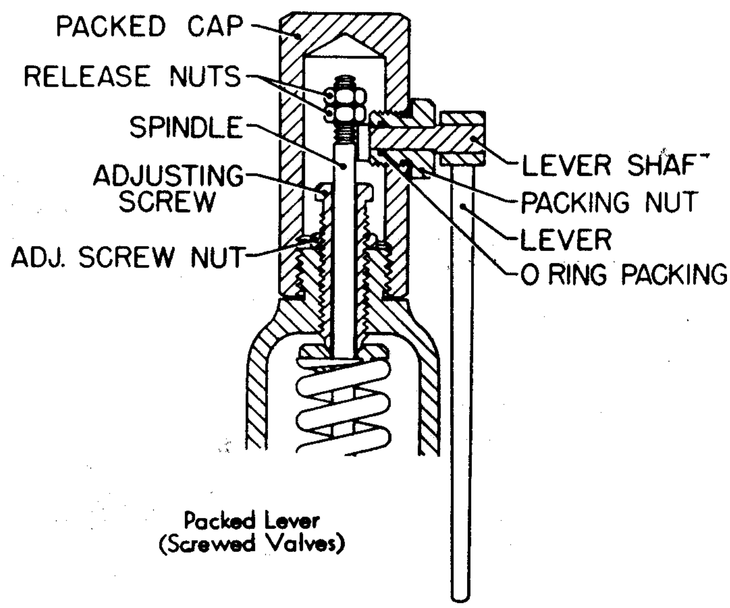


Fig. 10-29. Plain lifting levers are used on services where escape of discharging gases to the atmosphere is not objectionable.



Packed Lever
(Flanged Valves)



Packed Lever
(Screwed Valves)

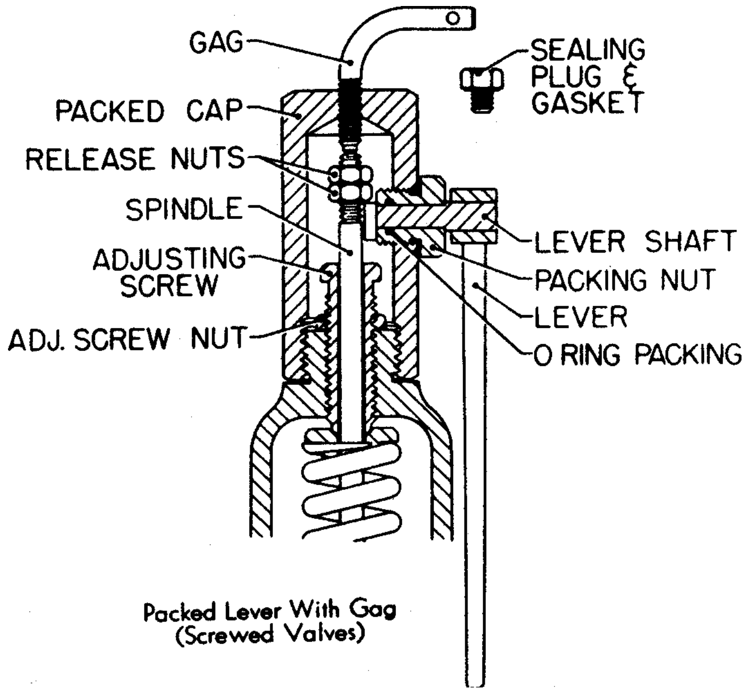
Fig. 10-30. Packed lifting levers are used where back pressure is present and discharging vapor must be contained.

Gags

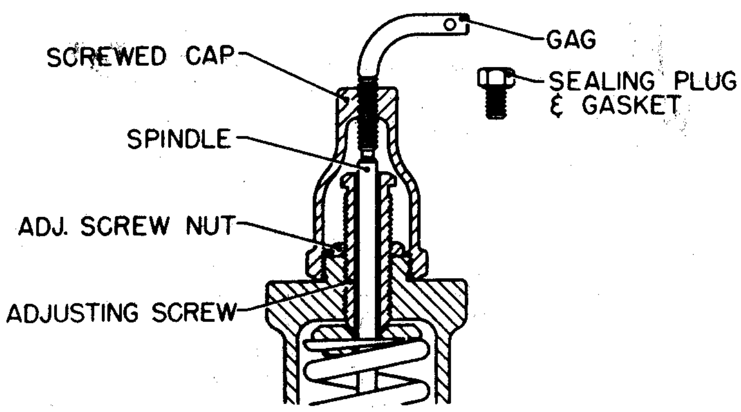
The purpose of the gag (Figure 10.31) is to hold the safety relief valve closed while equipment is being subjected to a pressure greater than its set pressure. The valve may left in place during a hydraulic test to avoid the cost of removal and reinstallation. The gag should be removed after using and never left on the valve.

Caps

Relief valves are normally furnished with screwed caps (Figure 12.40) but are optionally furnished with bolted caps (Figure 12.41).



Packed Lever With Gag
(Screwed Valves)



Screwed Cap With Gag
(Flanged Valves)

Fig. 10-31. Gags are used when the need arises to hold the valve closed while operating or testing the system at pressures above the set pressure.

CHAPTER - 11

APPLICATION OF VALVES

11.1 RECOMMENDED VALVE SERVICES

This section deals with the more common valves which are used to control flow in a piping system. Control of flow, as used here, refers to fully open, fully closed, or throttling services. Included in this category are the following valves :

Gate Y-valves	Diaphragm	
Globe	Plug	Safety Valve/ Relief Valve
Angle	Ball	
Needle	Butterfly	

Table 11.1

	Services							
Valve	On-Off	Throttling	Diverting flow	Freq. Oper.	Low Press. Drop	Slurry Handling	Quick Opening	Pressure Relieving
Gate	X				X		X	
Globe	X	X*		X				
Plug	X	X*	X	X	X		X	
Ball	X	X*	X	X	X		X	
Butterfly	X	X		X	X	X	X	
Diaph.	X	X*				X	X*	
Y		X*		X				
Needle		X						
Safety Valve								X

* Certain configurations only.
** All of these valves may not be completely free draining, but they trap a minimum amount of fluid in the line.

Table 11.1 supplies the recommended services for the various valves. This will serve as a preliminary guide as to the type of the valve to be considered for a specific service.

Table 11.2 summarizes the size ranges and operating ranges of the conventional valves. The ranges shown are average and will vary between manufacturers. Maximum figures are shown, which may not be attainable in all materials of construction. The same applies to the size ranges.

Table 11.2 Size and Operating Ranges of Valves

Valve	Sizes-Inches		Operating Ranges			
			Temperature, °F		Pressure, psi	
	Min.	Max.	Min.	Max.	Min.	Max.
Gate	1/8	48	-455	1250	Vacuum	10,000
Globe	1/8	30	-455	1000	Vacuum	10,000
Plug, lubricated	1/4	30	-40	600	Atm.	5,000
Plug, nonlubricated	1/4	16	-100	425	Atm.	3,000
Ball	1/4	36	-65	575	Atm.	7,500
Butterfly	2	36	-20	1000	Vacuum	1,200
Diaphragm	1/8	24	-60	450	Vacuum	300
Y	1/8	30	-455	1000	Vacuum	2,500
Needle	1/8	1	-100	500	Vacuum	10,000
Pinch	1	12	-100	550	Vacuum	300
Slide	2	75	0	1200	Atm.	400

Table 11.3 Check Valve Service Requirement

Service Requirement	Swing Check	Tilling Disc Check	Lift Check	Double Disc Check
Fast Closure speed	3	1	1	1
Variable flow condition	3	2	1	3
Prevent slam	3	1	1	1
Low Pressure drop	1	2	3	2
Seat tightness	1	3	2	3
Ease of Maintenance	1	3	2	2
Use in Dirty System	1	1	3	1

Relative ranking 1 = Highest

2 = Intermediate

3 = Lowest (This does not indicate poor type of valve it is a relative ranking)

11.2 APPLICATIONS & RELATIVE MERITS OF VALVES :

Many industrial processes require different services from valves. The following chart describes service, which can be obtained from a particular type of valve. Correct selection of valve will only render required service without problem.

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CHAPTER - 12

VALVE MAINTENANCE AND STORAGE

12.1 SAFETY

While taking up any maintenance job the related safety aspects should always be kept in mind and never be ignored. Following steps must be observed :

a) Obtain a ‘permit to work’ from competent authority, permit must specify the valve(s) to be taken up for maintenance : inform the steps to be taken for isolating the valve(s) from the system. Take proper protection for industrial and radiological safety point of view for valve.

b) Ensure that the valve is isolated from both the sides.

c) Drain the pipeline before working and be sure of the nature of the fluid being carried through the pipe. If the line handle liquid of corrosive nature use required personnel protective equipment : if it contains flammable gas arrange for purging by inert gas and keep fire fighting equipment ready nearby.

d) Allow the valve to cool down sufficiently.

e) Clean the surrounding area, make proper access to the working place : Take care of other hot lines, if any, around the valve.

f) Choose right tools. Consult manufacturer instruction for special tools, if required.

g) Keep valve on proper support.

h) Allow only authorised persons in the work area.

12.2 ROUTINE MAINTENANCE :

Good maintenance includes periodic inspection of valves, proper lubrication of all moving parts, attending small leaks immediately before they develop into big ones necessitating plant shut down for maintenance. Small leaks through glands or flanges may often be stopped by tightening the packing nut of flange bolt respectively.

For repair of various types of valves, the main areas need to be looked into are :

a. Visible outside leaks from

- Joints & Flanges.
- Gland packings.

b. Maintenance of valve seats & discs.

c. Operational difficulties.

12.3 VISIBLE OUTSIDE LEAKS

12.3.1 Joints and Flanges

Theoretically Gaskets are not necessary :

If two mating surfaces are machined is a perfect match and clamped together nothing would extrude between the faces.

But the high cost of the precision finishing necessary for this perfection makes it impractical to produce such surfaces. Hence gasket is the answer.

Basically a gasket is a piece of malleable material placed between two surfaces. It is compressed until it is squeezed in to the scratches, gaps and general irregularities which exist up all machined or moulded faces. By ruling these imperfections, the gasket blocks leakage paths.

So the main function of gasket, is to create a seal between two adjoining faces which will contain or bar liquid, gas or vapour, and simultaneously exclude dirt and contaminants.

It has to perform this function for the desired type of application.

12.3.2 Gland Packing :

Details have been already discucussed in seals manual. Compatible material of gland packings should be used and should be tightened with light gland pressure.

12.4 MAINTENANCE OF VALVE SEATS AND DISCS :

(Gate valve and safety valve have been taken as examples for maintenance)

Lapping is an operation of bringing surfaces to a high degree of smoothness. So it is in use for reconditioning valve seats and discs.

A. In general lapping is method of :

i) Improving surface texture

ii) Producing flat surfaces and true diameters

iii) Correcting dimensional errors.

B. This is accomplished by removing extremely small amount of material by means of lapping compounds.

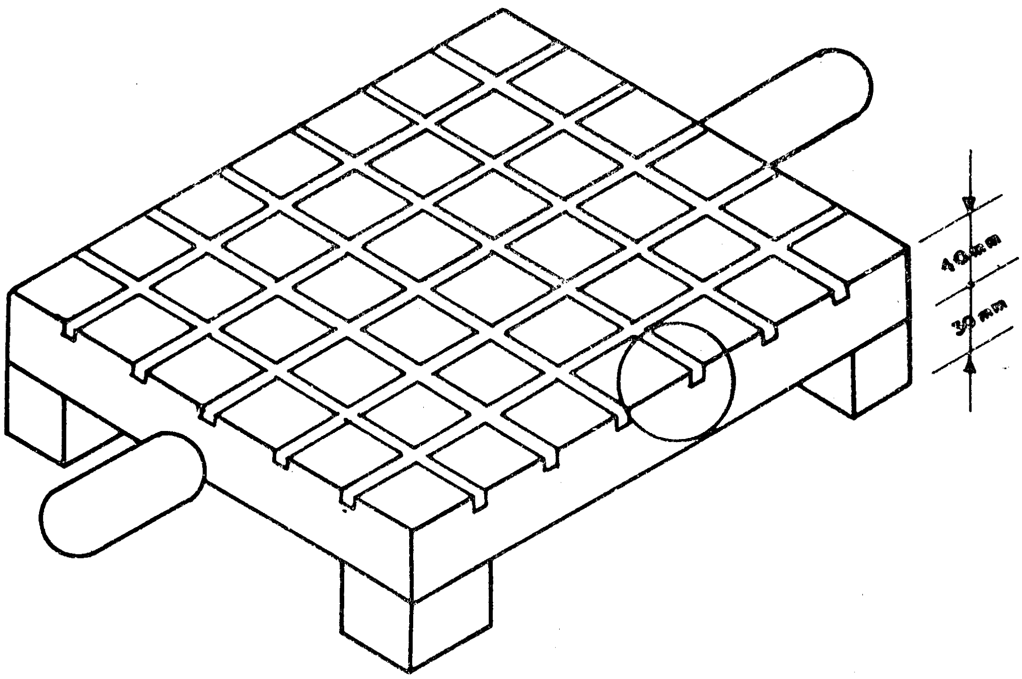
C. This lapping tool material should be softer than the material to be lapped. In valves, valve seats and discs are lapped independently to prevent any passing through the valve when the valve is in closed position.

12.4.1 Lapping of Valve Discs :

Lapping of valve discs with flat surfaces such as Stop Valves, Gate Valves is done on lapping plates.

Lapping plate is made of Cast Iron. It has a very flat surface. Surface has grooves as shown in Fig. 12.1. These grooves retain the lapping medium and also accomodate the material that is being removed from the disc by lapping operation.

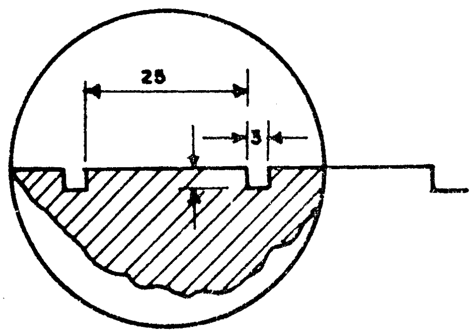
For lapping discs of regulating valves special cast iron tools are required.



700mm x 700mm x 40mm THICK
GROOVES 25mm x 25mm 3mm DEEP x 3mm WIDE

HANDELS :- APPROXIMATELY 150mm LONG x 25mm DIAMETER

FEET :- APPROXIMATELY 50mm HIGHT x 50mm WIDE.



LAPPING PLATE

FIG 12.1

Method

i) Clean the valve disc with suitable cleaner.

ii) Apply a thin layer of lapping compound to the disc. This will prevent rounding off the edge of disc.

iii) Place the disc on lapping plate and lap the disc imparting a semirotary movement to the disc. On large size discs two men may be required for this operation.

iv) Final lapping of the disc is done by using fine grade lapping compound.

12.4.2 Seat Lapping Plate :

These usually consist of two pieces .

i) The Cast Iron Lapping Disc with a dead flat surface in which a number of slots have been cut.

ii) A pilot, which fits closely into a recess in, the lapping plate and secured by a screw to it or directly screw in to the lapping disc.

The pilot is such of a diameter as to give enough clearance in the seat bore to allow for a slight eccentricity of motion when lapping the seat.

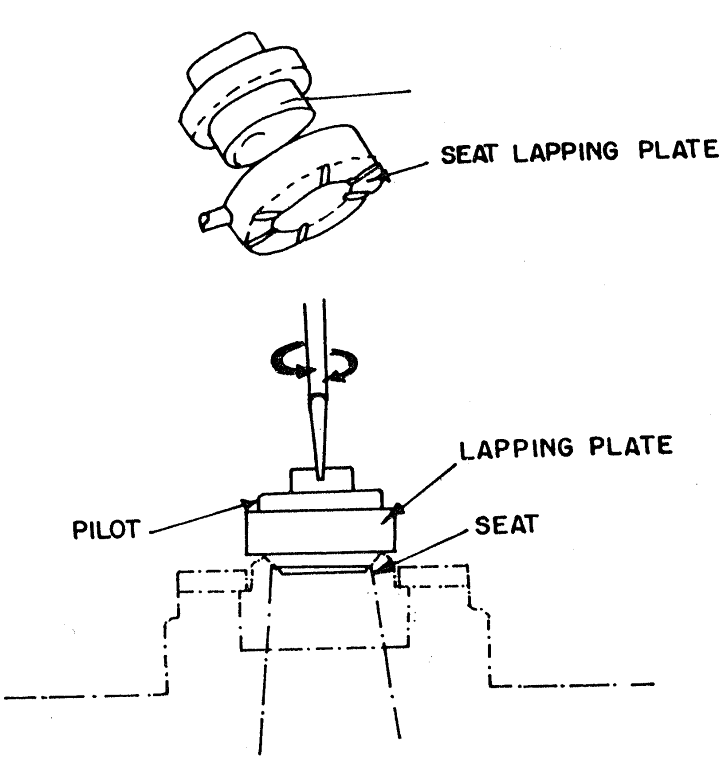
Method :

The lapping operation is carried out by a semirotary movement of the plate on the seat face produced by using a handle of suitable design.

Lapping compound is introduced between seat and lapping disc. Care should be taken to keep the lapping surface flat. The pilot should be removed and the lapping plate reconditioned after use of each seat. The surfaces of the lapping plate should then be carefully cleaned with a soft clean cloth and the pilot re-fitted. Fig. 12.2 shows Lapping Process of globe valve.

12.4.3 Lapping of Wedges (Gate Valve) :

Lapping of wedges to suit the body seats is a technique obtained only by practice, owing to the variation in thickness of; cross-section, care should be taken to lap uniformly.



BODY SEAT LAPPING

FIG 12·2 a

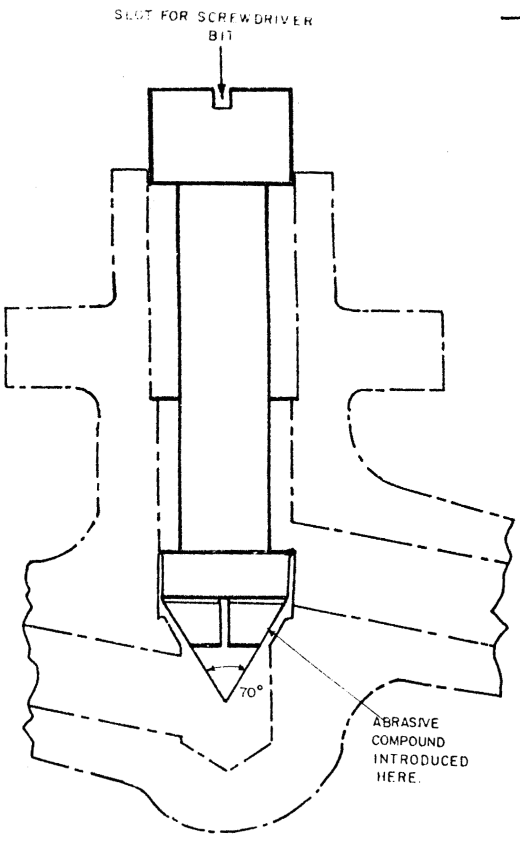


FIG – 12 ·2 b

LAPPING TOOL FOR BONNETLESS GLOVE VALVE.

12.4.4 Machining of Disc :

If the disc is only slightly pitted or scars, it can be restored by lapping operation using the lapping tools. Should the disc face be badly damaged and cannot be restored by lapping, machining will then be necessary.

For machining the disc with flat seating face

(a) Mount the disc in a lathe

(b) True the face and periphery

(c) Remove just sufficient metal to obtain a good clean. Face.

(d) Finally lap the disc as described.

For machining of disc and seats with taper seating faces, angles of seat and disc should be checked separately and machining should be done by setting the tool on correct angles.

On checking the angles of disc, it may be noticed that there is a difference between the angle of seat and disc. This difference will ensure that the bearing contact between the seat and disc is as low as possible.

Before starting the doing lapping of the wedge and seat, a contact using Prussian blue is must for ensuring uniform metal to metal contact all over the face.

12.4.5 TIPS ON LAPPING PROCEDURE :

- Keep work clean.
- A lap should not be used on more than one valve without being reconditioned.
- Always apply a very thin layer of compound to the lapping plate. This will prevent rounding off the edge of the seat.
- Replace the compound frequently after wiping off the old compound.
- Valve and seats must be lapped independently for using suitable lapping plates.
- Do not attempt to lap out deep imperfections, much time is saved by refacing.
- Keep the lapping plate clean and in good condition.
- Clean the lapping compound after lapping the body seat.

12.5 RECOMMENDED LAPPING COMPOUNDS FOR LAPPING VALVE SEATS:

Recommended lapping compound trade Name	**Grade Micron & Mesh**	**Colour Code**	**Special Instructions**	**Supplier**
Carbo Lap	Coarse 180		Use for Rough Lap Finish surface with fine lapping compound.	Bukhanvala & Sons, Bombay/
Valve Grinding	* Coarse 362 Medium 361 Fine 360		Use coarse, Medium Fine for Surface Finish Progressing from rough to fine.	Carborundum Universal Ltd. Madras.
Hind Lap. Co.	Course	Red	Use oil soluble high concentration compound.	LM Van Mop Moppes Diamond Tools India Ltd. Madras - 11
	Medium M_1 6/12	Green	Use a little oil along with paste.	
	Fine F1 0/2		Use coarse, Medium & Fine for surface finish progressing from rough to fine.	
Triefus	Coarse S 80/68	Pink	Use only for rough Lap. Finish surface with fine.	Macniel & Magor Ltd.
	Medium	Dark Red	Lap. Compoind use oil with paste. Use high concentration compound.	

12.6 OVER HAULING SAFETY VALVES :

12.6.1 General :

Whenever a safety valve requires overhaul always follow the manufacturers instructions.

The following headings on Safety Valves apply to a particular type but the information set out on this particular valve also applies to all other safety valve which are basically the same.

All safety valves are tested by the manufacturer to give a clean popping action and to reseat tightly. But if necessary make final adjustments to meet the requirements on site.

It is advisable to blow all safety valves by means of the casing gear before setting, to dislodge any scale, etc. that may cause damage to the seat faces. This should be carried out when the pressure is about 20% below the lowest set value.

12.6.2 Safety valve floating :

When commissioning boilers it is so important to check and adjust, if necessary, the opening or set pressure and the shut or blow-down pressure. This is known as floating and the floating of safety valve is normally done when the boiler is off load. If facility of testing valves in shop floor is available then same basic concepts are used for setting of all safety valves.

Procedure :

a. Check that boiler pressure is below 80% of the lowest set value. It is advisable to fit a pressure gauge and siphon at drum level, this can normally be fitted to the inspector connection of the pressure gauge control valve on the boiler drum. Also make arrangements to signal to the boiler operator for raising or lowering the boiler pressure as required.

b. Remove casing gear from the top of the valves i.e. padlock, pin, for lever and unite top cap.

c. Slightly release compression screw, remove split compression collars and return compression to its original setting.

d. Fit test gags firmly but not tight to all valves except the highest set valve. (When floating safety valves, it is advisable to start with the highest set valve). It is important that at no time should all valves be gagged. This is in case of an uncontrolled rise in pressure.

e. Raise boiler pressure to blow first valve being floated. Should pressure rise above set pressure of valve, ease off spring compression gently but firmly via the compression screw (use a good fitting spanner with about 3ft. leverage.)

   As soon as the valve opens signal, the boiler operator to lower boiler pressures. To increase Set pr. tighten the compression screw. Note the open and shut pressures, the difference between them is the blow down and should be within 4% of the B.O.P. A very short blow down is not recommended as pressure is then too close to the balance of the spring load, and over pressure will cause the valve to open and shut more than is necessary.

f. To adjust blow-down, first gag the valve.

g. Remove top adjusting ring pin, the adjusting ring can then be moved to the right or left easily with a screwdriver through the hole and engaging into the notches in the adjusting ring, move ring 10 notches at a time until required blow-down is reached.

h. Move adjusting ring to the right (up) to decrease blow-down and to the left (down) to increase blow-down. The pin should be replicated after each adjustment, making sure that it is engaged in the notch.

i. The lower adjusting ring is used to obtain a clean popping action and to cushion the closing action of the valve. The lower ring must not be used to adjust blow-down. Should the valve simmer for a short period after shutting, gag valve remove lower adjusting ring pin and with a screwdriver, raise the ring one notch at a time to remove simmer or buzzing. When satisfied with the test, proceed to the next valve and so go down to the superheater safety valve. It is advisable to allow time to let the valve cool down before giving the next blow. Forced or artificial cooling should not be employed.

j. When testing is complete remove the gags, fit compression rings; modify if necessary, and replace top gear.

Maintenance of Safety Valve :

a. Remove casing gear, remove lifting nut from the spindle, and release spring compression. Remove split compression collars, and retain them for each valve as a guide when resetting, the set pr. Where a lock nut is used instead of a collar, this should be loosened and left in position for resetting the set pressure.

b. Remove pillar nuts, bridge, spring and valve guide retaining plate, lift out spindle and valve assembly.

c. Remove the two adjusting ring pins, these are screwed through the valve chest, the lower ring pin is the longer of the two.

d. Lift out guide complete with top adjusting rings. The valve assembly spindle and guide must be handed carefully.

e. Make a note of the position of adjusting rings on both guide and seat as this will assist when resetting.

f. If there is any imperfection on seat or disk lap them.

Cast iron Lapping Plates and Cast Iron ring lap are recommended for lapping of valve seats. Never lap disk against seat.

g. Check the straightness of spindle.

h. Clean all the parts and assemble.

12.7 OVERHAULING A WEDGE GATE VALVE

(Refer Fig. 12.3)

12.7.1 Dismantling :

a. Mark and stamp the valve correctly.

b. Rotate the handwheel of the valve to keep the wedge in mid-position.

c. Loosen the nut indicated in the figure to remove the yoke assembly (apply rustoline if required)

d. Rotate hand wheel to close the valve. Rotate further so that yoke assembly raises on the stem.

e. Carefully remove the yoke assembly from the valve.

f. Loosen the gland nuts and remove gland flange and gland follower.

g. Loosen nut of the sleeve and remove the sleeve from pressure sealing bonnet.

h. Loosen the check nut with 'V' spanner. (Apply Rustoline if required.) Do not damage the slot on the nut while loosening.

i. Remove the cover plate, lock tube and split ring.

j. Re-assemble yoke on body.

k. Rotate handwheel for opening the self-sealing bonnet along with sealing ring and supporting ring is pulled out from position.

l. Remove yoke. Pull out pressure seal bonnet along with other components.

m. Remove wedge from stem.

n. Mark the position of wedge.

o. Remove stem from self-seal bonnet.

p. Remove old gland packing from self-sealing bonnet.

12.7.2 Inspection :

a. Clean all the components of the valve thoroughly using wire brush, kerosene cotton waste.

b. Inspect bonnet-sealing surfaces for amy damage.

c. Inspect spindle surface. Inspect spindle threads for any damage.

d. Check wedge of the valve for any damage.

e. Inspect studs & nuts for any damage.

f. Inspect flange faces of the valve.

g. Inspect the body seat of the valve for any damage.

h. Inspect Wedge seating areas.

12.7.3 Lapping of Valve Wedge

a. Clean the wedge thoroughly using proper cleaner.

b. Depending on the extent of damage to the wedge seating surface apply lapping compound to the well-cleaned cast iron lapping plate.

c. Start lapping operation by giving semirotary motion to the wedge on the lapping plate in clock wise & anti-clock wise direction.

d. Do not apply excessive pressure on the wedge.

e. Continue the operation with coarse lapping compound till all scratches are removed from the wedge-seating surface. Change the lapping compound frequently during the lapping operation. Always clean the old lapping compound from wedge & lapping plate before applying new lapping compound.

Use a fine grade-lapping compound to finish the job. After completion of lapping clean the wedge thoroughly using proper cleaner.

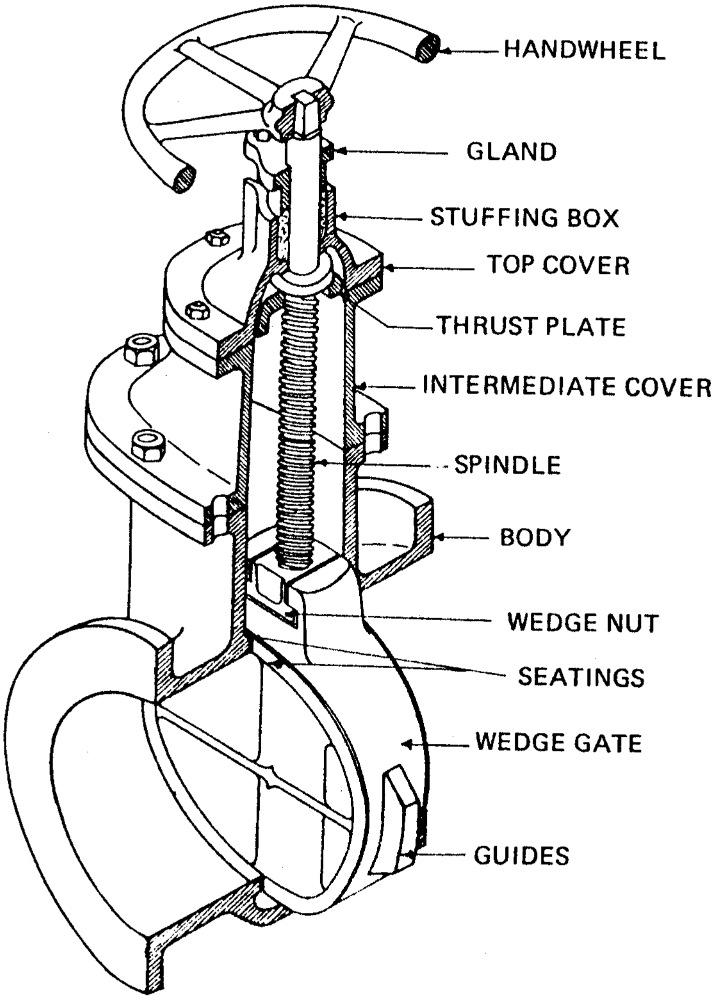


Fig. 12·3

12.7.4 Lapping of Body Seat

a. Clean body seat before lapping.

b. Check your cast iron lapping tool for flatness.

c. Apply a small quality of coarse lapping compound sparingly on the cast iron lapping tool.

d. Insert the guide in the lapping tool.

e. Place lapping tool into the body.

f. Start lapping the seat by giving semirotary motion to the lapping tool in clock-wise & anti-clock wise direction alternately.

g. Excessive pressure should not be applied.

Following is the procedure for lapping gate valve body by a special lapping tool.

Description of tool

This tool consists of driving units for driving the lapping disc and a clamping arrangement to fix on to the Valve Body.

The driving unit has the lapping disc at the one end and at the other end the handle to rotate the lapping disc. Lapping disc and the handle are connected by sprocket and chain. For the purpose of rough lapping adapter is provided to mount pneumatic driving units.

Clamping assy. consists of swivelling arrangements and fixing plate. This assembly also has provision for applying pressure on lapping disc.

Setting the lapping unit :

a. Select the lapping disc and base plate for the valve; size (refer chart) and clamp the lapping disc.

b. Fix the clamp assembly on the base plate. The base plate assembly is placed on the top flange of the valve body and clamp the base plate assembly with stud and nut available with the valve.

c. Place the unit inside the valve body through the base assembly and clamp the holder with clamp assembly.

d. Make the lapping disc to touch the seat ring uniformly by raising or lowering the lapping unit by loosening the holder and tighten this holder when the lapping disc is in full contact with the seat ring.

After this setting do not disturb the holder.

Lapping procedure :

a. After the above setting, remove the lapping unit from the valve body.

b. Apply rough lapping compound on the face of the lapping disc and place the lapping unit inside the valve body again and clamp.

c. Give the lapping pressure by tightening the Hex. Screw.

d. Rotate the handle for five minutes continuously.

e. After lapping, remove the lapping unit and clean the face of the seat ring and the lapping disc from lapping compound.

f. This process is repeated till the requirement is achieved.

g. After rough lapping, apply fine lapping compound on the face of the lapping disc and lap the seat ring as stated in step 4.

h. After fine lapping clean the seat ring face.

Apply the Blue Paste on the face of the wedge, and match the seat ring and check the area of contact.

Recondition the lapping disc.

If the surface of the lapping disc is not uniform (due to usage) remove a thin layer from this face by facing operation.

12.7.5 Sealing Rings

When there is leakage through sealing ring tighten the check nut. If the leakage continues then sealing ring has to be removed for replacing with a new one.

After remove of the bonnet from the valve, remove sealing ring from the bonnet.

Cleaning the mating surfaces of body and self-sealing bonnet. If any scratch mark is found on the sealing surface of the body remove the same by emery/lapping.

Asbestos sealing ring has to be used in carbon steel valve. Metallic sealing is used in the alloy steel valve.

In valves with metallic ring the spare ring has to be turned to suit to the bore of the body. There should be clearance of .03 mm to .05 mm between the ring and the bore.

It is important that specified amount of clearance is maintained.

12.7.6 Reassembly

a. Clean all the parts thoroughly.

b. Inserts stem through bottom of a self-sealing bonnet & apply graphite to the stem surfaces.

c. Assemble wedge with stem.

d. Insert self-sealing bonnet along with stem and wedge into the body carefully not damaging body and wedge seat.

e. Keep the sealing ring in position.

f. Supporting ring.

g. Assemble the split ring in the body in correct manner.

h. Arrest split ring by keeping lock tube in position.

i. Slide down the cover plate into the body.

j. Tighten the check nut on self-sealing bonnet.

k. Assemble the sleeves on self-sealing bonnet.

l. Assemble the gland bolts to the sleeve using pin and nut.

m. Insert sufficient number of packing ring into the self-sealing bonnet.

   Make sure the packing rings are of good quality and are recommended by manufacturer for the use on that type of valve.

   Packing material should be selected taking pressure & temperature into consideration.

n. Slide gland cover on stem and press the packing rings and tighten with gland bolts & nuts uniformly.

o. Screw down yoke assembly on stem.

p. Assemble it with body through the stud bolts.

q. Tighten the nuts in proper tightening sequence.

r. Lubricate the screw section of the stem as well as bearings subjected to thrust after completion of re-assembly.

s. All the valves on completion of re-assembly are to be tested hydraulically. The seat test is carried out at a working pressure of the valve.

12.8 STORAGE

Check for any visual damage to seats or threaded components by inspection wherever possible by keeping the valve fully open. Valves should be stored under cover protecting from the open atmospheric conditions.

Ensure to store the valves with the package bores covered with card boards wooden plugs or PVC end covers.

Protect the unpainted surfaces of valve components like stem, yoke bush etc. with grease or preserving oil (Kerosene with graphite powder).

Valves should not be rested on the butt-welded ends or on the hand-wheel.

Rest the valve upright on a wooden piece or board. Avoid resting the valve on by-pass tubes.

Store the valves always with disc/wedge closed.

12.9 HANDLING

Do not handle the valves roughly. Careless handling often results in the damage to the parts.

While lifting a valve with by-pass valve assembly the hand wheel or by-pass tube should not be used for lifting the valve. The sling should be passed around the main valve body while lifting.

12.10 INSTALLATION

Before, installation clean the sealing surfaces thoroughly to remove any lubricant or surface coating using trichloroethylene or carbon tetrachloride and remove carefully all dirt, scales and foreign matter from pipe lines and valves.

Check correct direction of the medium flow while installing the valves in lines.

Valves correctly selected in accordance with their service conditions should give years of trouble free service if properly installed and regularly maintained.

Valves should be installed at proper locations where there is adequate space for convenient operation and maintenance.

It is preferable to mount the valve with spindle in vertical position as far as possible.

Assemble the valves with pipelines in such a way that both valve and pipe flanges are square and tighten the bolts only after ensuring that the flanges are parallel. For weld-end valves care should be taken to avoid distortion which may cause line strains. The welds should be properly stress relieved.

Flange bolts must be tightened uniformly and in easy stages. Do not pull individual bolts to limits, instead tighten bolts on diametrically opposite sides of flanges until all bolts are uniformly tightened.

Keep valves tightly closed during installation. This will prevent damage to seats or disc surface due to foreign matter getting lodged in between the seats.

Do not force pipe into screwed end valve. Apply appropriate size wrench on the grip strips or sockets ends of valves nearest to pipe. Excessive wrench tightening may result in distorted shapes and leaky joints.

In case of leakage of flanges uniformly tighten all the bolts just sufficient to arrest leakage.

Do not reason to external welding of any structural member to valve body for fixing/ supporting the valve.

Provide adequate room for accomodating hand wheel and stem for full lift of valve.

Adequately support room for actuator in case of motor operated valve when installed in vertical lines.

During installation of electrical motor operated valves ensure to check the following :

a. Correct size of cables, relays contractors and fuses.

b. Check for correct operation of limit switches and torque switches. Do not tamper with the torque switches, which are factory set.

c. Check correct direction of rotation of motor for opening and closing of valve.

d. Check oil level in gear box.

e. Check for any leakage of gear oil at gasket joints.

f. Check for hand wheel disengagement when power supply is given to actuator.

CHAPTER - 13

VALVE INSPECTION AND TESTING

Following is the Indian Standard for Valve inspection and test (First Revision) prescribed by Indian Standard Institution [IS: 6157- 1981]

13.1 SCOPE

Covers inspection and pressure test requirements for valves such as gates, check, plug and ball type. This standard may be used for other types of valves when it is specified in the individual valve standards or subject to agreement between the manufacturer and the purchaser if not specified in individual valve standards.

13.1.1 Inspection

a. Inspection at manufacturer's Plant → If inspection by purchaser is specified in the purchase order, it shall be done at the manufacturer's plant. All reasonable facilities shall be given to the inspector for satisfying himself that the valves are manufactured in accordance with relevant standards and the purchase order.

b. Inspection Outside Manufacturer's plant → If inspection of shell components produced at other than the manufacturer's plant is specified in the purchase order, these components shall be inspected by the purchaser's inspector at that location or at the valve Manufacturer's works subject to agreement between the purchaser and the valve manufacturer.

c. Extent of Inspection → Normally inspection by the purchaser shall be limited to the following :

- Visual examination of any finished component in the assembled valve. Visual examination of castings to ensure conformity to IS: 8092-1976 'Surface quality of steel Testing for valves and fittings (Visual method).

- Dimensional check of the finished valve.

- Dimensional checks of the valve components. These checks shall be carried out when agreed to between the manufacturer and the purchaser.

- While witnessing of shell and seat pressure tests as specified in this standard, the purchaser's inspector may waive any part of normal inspection.

- If specified in the purchase order, non-destructive testing, such as radiography and magnetic particle, on casting and forging shall be carried out by the manufacturer to an agreed procedure or specification. In the presence of purchaser's inspectors either at the valve manufacturer's plant or at the place of the supplier of the components. If copies of the relevant test certificates are to be given, this shall be so stated in the purchase order, including the number of copies required.

- Material used for various components of valves shall be as specified in various specifications, indicated in the relevant individual valve-type standards. Any requirements of certificates for, physical test and chemical composition of materials shall be stated in the purchase order.

- If inspection is specified, the valve manufacturer shall give at least seven-day notice on the availability of valves for inspection and tests.

- Valves shall normally be tested before painting/primer coating. However, if phosphate coating is a normal practice of the valve manufacturer before assembly, such coating need not be removed before testing. If pressure tests in the presence of the purchaser's representative are specified in the purchase order, painted values from stock may be retested without removal of paint. In case of valve with permanent lining such as PTFE, rubber, glass etc, the purchaser may specify pressure test on the shell prior to lining of the valve in addition to such tests on shell following lining.

13.1.2 Pressure Test

The pressure tests indicated in this standard shall be carried out on each valve.

a. **Shell Test** → the hydrostatic test for the shell of the valves shall be carried out at a gauge pressure not less than 1.5 times the pressure rating at 38^0C rounded off to the next higher 1 bar increment. During these tests discs or wedges, plugs shall remain in the open position and balls in the half open position. The packing gland in valves with stuffing box shall be sufficiently tight to maintain the test pressure. Visually detectable leakage through pressure boundary walls is not acceptable. There shall be no harmful inelastic deformation during or after tests. Leakage from packing shall not be the cause for rejection, if it could be demonstrated that the packing will not leak at the rated working pressure of the valve.

b. **Back Seat Test →** This hydrostatic test shall be made on gate and globe-valve by applying pressure inside the assembled valve, with the valve ends closed, valve fully opened and either with stem packing removed or completely loose. Back seat test pressure shall be same as that of seat test pressure.

c. **Seat test (Air) →** Valves shall be subjected to an air seat test at any pressure between 5.5 to 6.9 bar gauge. In case pressure rating is less than 5.5 bar air seat test pressure, if specified in purchase order, shall be equal to pressure rating. There shall be no leakage during the test.

On valves intended for low differential pressure service or vacuum service, a low-pressure are seat test shall be carried out by the manufacturer, if so specified in the purchase order. The test pressure then shall be specified by the purchaser and witnessed by purchaser's representative, if so desired. The pressure shall be applied as given below :

i) Globe-valves; under the disc.

ii) Check-valves; This test is not required; and

iii) Gate, plug and ball valves successively to each side of the closed valve. For Valves designed for flow in one direction only and so marked on the valve the pressure shall be applied on the upstream side of the valve only.

In all cases the valve shall be in the closed position with the side not under pressure open to atmosphere for detection of leakage.

For valves in double block and bleed application and for valves with independent double seating, the pressure shall be applied inside the bonnet or body with the discs closed and both sides open for inspection.

Plug and ball valves shall be operated from fully closed to fully open position three times to demonstrate satisfactory mechanical operation and continued tightness after operation. It is permitted to charge sealant before testing on valves relying on sealing compound to effect seal.

d. **Hydrostatic Seat Test :**

The seat test shall be made with seat clean and free of oil. However, if necessary to prevent galling, the seats may be coated with a film of oil of viscosity not greater than that of kerosene. This requirement does not apply to a valve in which a lubricant provides the primary seal. The seat test shall be carried out by closing the valve in the normal manner.

Valve shall be subjected to hydrostatic seat tests at a gauge pressure not less than 110 percent (the hydrostatic seat test pressure shall not exceed the body rating or seat rating whichever is lower) of the rated pressure 38^0C rounded off to the next higher 1 bar increment. This shall be applied as specified in the seat test (air). There shall be no visible leakage during the test.

For check valves the hydrostatic seat pressure shall be applied on the down stream side. In addition to this, check valves shall also be tested on the down Stream side to 25 percent of the hydrostatic seat test pressure.

No leakage is permissible during these tests.

13.2 INTEGRITY TESTING IN SAFETY VALVES

13.2.1 Purpose

The purpose of these tests is to establish that each and every safety valve is adjusted to suit its operating requirements and is able to withstand the specified pressure and temperature. This is based on ISO 4128 - 1981 (E).

13.2.2 General

All temporary pipes and connections and blanking devices shall be adequate to withstand the test pressure.

Any temporary welded-on attachments shall be carefully removed and the resulting weld scars shall be ground flush with the parent material. After grinding, all such scars shall be inspected by magnetic particle or fluid penetrant techniques.

All bourdon tube pressure gauges or other recognized pressure measuring devices fitted to test equipment shall be regularly tested and calibrated in accordance with the appropriate national standard, to ensure accuracy.

13.2.3 Hydraulic test

a. Application

The body seat of safety valves shall be blanked off and a test pressure of 1.5 times the maximum pressure for which the safety valve is designed shall be applied only to the part of the body at the inlet side of the seat.

Safety valves to be installed with a free discharge or where the only back pressure is built-up back pressure do not require a hydraulic test to be applied to that part of the valve on the discharge side of the seat. In the case where a safety valve is to be subjected to a superimposed back pressure or valves on closed discharge systems (closed bonnet valves) then a hydraulic test of 15 times the maximum back pressure on the valve shall be applied to those parts on the discharge side of the seat.

b. Duration of the hydraulic test

The test pressure shall be applied and maintained at the required pressure for a sufficient length of time to permit a visual examination to be made of all surfaces and joints, but in any case for not less than the times detailed in table 13.1. For tests on the discharge side of the seat the testing time shall be based on the pressure specified in point a of 13.2.3 and the discharge size.

c. Safety requirements

Water of suitable purity shall normally be used as the test medium. Where other testing media are used, additional precautions may be necessary.

Valve bodies shall be properly vented to remove entrapped air.

Materials which are liable to failure by brittle fracture are incorporated in that part of the safety valve which is to be hydraulically tested, then both the safety valve, or part thereof, and the testing medium shall be at a sufficient temperature to prevent the possibility of such failure.

No valve or part thereof undergoing pressure testing shall be subjected to any form of shock loading, for example hammer testing.

13.2.4 Pneumatic test

a. Application

Pressure testing with air or other suitable gas should be avoided but may be carried out in place of the standard body hydraulic test with the agreement of all parties involved only in the following cases :

a) Valves of such design and construction that is not practicable for them to be filled with liquid; and/or

b) Valves that are to be used in service where even small traces of water cannot be tolerated.

The test pressure and method of application of this pressure shall be as required by point **a** of 13.2.3.

b. Duration of pneumatic tests

The times and conditions of these tests shall be as indicated in point **a** of 13.2.3.

Table - 1 : Minimum duration of hydraulic test

Nominal valve size DN	Pressure rating		
	Up to and including 40 bar	Over 40 bar upto and including 64 bar	Over 64 bar
	Duration in minutes		
Up to and including 50	2	2	3
over 50 up to and including 65	2	2	4
over 65 up to and including 80	2	3	4
over 80 up to and including 100	2	4	5
over 100 up to and including 125	2	4	6
over 125 up to and including 150	2	5	7
over 150 up to and including 200	3	5	9
over 200 up to and including 250	3	6	11
over 250 up to and including 300	4	7	13
over 300 up to and including 350	4	8	15
over 350 up to and including 400	4	9	17
over 400 up to and including 450	4	9	19
over 450 up to and including 500	5	10	22
over 500 up to and including 600	5	12	24

c. Safety requirements

The hazards involved in pneumatic testing shall be considered and adequate precautions taken. Attention is drawn to some relevent factors, namely :

If a major rupture of the valve should occur at some stage during the application of pressure, considerable energy will be released; hence no personnel should be in the immediate vicinity during pressure raising (for example a given volume of air contains 200 times the amount of energy that a similar volume of water contains, when both are the same pressure).

The risk of brittle failure under test conditions shall have been critically assessed at the design stage and the choice of materials for valves which are to be pneumatically tested shall be such as to avoid the risk of brittle failure during test. This necessitates provision of an adequate margin between the transition temperature of all parts and the metal temperature during testing.

Attention is drawn to the fact that if the gas pressure is reduced to the valve under test from high pressure storage, the temperature will fall.

Valves undergoing pneumatic test should not be approached for close inspection until after the pressure raising has been completed.

No valve undergoing pneumatic test shall be subject to any form of shock loading.

Precautions shall be taken against pressures generated in excess of test pressure.

13.2.5 Adjustment of safety valve cold differential test pressure

It is not permissible to adjust the cold differential test pressure of a safety valve using air or other gas as the test medium unless the safety valve has previously been subjected to the standard integrity test in accordance with 13.2.3 or 13.2.4

13.3 HYDROSTATIC TESTING OF STEEL VALVES

(MSS-SP-61)

13.3.1 Scope

a) Valves shall be capable of meeting the requirements set forth in this standard Practice.

b) This standard practices covers seat and shell pressure testing on steel gate, globe, angle and check valves designed and made of materials to merit the rating established in American Standard ASA B 16.5.1957.

13.3.2 Specific Test Requirement

a) All tests shall be made by the manufacturer at the manufacturer's plant.

b) Test fluid for hydrostatic shell test and for hydrostatic seat test shall be water.

c) Hydrostatic shell test shall be made at the test pressure specified in Tables I of 13.2 and 13.3.

d) Hydrostatic shell test shall be made at the test pressure specified in Tables II or 13.3 and 13.4.

e) Air seat test, when used, shall be made at the test pressure specified in Tables 13.3 and 13.4.

f) When shell and seat tests are being conducted with water, the valve shall be relieved of air and the temperature of the water shall not exceed 125^{0}F.

g) The minimum length of time for the hydrostatic seat test shall be in accordance with Table 13.6.

h) The minimum length of time for the hydrostatic seat test shall be in accordance with Table 13.7.

i) Valves shall not be painted before shall pressure tests are competed. If pressure tests in the pressure of Purchaser's representative are specified, painted valves from stack may be retested without removal of the paint.

13.3.3 Test Pressure

All pressure referred to in this standard practice are understand to be expressed in pounds per square inch above atmospheric pressure, i.e. pounds per square inch gauge.

13.3.4 Gate Valve

Shell Tests

a) The valve shall be given a hydrostatic shell test in the full open position with the valve ends closed.

b) Under Par 13.3.4 (a) test conditions, the valve shall shown no leakage.

c) The back seat, if provided shall then be removed from contact and the packing compressed by tightening the gland so that the stuffing box or condensation chamber, if any, will be subjected to the hydrostatic test pressure and shell show on leakage.

Seat Tests :

d) Valve shall be given a hydrostatic seat test applied successively on each side of the closed gate with the opposite side open for inspection. As an alternate the seat test may be made by applying the pressure inside the bonnet or body with the disc closed and both sides open for inspection. The maximum permissible leakage rate on each seat shall be 10 cubic centimeters per hour per inch of diameters of nominal valve size.

e) At the manufacturer's option an air seat test may be used. The test shall be conducted as described in Para 13.3.4(d). The maximum permissible leakage rate on each seat shall be 1/10 of a standard cubic feet of air per hour inch of diameter of nominal valve size.

13.3.5 Globe and Angle Valves

Shell tests :

a) Valves shall be given a hydrostatic shell test in the full open position with the valve ends closed.

b) In above test conditions, the valve shall shown no leakage.

c) The back seat if provided shall then be removed from contact and the packing compressed by tightening the gland so that the stuffing box or condensation chamber, if any, will be subjected to the hydrostatic test pressure and shall show no leakage.

Seat Tests

d) Valves shall be given a hydrostatic seat test by applying the pressure under the closed disc and the other and open for inspection. The maximum permissible leakage rate shall be 10 cubic centimeters per hour per inch of diameter of nominal valve size.

e) At the manufacturer's option an air seat test may be used. The test shall be conducted as described in Pare 13.3.5 (d). The maximum permissible leakage rate on each seat shall be 1/10 of a standard cubic foot of air per hour per inch of diameter of nominal valve size.

13.3.6 Check Valve

Shell Tests :

a) Valve shall be given a hydrostatic shell test in the full open position with the valve ends closed.

b) Under Par 13.3.6 (a) test conditions, the valve shall shown no leakage.

Seat Tests:

c) Valve shall be given a hydrostatic seat test by applying the pressure above the disc, the other side open for inspection. The maximum permissible leakage rate shall be 10 cubic centimeters per hour per inch of diameter of nominal valve size.

d) At the manufacturer's option an air seat test may be used. The test shall be conducted as described in Par 13.3.6 (c). The maximum permissible leakage rate on each seat shall be 1/10 of a standard cubic feet of air per hour per inch of diameter of nominal valve size.

TABLE - 13.2

SHELL TEST

(ASA B 16.5 MATERIALS OTHER THAN TYPE 304)

PRIMARY SERVICE PRESSURE RATING, lbs	HYDROSTATIC TEST PRESSURE, Psig.
150	425
300	1100
400	1450
600	2175
900	3250
1500	5400
2500	9000

TABLE - 13.3

SHELL TEST

(ASA B 16.5 MATERIALS OTHER THAN FOR TYPE 304)

PRIMARY SERVICE PRESSURE RATING, lbs	HYDROSTATIC TEST PRESSURE, psig	AIR TEST PRESSURE psig
150	300	80
300	750	80
400	1000	80
600	1500	80
900	2200	80
1500	3600	80
2500	6000	80

TABLE - 13.4

SHELL TEST FOR TYPE 304

PRIMARY SERVICE PRESSURE RATING	**HYDROSTATIC TEST PRESSURE, PSTG.**
150	425
300	925
400	1250
600	1875
900	2775
1500	4650
2500	7725

TABLE - 13.5

SHELL TEST FOR TYPE 304

PRIMARY SERVICE PRESSURE RATING	**HYDROSTATIC TEST PRESSURE, PSTG**	**AIR TEST PRESSURE**
150	300	80
300	625	80
400	825	80
600	1250	80
900	1850	80
1500	3100	80
2500	5150	80

*See paragraphs 4(d), 5(e) and 6(d).

Table - 13.6

DURATION OF HYDROSTATIC SHELL TEST

TIME IN MINUTES, MINIMUM 1 MINUTE

Valve size in Inch.	Primary service pressure rating.							Remarks if any -
	150	300	400	600	900	1500	2500	
2 & smaller	1	1	1	1	1	1	1	Time duration is period of inspection after valve is fully prepared and under test pressure.
2½	2	2	2	2	2	4	4	
3	2	2	2	2	3	4	4	
3½	2	2	2	2	3	4	5	
4	2	2	3	3	4	5	6	
5	2	2	3	3	4	5	6	
8	2	3	3	4	5	8	9	
6	2	2	3	3	5	6	7	
10	3	3	4	5	6	9	11	
12	3	3	4	5	7	11	13	
14	3	4	5	6	8	11	-	
16	3	4	5	6	9	13	-	
18	3	4	5	7	9	14	-	
20	3	5	6	7	10	16	-	
24	4	5	6	8	12	18	-	

Table - 13.7

DURATION OF HYDROSTATIC SHELL TEST

TIME IN MINUTES, MINIMUM ONE AND HALF MINUTE

Valve size in Inch.	Primary service pressure rating.						
	150	300	400	600	900	1500	2500
2 & smaller	½	½	½	½	½	½	½
2½	½	½	½	½	½	½	1
3	½	½	½	½	½	½	1
3½	½	½	½	½	-	-	-
4	½	½	½	½	½	1	1
5	½	½	½	½	½	1	1 ½
6	½	½	½	½	½	1	1 ½
8	½	½	½	1	1	1 ½	2
10	½	½	1	1	1	1 ½	2 ½
12	½	½	1	1	1 - ½	2	3
14	½	1	1	1	1 - ½	2	-
16	½	1	1	1	1 - ½	2 ½	-
18	½	1	1	1 ½	1 - ½	2 ½	-
20	½	1	1	1 ½	2	3	-
24	½	1	1	1 ½	2	3 ½	-

1) Time duration is period of inspection after valve is fully prepared and under full test pressure.

2) Valves of double disc or other design that are tested by applying pressure into the internal cavity of the valve satisfy the seat test requirements if each seat is tested for the duration of time specified above.

CHAPTER - 14

VALVE TROUBLE SHOOTING

14.1 FOR GATE AND GLOBE VALVES

14.1.1 Problem : Seat passing

S.No.	Causes	Remedy
a.	Over tightening of gland bolts.	Slightly relieve the gland pr. by looseing the nuts.
b.	Insufficient lubrication for stem and yoke bush or ball bearings.	Lubricate stem, yoke bush and ball bearings according to lubrication chart.
c.	Damage to body and disc/ plug and seats.	Machine, grind and lap depending on the gate valve.
d.	In correct operation (Throttling by gate valve)	Do maintenance on disc of wedge gate valve.
e.	Setting of position limit switches for closing.	For close set only torque switch for gate valve
f.	In correct torque switch setting.	Set correct value of torque in actuator.

14.1.2 Problem : Leakage through body bonnet joint.

S.No.	Causes	Remedy
a.	Insufficient bolt tightening.	Tighten uniformly and in stages all the nuts. In case of pressure seal bonnet tighten the castle nut slightly after pressurization.
b.	Damage gasket.	Replace with new gasket.
c.	Damage to sealing surfaces of body and yoke/bonnet.	Rectify by machining the surfaces maintaining parallelism.
d.	Incorrect gasket	Ensure right type of gasket with correct material and dimensions.
e.	Yielding of gasket	Renew the gasket.

14.1.3 Problem : Leakage through gland packing.

S.No.	Causes	Remedy
a.	Insufficient gland pressure	Tighten the gland bolts.
b.	Insufficient packing rings	Fill stuffing box with sufficient number.
c.	Pitting of stem or ridges or grooves in stem surface.	Replace the stem if the damage is more.
d.	Damage packing rings	Replace all packing rings.
e.	Incorrect packing	Replace with correct one.

14.1.4 Problem : Operational difficulty

S.No.	Causes	Remedy
a.	Insufficient lubrication	Provide proper lubrication to stem.
b.	Over tightening of gland packing.	Tighten gland nut to arrest leakage through gland.
c.	Wrong connection of terminals in actuator.	Follow circuit diagram of respective actuator.
d.	Stem thread damage	Chase the threads or replace the components.
e.	Damage to ball bearing	Replace with new bearing.
f.	Stem bending	Replace with new stem.
g.	Excessive closing force	Ensure that the valves are not over tightened in the case of motor operated valves. The closing torque should not be set beyond the required setting.

14.2 FOR BUTTERFLY VALVE

14.2.1 Problem : Disc does not seat within liner because

S.No.	Possible Causes	Remedies
a.	Linkage is out of adjustment.	Adjust linkage.
b.	Key has sheared.	Replace the key.
c.	Liner has been damaged by flowing fluid.	Replace liner assembly and taper pins.
d.	Liner has swollen.	Notify to manufacturer representative.
e.	Actuator is too small	Notify to manufacturer representative.
f.	Valve has been subjected to service conditions that have exceeded the original design specifications.	Notify to manufacturer representative. Note : Liner may have to be bonded to body for vacuum or high velocity services.

14.2.2 Problem : Shaft Leakage due to non sealing of 'O' ring

S.No.	Possible Causes	Remedies
a.	O-ring seal is damaged.	Replace 'O' ring
b.	Valve shaft is scored at O-ring seal area	Remove score with polish paper or buffer.
c.	Vulcanized seal between O-ring retainer and liner has broken.	Replace 'O' ring

14.2.3 Problem : Valve shaft does not turn

S.No.	Possible Causes	Remedies
a.	Key in valve shaft has sheared.	Disconnect linkage. Try to turn butterfly valve shaft manually. If disc moves freely, simply replace key. If the shaft does not move take the valve out of the pipeline before replacing the key. Check for disc obstruction or shaft seizing in the body bore.
b.	Liner is swollen.	Notify your manufacturer representative.
c.	Actuator size is too small.	Notify your manufacturer representative.

14.2.4 Problem : Valve shaft turns but the valve does not control fluid

S.No.	Possible Causes	Remedies
a.	Pins have sheared.	Take the valve out of service, remove it from the pipeline and inspect for disc obstruction or damage. Replace the disc and shaft it the disc is chipped or broken, or if the taper pin holes in the disc are deformed. If only the shaft shows damage, or if shaft taper pinholes are deformed, replace the shaft only. If disc, shaft and taper pinholes appear undamaged, insert new taper pins and resume operation.
b.	Valve has been subjected to service	Notify your fisher representative.conditions that have exceeded the original design specifications.

14.2.5 Problem : Excessive play in the linkage

S.No.	Possible Causes	Remedies
a.	Bolts on the Clevis and adjustable lever are loose but not worn.	Tighten loose bolts.
b.	The linkage or linkage bolts are worn.	Replace worn linkage or linkage bolts.

14.2.6 Problem : Actuator fails to maintain stable position when flow requirements are constant

S.No.	Possible Causes	Remedies
a.	Positioner is out of adjustment.	See manufacturer's instruction manual for positioner adjustment necessary to stabilize operation.
b.	Excessive friction within piston actuator.	Actuator needs lubrication. See manufacturer's instruction manual for lubrication procedures.
c.	Actuator piston rod is binding within its own guide bushing.	Take valve out of service. Remove clevis bolt from linkage and remove the piston rod guide bushing. Stroke the actuator and observe the motion. If motion is smooth, problem lies within the guide bushing. The guide bushing should be replaced. Check the piston rod. If it is worn in the area, which has contacted the guide bushing, it should be replaced.

14.3 FOR SAFETY VALVES

14.3.1 Problem : Leaking of Safety valve :

S.No.	Possible Causes	Remedies
a.	Damaged Seat	• Recondition or replace the seat. • Sometimes foreign material are trapped between the seats and hold the seat apart. This problem is solved by popping the valve with lever to blow trapped particles.
b.	Tight Lifting Gear	In some cases it is noticed that the fork lever and lifting nut slightly holds the seat apart, causing the valve to leak. Readjust and correct the clearance. Usual value of clearance is about 2 mm between spindle nut and forked lever.

S.No.	Possible Causes	Remedies
c.	Distortion	This is caused by any abnormal strains, such as expansion loads or excessive weight of piping coming onto the valve body and cause misalignment of the valve parts and promote leakage. Such leaks can be stopped by relieving the strains.
d.	Improper ring Adjustment	Improper adjustment leads to leakage. Adjust rings for slightly more blowdown.
e.	Wrong operating Pressure	This is resulted due to more gap between set pressure and operating pressure. The remedy is to provide the greatest possible margin between these two pressure.

14.3.2 Problem : Incorrect popping pressure

S.No.	Possible Causes	Remedies
a.	Sticking of the moving parts	Do maintenance.
b.	Popping at very low pressure	• Seat damage, which can be correct by repairing/replacement. • Spring of safety valve may seldom be faulty hence replace with spare one.

14.3.3 Problem : Incorrect Blowdown

S.No.	Possible Causes	Remedies
a.	Improper adjustment	Adjust and lock properly the locking pin for upper and lower adjusting rings.

14.3.4 Problem : Spindle Bending

S.No.	Possible Causes	Remedies
a.	Normally occurs when the valves are gagged in cold condition.	Take utmost care to eliminate this practice.

14.3.5 Problem : Hang-up

S.No.	Possible Causes	Remedies
a.	Mechanical interference	Correct the remedy by overhauling and readjustment.
b.	Improper blow down	Readjust the blow down.

14.3.6 Problem : Valve Simmering

S.No.	Possible Causes	Remedies
a.	Setting of lower adjusting ring to low value.	Adjust the ring by raising the ring one notch by one until the simmer or buzzing is removed.

14.4 FOR PLUG VALVE

14.4.1 Problem : Passing (Internal leakage)

S.No.	Possible Causes	Remedies
a.	In adequate lubrication	• Lubricate valve thoroughly. • If grease backpressure fails to build up while lubricating, the valve is out of adjustment. The plug is not seated in the body and the lubricant that is added will be dispersed into the line.
b.	Damaged/ scored plug	Repair/ replace the plug and seating surfaces.
c.	Incomplete positioning	Correct the position of the handle.

14.4.2 Problem : Leakage

S.No.	Possible Causes	Remedies
a.	Insufficient bolt tightening.	Tighten uniformly and in stages all the nuts. In case of pressure seal bonnet tighten the castle nut slightly after pressurization.
b.	Damage gasket.	Replace with new gasket.
c.	Damage to sealing surfaces of body and yoke/bonnet.	Rectify by machining the surfaces maintaining parallelism.
d.	Incorrect gasket	Ensure right type of gasket with correct material and dimensions.
e.	Yielding of gasket	Renew the gasket.

14.4.3 Problem : Leakage Through Gland Packing

S.No.	Possible Causes	Remedies
a.	Insufficient gland pressure	Tighten the gland bolts.
b.	Insufficient packing rings	Fill stuffing box with sufficient number
c.	Pitting of stem or ridges or grooves in stem surface.	Replace the stem if the damage is more.
d.	Damage packing rings	Replace all packing rings
e.	Incorrect packing	Replace with correct one.

14.4.4 Problem : Hard Operation

S.No.	Possible Causes	Remedies
a.	Use of improper lubricant	• Lubricate valve thoroughly with the proper lubricant. • Should the valve remain difficult to operate after lubrication, loosen gland (or bonnet) slightly and relubricate valve thoroughly.
b.	Hard/ tighten glands	Loosen the gland to moderate value.
c.	Jammed plug	Open, clean and reassemble the valve with thorough lubrication.

14.5 FOR BALL VALVE

14.5.1 Problem : Passing Internal Leakage

S.No.	Possible Causes	Remedies
a.	Damaged seals	Replace the rubber seals
b.	Damaged ball at sealing portion.	Replace the ball
c.	Incomplete positioning	Correct the position with handle.

14.5.2 Problem : Leakage Through Body Bonnet Joint

S.No.	Possible Causes	Remedies
a.	Insufficient bolt tightening.	Tighten uniformly and in stages all the nuts. In case of pressure seal bonnet tighten the castle nut slightly after pressurization.
b.	Damage gasket.	Replace with new gasket.
c.	Damage to sealing surfaces of body and yoke/bonnet.	Rectify by machining the surfaces maintaining parallelism.
d.	Incorrect gasket	Ensure right type of gasket with correct material and dimensions.
e.	Yielding of gasket	Renew the gasket.

14.5.3 Problem : Leakage Through Gland Packing / ‘O’ Ring

S.No.	Possible Causes	Remedies
a.	Insufficient gland pressure	Tighten the gland bolts.
b.	Insufficient packing rings	Fill stuffing box with sufficient number
c.	Pitting of stem or ridges or grooves in stem surface.	Replace the stem if the damage is more.
d.	Damage packing rings/O-rings.	Replace all packing rings/ O-rings.
e.	Incorrect packing	Replace with correct one.

14.5.4 Problem : Hard Operation

S.No.	Possible Causes	Remedies
a.	Improper setting of the seals	Replace the seals and position correctly
b.	Hard/tighten glands	Loosen the gland to moderate value.
c.	Jammed ball	Open, clean and reassemble the valve with lubrication at operating end.

14.6.0 FOR DIAPHRAGM VALVE

14.6.1 Problem : Passing (Internal Leakage)

S.No.	Possible Causes	Remedies
a.	Damaged diaphragm	• Replace the diaphragm. • Closing with high force will result damaging of the diaphragm.
b.	Damaged seat	Recondition the seating surface
c.	Incorrect positioning	Correct the position with handle.

14.6.2 Problem : Leakage Through Body Bonnet Joint

S.No.	Possible Causes	Remedies
a.	Damaged diaphragm	Replace the diaphragm

14.7.0 FOR CHECK VALVE

14.7.1 Problem : Stuck Closed

S.No.	Possible Causes	Remedies
a.	Binding dur to rust, dirt and crud accumulation.	• Overhaul the check valve. • Ensure filtered flow.
b.	Damaged seat	Recondition the seating surface
c.	Incorrect positioning	Correct the position with handle.

14.7.2 Problem : Passing of the valve

S.No.	Possible Causes	Remedies
a.	Improper seating	• Check internal parts and rectify the problem.
b.	Corrosion, general wear, foreign material and or misalignment.	• Replace the parts in case of general wear, corrosion. • Ensure to prevent entry of foreign material. • Realign the parts such as disc, seat and other internal matching parts.

14.7.3 Problem : Leakage Through Body Cover Joint

S.No.	Possible Causes	Remedies
a.	Insufficient bolt tightening.	Tighten uniformly and in stages all the nuts. In case of pressure seal bonnet tighten the castle nut slightly after pressurization.
b.	Damage gasket.	Replace with new gasket.
c.	Damage to sealing surfaces of body.	Rectify by machining the surfaces maintaining parallelism.
d.	Incorrect gasket	Ensure right type of gasket with correct material and dimensions.
e.	Yielding of gasket	Renew the gasket.

<table>
<tr><td>NUCLEAR POWER CORPORATION OF INDIA LTD.
(A Government of India Enterprises)
Rajasthan Atomic Power Station
Nuclear Training Centre

CHECK LIST FOR WEDGE DISK GATE VALVE PRACTICE</td><td>Course No. : M-MP-2.8
Revision No. : 0
No. of sheets : 4

Prepared by R.P. Saini, SO/E
Prashant Puri, STO
Reviewed by C.M. Mishra, Enc(MT)
Approved by N. Nagaich, TS</td></tr>
<tr><td>Name :</td><td>Date of work start :
Date of work completed :</td></tr>
<tr><td colspan="2">Safety Instructions :
1. Ensure process side isolation before dismantling of equipment.
2. All openings must be blanked properly before leaving the job.
3. Valve internal components must be covered properly before leaving the job.
4. Tools and lifting tackles required for maintenance and rigging jobs should be in good working condition and have been tested withing last one year.
5. Use personnel protection to avoid injury.
6. Any spillage in working area must be cleaned immediately.
7. Use specified cleaning agent only. Kerosene etc. used for cleaning must be collected in a properly tagged air tight container before leaving the job everyday.
8. Working area must be free from unwanted materials, oils, water etc.</td></tr>
</table>

1.0 PRE-REQUISITES :

- Pre-Job briefing shall be carrying out.
- Keep all blanks ready for prevention of foreign material exclusion.

2.0 TOOLS & TACKLES :

- Spanner set
- Hollow Punch
- 2 lbs. Hammer,
- Screw Driver 8”
- Gland puller

3.0 SPARE PARTS :

a. Gland packing - cross-section ....

b. Bonnet gasket size : ....

4.0 DISMANTLING

S.No.	ACTIVITY	Observation
a.	Rotate the hand wheel to keep the wedge in the middle position.	Done/ Not Done
b.	Loosen bonnets bolt and crack the bonnet joint check for perfect isolation. If isolation is perfect, remove bonnet bolts nut.	Done/ Not Done
c.	Remove bonnet assembly carefully to avoid the damaging of valve seat.	Done/ Not Done
d.	Mark the position of wedge for reassembly purposes.	
e.	Wrap the bonnet assembly in P.V.C.	Done/ Not Done
f.	Install blank on bonnet opening with gasket.	Done/ Not Done
g.	Shift the bonnet with Yoke assembly to suitable place.	
h.	Remove the hand wheel.	
i.	Remove gland follower from the yoke assembly.	Done/ Not Done
j.	Remove gland packing.	Done/ Not Done
k.	Remove disc with stem.	Done/ Not Done

5.0 INSPECTION & MEASUREMENTS

S.No.	Part	Condition	Action taken
a.	Inspect seat condition	Ok / Worn Out / Part Damaged	
b.	Bonnet gasket.	Hard / Damaged / Ok / Part Damage	
c.	Disk seating portion	Ok / Pitting / Eroded / Part	
d.	Packing condition	Ok / Worn Out / Damaged Part	
e.	Stuffing Box	Scored / corroded / Ovel / Ok	

f.	Stem trueness and surface	Ok / Bend / Scoring / damage thread	
g.	Gland seal 'O' ring	Ok / Worn Out / Damaged	
h.	Stem threads	Ok/Damaged	
i.	Bonnet gasket seating surface of valve body flange & bonnet flange.	Ok / Pitting / Repaired.	

6.0 ASSEMBLY

S.No.	ACTIVITY	OBSERVATION
a.	Clean all parts thoroughly.	Ok / Not Ok
b.	Check blue contact of disk with seat. It should make at least 80% contact with the matching part. Contact before repairing Contact after repairing	__________ __________ __________
c.	Install the Yoke on bonnet	Done/ Not Done
d.	Insert stem from bonnet and Yoke assembly.	Done/ Not Done
e.	Assemble disk with stem.	Done/ Not Done
f.	Install gland packing.	Done/ Not Done
g.	Install gland follower.	Done/ Not Done
h.	Check valve operation by manually moving gland stem. It should be free motion.	Done/ Not Done
i.	Get new bonnet gasket from 1/8" thick Buna-N or Neoprene rubber sheet. Ensure thickness & finish is uniform.	Done/ Not Done
j.	Shift bonnet assembly on position.	Done/ Not Done
k.	Remove blank & keep for safe custody.	
l.	Clean seat by acetone/ Kerosene.	
m.	Install bonnet assembly with new gasket. Do not apply lubricant on gasket.	Done/ Not Done
n.	Tight bonnet bolts. Ensure uniform sequential tightening Do not lever on spanner.	Done/ Not Done

7.0 HOUSE KEEPING

S.No.	ACTIVITY	OBSERVATION
a.	Waste packed in PVC bag, tag & kept in disposal area.	Done/ Not Done
b.	Consumables like gasket, seal components, cotton rags etc. are disposed in waste disposal drum.	Done/ Not Done
c.	Remove all tools and tackles from location.	Done/ Not Done

8.0 TESTING

S.No.	ACTIVITY	OBSERVATION
a.	Check manual operation of the valve.	Ok/ Not Ok
b.	Observe any abnormality in the valve operation.	Ok/ Not Ok
c.	Observe leakage from valve gland.	Ok/ Not Ok
d.	Observe leakage from bonnet gasket.	Ok/ Not Ok

9.0 POST MAINTENANCE REVIEW

a. Deficiencies noticed :

b. Probable reasons for the deficiency occurred :

c. Corrective actions taken :

d. Actions taken to avoid the deficiencies in future.

NUCLEAR POWER CORPORATION OF INDIA LTD. (A Government of India Enterprises) **Rajasthan Atomic Power Station** Nuclear Training Centre **CHECK LIST FOR BUTTERFLY VALVE PRACTICE**	Course No. : M-MP-2.8 Revision No. : 0 No. of sheets : 4 Prepared by R.P. Saini, SO/E Prashant Puri, STO Reviewed by C.M. Mishra, Enc(MT) Approved by N. Nagaich, TS
Name :	Date of work start : Date of work completed :

Safety Instructions :

1. Ensure process side isolation before dismantling of equipment.
2. All openings must be blanked properly before leaving the job.
3. Valve internal components must be covered properly before leaving the job.
4. Tools and lifting tackles required for maintenance and rigging jobs should be in good working condition and have been tested withing last one year.
5. Use personnel protection to avoid injury.
6. Any spillage in working area must be cleaned immediately.
7. Use specified cleaning agent only. Kerosene etc. used for cleaning must be collected in a properly tagged air tight container before leaving the job everyday.
8. Working area must be free from unwanted materials, oils, water etc.

1.0 PRE-REQUISITES :

- Pre-Job briefing for the job.
- Keep all blanks ready for prevention of foreign material exclusion.
- Ensure complete isolation from process side.
- Make sure the valve is closed and the pipe line has been drained.

2.0 TOOLS & TACKLES :

1. Spanner set
2. Punch
3. 2lbs. Hammer,
4. Screw Driver 8”

3.0 SPARE PARTS :

1. Buna-N ‘O’ ring-2 Nos.
2. Valve Liner size

4.0 OBSERVATIONS PRIOR TO DISMANTLING :

1. Type of deficiency :
2. Type of maintenance : PM/BREAK DOWN

5.0 INSPECTION :

1. Observation of wear/damage of the valve

a	Liner condition	Ok/ Damaged
b	Steam	Ok/Worn out.
c	Flapper	Ok/Scratches.
d	O-rings	Ok/Worn out.
e	Wood rough key	Ok/Damaged
f	Bronze bushing	Ok/Worn out.

6.0 DISMANTLING

S.No.	ACTIVITY	OBSERVATION
a.	Remove gland cover plate/leakage collection adopter.	Done/Not Done
b.	Grind off pinned end of taper pins, using hammer and drift punch, remove taper pins.	Done/Not Done
c.	Pull out the stem by hand.	Done/Not Done
d.	Pull not the disc/flapper.	Done/Not Done
e.	Take out liner. For unbounded liner collapse liner at one hub and pull by hand. The liner bonded to the body may be burnt off with a torch/chipped off with a hammer and chisel.	Done/Not Done
f.	Remove primary ‘O’ ring seals from both liner shaft holes.	Done/Not Done
g.	Remove bronze bushing out with the use of bushing puller or hammer and chisel.	Done/Not Done

7.0 ASSEMBLY :

S.No.	ACTIVITY	OBSERVATION
a.	Ensure for : i) Liner material is Buna-N (or as specified) ii) For correct size & type. iii) Material is not aged out. iv) No external defects like v) Abrasion/cut etc.	 Done/Not Done Done/Not Done Done/Not Done Done/Not Done Done/Not Done
b.	Clean and roughen the back of the liner with a coarse wire brush for good bonding. Also roughen the body bore and flange faces of the valve body after removal of any rust or dirt.	Done/Not Done
c.	Wash the abraded surfaces of the liner and body with	Done/Not Done
d.	Put new bronze bushing into body stem holes.	Done/Not Done
e.	Spread a thin coat of adhesive over entire surface of the body bore, flange faces and back of the liner whenever the body and liner make contact.	Done/Not Done
f.	Insert the liner into the valve body without the O-rings. Insert the disc and shaft then close to the zero degree position. This will assure a tight bond of the liner against the body.	Done/Not Done
g.	The liner must be held against the flange faces also. This can easily be done by laying the valve on the flange face with sufficient weight placed on the opposite flange face.	Done/Not Done
h.	The valve should be allowed to cure for the period recommended by the manufacturer, after which the disc and stem can be removed.	Done/Not Done
i.	O-ring are not left in place during bonding because of the possibility of getting adhesive on them. Also, with O-ring in place the piston action forces air behind the liner when installing the stem. This creates air pockets that would weaken the total bond. Do not use any O-ring < 70 shore A > 90 shore A	Done/Not Done

j.	Insert primary O-ring seals at both stem holes in liner.	Done/Not Done
k.	Put disc into liner. Use silicon grease for ease of assembly.	Done/Not Done
l.	Insert valve stem.	Done/Not Done
m.	Align taper pin holes in disc and stem. Insert taper pins. Use hammer to seat pins. Use sealing compound on pins for positive sealing.	Done/Not Done
n.	Insert secondary O-ring in gland leakage collection adopter.	Done/Not Done
o.	Install gland leakage collection adopter at gland portion with new gasket and tight the loading bolts.	Done/Not Done

8.0 HOUSE KEEPING :

S.No.	ACTIVITY	OBSERVATION
1.	Waste packed in PVC bag, tag & kept in disposal area.	Done/Not Done
2.	Consumables like gasket, seal components, cotton rags etc.	Done/Not Done

9.0 TESTING

S.No.	ACTIVITY	OBSERVATION
a.	Check manual operation of the valve	Ok/Not Ok
b.	Observe any abnormality in the valve operation.	Ok/Not Ok
c.	Observe leakage from valve gland.	Ok/Not Ok
d.	Observe leakage from bonnet gasket.	Ok/Not Ok

10.0 POST MAINTENANCE REVIEW :

a. Deficiencies noticed :

b. Probable reasons for the deficiency occurred :

c. Corrective actions taken :

d. Actions taken to avoid the deficiencies in future :

NUCLEAR POWER CORPORATION OF INDIA LTD. (A Government of India Enterprises) Rajasthan Atomic Power Station Nuclear Training Centre CHECK LIST FOR DIAPHRAGM VALVE PRACTICE	Course No. : M-MP-2.8 Revision No. : 0 No. of sheets : 4 Prepared by R.P. Saini, SO/E Prashant Puri, STO Reviewed by C.M. Mishra, Enc(MT) Approved by N. Nagaich, TS
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5. Use personnel protection to avoid injury.
6. Any spillage in working area must be cleaned immediately.
7. Use specified cleaning agent only. Kerosene etc. used for cleaning must be collected in a properly tagged air tight container before leaving the job everyday.
8. Working area must be free from unwanted materials, oils, water etc.

1.0 PRE-REQUISITES :

- Pre-Job briefing done.
- Keep all blanks ready for prevention of foreign material exclusion.
- Ensure complete isolation from process side.
- Make sure the valve is closed and the pipe line has been drained.

2.0 TOOLS & TACKLES :

- Spanner set
- Punch
- 2lbs. Hammer,
- Screw Driver 8”

3.0 SPARES :

New Diaphragm :

Type - Cup type/weir type (Screwed/button)

Size -

Make - Saunders

O-ring

4.0 OBSERVATIONS PRIOR TO DISMANTLING

S.No.	ACTIVITY	OBSERVATION
1.	Check leakage collection report.	Done/ Not Done
2.	Type of deficiency :	
3.	Type of maintenance :	PM/Break Down

5.0 DISMANTLING

S.No.	ACTIVITY	OBSERVATION
a.	Loosen bonnet bolts.	Done/ Not Done
b.	Remove bonnets bolts and lift valve bonnet off body.	Done/ Not Done
c.	In case of screwed diaphragm holder unscrew the diaphragm from compressor by turning counter clock wise the screw or pull out diaphragm holder the diaphragm from compressor in case of button type.	Done/ Not Done
	a) Through stem	Ok/Rectified
	b) Through bonnet joint	Ok/Rectified
d.	Inspect (visually) the removed diaphragm. State condition & cause of failure.	
	a) Through rupture	Done/ Not Done
	b) Crack	Done/ Not Done
	c) Bulged inward	Done/ Not Done
	d) Hard & brittle	Done/ Not Done
	e) Detached from pin/ button.	Done/ Not Done
e.	Put old diaphragm in PVC bag & store at waste area.	Done/ Not Done

6.0 INSPECTION :

Diaphragm :	
ı Visual	Good/ No crack/ reduction in resilience.
ı Shore 'A' hardness	65-70
ı Material	Buna-N/Nitrile/EPDM.
O-ring :	
ı Visual	No crack, dents, cut, warping on surface, ensure no moulding line projection on sealing side.
ı Shore 'A' hardness	65-75
ı Material	Buna-N/Nitrile.
Bonnet assembly :	
ı Compressor for any burrs	Ok / Rectified
ı Visual	Good / No cracks.
ı Sealing area	Ok / Cleaned
ı Condition of thread or button of Diaphragm	Ok / Damaged
Body assembly :	
ı Cleanliness of all parts	Ok / Clean
ı Condition of gasket surface	Ok / Not Ok
ı Condition of studs and nuts	Ok / Not Ok
ı Contact of valve seat with disc (It should be 100%)	Ok / Not Ok

7.0 ASSEMBLY :

No.	ACTIVITY	OBSERVATION
a.	Clean valve body & sealing area.	Ok / Cleaned
b.	Screw in new diaphragm into compressor, hand tight until bolt holes in diaphragm and bonnet flange register then back, off one half turn (in case of button type wet the button & force it into compressor cavity with twisting motion).	Done/ Not Done
c.	If deficiency reported from gland leak then whole bonnet assembly change with spare tested bonnet assembly.	Done/ Not Done

d	Ensure hand wheel locking on valve stem.	Done/ Not Done
e.	Replace new diaphragm at compressor.	Done/ Not Done
f.	Ensure compressor guides are in respective guide slots.	Done/ Not Done
g.	Mount the bonnet on body & tighten bolts gently.	Done/ Not Done
h.	Close valve fully, back off one quarter turn off hand wheel then tighten bonnet bolts with spanner. Ensure while tightening bonnet.	Done/ Not Done
i.	Diaphragm is not getting compressed at its seat.	
j.	Compressor is in its guide slots.	
k.	Diaphragm is compressed enough between flanges of bonnet joint.	
l.	Open the valve, retighten bonnet bolts to ensure enough compression on diagram at flange joint.	Done/ Not Done

8.0 HOUSE KEEPING :

No.	ACTIVITY	OBSERVATION
a.	Waste packed in PVC bag, tag & kept in disposal area.	Done/ Not Done
b.	Consumables like gasket, seal components, cotton rags etc are disposed in waste disposal drum.	Done/ Not Done

9.0 TESTING :

No.	ACTIVITY	OBSERVATION
a.	Check manual operation of the valve should be mechanically free to operate.	Ok / Not Ok.
b.	Observe leakage for the Valve Gland.	Ok / Not Ok
c.	Observe the leakage for the Valve Bonnet	Ok / Not Ok

10.0 POST MAINTENANCE REVIEW :

a. Deficiencies noticed :

b. Probable reasons for the deficiency occurred :

c. Corrective actions taken :

d. Actions taken to avoid the deficiencies in future.

NUCLEAR POWER CORPORATION OF INDIA LTD. (A Government of India Enterprises) **Rajasthan Atomic Power Station** Nuclear Training Centre **CHECK LIST FOR RELIEF VALVE PRACTICE**	Course No. : M-MP-2.8 Revision No. : 0 No. of sheets : 5 Prepared by R.P. Saini, SO/E Prashant Puri, STO Reviewed by C.M. Mishra, Enc(MT) Approved by N. Nagaich, TS
Name :	Date of work start : Date of work completed :

Safety Instructions :

1. Ensure process side isolation before dismantling of equipment.
2. All openings must be blanked properly before leaving the job.
3. Valve internal components must be covered properly before leaving the job.
4. Tools and lifting tackles required for maintenance and rigging jobs should be in good working condition and have been tested withing last one year.
5. Use personnel protection to avoid injury.
6. Any spillage in working area must be cleaned immediately.
7. Use specified cleaning agent only. Kerosene etc. used for cleaning must be collected in a properly tagged air tight container before leaving the job everyday.
8. Working area must be free from unwanted materials, oils, water etc.

1.0 PRE-REQUISITE :

a. Ensure pre-job brefing has been done.

b. Ensure RV blank and nozzle blank is ready.

2.0 TOOLS & TACKLES :

a. Lapping tools : Flat lap, Angle lap, and ring lap.

b. Spring loading : Square on stem : 5/8” D spanner.

c. i). RV bonnet : .... combination spanner and flogging wrench.

ii). RV inlet/outlet flange : .... flogging and combination spanner.

d. Bonnet L/C flange : .... combination spanner.

e. Magnifying glass.

f. Measuring tools - Vernier caliper, micrometer.

3.0 SPARES :

a. Bonnet Gasket : 1/8” Thick. Permanite gasket

b. Bonnet L/C gasket :

c. Gasket and guide gasket :1/16” Thick. Permanite gasket.

d. Silicon grease, never seize grease, Acetone etc.

e. Polythene bags.

f. Blank : 7 1/2” PCD x 8No. holes (2Nos.)

4.0 RV REMOVAL :

No.	ACTIVITY	OBSERVATION
a.	Remove casing gear from the Top of the valves i.e. Padlock, pin for lever and cap.	Done/ Not Done
b.	Hold the valve stem and release the spring loading by unscrew adjusting screw and lock nut.	Done/ Not Done
c.	Unscrew the bonnet base nuts and L/C flange, keep properly.	Done/ Not Done
d.	Remove the bonnet assembly relief valve. Pack stem, spring with washers and disc holder assembly separately in PVC bag. Bring these components to valve maintenance area. Keep valve bonnet properly.	Done/ Not Done
e.	a Blank the valve bonnet and L/C opening	Done/ Not Done/ NA
	b Blank the inlet, outlet and L/C opening	Done/ Not Done/ NA
f.	Clean the components.	Done/ Not Done

5.0 DISMANTLING :

a. Dismantled the disc holder and guide assembly and record the following observations :

Record the position of Upper Adjusting ring and Lower adjusting ring and remove locking pins.

5.1.1 Disc :

No.	Parts Area	OBSEVATION
a.	Disc face	Pitting / Erosion / OK
b.	Disc back (for any galling)	____________________
c.	Disc snap rings (retainer)	OK / damaged

5.1.2 Disc holder :

No.	Check	OBSEVATION
a.	Visual :	____________________
b.	Pivot (stem) should be line contact with mating face of disc holder & stem.	Scoring / OK / _______
c.	Disc seating area (for any galling).	____________________

5.1.3 Spring assembly :

a.	Spring (Rusting, Squareness)	____________________
b.	Spring (DPT)	____________________

5.2 Valve stem

i.	Record valve stem bend (Limit <0.002” TIR)	____________________
ii.	Stem ball (for any damage)	____________________
iii.	Stem to adjusting screw clearance (Should be within	_________ inch 0.060”)
iv.	Stem OD	
v.	Adjusting screw ID	
vi.	Clearance (v - iv)	
vii.	If clearance not within limit record action taken	____________________

5.3 Valve nozzle seat condition Pitting/Erosion/OK

5.4 Blow down ring condition (if required) ____________________

6.0 ASSEMBLY :

No.	ACTIVITY	OBSERVATION
a.	Lap and polish disc to the flatness of 2 to 3 light bend Light	bend _________
b.	Lap/ machine the valve stem and disc holder ball joint. Take blue contact.	Contact _______
c.	Remove galling marks to disc and disc holder (if required)	Done/Not required.
d.	Assemble disc in disc holder. Ensure disc movement is free.	Done/ Not Done
e.	Adjust the upper adjusting ring and lower adjusting ring as per the earlier position as marked during dismantling.	Done/ Not Done
f.	Lap valve nozzle seat, first by guided angle (88”) lap and than by guided flat lap.	Done/ Not Done
g.	Measure nozzle seat width (limit <0.037 inch).	_______________
h.	Take seat and disc blue contact.	Contact ________
i.	Assemble and install valve/ valve bonnet with new gaskets.	Done/ Not Done
j.	Record bonnet flange gap at four opposite places for uniform tightening. (Gap should be uniform within 0.002 inch).	Initial gap : Final gap :

7.0 RV TESTING

No.	ACTIVITY	OBSEVATION
a.	Do setting of the RV, record the popping pressure. Set the pressure by changing the loading of the main spring.	Done / Not Done
b.	Adjust the blow down by removing the adjusting ring pin, the adjusting ring can then be moved to the right or left easily with a screw driver through the hole and engaging into the notches in the adjusting ring, move ring 10 notches at a time until the required blow down is reached.	Done / Not Done

c.	Move adjusting ring to the right (up) to decrease blow down and to the left (down) to increase blow down. The pin should be placed after each adjustment, making sure that it is engaged in the notch.	Done / Not Done
d.	The lower adjusting ring is used to obtain clean popping action and to cushion the closing action of the valve. The lower ring mustn't be used to adjust blow down. Should the valve simmer for a short period after shutting, gag Valve, remove lower adjusting ring pin and with screw driver, raise the ring one notch at a time to remove simmer or buzzing.	Done / Not Done
	Observe any leakage from RV Bonnet	Done / Not Done
	Observe any leakage from valve gland	Done / Not Done

8.0 HOUSE KEEPING

No.	ACTIVITY	OBSEVATION
a.	Waste packed in PVC bag, tag & kept in disposal area.	Done / Not Done
b.	Consumables like gasket, seal components, cotton rugs etc. are disposed in waste disposal drum.	Done / Not Done
c.	Remove all tools and tackles from location.	Done / Not Done

9.0 POST MAINTENANCE REVIEW :

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<table>
<tr><td>NUCLEAR POWER CORPORATION OF INDIA LTD.
(A Government of India Enterprises)
Rajasthan Atomic Power Station
Nuclear Training Centre

CHECK LIST
FOR
GLOBE VALVE PRACTICE</td><td>Course No. : M-MP-2.8
Revision No. : 0
No. of sheets : 4

Prepared by R.P. Saini, SO/E
Prashant Puri, STO

Reviewed by C.M. Mishra, Enc(MT)

Approved by N. Nagaich, TS</td></tr>
<tr><td>Name :</td><td>Date of work start :
Date of work completed :</td></tr>
</table>

Safety Instructions :

1. Ensure process side isolation before dismantling of equipment.
2. All openings must be blanked properly before leaving the job.
3. Valve internal components must be covered properly before leaving the job.
4. Tools and lifting tackles required for maintenance and rigging jobs should be in good working condition and have been tested withing last one year.
5. Use personnel protection to avoid injury.
6. Any spillage in working area must be cleaned immediately.
7. Use specified cleaning agent only. Kerosene etc. used for cleaning must be collected in a properly tagged air tight container before leaving the job everyday.
8. Working area must be free from unwanted materials, oils, water etc.

1.0 PRE-REQUISITES :

- Pre-Job briefing shall be carrying out.
- Keep all blanks ready for prevention of foreign material exclusion.

2.0 TOOLS & TACKLES :

- Spanner set.
- Hollow Punch
- 2 lbs. Hammer
- Screw Driver 8”
- Gland Puller

3.0 SPARE PARTS :

a. Gland packing - Cross-section............................

b. Bonnet gasket size : ....

4.0 DISMANTLING

No.	ACTIVITY	OBSERVATION
a.	Rotate the hand wheel to keep the plug in the middle position.	Done / Not Done
b.	Loosen bonnets bolt and crack the bonnet joint check for perfect isolation. If isolation is perfect, remove bonnet bolts nut.	Done / Not Done
c.	Remove bonnet assembly carefully to avoid the damaging of valve seat.	Done / Not Done
d.	Mark the position of plug for reassembly purposes.	Done / Not Done
e.	Wrap the bonnet assembly in P.V.C.	Done / Not Done
f.	Install blank on bonnet opening with gasket.	Done / Not Done
g.	Shift the bonnet with Yoke assembly to suitable place.	Done / Not Done
h.	Remove the Hand Wheel.	Done / Not Done
i.	Remove gland follower from the yoke assembly.	Done / Not Done
j.	Remove gland packing.	Done / Not Done
k.	Remove Plug with stem.	Done / Not Done

5.0 INSPECTION & MEASUREMENTS

No.	Part	Condition	Action taken
a.	Inspect seat condition	Ok/Worn Out/Damaged	
b.	Bonnet gasket.	Hard/Damaged/Ok	
c.	Disk seating portion.	Ok/Pitting/Eroded	
d.	Packing condition	Ok/Worn out/Damage	
e.	Stuffing Box	Scored/corroded/Ovel/Ok	
f.	Stem trueness and surface	Ok/Bend/Scoring/damaged thread	
g.	Gland seal ‘O’ ring.	Ok/Worn out/Damage	

h.	Stem threads	Ok/Damaged	
i.	Bonnet gasket seating surface of the valve body flange & bonnet flange.	Ok/Pitting/Repaired.	

6.0 ASSEMBLY

No.	ACTIVITY	OBSEVATION
a.	Clean all parts thoroughly.	Ok/Not Ok
b.	Check blue contact of disk with seat. It should make at least 80% contact with the matching part. Contact before repairing Contact after repairing	____________ ____________ ____________
c.	Install the Yoke on bonnet	Done/ Not Done
d.	Insert stem from bonnet and Yoke assembly.	Done/ Not Done
e.	Assemble disk with stem.	Done/ Not Done
f.	Install gland packing.	Done/ Not Done
g.	Install gland follower.	Done/ Not Done
h.	Check valve operation by manually moving gland stem. It should be free motion.	Done/ Not Done
i.	Get new bonnet gasket from 1/8" thick Buna-N or Neoprene rubber sheet. Ensure thickness & finish is uniform.	Done/ Not Done
j.	Shift bonnet assembly on position.	Done/ Not Done
k.	Remove blank & keep for safe custody.	Done / Not Done
l.	Clean seat by acetone/ Kerosene.	Done / Not Done
m.	Install bonnet assembly with new gasket. Do not apply lubricant on gasket.	Done/ Not Done
n.	Tight bonnet bolts. Ensure uniform sequential tightening. Do not lever on spanner.	Done/ Not Done

7.0 HOUSE KEEPING

No.	ACTIVITY	OBSEVATION
a.	Waste packed in PVC bag, tag & kept in disposal area.	Done / Not Done
b.	Consumables like gasket, seal components, cotton rags etc. are disposed in waste disposal drum.	Done / Not Done
c.	Remove all tools and tackles from location.	Done / Not Done

8.0 TESTING

No.	ACTIVITY	OBSEVATION
a.	Check manual operation of the valve.	Ok / Not Ok
b.	Observe any abnormality in the valve operation.	Ok / Not Ok
c.	Observe leakage from valve gland.	Ok / Not Ok
d.	Observe leakage from bonnet gasket.	Ok / Not Ok

9.0 POST MAINTENANCE REVIEW

a. Deficiencies noticed :

b. Probable reasons for the deficiency occurred :

c. Corrective actions taken :

d. Actions taken to avoid the deficiencies in future.

<table>
<tr><td>NUCLEAR POWER CORPORATION OF INDIA LTD.
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Rajasthan Atomic Power Station
Nuclear Training Centre

CHECK LIST FOR
WEDGE DISK GATE VALVE
PRACTICE</td><td>Course No. : M-MP-2.8
Revision No. : 0
No. of sheets : 8

Prepared by R.P. Saini, SO/E
Prashant Puri, STO
Reviewed by C.M. Mishra, Enc(MT)
Approved by N. Nagaich, TS</td></tr>
<tr><td>Name :</td><td>Date of work start :
Date of work completed :</td></tr>
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Safety Instructions :

1. Ensure process side isolation before dismantling of equipment.
2. All openings must be blanked properly before leaving the job.
3. Valve internal components must be covered properly before leaving the job.
4. Tools and lifting tackles required for maintenance and rigging jobs should be in good working condition and have been tested withing last one year.
5. Use personnel protection to avoid injury.
6. Any spillage in working area must be cleaned immediately.
7. Use specified cleaning agent only. Kerosene etc. used for cleaning must be collected in a properly tagged air tight container before leaving the job everyday.
8. Working area must be free from unwanted materials, oils, water etc.

1. PREREQUISITES :

No.	ACTIVITY	OBSERVATION
a.	Ensure complete isolation from Electrical and Process side.	Done / Not Done
b.	Make sure the valve is closed and the pipe line has been drained.	Done / Not Done
c.	Ensure Chain pulley block is in good working order.	Ok / Not Ok

2. TOOLS AND TACKLES AND CONSUMABLES :

a. Stand for Bonnet One No.

b. Disc Assembly and Disc Assembly Tool One No.

c. Combination Square 1-5/16 inches, 1 1/2 inches, 11/16 inches, 1 11/6 inches. One Each.

d. Allen Key Set One No.

e. Screw Driver 12 Inches One No.

f. V.Calliper 6 Inches One No.

g. Hammer 2Lbs One No.

h. Centre Punch One No.

i. Feeler Gauge One No.

j. Prucain Blue One No.

k. Cotton Rags

l. CTC/Kerosene

m. Plastic Sheet

n. Tray

3. OBSERVATIONS PRIOR TO DISMANTLING :

1. Type of deficiency :

2. Type of maintenance : PM/BREAK DOWN

3. Take following measurements and record. DONE/NOT DONE

S.No.	CHECKS		AS FOUND	AS LEFT
1.	Gap between flanges	E		
		W		
		N		
		S		
2.	Live loading measurement	N		
		S		

4. DISMANTLING :

A)	Removal of Bonnet from valve :	
1.	Remove leakage collection tubings from gland and bonnet and install spare nuts on fittings for protection.	Done / Not Done
2.	Put matching mark on the bonnet joint. Measure the gap between flanges by Feeler gauge at four places and record it.	Done / Not Done
3.	Loose the Locking plate of Bonnet Nut.	Done / Not Done
4.	Unscrew the bonnet nuts using Combination Wrench.	Done / Not Done
5.	Provide check nuts on top of the long studs and remove the studs by unscrewing them.	Done / Not Done
6.	Sling the bonnet and support it by chain block.	Done / Not Done
7.	Lift off the bonnet assembly from valve. Care must be taken to avoid any damage to discs as they leave the seat.	Done / Not Done
8.	Lower the Bonnet Assembly and Wrap it in PVC Sheets and Shift it to Valve Maint. area.	Done / Not Done

B)	Dismantling of removed Bonnet :	
1.	Support the valve bonnet in the stand.	Done / Not Done
2.	Support the stem from bottom.	Done / Not Done
3.	Unlock and remove the discs from the disc holder.	Done / Not Done
4.	Open Four Nuts of Actuator and remove the Nuts	Done / Not Done
5.	Unlock the mechanical stopper Lock nut and remove the stopper keys. (LH threads.)	Done / Not Done
6.	Unscrew the mechanical stopper and remove it	Done / Not Done
7.	Tap the valve stem from top gently and remove it from the bottom of Bonnet.	Done / Not Done
8.	Remove the old gland packing, Lantern ring and Korute block. Dispose them in PVC bag at proper place.	Done / Not Done
9.	Keep the Bonnet up side down on floor and unscrew the back seat if required.	Done / Not Done

10.	Clean all the parts properly using appropriate cleaning agents like CTC.	Done / Not Done

5. CLEANING AND INSPECTION :

A. INSPECTION OF BONNET :

I. CHECKS BEFORE BONNET REMOVAL :

S.No.	CHECKS	AS FOUND	AS LEFT
1.	Gap between flanges		
2.	Live loading gap N		
	S		

II. BONNET INSPECTION :

S.No.	**CHECKS**	**Observation**	**REMARKS** (ACTION TAKEN)
1.	Cleanliness of all parts	Ok/Cleaned	
2.	Condition of gasket surface	Ok/Not Ok	
3.	Condition of Female threads of back seat (To be checked if back seat is removed)	Ok/Not Ok	
4.	Diameter of flange holes Hole dia.	Ok / Not Ok / Rectified	
5.	Condition of Back seat (Check Blue contact)	Ok / Not Ok / Rectified	
6.	Condition of stuffing box	Ok / Not Ok	

B. VALVE STEM INSPECTION

S.No.	Checks	As found	Action taken	As left
1.	Condition of threads - Visually - By Mech. stopper Lock nut - By actuator Drive bush	 Ok/Not Ok Ok/Not Ok Ok/Not Ok		
2.	Condition of stem at gland portion	Ok/Corrosion/ Pitting		
3.	Other abnormalities :			
	Wear/erosion of other surfaces			
	Damage to Keys			
	Damage to Key ways			
4.	Condition of Back seat (Check Blue contact)	Ok/Not Ok		
5.	Distance of Mech. stopper from Back seat (Normal=)			

6.	Check stem bend (It should not be more than)									
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
0^o										
90^o										
180^o										
270^o										

Eccentricity of Valve Stem	Maximum Eccentricity	Loacation of Max. (1 to 10) / Position (^{O})	Remarks
As found			
As left			

C. INSPECTION OF VALVE BODY :

S.No.	Checks	Observations (As found)	Remarks (Action Taken)
1.	Cleanliness of all parts	OK/CLEAN	
2.	Condition of gasket surface	OK/NOT OK	
3.	Condition studs and nuts	OK/NOT OK	
4.	Contact of valve seat with disc (It should be 100%)	OK/NOT OK	

d. INSPECTION OF VALVE DISC, SPRING, RETAINING RING :

S.No.	Checks	As Found	Action Taken	As Left
1.	Condition of Disc	Surface Erosion/Cracks		
2.	Contact of Disc with Seat Blue contact (should be 100%)			
3.	Condition of spring - Stiffness - Visual Cracks	 OK/NOT OK OK/REPLACE		

e. CONDITION OF OTHER HARDWARE :

S.No.	Checks	As Found	Action Taken	As Left
1.	Condition of Mech stopper	OK / NOT OK		
2.	Condition of lantern ring	OK / NOT OK		
3.	Condition of Belleville springs (Check for cracks and flattening)	REUSE / REPLACE		

6. ASSEMBLY :

No.	ACTIVITY	OBSERVATION
a.	Keep the Valve bonnet on assembly stool.	Done / Not Done
b.	Install the valve stem in the bonnet at approximately 50% close position. Ensure disc holder.	Done / Not Done
c.	Install pillars in position properly. (2 Nos)	Done / Not Done
d.	Install Korute block in the stuffing box. Install gland packings. Ensure correct position of the Lantern ring.	Done / Not Done
e.	Install Mechanical stopper on the valve stem with Woodruff key and Taper key and lock it with lock nut and allen screws. Ensure that the stem is in correct orientation w.r.t. the bonnet.	Done / Not Done
f.	Install the actuator mounting plate on two support rods and tighten nuts.	Done / Not Done

7.0 CHECKS DURING INSTALLING :

No.	ACTIVITY	OBSERVATION
a.	Check the gasket surfaces.	Ok / Not Ok
b.	Check leakage collection fittings and its orientation.	Ok / Not Ok
c.	Install gaskets in position with Neversieze compound.	Done / Not Done
d.	Install disc in its position and tighten disc holder bolts. Apply Silicone grease on sealing faces.	Done / Not Done
e.	Install the Disc clamp on the disc and compress properly.	Done / Not Done
f.	Before installation confirm that there is no dent or scratch on the disc sealing surfaces.	Done / Not Done
g.	When disc gets inserted in the seat remove the disc clamp.	Done / Not Done
h.	Retighten the nuts by Pneumatic wrench and control the value of compression of the gasket. The gasket compression should be maintained 0.045” to 0.050”.	Done / Not Done
i.	Install the leakage collection tubing.	Done / Not Done
j.	Install Actuator.	Done / Not Done

8.0 HOUSE KEEPING :

No.	ACTIVITY	OBSERVATION
a.	Get all the waste generated during maintenance removed from the area and dispose it in proper place in PVC bags.	Done / Not Done
b.	Collect all the tools and tackles used during maintenance/ installation.	Done / Not Done
c.	Deposit all the protective equipment used by personnel.	Done / Not Done

9.0 TESTING :

No.	ACTIVITY	OBSERVATION
a.	Check manual operation of the valve through actuator. Should be mechanically free to operate.	Ok / Not Ok
b.	Get electrical connections, Limit switch setting and Torque switch setting done by Electrical Maintenance group.	Done / Not Done
c.	Keep the valve in 50% open position. Give short commands in ‘Open’ and ‘Close’ direction.	Done / Not Done
d.	Check correct setting of switches by ‘Closing’ and ‘Opening’ the valve.	Ok / Not Ok
e.	Observe for abnormal ‘Noise’ or ‘Vibrations’ in the actuator.	Ok / Not Ok
f.	Observe leakage from valve gland.	Ok / Not Ok
g.	Observe for leakage from bonnet gasket.	Ok / Not Ok

10.0 POST MAINTENANCE REVIEW

a. Deficiencies noticed :

b. Probable reasons for the deficiency occurred :

c. Corrective actions taken :

d. Actions taken to avoid the deficiencies in future:

NUCLEAR POWER CORPORATION OF INDIA LTD. (A Government of India Enterprises) **Rajasthan Atomic Power Station** Nuclear Training Centre **CHECK LIST FOR TAPER PLUG VALVE PRACTICE**	Course No. : M-MP-2.8 Revision No. : 0 No. of sheets : 5 Prepared by R.P. Saini, SO/E Prashant Puri, STO Reviewed by C.M. Mishra, Enc(MT) Approved by N. Nagaich, TS
Name :	Date of work start : Date of work completed :

Safety Instructions :

1. Ensure process side isolation before dismantling of equipment.
2. All openings must be blanked properly before leaving the job.
3. Valve internal components must be covered properly before leaving the job.
4. Tools and lifting tackles required for maintenance and rigging jobs should be in good working condition and have been tested withing last one year.
5. Use personnel protection to avoid injury.
6. Any spillage in working area must be cleaned immediately.
7. Use specified cleaning agent only. Kerosene etc. used for cleaning must be collected in a properly tagged air tight container before leaving the job everyday.
8. Working area must be free from unwanted materials, oils, water etc.

1. PREREQUISITES :

a. Pre-job briefing done.

b. Make sure the valve is closed and the pipe line has been drained.

c. Keep all blanks reading fpr penetration of Foreign Material Exclusion.

2. TOOLS AND TACKLES AND CONSUMABLES :

ι	Combination Square	13/16 inches	One No.
ι	Gland Puller		One No.
ι	Screw Driver	12 inches	One No.
ι	V. Calliper	6 inches	One No.
ι	Hammer	2lbs	One No.

- Centre Punch One No.
- Prucain Blue One No.
- Cotton Rags
- CTC/Kerosene
- Plastic Sheet
- Tray

3. SPARES NEEDED :

- Gasket of the size :
- Fasteners :

4. OBSERVATIONS PRIOR TO DISMANTLING :

1. Type of deficiency :
2. Type of maintenance : PM/BREAK DOWN
3. Take following measurements and record. DONE/NOT DONE

5. DISMANTLING :

No.	ACTIVITY	OBSERVATION
a.	Put matching mark on the bonnet joint.	Done/Not Done
b.	Loose the Two Number Gland Follower / Mechanical Stopper bolt and remove it.	Done/Not Done
c.	Remove Gland Packing by Gland Puller	Done/Not Done
d.	Loose the remaining Two Nos. bolts of Bonnet to Valve Body and remove the bonnet with Stem and Plug.	Done/Not Done
e.	Disconnect the plug from stem.	Done/Not Done

6. CLEANING AND INSPECTION :

A. Inspection of Bonnet :

I. Checks Before Bonnet Removal :

S.No.	Checks	As Found	As Left
1.	Gap between flanges		

II. Bonnet Inspection :

S.No.	Checks	Observations	Remarks (Action taken)
1.	Cleanliness of all parts	Ok / Cleaned	
2.	Condition of gasket surface	Ok / Not Ok	
3.	Diameter of flange holes Hole dia.	Ok / Not Ok / Rectified	
4.	Condition of stuffing box	Ok / Not Ok	

B. Valve Plug Inspection :

S.No.	Ckecks	As Found	Action Taken	As Left
1.	Condition of threads - Visually	 Ok/Not Ok Ok/Not Ok Ok/Not Ok		

3. Valve Stem Inspection :

S.No.	Ckecks	As Found	Action Taken	As Left
i.	Condition of threads - Visually	 Ok/Not Ok		
ii.	Condition of stem at gland portion	Ok/Corrosion/ Pitting		
iii.	Other abnormalities :			
	Wear/erosion of other surfaces			
	Damage to Keys			
	Damage to Key ways			

S.No.										
iv.	Check stem bend (It should not be more than)									
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
v.										
vi.										
vii.										
viii.										

ECCENTRICITY OF VALVE STEM	MAX. ECCENTRICITY	LOCATION OF MAX. (1 TO 10)/POSITION (^{o})	REMARKS
As found			
As left			

4. Inspection Of Valve Body :

S.No.	CHECKS	OBSERVATIONS (AS FOUND)	REMARKS (ACTION TAKEN)
a.	Cleanliness of all parts	OK/CLEAN	
b.	Condition of gasket surface	OK/NOT OK	
c.	Condition studs and nuts	OK/NOT OK	
d.	Contact of valve	OK/NOT OK	

7.0 CHECKS DURING INSTALLATION :

a.	Check the gasket surfaces.	Ok / Not Ok
b.	Install gaskets in position with Neversieze compound.	Done / Not Done
c.	Before installation confirm that there is no dent or scratch on the sealing surfaces (Plug and Seat in the Body).	Done / Not Done

8.0 ASSEMBLY :

a.	Install the plug in the bonnet and connect with stem.	Done / Not Done
b.	Install bonnet on the body with gasket.	Done / Not Done
c.	Give suitable torque to the bonnet and body fasteners.	Done / Not Done
d.	Install the gland of suitable size and Numbers.	Done / Not Done
e.	Install the Gland follower and preload the packing.	Done / Not Done
f.	Install the lever.	Done / Not Done
g.	Rotate the plug for ensuring the smooth operation.	Done / Not Done

9.0 HOUSE KEEPING :

a.	Get all the waste generated during maintenance removed from the area and dispose it in proper place in PVC bags.	Done / Not Done
b.	Collect all the tools and tackles used during maintenance/ installation.	Done / Not Done
c.	Deposit all the protective equipment used by personnel.	Done / Not Done

10.0 TESTING

a.	Check manual operation of the valve.	Ok/ Not Ok
b.	Observe any abnormality in the valve operation.	Ok/ Not Ok
c.	Observe leakage from valve gland.	Ok/ Not Ok
d.	Observe leakage from bonnet gasket.	Ok/ Not Ok

11.0 POST MAINTENANCE REVIEW

a. Deficiencies noticed :

b. Probable reasons for the deficiency occurred :

c. Corrective actions taken :

d. Actions taken to avoid the deficiencies in future.