Abu Dhabi Gas Liquefaction Company Ltd

Job Training

Mechanical Technician Course

Module 7

Valves

ADGAS Personnel & Training Division

Contents

Contents

Pre-Requisite	Completion of A.T.I. Maintenance Programme, ADGAS Induction Course and Basic Maintenance Technician Course.
Course Objectives	The Job Training Mechanical Technician Course is the second phase of the development programme. It is intended specifically for Mechanical Maintenance Developees. On completion of the Course the developee will have acquired an awareness of some of the equipment, terminology, and procedures related to mechanical maintenance of ADGAS LNG plant. Appropriate safety procedures will continue to be stressed at all times.
Module Objectives	On completion of this module, the developee will be able to correctly : • identify valve parts and state their functions • identify types of valves and describe their applications • dismantle and re-assemble a valve • perform lapping of valve seats • perform static pressure testing of valves • describe valve selection and specification criteria • describe typical valve faults and their repair
Methodology	The above will be achieved through the following: • pre-test • classroom instruction • audio visual support • site visit • tasks & exercises • post-test

Abbreviations and Terminology

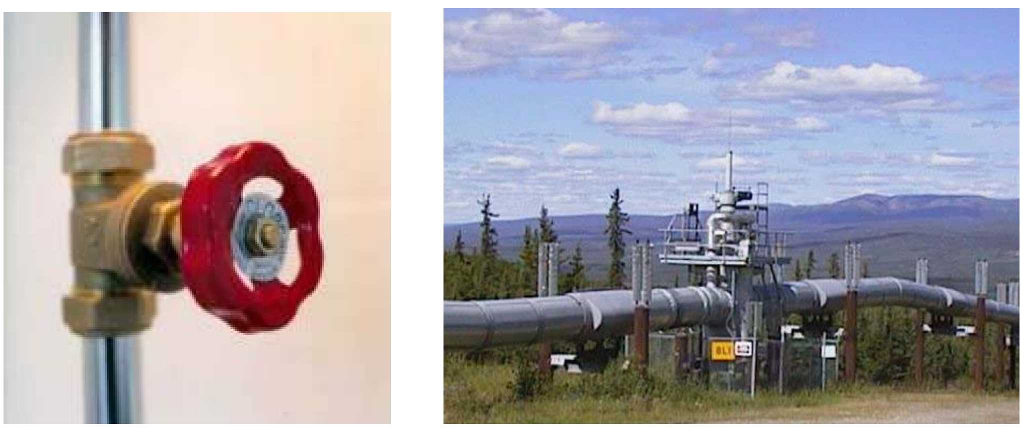
FC	Fail closed
FL	Fail locked
FO	Fail open
MOV	Motor Operated Valve
PRV	Pressure Relief Valve
PSV	Pressure Safety Valve
SOV	Solenoid Operated Valve

Armature	Part of an electric machine that strengthens magnetic fields.
Bonnet	Removable cover giving access to valve trim.
Cast	Method of producing shaped components by pouring molten material into a mould.
De-energised	Having no electric current passing through it.
Dynamic seal	A seal between parts that move relative to each other.
Energised	Having electric current passing through it.
Erosion	A slow wearing away, usually by a fluid flowing over a surface.
Fail closed	Describing a valve that automatically closes when the system fails.
Fail open	Describing a valve that automatically opens when the system fails.
Fail safe	Describing something that goes to a safe condition when the system fails.
Flow rate	Volume of fluid flowing past a point in unit time; SI units litres/sec.
Forged	Method of producing components by hammering hot metal into shape, usually between shaped dies.
Gear Ratio	The ratio between diameters or numbers of teeth on meshing gears.
Overpressure	Pressure that is higher than the specified value.
Perimeter	The distance all around the outside of an area.
Pig (pigging)	A plug that is pushed through a pipeline by a gas or liquid to perform various functions such as flushing, inspection and cleaning.
Port	An entry or exit through which fluids pass.
Regulating valve	Another name for a throttling or flow-control valve.
Setpoint pressure	A predetermined pressure value at which a component is set to operate.
Turbulence	Flow that is not smooth or regular.
Yoke	External part of a valve that supports stem bushing.

1 Introduction

Valves were mentioned in the earlier module *Pipework*, where they were listed with other pipe fittings. Because they are the most important part of any piping system, they are described more fully in this module.

The gas liquefaction process uses a lot of valves. ADGAS uses many different types of valves in a large range of sizes. Examples of small and large valves are shown in **Figure 1.1**.



(a) Small Manually Operated Valve (b) Large Automatically Operated Valve

Figure 1.1: Small and Big Valves

Valves control the flow of fluids through pipes by:

- starting and stopping flow—to control process or isolate part of a pipeline
- changing the *flow rate*—allowing more or less fluid to flow
- re-directing flow from one line to another at a pipeline *junction*

A ***junction*** is a point where two or more paths meet.

- allowing flow in one direction only
- reducing fluid pressure
- keeping the pressure in a container or pipeline below a fixed maximum
- preventing accidents by relieving *overpressure* in a container or pipeline

It is very important to use the correct:

- valve type—to suit the task it performs, as described above
- size—to suit the pipe size and the flow rate required
- material—to suit the fluid passing through it and to avoid corrosion

The ADGAS Piping Specifications list the valves used for all applications on the plant.

2 Basic Valve Components

The design of different types of valves and some of the components used may *vary*. There are, however, some basic parts that are common to most valves. These parts are shown in **Figure 2.1**.

To ***vary*** means to change.

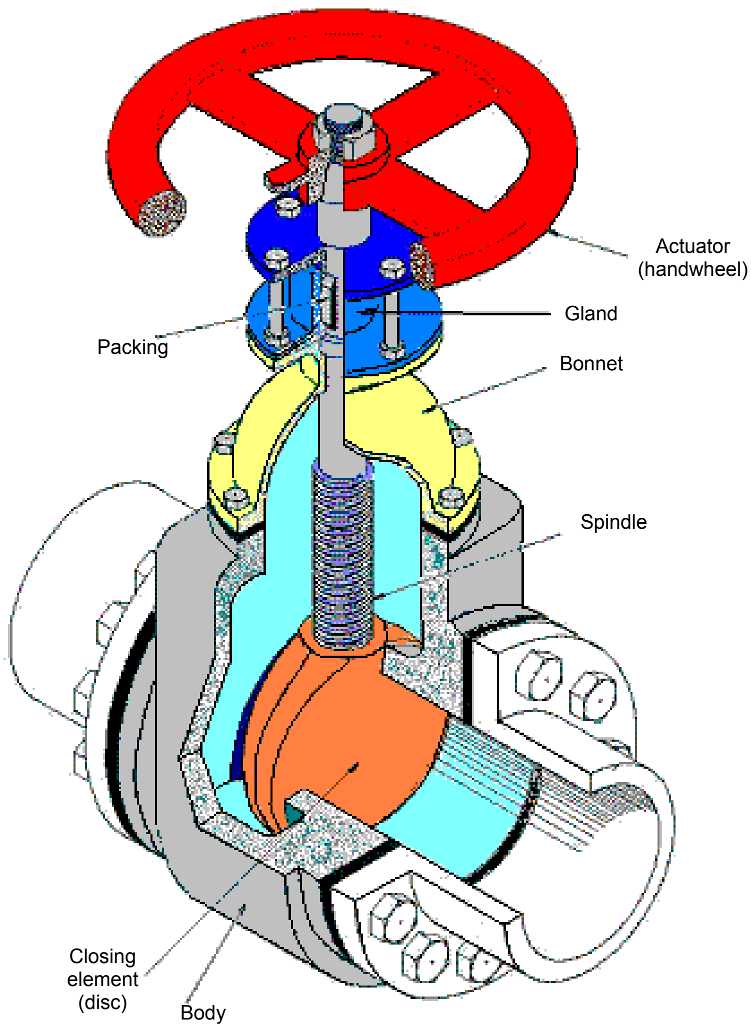


Figure 2.1: Basic Parts of a Valve

The valve body is the main part of the valve. All other parts fit onto the body. It is usually *cast* or *forged* and the shape varies with the type of valve. Inlet and outlet pipes fit onto the valve body through threaded, bolted (flanged) or welded joints. The fluid passes through the valve body when the valve is open. The valve body must be strong enough to take the maximum pressure of the process fluid. It must also be made of a material that is not attacked by the fluid.

The valve bonnet is a removable cover fitted to the body. Some bonnets support the moving parts of the valve. Others just close the hole in the body through which the moving parts pass for assembly and dismantling.

The valve trim is the name give to the parts inside a valve. This normally includes:

- the opening/closing element—closes the fluid path through the valve body
- the valve stem—connects the actuator to the closing element
- the valve seat—makes a seal with the closing element when the valve is closed
- sleeves—sometimes used to guide the stem

Valve packing was described in detail in the earlier module in this course: *Gland Packing*. It allows the valve stem to pass into the valve body without loss of fluid or fluid pressure from the valve. It forms a *dynamic seal* between the valve stem and the bonnet.

The actuator operates the stem and closing element assembly. The simplest actuator is the manually operated handwheel shown in **Figure 2.1**. Other actuators may be operated by:

- electric motor—motor operated valve (MOV)
- electric solenoid—solenoid operated valve (SOV)
- air—pneumatically operated valve
- oil—hydraulically operated valve

Valve actuators are described in **Section 7** of this module.

Valves can be divided into four classes:

- block valves—stop and start flow
- throttle valves—control flow rate
- non-return (or check) valves—prevent flow reversal
- pressure control valves—prevent fluid pressure *exceeding* a set maximum

To ***exceed*** is to be greater than.

These valves may have additional parts, or parts that are different from those described in this section and shown in **Figure 2.1**. They are described in the following sections.

3 Block Valves

Block valves either allow full flow or stop flow completely. They should only be operated in the fully open or fully closed position. If they are only partly opened, they offer a lot of resistance to flow. Fluid friction and *turbulence* cause a loss of pressure in the fluid and can cause vibration.

Block valves are not meant to control flow rate.

There are four main types of block valve used on the plant:

- gate valves
- slide valves
- ball valves
- plug valves

3.1 Gate Valves

Most valves in the ADGAS plant are gate valves.

They are used to start or stop a flow completely. They should not be used to control flow rate. Using a gate valve in a partially open position can damage the valve. Fluid flow across the gate causes *erosion* to the gate making it impossible to seal well against its seat.

Fluid can flow through most gate valves in either direction.

The closing element in a gate valve is a wedge-shaped disc or gate attached to the end of the stem, as shown in **Figure 2.1**. The gate fits into a wedge-shaped seat in the valve body to stop flow through the valve, as shown in **Figure 3.1**.

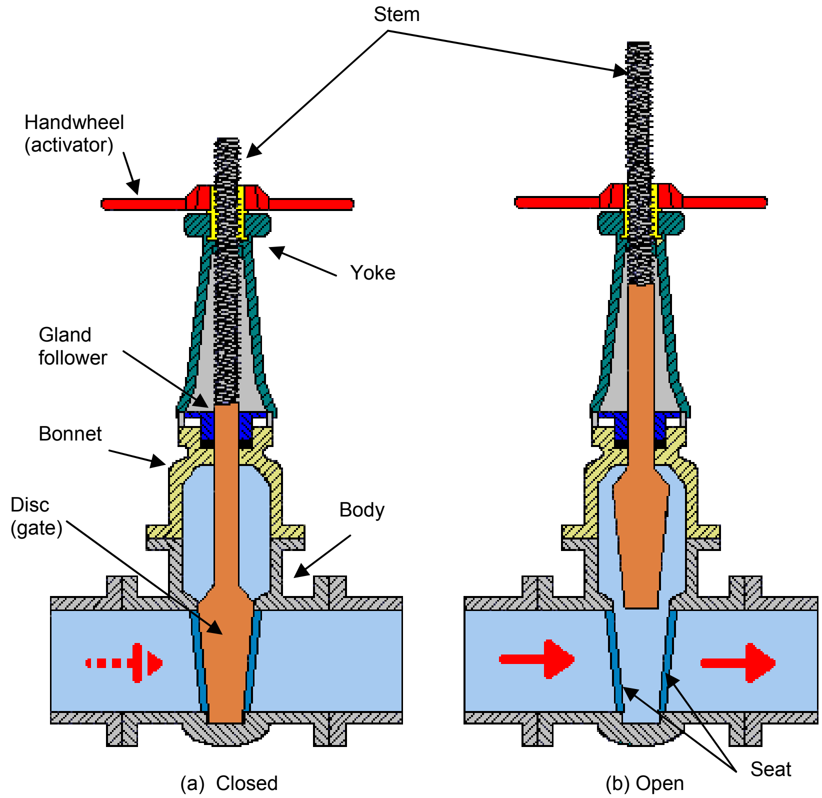


Figure 3.1: Rising Stem Gate Valve

Turning the handwheel raises and lowers the gate. When the gate valve is fully closed, the gate fills the passage and stops the flow through the valve completely.

When the valve is fully opened, the gate is positioned above the passage in the valve body. This allows full flow through the valve, with little or no *obstruction*. There is very little pressure drop across the valve.

> An ***obstruction*** gets in the way.

Gate valves are classed as *linear-motion* valves as the closing element moves in a straight line (e.g. down and up) to close and open the valve.

Gate valves can have rising or non-rising stems. The valve shown in **Figure 3.1** has a rising stem. The stem moves up and down with the gate. A rising stem is fixed to the gate and can not turn in it. The upper part of the stem is threaded and screws into a mating thread in a bushing. The bushing is held in a *yoke* located at the top of the *bonnet* as shown in **Figure 3.2**. The actuator turns the bushing in the yoke, screwing the stem into or out of the valve body.

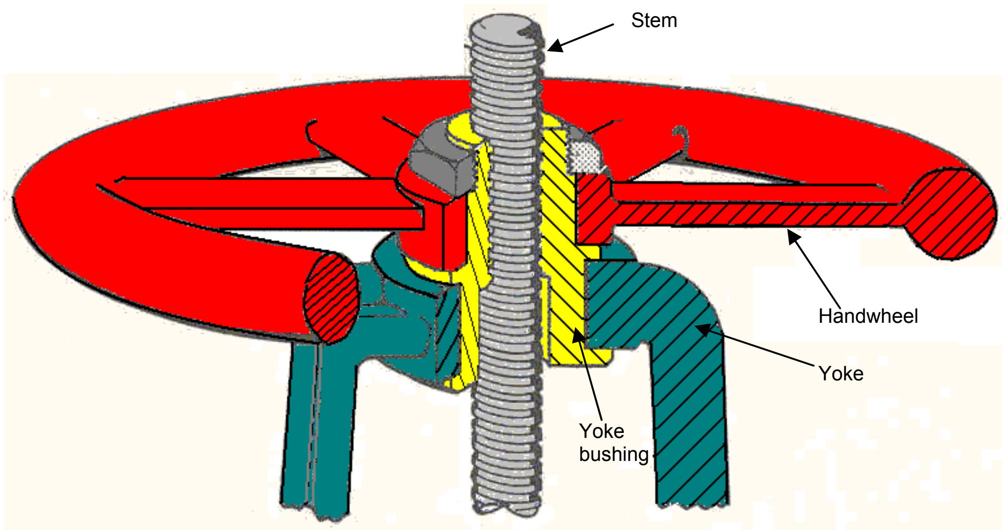


Figure 3.2: Detail of Yoke Bushing—Rising-stem Gate Valve

Non-rising stems are threaded at the bottom. This thread mates with a thread in the gate as shown in **Figure 3.3**. Left-hand threads allow clockwise rotation of the handwheel to lower the gate and close the valve.

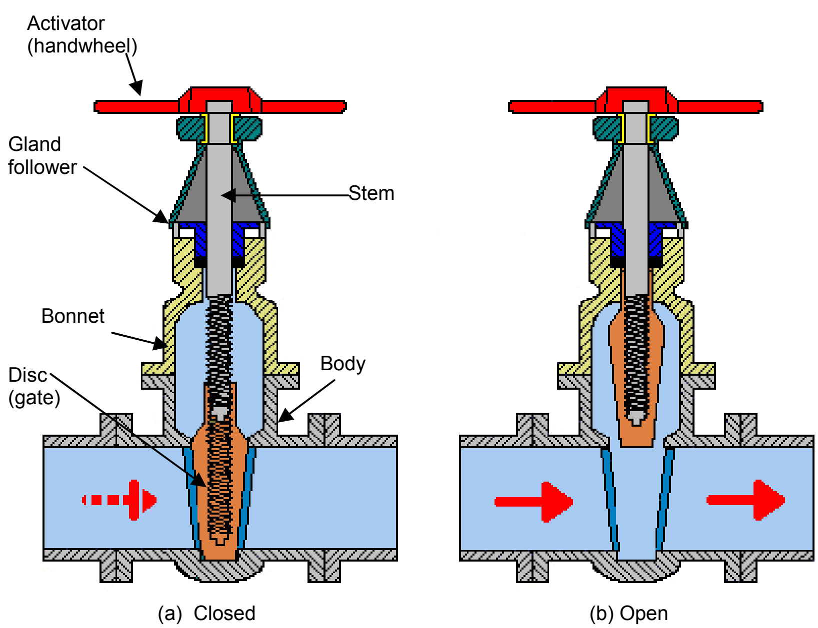


Figure 3.3: Non-rising Stem Gate Valve

The stem is fixed to the actuator and turns with it, as shown in **Figure 3.4**. The stem can rotate in its housing but does not move axially.

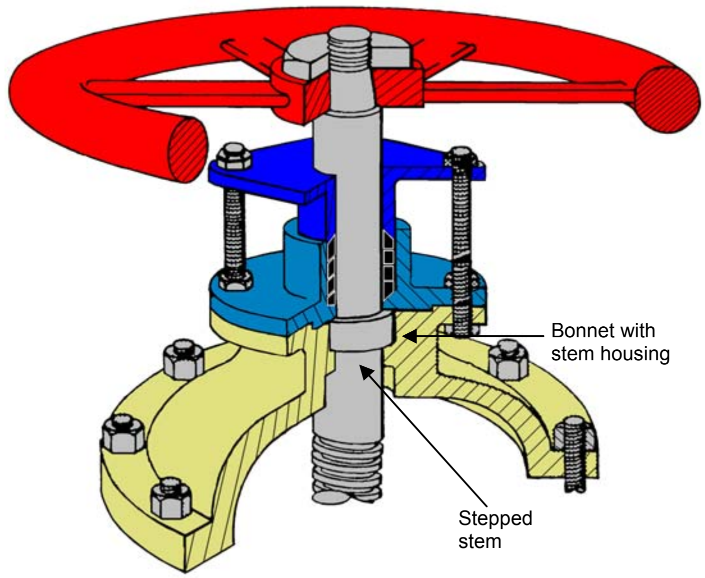


Figure 3.4: Detail of Upper Stem Location—Non-rising Stem Gate Valve

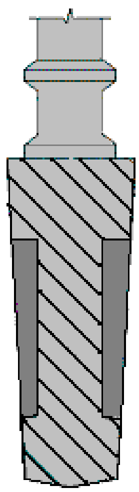
An open gate valve allows anything that can pass through the pipeline to pass through the valve. Sometimes it is necessary to send solid objects along a pipeline. The object sent is called a *pig* and the process is called *pigging*. A pipeline is pigged to flush pipes, clear blockages or for inspection purposes. Gate valves allow these operations. **Figure 3.5** shows a cutaway section of pipe containing a pig.

Figure 3.5: Pipeline Pig

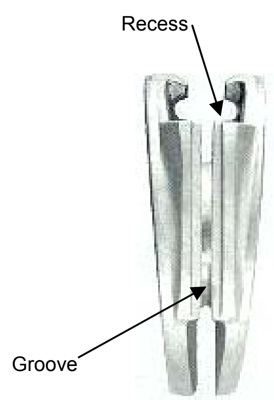
The gate, or disc design may be:

- solid wedge
- flexible wedge
- split wedge
- parallel disc

Most gate valves have solid-wedge discs. A solid wedge is cast or forged in one piece as shown in **Figure 3.6(a)**.



(a) Solid-wedge Disc



(b) Flexible-wedge Disc

Figure 3.6: Disc Design

This is the simplest and strongest type of disc.

The flexible-wedge is also made in one piece. It has a groove cut around its *perimeter* that allows it to bend a little to fit the shape of the seat more easily. These discs may also have recesses cast into them to increase flexibility, as shown in **Figure 3.6(b)**.

Flexible-wedge discs are used for valves in steam lines. When the temperature of a closed valve rises, solid-wedge discs can expand and stick in their seats. Flexible-wedge discs can compress mere easily and are less likely to distort.

Figure 3.7 shows a rising-stem, flexible-wedge gate valve.

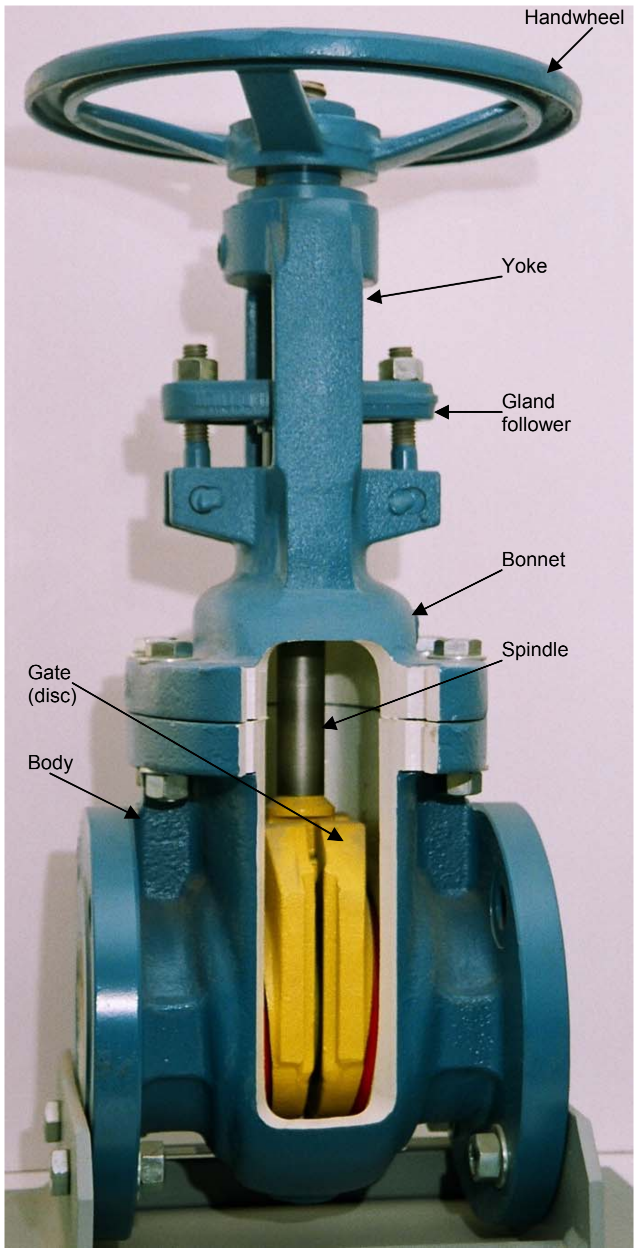


Figure 3.7: Cutaway Rising-stem, Flexible-wedge Gate Valve

Split-wedge discs are made in two separate halves. This allows the wedge angle between their outer faces to adjust to fit the seat. This is especially useful if a solid particle is stuck between the disc and its seat. Split-wedge discs are used for gases, especially corrosive gases.

Parallel slide valves also have split discs. Their faces are parallel, not wedge shaped, as shown in **Figure 3.8**. A spring between the disc halves pushes them against their seats. When the valve is closed, the disc on the outlet side is also pushed against its seat by the fluid pressure on the inlet side.

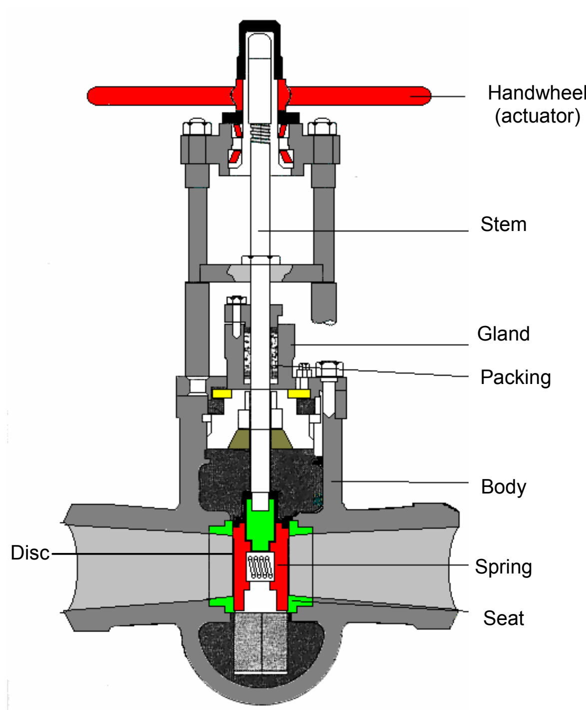
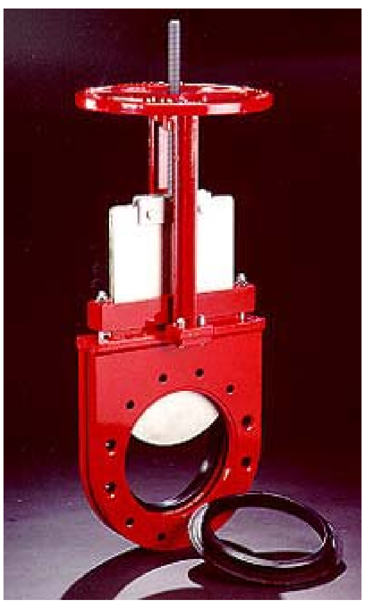


Figure 3.8: Parallel-slide Gate Valve

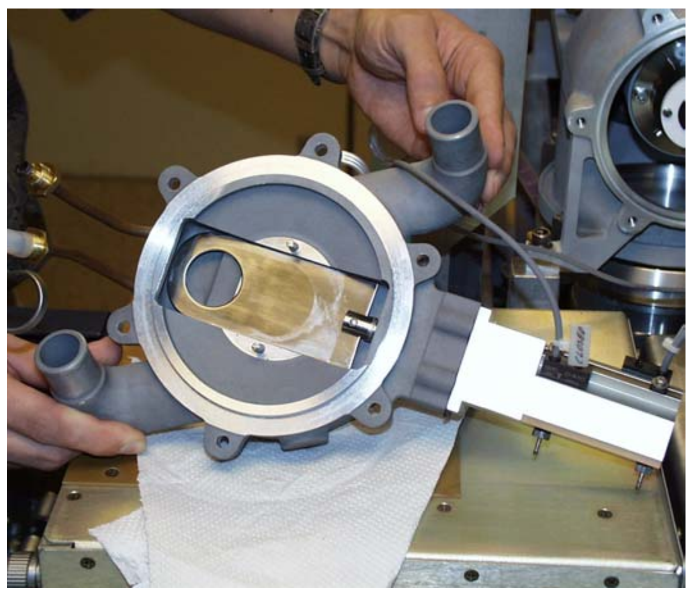
As the valve opens and closes, the sliding action keeps the disc faces clean but causes wear to discs and seats. When fully open, the discs are completely clear of the bore giving no obstruction to flow through the valve.

Gate valve seats may be *integral* with the valve body or separate seat rings. Integral seats are cut into the valve body and are part of the body. These seats can not be replaced. They can be repaired by lapping with grinding paste. Seat rings may be pressed or screwed into the body. These can be of a different material and can be replaced when worn or damaged.

Knife gate valves, have a simple, one-piece closing element. It is a parallel-sided plate that may move clear of the flow path to open or may have a hole that moves into the flow path. These two types are shown in **Figure 3.9(a)** and **(b)**.



(a)



(b)

Figure 3.9: Knife Gate Valves

3.2 Ball Valves

Ball valves start and stop flow by rotating a ball-shaped closing element. They are classed as *rotational-motion* valves. The ball has a hole through it of the same diameter as the pipeline. The valve is open when the hole lines up with the inlet and outlet of the valve body. **Figure 3.10** shows a ball valve with part of the body cut away to show the closing element.

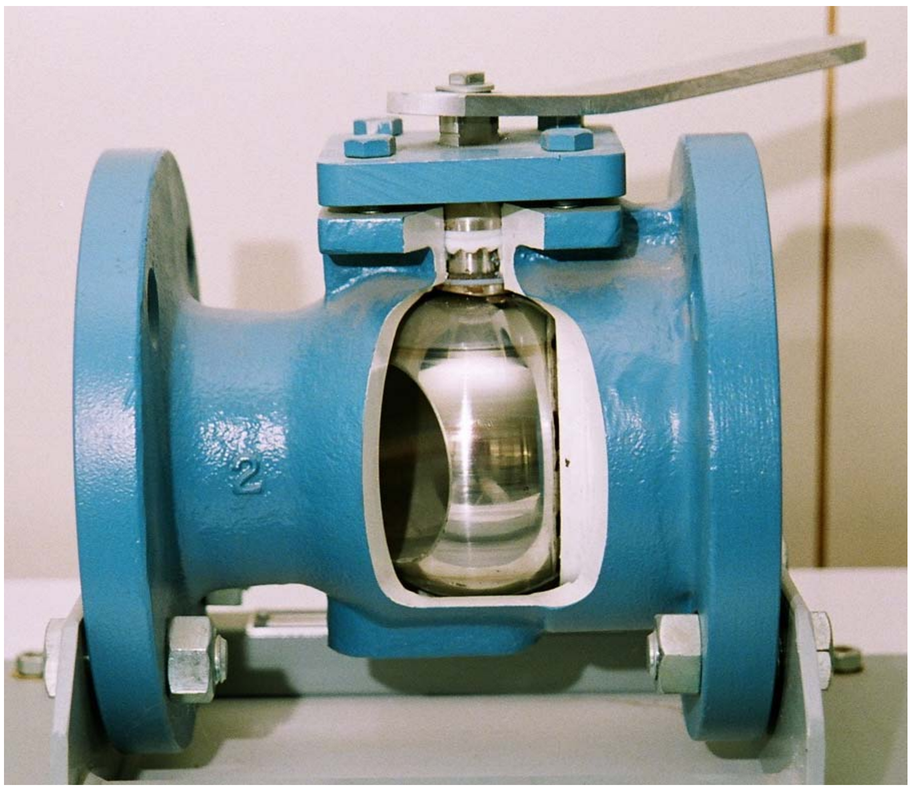
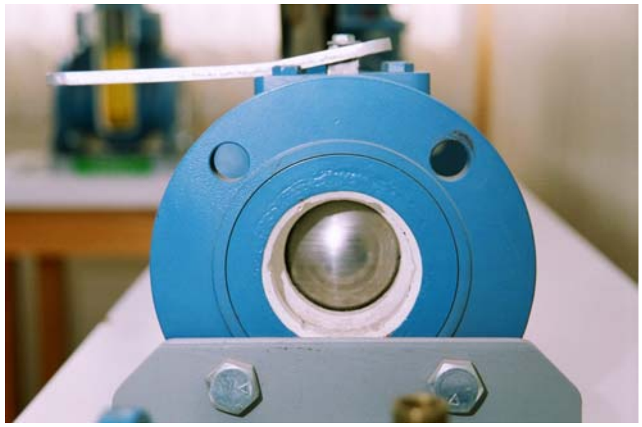


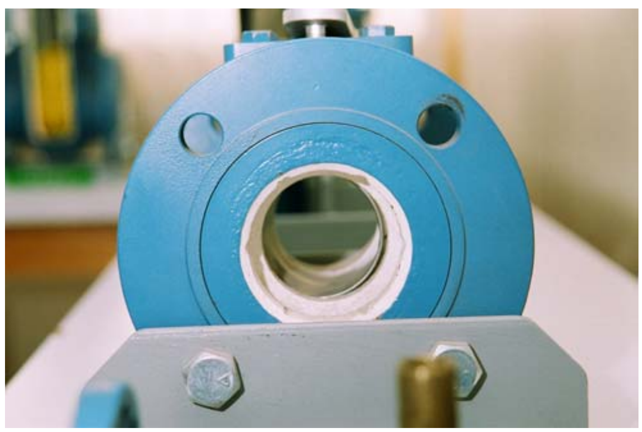
Figure 3.10: Cutaway Ball Valve

The valve above is shown partially open to show the hole in the ball. This is not the normal valve position; a ball valve is normally only used in the fully closed or fully open positions.

Figure 3.11 shows the same ball valve looking through the valve inlet. In **Figure 3.11(a)** the valve is in the closed position. In **Figure 3.11(b)** the valve is in the open position.



(a) Valve Closed



(b) Valve Open

Figure 3.11: Ball Valve—End View

The open valve leaves a clear path for flow with no obstruction. These valves can be pigged.

The valve shown has a lever actuator that turns through 90^{o} between the fully closed and fully open positions. The lever is in line with the pipeline when the valve is open.

3.3 Plug Valves

Operation of a plug valve is similar to the ball valve; they are also rotational-motion valves. The main difference is the shape of the closing element, which is a tapered plug of circular section. The plug has a hole called a *port*. **Figure 3.12** shows a plug valve that is lined with PTFE to protect it from corrosion and allow lubricant-free operation.

Figure 3.12: Single-port Plug Valve

Single-port plug valves are used to start and stop flow. Multi-port plug valves re-direct flow from one pipeline to another. **Figure 3.13** shows an example of a multi-port plug valve.

Figure 3.13: Multi-port Plug Valve

4 Flow Control (Throttle) Valves

The control of flow rate by reducing the area of the flow path through a valve is called *throttling*. Throttling a fluid also reduces its pressure.

Block valves should not be used to throttle flow. The pressure drop across them is too great and the flow becomes *turbulent*. Fluid flow can be either smooth (*laminar)*, or not smooth (*turbulent*) as shown in **Figure 4.1**.

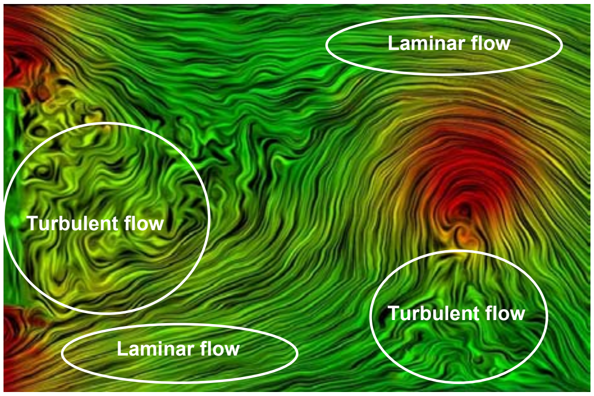


Figure 4.1: Fluid Flow Patterns

Turbulent flow can cause many problems in pipelines and equipment. In a valve, it can erode the closing element and valve seat. Erosion was described in the earlier module in this course: *Bearings*. It is the slow wearing away of a solid material by a fluid passing over it. Turbulent flow increases the rate of wear. **Figure 4.2** shows smooth and turbulent flow in rivers.

(a) Turbulent (b) Laminar

Figure 4.2: Water Flow in Rivers

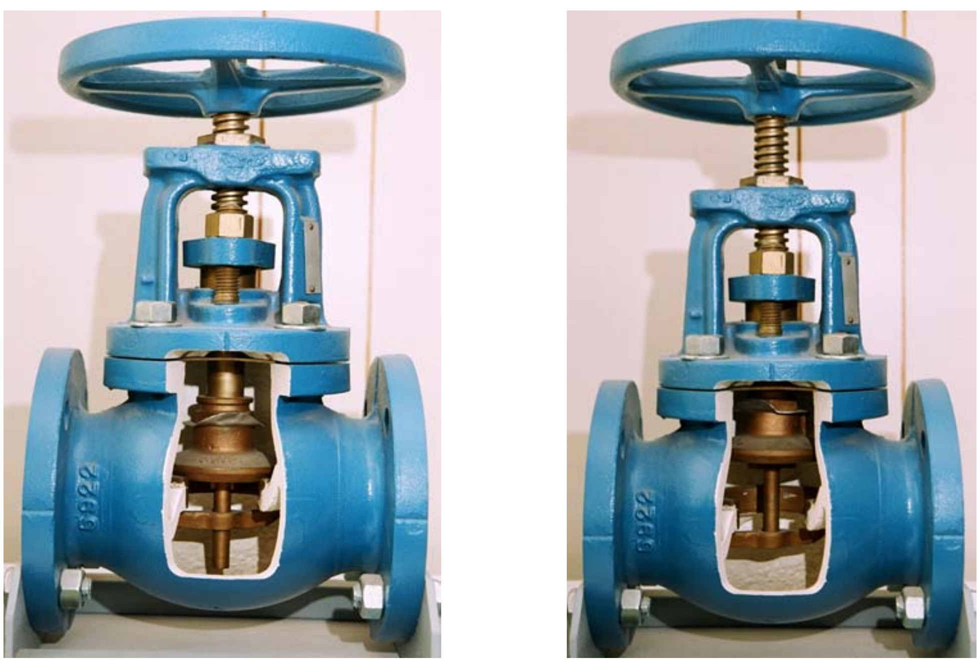
Throttle valves are designed to operate partially opened with little pressure loss and turbulence. Throttle valves are also called *regulating valves*.

There are four main types:

- globe valves
- butterfly valves
- diaphragm valves
- needle valves

4.1 Globe Valves

Globe valves are linear-motion valves and can look very similar to gate valves from the outside. Globe valves have rising stems but, unlike gate valves, the actuator is fixed to the stem and rises with it. **Figure 4.**3 shows a globe valve in the fully closed and open positions.



(a) Valve Closed (b) Valve Open

Figure 4.3: Globe Valve

Globe valve design makes them good for flow regulation as well as starting and stopping flow. In most designs, the flow direction is as shown in **Figure 4.4**. Here, the fluid pressure helps to push the valve open. The packing is not under pressure when the valve is closed and this helps it to last longer.

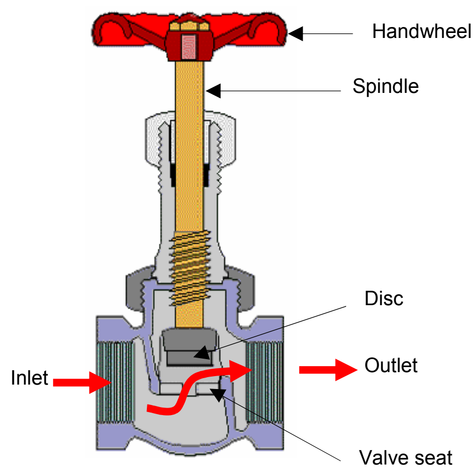


Figure 4.4: Flow through Z-type Globe Valve

The flow direction is often marked on the valve body. Make sure that you fit the valve the correct way around.

Globe valves can have three main types of body.

- Z-type
- angle
- Y-type

The valves shown in **Figures 4.3** and **4.4** have Z-type bodies. The name is given because of the path the fluid has to take as it passes through the valve. It changes direction twice, like the letter Z.

Z-type globe valves are used mainly for small-size, low-pressure applications. In large, high-pressure lines, the changes of flow direction cause a large pressure drop and turbulence that can damage the trim.

Figure 4.5 shows an angle-type globe valve. The flow changes direction only once and the pressure drop is less than for the Z-type. It can be used for medium-pressure applications.

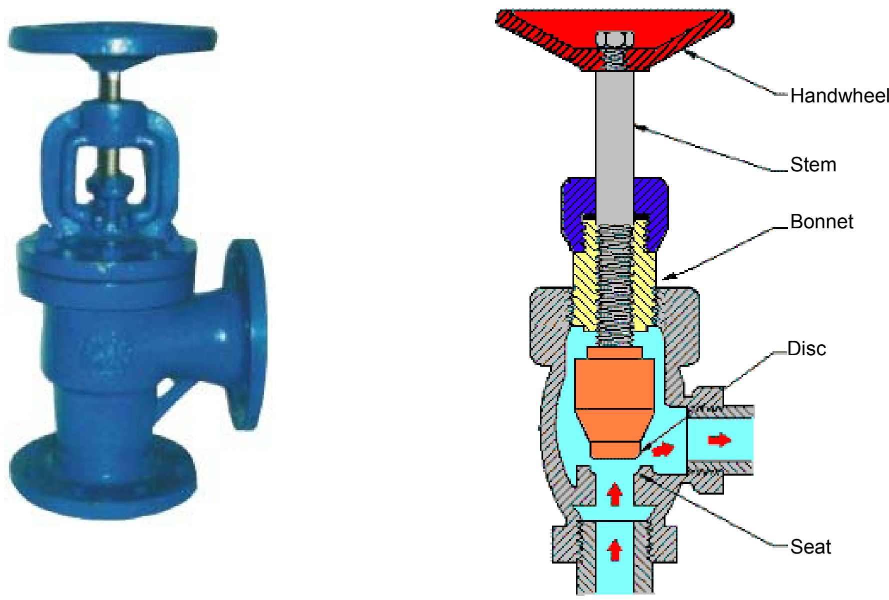


Figure 4.5: Angle-type Globe Valve

Figure 4.6 shows a Y-type globe valve. Having the seat at about 45^{o} to the flow direction straightens the flow path and reduces the pressure drop. This type of valve can be used for high-pressure applications.

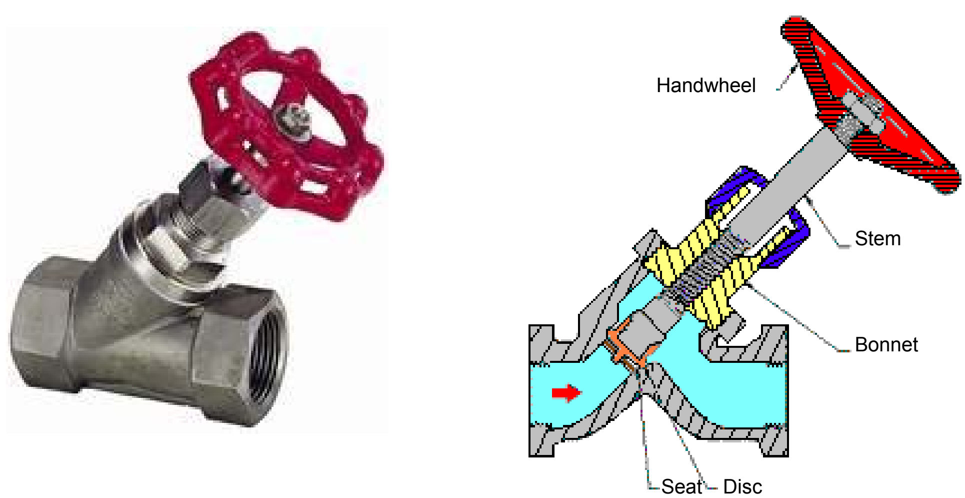


Figure 4.6: Y-type Globe Valve

Most globe valves use one of three types of disc:

- ball
- plug
- composition

Ball discs have a curved lower surface. They seal on a tapered seat that has a flat surface, as shown in **Figure 4.7(a)**. They are used mainly for low-pressure and low-temperature applications.

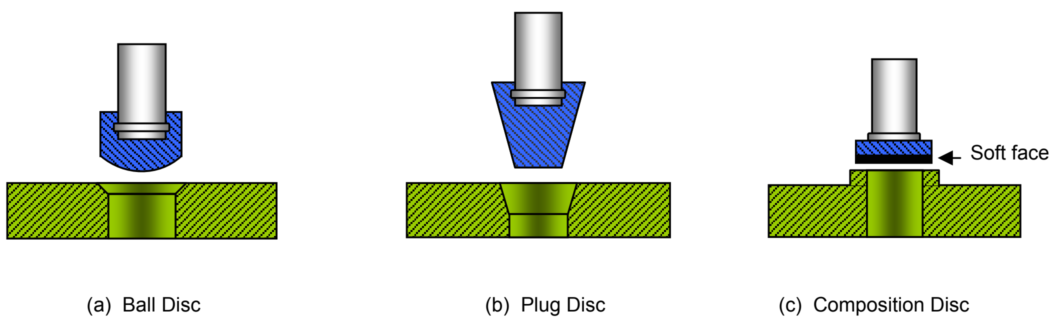


Figure 4.7: Globe Valve Discs

Plug discs come in different shapes but are all tapered. The seat has a matching taper as shown in **Figure 4.7(b)**.

Composition discs have a hard backing piece with a soft face as shown in **Figure 4.7(c)**. Hard particles trapped between the disc and the seat push into the soft face, maintaining a good seal. Composition discs are replaceable.

4.2 Butterfly Valves

Butterfly valves are rotational-motion valves. Like ball and plug valves, they need only a quarter turn (90^{o}) to fully open or close them. They can start, stop and regulate flow, although they are not very good at completely stopping flow. **Figure 4.8** shows a typical butterfly valve. The lever is in line with the pipeline when the valve is open.

(a) Valve Closed (b) Valve Open

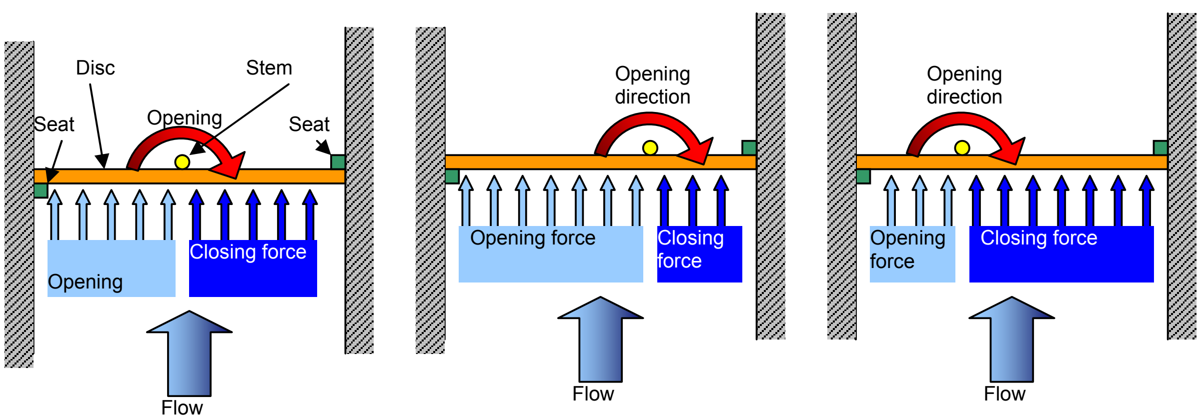
Figure 4.8: Lever-operated Butterfly Valve

The closing element is a circular disc of a similar diameter to the ID of the pipe. The disc turns to open and close the valve. The disc or seat may be made of a polymer (plastic) to give a better seal.

Butterfly valves are simple and take up little space. This makes them especially good for use in large pipelines or where there is not much space. Operating a butterfly valve can take a lot of force as you have to push it against the fluid pressure. Larger valves usually have geared actuators to make operation easier, as shown in **Figure 4.9**.

Figure 4.9: Geared Butterfly Valves

Most butterfly discs turn on a stem that passes through the centre of the disc along a diameter. When the valve is closed, fluid pressure pushes equally on both sides of the stem: half the force is pushing in the closing direction and half in the opening direction, as shown in **Figure 4.10(a)**.



(a) Central Stem—equal pressure (b) Offset Stem—quick open (c) Offset Stem—quick close

Figure 4.10: Butterfly Valve Stem Positions

If the closing mechanism failed and the disc became free to turn on its own, there is an equal chance of the valve swinging open or closed.

Some valves have a stem that is offset from the centre. With the stem offset as shown in **Figure 4.10(b)**, the fluid force is greater on the side that opens the valve. This makes opening easier and closing more difficult. If the mechanism fails and the disc becomes free it will automatically open. This type of valve can be used in *fail open* applications.

If the stem is offset to the other side, as shown in **Figure 4.10(c)**, the valve is easy to close but difficult to open. If the mechanism fails and the disc becomes free it will automatically close. This type of valve can be used in *fail closed* applications.

Make sure that you fit offset-stem valves so that flow is in the correct direction. If not, a fail-open valve will become fail-closed and a fail-closed valve becomes fail-open. **Figure 4.11** shows a large butterfly valve with an offset stem.

Figure 4.11: Offset-stem Butterfly Valve

4.3 Diaphragm Valves

The closing element of a diaphragm valve is not a solid disc. Instead, it has a sheet of flexible material called a *diaphragm*. This diaphragm completely separates the valve trim from the fluid flowing through the valve. This means that the fluid does not contact the trim and the stem does not need any gland packing. **Figure 4.12** shows an exploded view of a typical diaphragm valve.

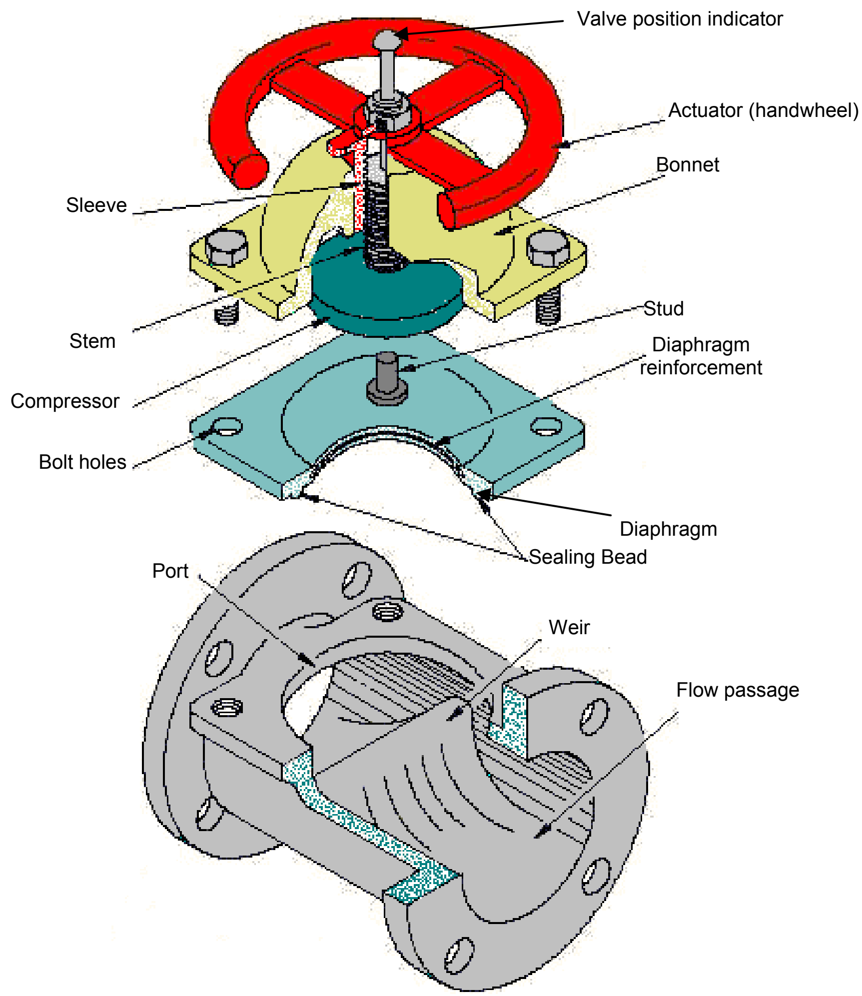
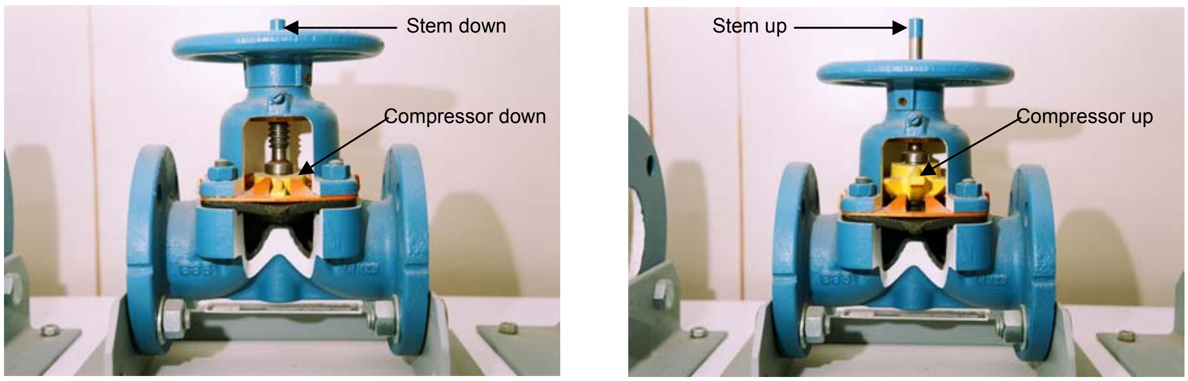


Figure 4.12: Exploded View of Diaphragm Valve with Weir

Diaphragm valves are rising-stem, linear-motion valves. As the actuator turns, the stem screws into or out of the sleeve attached to the actuator. The stem of the valve in the figure can not be seen from outside. You can see the position of the valve from a *position indicator* that rises and falls with the stem.

A *compressor* is attached to the bottom of the stem. Its job is to push down on the diaphragm to close the valve. A stud locates the compressor on the diaphragm.

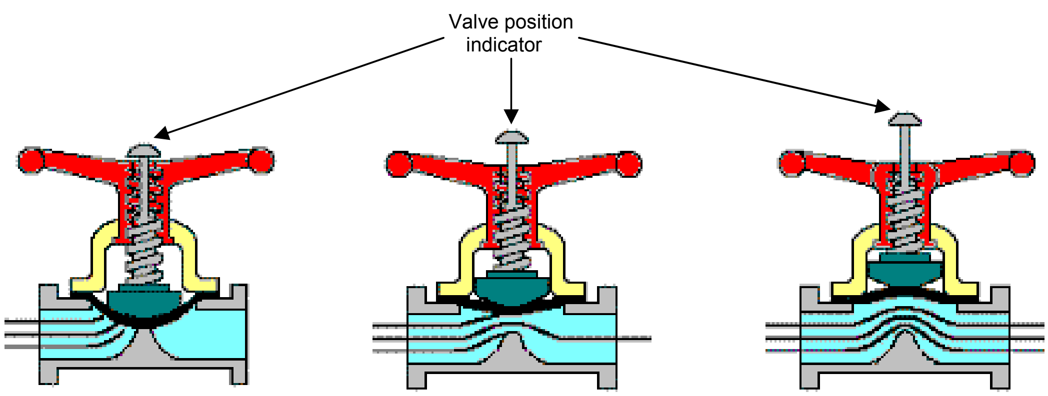
Figure 4.13 shows a diaphragm valve in the fully closed and open positions. This valve has no position indicator as you can see the valve stem.



(a) Fully Closed (b) Fully Open

Figure 4.13: Diaphragm Valve

The diagram in **Figure 4.14** shows a diaphragm valve in the closed, throttling and open positions.



(a) Closed (b) Throttling (c) Open

Figure 4.14: Diaphragm Valve Positions

4.4 Needle valves

Needle valves are linear-motion valves. They can make very small adjustments to flow rate. Their name comes from the long, tapered shape of the bottom of the spindle that forms the closing element. **Figure 4.15** shows a typical needle valve.

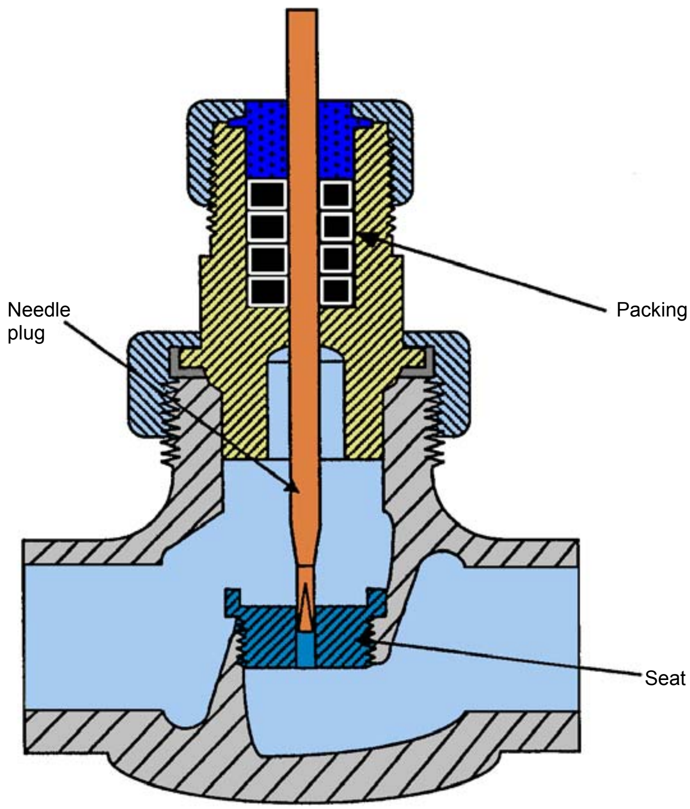
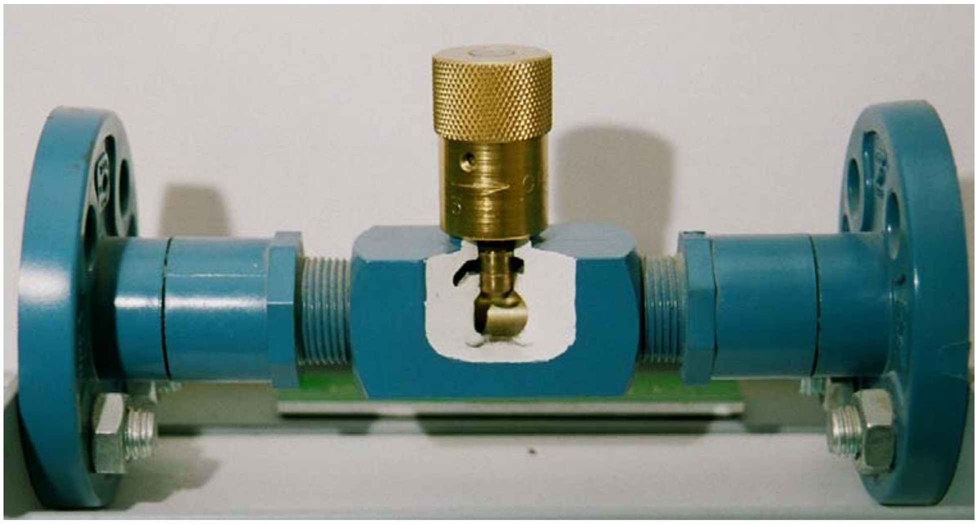
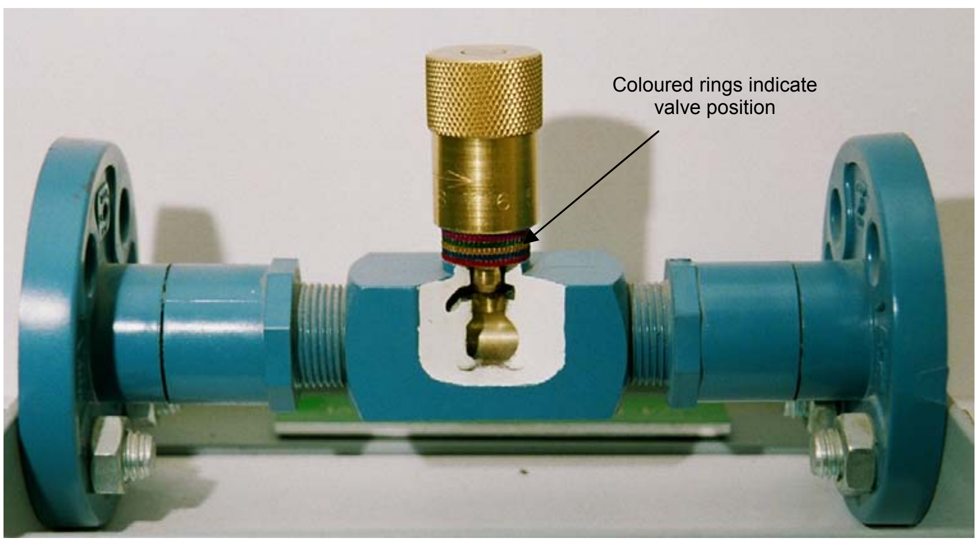


Figure 4.15: Needle Valve

Figure 4.16 Shows a cutaway needle valve in the closed and open positions.



(a) Valve Closed



(b) Valve Open

Figure 4.16: Cutaway Needle Valve

5 Non-return (Check) Valves

Non-return valves, also called *check valves*, stop flow reversal in a pipe. They only allow fluid to flow in one direction.

The pressure of the fluid passing through the valve in the correct direction opens it automatically. If the flow tries to reverse, the valve closes automatically. They have an arrow on the body that shows the correct flow direction, as shown in **Figure 5.1**. Make sure that you mount non-return valves the correct way round.

Figure 5.1: Non-return Valve

There are a number of designs of non-return valve. Some rely on the weight of the closing element and fluid flow only to close them. Others have a spring to help close them.

5.1 Swing Check Valves

In this type, the valve disc is hinged at the top. When there is no flow, the weight of the disc closes the valve. **Figure 5.2** shows a typical swing-check valve in open and closed positions.

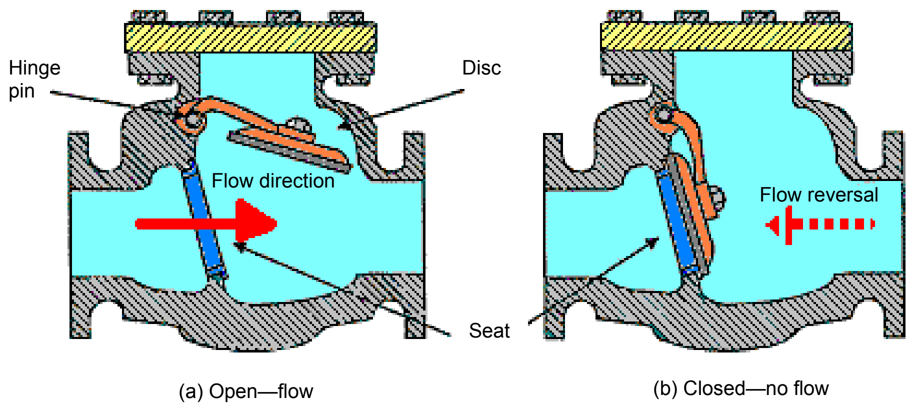


Figure 5.2: Swing-check Valve

This valve must be mounted in a horizontal pipeline, with the disc hinge at the top to allow gravity to close it. If it can not be mounted in this way, another type of check valve should be used, or a swing-type with an external counterbalance, as shown in **Figure 5.3**.

Figure 5.3: Swing-check Valve with Counterbalance

The counterbalance arm clamps onto the hinge pin in a position that closes the disc.

5.2 Lift Check Valves

These valves have a similar valve body and seating arrangement to globe valves. **Figure 5.4** shows the body of a lift check valve.

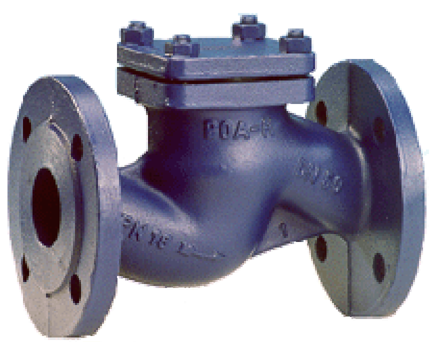
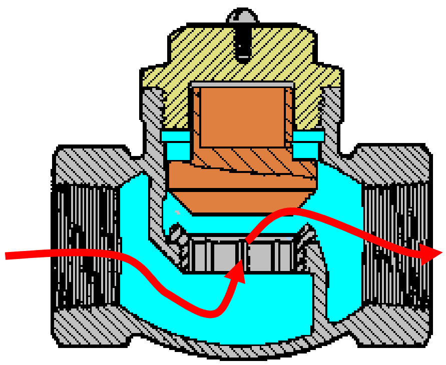
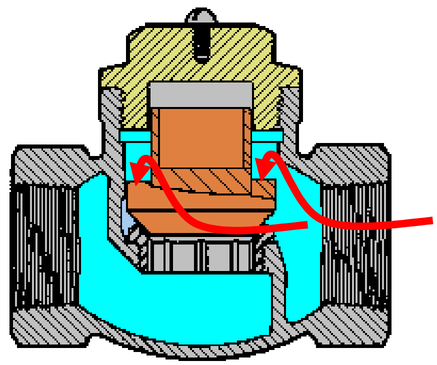


Figure 5.4: Lift Check Valve—Outside View

Flow must enter from under the seat to lift the closing element, as shown in **Figure 5.5(a)**. Flow in the reverse direction pushes the closing element against its seat, as shown in **Figure 5.5(b)**.



(a) Flow



(b) No Flow

Figure 5.5: Flow through a Lift Check Valve

The closing element may be free to fall under its own weight, as shown in **Figure 5.5** or it may be helped by a spring, as shown in **Figure 5.6**.

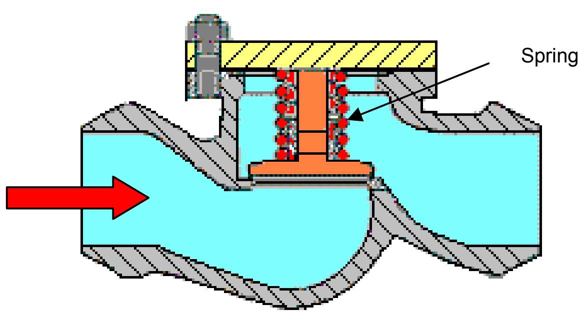


Figure 5.6: Spring-loaded Lift Check Valve

5.3 Piston Check Valves

Piston check valves are similar to lift check valves. Instead of a valve disc there is a piston that slides in a cylinder. This gives a smoother motion during operation. **Figure 5.7** shows an example of this type of valve.

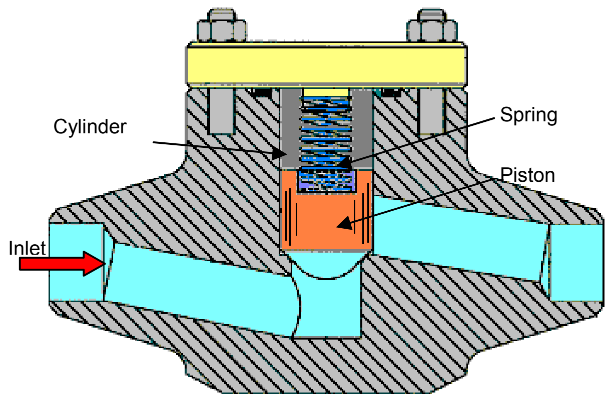
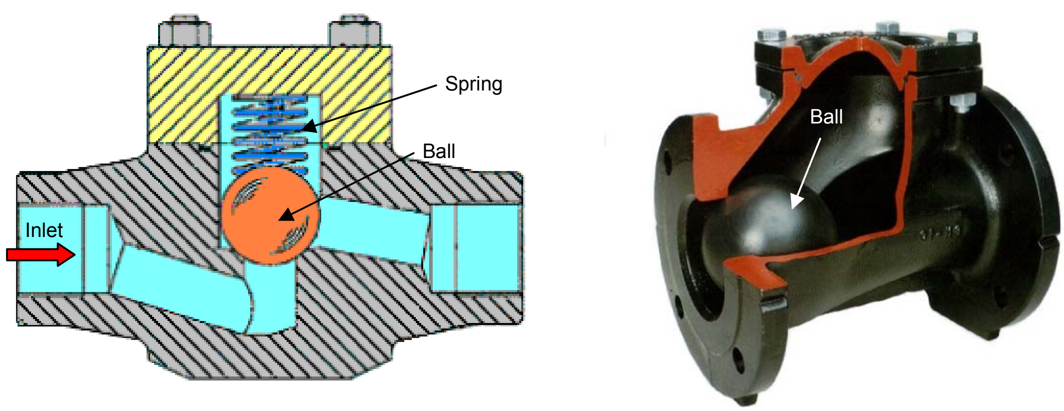


Figure 5.7: Piston Check Valve

5.4 Ball Check Valves

These have a spherical (ball-shaped) closing element. Like the other check valves, the closing element may operate by gravity or the flow pressure or it may be spring-loaded. **Figure 5.8** shows examples of ball check valves.



(a) Spring-loaded Ball Check Valve

(b) Flow-activated Ball Check Valve

Figure 5.8: Ball Check Valves

5.5 Stop Check Valves

A stop check is a non-return globe valve. It is similar to a globe valve but the valve disk is free to slide on the stem.

With the valve stem raised, it acts as a lift check valve allowing flow only from below the disc, as shown in **Figure 5.9**. If there is no flow, or if flow reverses, the disc drops into the position shown in the figure.

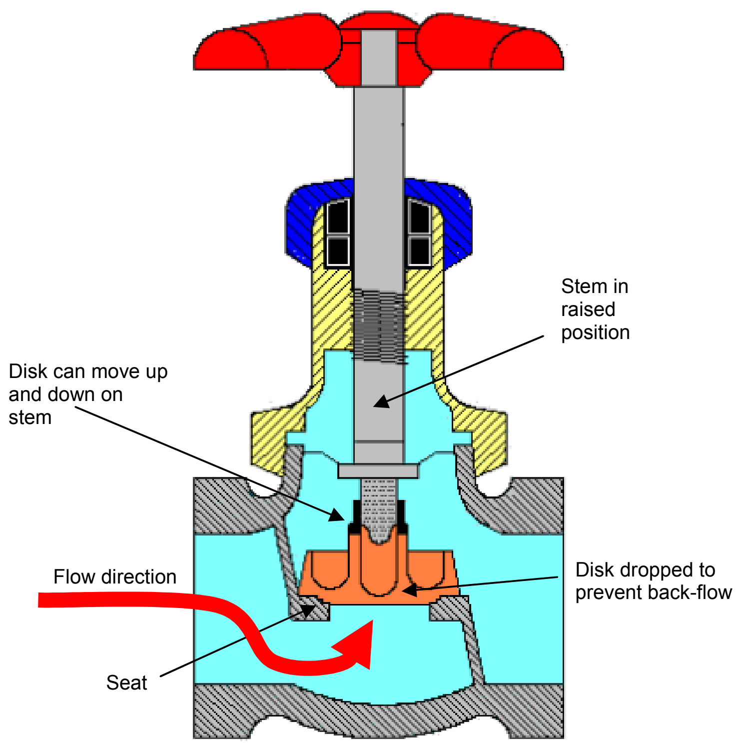


Figure 5.9: Stop Check Valve

When the stem is lowered to the closed position, the disc can not lift and flow is stopped in both directions.

6 Pressure Control Valves

Pressure control valves can be divided into three main types:

- pressure reducing
- pressure relief
- pressure safety

Pressure reducing valves operate where a pressure drop is needed between two parts of a process.

Pressure relief valves maintain fluid pressure below a maximum allowable value for a process.

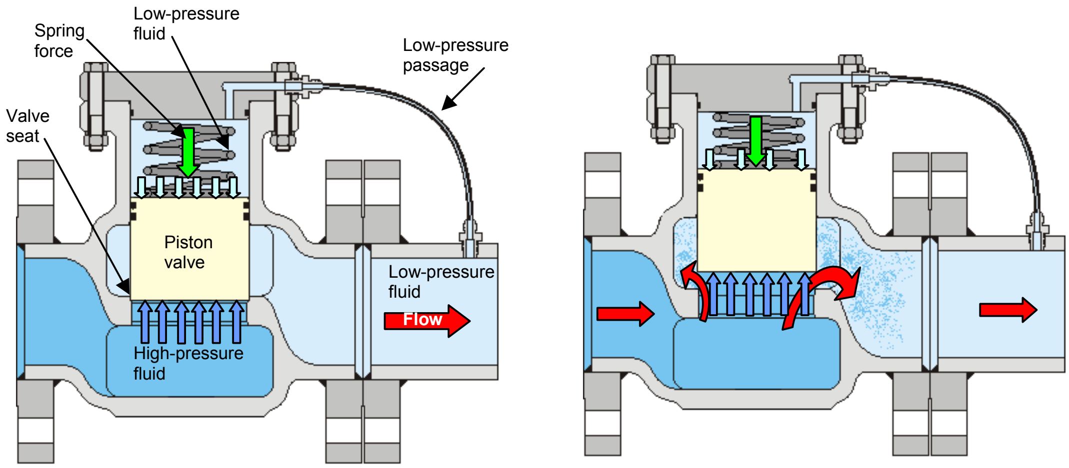
Pressure safety valves protect the plant from damage caused by overpressure.

These last two valves do similar jobs and are similar in construction.

6.1 Pressure Reducing Valves

Reducing valves automatically reduce liquid or gas pressure to a pre-set value. One common use is to control the pressure of gas leaving gas bottles and vessels. You will see pressure reducing valves on gas welding equipment

Their construction can be quite complicated but a simple, non-adjustable valve is shown in **Figure 6.1**.

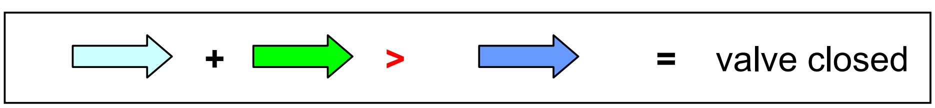


(a) Closed— Correct Outlet Pressure (b) Open— Low Outlet Pressure

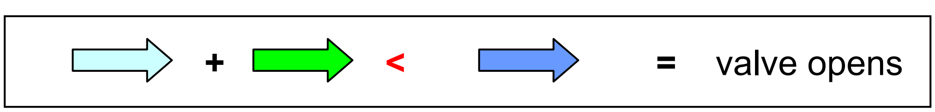
Figure 6.1: Simplified Non-adjustable Pressure Reducing Valve

The operation of this valve depends on the balance between the fluid pressures acting above and below a piston, and a spring force.

When the force of the low pressure fluid plus the spring force pushing down on the piston is more than the force of the high pressure supply fluid pushing up, the piston closes the valve.



When the force of the low pressure fluid drops, the new lower pressure plus the spring force pushing down on the piston becomes less than the force of the high pressure fluid pushing up and the piston opens the valve.



During operation, the valve continuously opens and closes to maintain a flow of fluid at the reduced pressure.

The only way to change the outlet pressure in the simple valve is to change the spring to a stronger or weaker one. Some reducing valves have an adjusting screw to change the spring force. This allows you to change the output fluid pressure easily.

Many reducing valves have more than one piston and may also use diaphragms to improve their performance. **Figure 6.2** show an example of a steam pressure reducing valve.

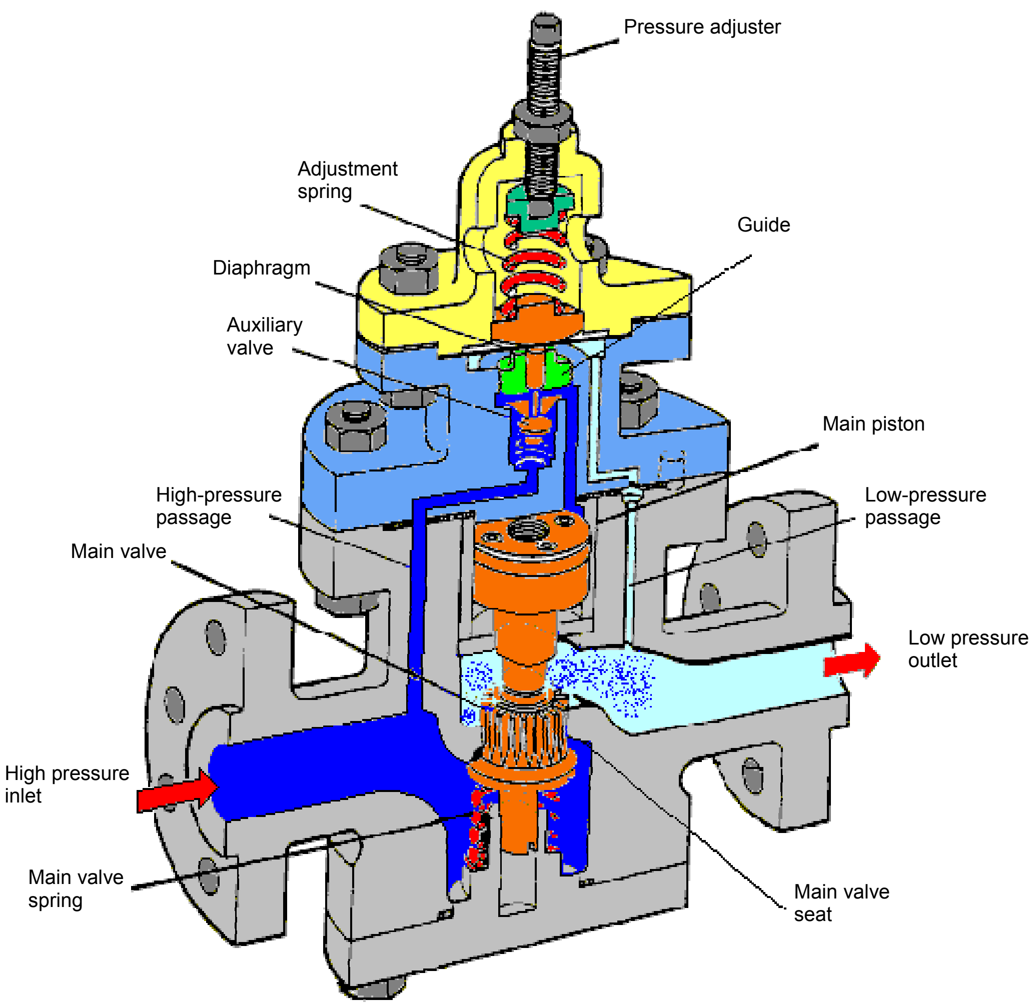


Figure 6.2: Adjustable Steam Pressure Reducing Valve

6.2 Pressure Relief Valves (PRVs)

Pressure relief valves are used mainly to relieve overpressure of liquids. This often happens when a liquid in a closed container or pipeline expands as its temperature increases.

Under normal operating conditions, a spring holds the PRV closed. Fluid pressure pushes against the spring to open the valve. The fluid pressure needed to push the valve open is called the *setpoint pressure*. The setpoint pressure is usually the maximum normal operating pressure of the liquid. An adjustment screw changes the spring force for different setpoint pressures.

When the liquid pressure exceeds the setpoint pressure, the valve opens slowly. It releases just enough liquid to bring the pressure down to the normal operating pressure. The spring then closes the valve slowly so that normal operations can continue. The outlet from the valve is connected back into the inlet of the equipment so that no liquid is lost. **Figure 6.3** shows a typical PRV. Notice that the valve outlet diameter is greater than the inlet. This allows fluid to escape quickly to bring pressure down to normal.

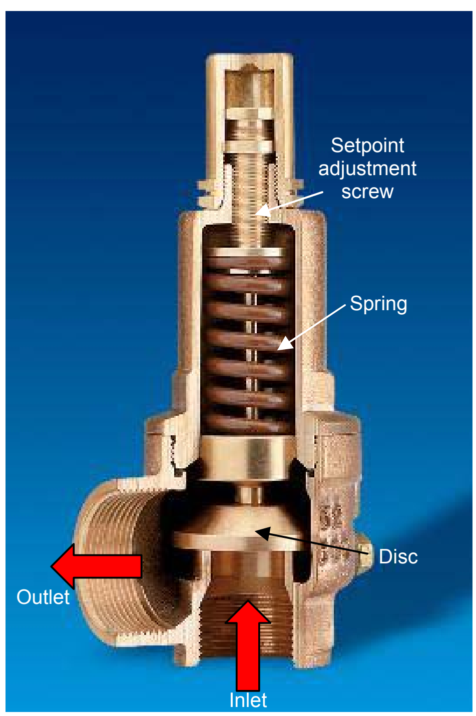


Figure 6.3: Pressure Relief Valve—PRV

6.3 Pressure Safety Valves (PSVs)

Pressure safety valves are used mainly to relieve overpressure of gases and vapours (e.g. steam). The setpoint pressure is greater than the maximum normal operating pressure of the process fluid but less than the maximum safe working pressure of the equipment.

operating pressure < opening setpoint pressure < maximum safe working pressure

When the fluid pressure exceeds the setpoint pressure, the valve *pops* fully open. This happens very quickly to release overpressure as quickly as possible. The pressure at which the valve closes again is lower than the opening setpoint pressure. The difference between opening and closing pressures is called the *blowdown*.

Blowdown is given as a percentage of opening setpoint pressure.

For example, a valve may open at 15bar with a blowdown of 10%.

> 10% of 15bar is 1.5bar
>
> the valve will close at a pressure that is 1.5bar lower than 15bar
>
> 15bar – 1.5bar = 13.5bar.

PSVs on gas processing systems normally vent to flare—the valve outlet is connected to the flare system where the gas burns off.

PSVs on steam systems vent to atmosphere—the steam is released into the air.

Figure 6.4 shows a typical PSV.

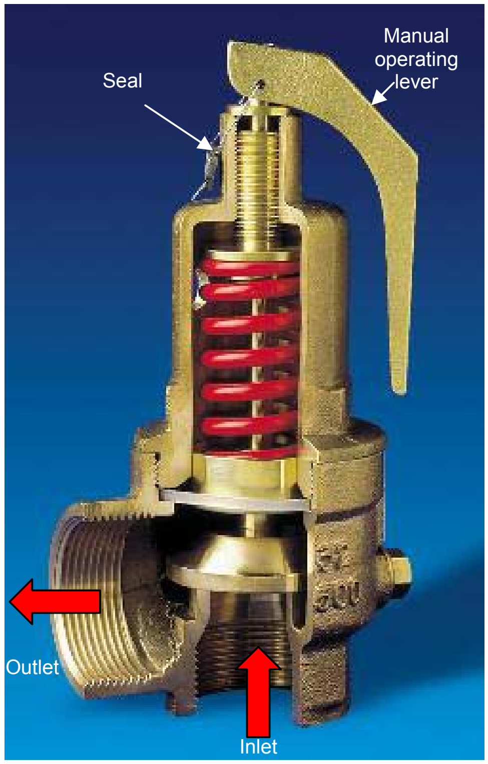


Figure 6.4: Pressure Safety Valve—PSV

The PSV outlet diameter is greater than the inlet for the same reason as for the PRV.

PSVs often have an external operating lever. This is used to manually check the operation of the valve.

All valves should be handled with care and kept clean but this is especially important for PSVs. They protect the plant and their failure to operate correctly can cause a lot of expensive damage and injury to personnel. Make sure that all protective plugs and wrappings are in place when you receive a PSV from stores.

Before fitting, check that all wrappings and plugs are removed and that the seals protecting the valve settings are in place and unbroken. Check the information on the nameplate and identification tags against the work order. Make sure that inlet and outlet ports and the pipes going to them are clean.

Valves removed from service should be tested in the workshop. The opening setpoint pressure and blowdown are tested and their values recorded. **Figure 6.5** shows a PSV being tested on a special rig.

Figure 6.5: Pressure Testing a PSV/PRV

6.4 Rupture Discs

Rupture discs, also called *bursting discs*, are a simple and cheap form of pressure safety device. They have no moving parts and break when a particular pressure is reached, allowing fluid to escape very quickly. A rupture disc is chosen that will burst as soon as the maximum allowable system pressure is exceeded.

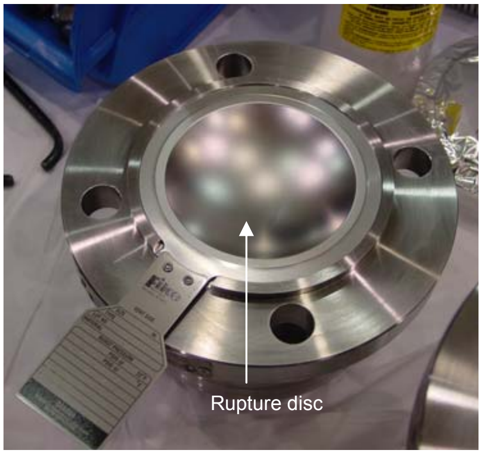
Once the disc has burst, it is replaced with a new disc of the correct bursting pressure. **Figure 6.6** shows rupture discs before and after bursting.

Figure 6.6: Rupture Discs Before and After Use

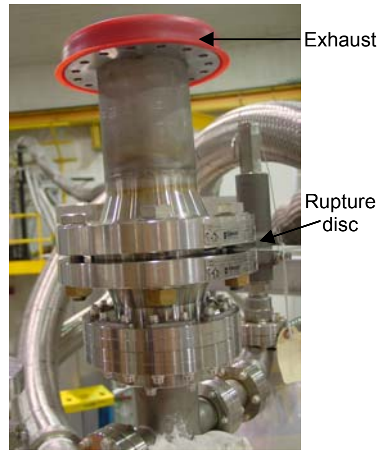
Most discs are circular with a *concave* dished surface, as shown in **Figure 6.7**.

Figure 6.7: Dished Disc before Fitting

The disc is fitted between flanges in a special assembly as shown in **Figure 6.7**.



(a) Disc in Place in Lower Half of Assembly



(b) Disc Assembly in System

Figure 6.7: Rupture Disc Assembly

When the disc bursts, the fluid may vent to a holding vessel, straight to atmosphere or through an exhaust device like the one shown in **Figure 6.7(b)**.

In some systems a rupture disc is fitted just before a PSV. This is done where the fluid being contained is very corrosive and could damage the valve so that it does not operate properly. The disc forms a barrier between the system fluid and the PSV. This arrangement is shown in **Figure 6.8**.

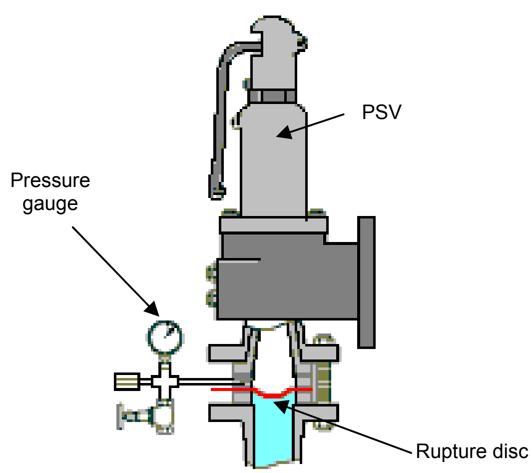


Figure 6.8: Rupture Disc Mounted in Series with PSV

7 Valve Actuators

An actuator is the part of a valve system that operates the valve.

Valve operation may be:

- manual—operated directly by a person
- semi-automatic—operated by another source of power that is switched on by a person
- automatic—operated by another source of power that is switched on by a signal from a sensing device

There are six main types of actuator:

- manual
- electric motor
- electric solenoid
- pneumatic
- hydraulic
- self-actuated—check valves, PRVs and PSVs (described in the last section)

The type of actuator used depends mainly on whether or not automatic operation is needed and how much torque is needed to operate the valve.

Automatically operated valves need a source of power to operate them: electric, pneumatic or hydraulic. If this power source fails, the valve must be left in a safe position—it must *fail safe*. This may be open, closed or in the position it was operating in before the power failure. Automatically operated valves may be:

- fail open
- fail closed
- fail locked

7.1 Manual Actuators

The most common manual actuators are:

- handwheel—for linear motion valves: gate valves, globe valves, etc.
- lever—for rotational motion valves: ball valves, butterfly valves, etc.

Most of the valves shown earlier in this module have manual actuators. **Figure 7.1** shows another example of handwheel and a lever-actuated valves.

(a) Handwheel-actuated Gate Valve (b) Lever-actuated Ball Valve

Figure 7.1: Handwheel and Lever-actuated Valves

Some larger handwheel-actuated valves have *hammer handwheels*. These turn freely on the spindle for part of a turn. The wheel has lugs that hit against a bar (the secondary wheel) that is fixed to the spindle, as shown in **Figure 7.2**.

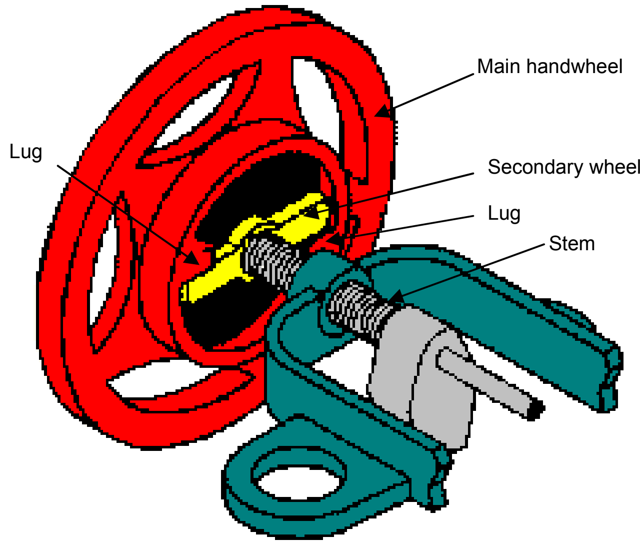
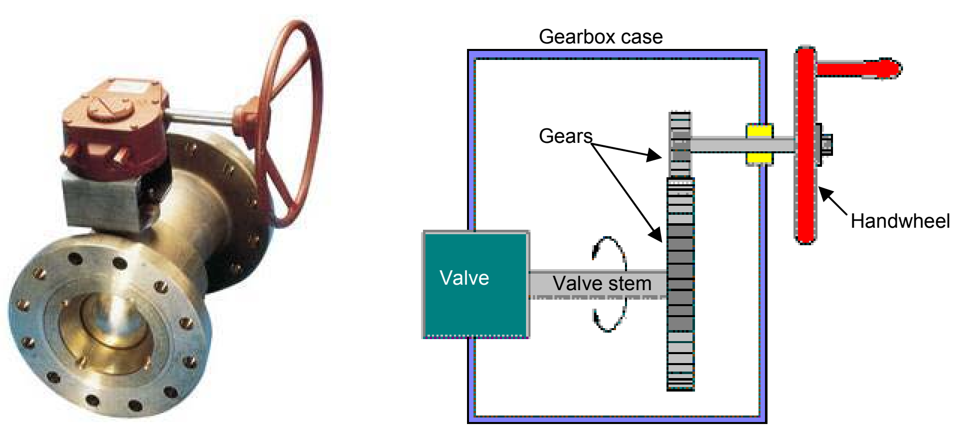


Figure 7.2: Hammer Handwheel

The hammering action of the lugs on the secondary wheel helps the operator to open a valve when it is stuck.

A gear system is used on bigger valves to increase the actuating torque. **Figure 7.3(a)** shows a typical gear-actuated valve.



(a) Gear-actuated Ball Valve (b) Actuator Gearbox

Figure 7.3: Gear Actuators

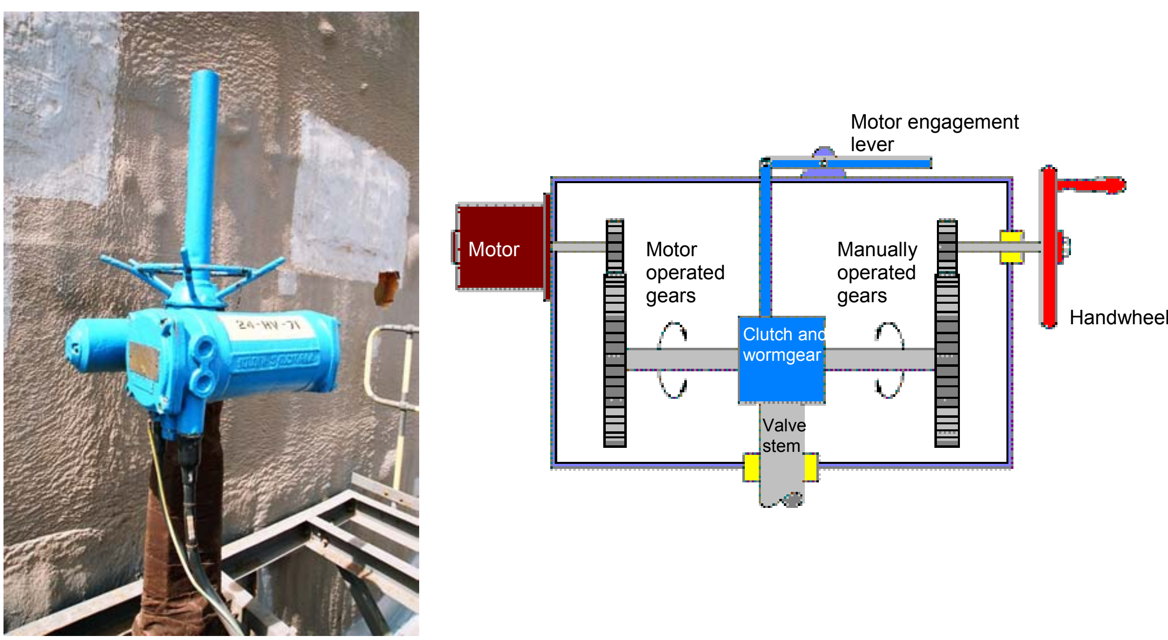
The handwheel is fixed to a small gear that engages with a bigger gear on the valve stem, as shown in **Figure 7.3(b)**.

The *gear ratio*:

- reduces the speed of operation—the valve stem turns more slowly than the handwheel
- increases the torque—the torque at the valve stem is more than the torque you use at the handwheel

7.2 Electric Motor Actuators (MOVs)

Motor operated valves (MOVs) allow semi-automatic and automatic operation. The motor turns the valve stem through a gear train. This increases the motor torque at the valve stem. **Figure 7.4(a)** shows a typical MOV and **Figure 7.4(b)** shows an example of a gear train that allows motor or manual operation. The handwheel gear can be disengaged for automatic operation.



(a) Motor-actuated Gate Valve

(b) Actuator Gearbox

Figure 7.4: Motor Operated Valve and Actuating Gearbox

The motor can be reversed for opening or closing the valve. These valves can control flow but motor actuators are mainly used to fully open and close the valve. Limit switches stop the motor when the valve is fully open or closed.

7.3 Electric Solenoid Actuators (SOVs)

When current passes through a coil of wire, the coil acts like a magnet. It attracts magnetic materials like iron. We say that the coil is *energised*.

An electric solenoid uses this idea to move an iron *armature*. The magnetic field pulls the armature into the coil when the current is switched on.

Solenoid operated valves (SOVs) use this motion to operate a valve. Because the motion is linear, an SOV operates directly on the valve stem to open and close it. This is different from the MOV, which rotates the stem in the normal way. SOVs are mainly used on linear motion valves.

A spring pushes the valve in one direction:

- open for fail open valves
- closed for fail closed valves

When the current is switched off (the solenoid is *de-energised*), or when power fails, the spring operates the valve.

The solenoid moves the valve in the other direction when the current is switched on (the solenoid is *energised*).

The solenoid can be energised automatically, or semi-automatically with a manual switch.

Figure 7.5 shows the basic parts of an SOV.

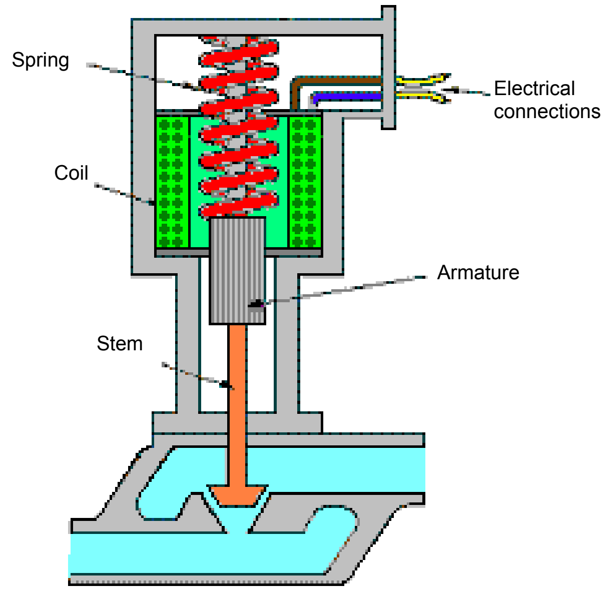


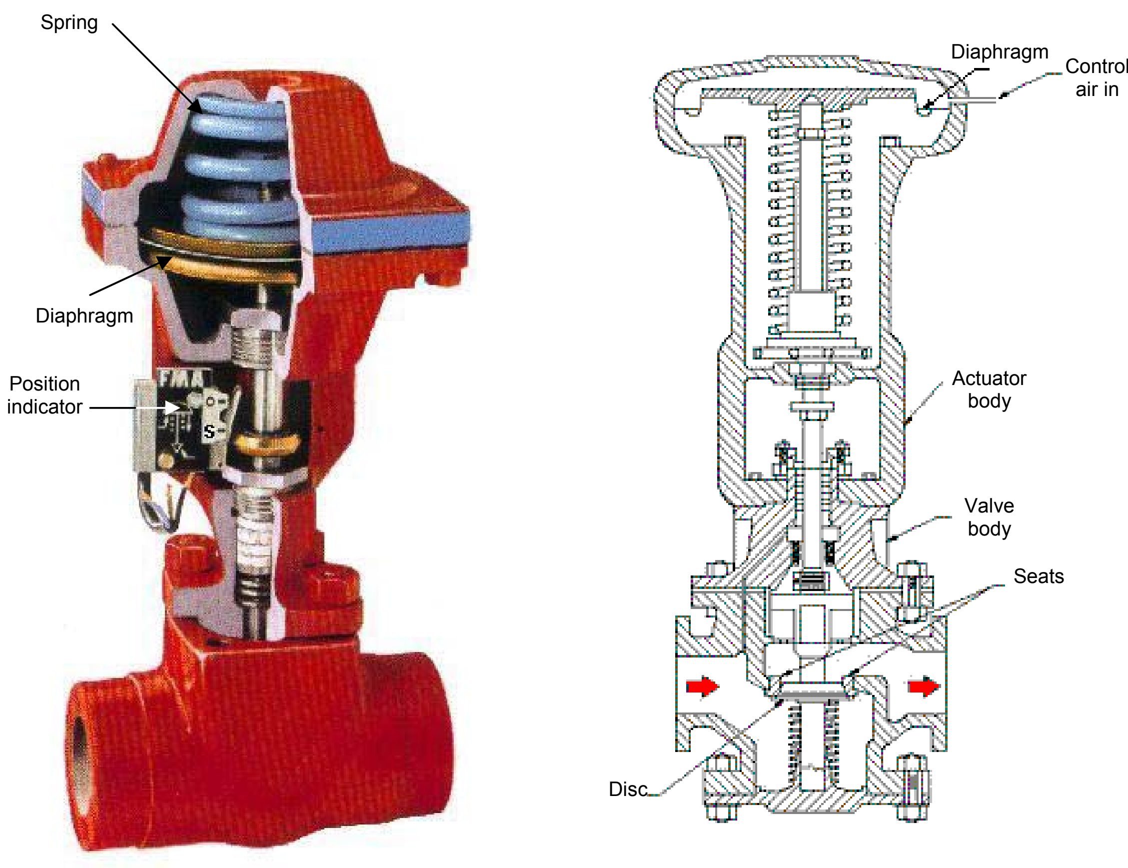
Figure 7.5: Solenoid Actuated Valve

Solenoid valves are often used to control the air supply to larger, pneumatic valve actuators. **Figure 7.6** shows a small solenoid air valve.

Figure 7.7: Solenoid Actuated Air Valve

7.4 Pneumatic Actuators

Pneumatic actuators are operated by air pressure. The air pushes on a diaphragm that moves the stem up or down. Some actuators are moved both ways by air pressure but most use air to operate in one direction and have a spring that pushes in the other direction. In **Figure 7.7(a)** you can see the spring above the diaphragm, pushing down to operate the valve. The section shown in **Figure 7.7(b)** shows the spring below the diaphragm, pushing up to operate the valve.



(a) Fail Closed Gate Valve

(b) Fail Closed Globe Valve

Figure 7.7: Pneumatic Actuators

Pneumatic actuators are mainly used to operate linear motion valves. They can be operated automatically, or semi-automatically with a manually-energized solenoid valve on the air line.

If the spring **opens** the valve when air pressure is removed, the valve will *fail open* and it is called a *direct-acting* valve.

If the spring **closes** the valve when air pressure is removed, the valve will *fail closed* and it is called a *reverse-acting* valve.

Figure 7.7(a) shows a pneumatically activated gate valve. The position indicator shows that the valve is open (O) when raised by air pressure below the diaphragm, and shut (S) by the spring. **Figure 7.7(b)** shows a pneumatically activated globe valve. The valve is open when lowered by air pressure above the diaphragm and closed by the spring. Both these valves are fail-closed, reverse-acting valves.

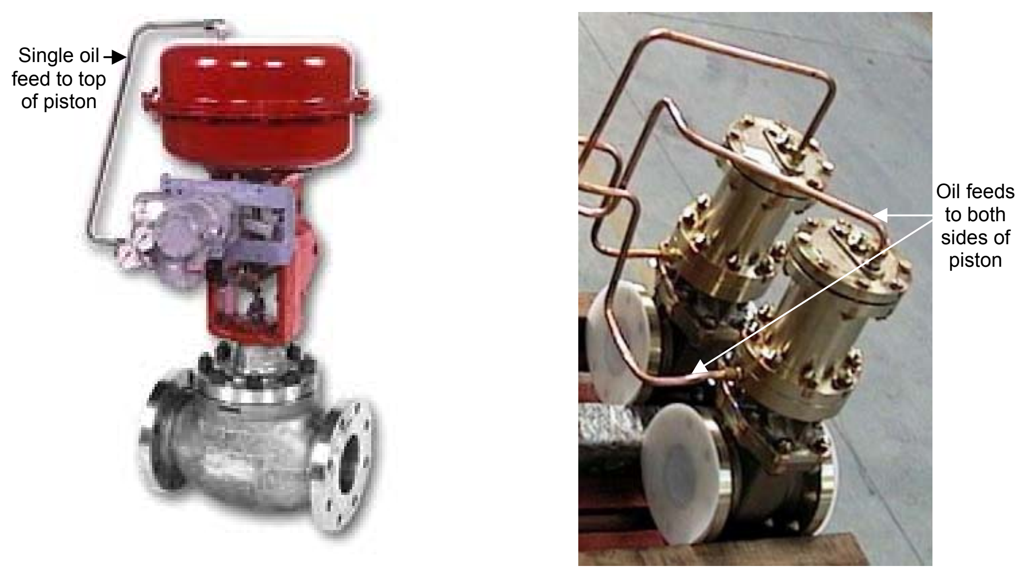
Valves that have air pressure on both sides of the diaphragm are called *duplex* valves. They are operated by adjusting the pressure above and below the diaphragm.

Some pneumatic actuators use a piston instead of a diaphragm. This allows the greater motion needed to operate rotational motion valves through a lever system.

7.5 Hydraulic Actuators

Hydraulic actuators perform in a similar way to pneumatic actuators. They use oil, or sometimes water, to move a piston. The hydraulic fluid is pumped to one side of the piston to operate the valve in one direction. If a spring operates the valve in the opposite direction, it will be fail-open or fail-closed, depending on which way the spring operates the valve. Some hydraulic actuators use *double-acting* cylinders that operate by pumping oil to either side of the piston. Pumping to one side opens the valve and pumping to the other side closes the valve. If power is lost to a double-acting actuator, the valve normally stays where it is at the time of failure: it is *fail locked*.

Figure 7.8 shows two different types of hydraulic valve actuators.



(a) Single-acting Spring Return Hydraulic Actuator

(b) Double-acting Hydraulic Actuators

Figure 7.8: Hydraulic Actuators

8 P&ID Valve Symbols

Many of the symbols used on P&IDs were described in the Basic Maintenance Course module, *Drawings and Diagrams*. Symbols used on ADGAS P&IDs were also given in the module on *Pipework* in this course. **Table 8.1** shows the symbols used for the valves described in this module.

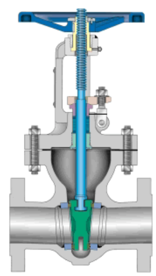
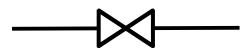
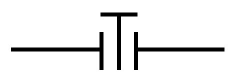
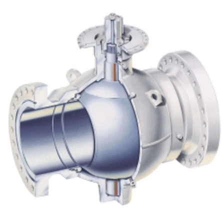
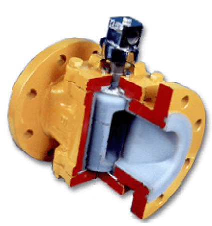
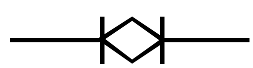
Name	Valve	Symbol
Gate valve		
Parallel slide valve (manually operated)		
Ball valve		
Plug valve		

Table 8.1(a): P&ID Valve Symbols

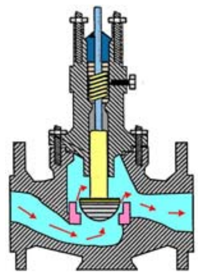
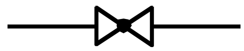
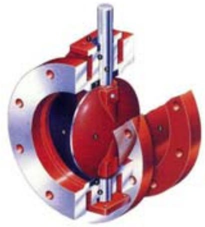
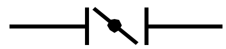
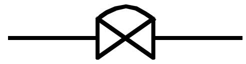
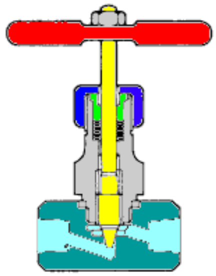
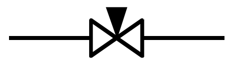
Name	Valve	Symbol
Globe valve		
Butterfly valve		
Diaphragm valve		
Needle valve		

Table 8.1(b): P&ID Valve Symbols

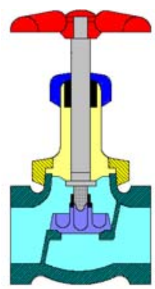
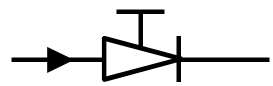
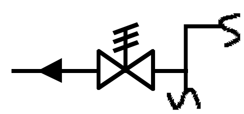
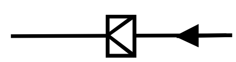
Name	Valve	Symbol
Check valve		
Stop check valve		
Pressure relief valve		
Rupture (bursting) disc		

Table 8.1(c): P&ID Valve Symbols

Table 8.2 shows symbols used to indicate types of actuators.

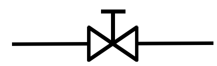
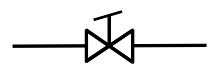
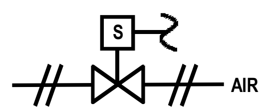
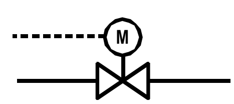
Name	Actuator/valve	Symbol
Manually operated (handwheel)		
Manually operated (lever)		
Electric solenoid		
Electric motor, pneumatic and hydraulic actuated	 	 M – electric motor N - pneumatic H - hydraulic

Table 8.2: P&ID Valve Actuator Symbols

9 Valve Applications

Using the correct valve for any application is very important. Different types of valve perform different jobs on the plant: blocking flow (start/stop); throttling (flow rate control); pressure control; flow direction control; safety. The size and pressure rating of a valve is important to allow the correct flow rate and process pressure to be safely maintained. This information is usually marked on the valve body. The valve material must be *suitable* for the type of fluid being handled. Often the valve trim is of a different material than the bonnet and body and these are specified separately. All of these requirements are listed in the ADGAS Piping Specification. **Appendix A** contains ADGAS Specification A as an example. **Appendix B** shows the BS standard materials and dimensions for class 150, 300 and 600 gate valves.

Something is ***suitable*** when it is correct for the job it must do.

Table 9.1 contains a guide to the use of the more common valves.

Valve	Stop-start	Throttling	Frequent operation	Low pressure drop	Size range mm	Pressure range (bar)	Temperature range (°C)
Gate	✓			✓	3-1220	vac to 667	-270 to 680
Slide	✓				50-1900	atm. to 27	-18 to 650
Ball	✓		✓	✓	6-914	atm to 500	-55 to 500
Plug	✓		✓	✓	6-406	atm to 200	-70 to 200
Globe (Z)	✓	✓	✓		3-726	vac to 667	-270 to 540
Y-type	✓	✓	✓	✓	3-762	vac to 167	-270 to 540
Butterfly	✓	✓	✓	✓	50-914	vac to 80	-30 to 540
Diaphragm	✓	✓			3-610	vac to 20	-50 to 230
Needle		✓			3-25	vac to 667	-70 to 260

Table 9.1: Valve Applications

You do not need to remember all this information but it gives you an idea of suitable applications.

10 Valve Maintenance

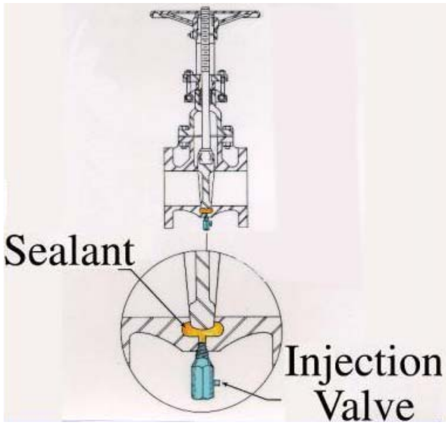
Discs and seats are the parts of a valve that are most likely to become worn or damaged. Damage to these causes the valve to leak internally. They can be damaged by corrosion and erosion. In some valves the seats can be repaired by lapping with grinding paste. You will see how this is done and do it yourself in the practical Exercises in this module. Some valves have separate seats that you can remove and replace when they are damaged.

External leakage is caused by failure of a gasket or packing. A little leakage from packing is acceptable and is often needed to lubricate the stem. Sometimes, you can reduce leakage by tightening down the gland follower. If this does not work you need to replace the packing as described in the module *Gland Packing*.

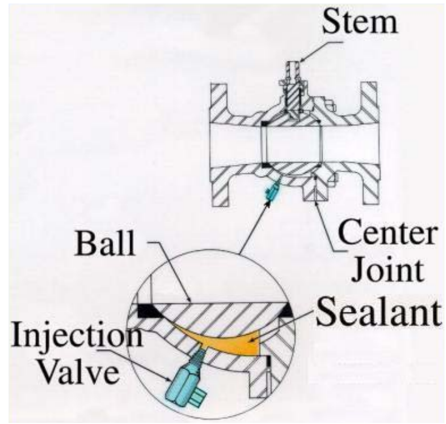
Gasket leaks may also be stopped by tightening flange bolts but this is not recommended. You must be careful not to exceed the recommended stud torque or you may shear a stud. This would cause even more leakage and possibly complete failure of the gasket.

Wherever possible, the valve should be isolated and removed from service for repairs. If this is not possible for operational reasons, a leaking valve can be temporarily repaired by injecting a sealant. Permanent repairs can then be done during a shut-down period.

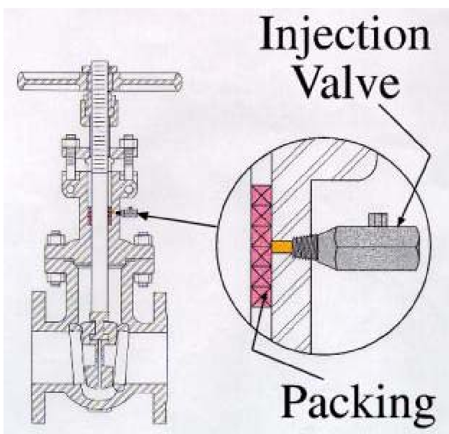
Sealant injection for different parts of a valve is shown in **Figure 10.1**.



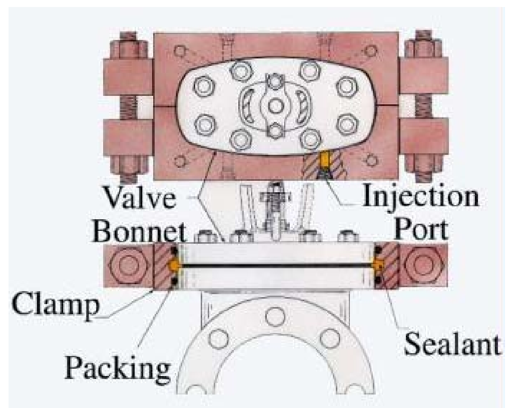
(a) Gate Valve Seat Repair



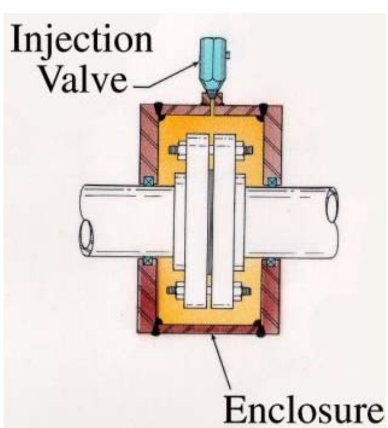
(b) Ball Valve Seat Repair



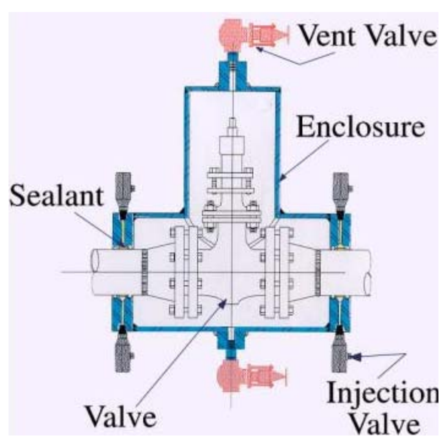
(c) Packing Repair



(d) Bonnet Repair



(e) Flange Repair



(f) Total Valve Sealing

Figure 10.1: Temporary Valve Repairs

For seat repairs, the valve body is drilled and sealant injected into the area of the seat as shown in **Figure 10.1(a)** and **(b)**.

Gland sealing is done in a similar way, by drilling the packing gland and injecting sealant into the stuffing box, as shown in **Figure 10.1(c)**.

To repair the bonnet gasket, a clamp is fitted around the joint and sealant injected through a hole in the clamp, as shown in **Figure 10.1(d)**.

To repair flange and body leaks the leaking part is enclosed in a jacket. The jacket is then injected with sealant as shown in **Figures 10.1(e)** and **(f)**.

Other parts of a valve that you should check for damage are bushings in the yoke or bonnet.

11 Summary

In this module you have looked at the most common types of valves used on the ADGAS plant. You should be able to identify these valves, describe the main features of their construction and know their applications.

There are many special valves used in the gas industry, for example:

- cryogenic valves, for use on the very low-temperature liquefied gas lines
- Orbit valves, which combine linear and rotary motion to give a good seal with less wear on sealing surfaces during operation

Special valves are not covered in this module.

12 Glossary

Here are some words used in this module that might be new to you. You will find these words in *coloured italics* in the notes. There is a short definition in a box near the word in the notes.

Word	First Used on Page:	Part of Speech	Meaning	Example of Use
Junction	6	noun	Point at which two things meet.	You will find a fuel station at the third road junction after these traffic lights.
Vary	8	verb	To change.	The accelerator pedal is used to vary the speed of the car.
Exceed	10	verb	To be more than what is normal or allowed.	If you exceed the speed limit you may be fined by the traffic police.
Suitable	62	adjective	Correct or acceptable for a particular purpose.	Your working overalls may not be suitable dress for dinner in the mess.
Obstruction	12	noun	Something that blocks a path or gets in the way.	Road works caused an obstruction that resulted in a traffic jam 5 kilometres long.

Appendix A ADGAS Piping Specification A

ADGAS PIPING SPECIFICATION 'A'

ISSUE 3 DATE: MAY 1995

SERVICE: GENERAL PROCESS, SWEET FUEL GAS, LP STEAM, LIGHT DISTILLATE AND H F O, UTILITY AIR, INST. AIR, NITROGEN, PROPANE, CARBONATE SOLUTIONS

DESIGN CODE	CORROSION ALLOWANCE 0.05"	RATING 150# RF CARBON STEEL

SERVICE LIMITS: (BASED ON FLANGES)																		
	TEMPERATURE °C	38	50	75	100	125	150	175	200	225	250	260	275	300	325	350	375	400
	PRESSURE BARG	20	19	19	18	16.75	16	15	14.0	13	12	12	11	10	9.3	8.4	7.4	6.5

NOTES:

1. WALL THICKNESS FOR 20" NB PIPE & ABOVE TO BE CALCULATED (SEE ALSO BECHTEL SUPPLEMENT L2).
2. FABRICATION AND INSPECTION TO BP GS 118-5.
3. CARBON CONTENT OF ALL STEEL TO BE LIMITED TO 0.25 PERCENT MAX.
4. N D T REQUIREMENTS TO BE ADVISED BY CORROSION AND INSPECTION DEPARTMENT.
5. WELDS TO BE STRESS RELIEVED ON CARBONATE & DEA DUTIES TO BP GS 118-5.
6. ALL METALLIC MATERIALS USED ON CARBONATE, DEA & SOUR GAS DUTIES TO N A C E SPEC. MR-01-75 LATEST REV.
7. PARALLEL SLIDE GATE VALVES TO BE USED ONLY IN STEAM LINES OUTSIDE PROCESS AREAS.
8. STEAM SERVICE VALVES 8" & ABOVE TO HAVE INTEGRAL TYPE BYPASS.
9. SERVICE TEMP. OF SOFT SEAT BALL VALVES TO BE LIMITED TO 250°C MAX.
10. WN FLANGES TO BE USED ONLY FOR FTG TO FTG PURPOSE & STEAM LINES WITHIN PROCESS AREAS.
11. BURIED LINES TO BE COATED AND WRAPPED TO BP STD 144.
12. WHERE LINES ARE STRESS RELIEVED DO NOT USE SW VALVES. USE FLANGED VALVES SPEC. AS FOR 2" FLANGED.

COMPONENT	SIZE	DESIGN & MATERIAL SPECIFICATION	REMARKS
GATE VALVES	1½" & BELOW	800 # FS SW BS 5352, MATL. BS 1503. 221-430, 13% CR. TRIM	NOTE 12
	2" - 12"	150# RF BS 1414, MATL. CS BS 1504-161 GR 480, 13% CR. TRIM	NOTE 8
	14" - 42"	AS ABOVE WITH BEVEL GEAR OPERATION	NOTE 8
	2" - 6"	150# RF PARALLEL SLIDE, MATL. CS BS 1504-161 GR. 480, 13% CR. TRIM	NOTE 7
	8" - 12"	AS ABOVE WITH INTEGRAL BYPASS	NOTE 8
	14" & ABOVE	AS ABOVE WITH INTEGRAL BYPASS AND GEAR OPERATION	
GLOBE VALVES	1½" & BELOW	800 # FS SW BS 5352, MATL. BS 1503-221-430, 13% CR. TRIM	NOTE 12
	2" - 8"	150# RF BS 1873, MATL. CS BS 1504-161 GR 480, 13% CR. TRIM	
	8"	AS ABOVE WITH INTEGRAL BYPASS	NOTE 8
CHECK VALVES	1½" & BELOW	800 # FS SW PISTON TYPE BS 5352, MATL. BS 1503-221-430, 13% CR. TRIM	NOTE 12
	2" - 24"	150# RF SWING TYPE BS 1868, MATL. CS BS 1504-161 GR 480, 13% CR. TRIM	
PLUG VALVES	2" - 4"	150# RF BS 5353, MATL. CS BS 1504-161 GR. 480	
	6" - 24"	AS ABOVE WITH GEAR OPERATION	
BALL VALVES	2" - 8"	150# RF FULL PORT BS 5351, MATL. CS BS 1504-161 GR. 480, PTFE SEALS, SS BALL	NOTE 9
VENT & DRAIN VALVES	1½" & BELOW	800# FS GATE OESW/OESCRD API, BS 5352, MATL. BS 1503-221-430, 13% CR. TRIM	NOTE 12
	1½" & BELOW	800# FS SW LUBRICATED PLUG VALVES BS 5353 REG. PATTERN, LEVER OP., MATL. BS 1503-221-430	

ADGAS PIPING SPECIFICATION 'A'

ISSUE 0 DATE: JULY 1993

COMPONENT	SIZE	WT.	DESIGN & MATERIAL SPECIFICATION	REMARKS
PIPING	1½" & BELOW	SCH. 80	MATL. CS SMLS. API 5L GR. B OR ASTM A 106 GR. B	
	2" - 6"	SCH. 40		
	8" - 16"	SCH. 30		
	18"	$^3/_8$" THK		
	20" & ABOVE	NOTE 1	MATL. API 5L, GR. B	
B. W. FITTINGS	2" - 6"	SCH. 40	DIMS. BS 1640, PART 3, MATL. GR. WPB/ASTM A 234 GR. WPB	
	8" - 16"	SCH. 30		
	18"	$^3/_8$" THK		
	20" - 24"	NOTE 1		
FLANGES (GEN.)	ALL		150# SO RF BS 1560, MATL. ASTM A 105 OR BS 1503-221-430	Note 10
	2" - 6"	SCH. 40	150# WN RF BS 1560, MATL. ASTM A 105 OR BS 1503-221-430	
	8" - 16"	SCH. 30		
	18"	STD		
	20" - 24"	NOTE 1		
FLANGES (ORIFICE)	2"	SCH. 40	300# WN RF BS 1560, MATL. ASTM 105 OR BS 1503-221-430	
	8" - 16"	SCH. 30		
SPADES	1" - 16"	--	150# REVERSIBLE SPADE; 150# RING & SPADE SET — TO BP STD DRG. S-0755M, MATL.BS 1501-151, GR. 400 OR 430	
	18" - 48"			
BOLTING			BS 4882, GR. B7 STUDS, GR. 2H NUTS	
GASKETS			150# RING TYPE FOR FLANGES TO BS-1560, MATL, BS 1832, $^1/_{16}$" THK CAF GRAPHITED	
SW FITTINGS	1½" & BELOW		3000# DIMS. & MATL. BS 3799, GR. WPA/WPB	
		SCH. 160	NIPPLES — API 5L, GR. B OR ASTM A 106 GR. B	
		SCH. 80	SWAGE NIPPLES — BS 3799, GR. WPA/WPB	
SCRD. FITTINGS				
SOCKOLETS	1½" & BELOW	--	3000# MATL. ASTM A 105	
WELDOLETS	2" - 4"	SCH. 40	MATL. ASTM A 105	

HEADER SIZES (IN INCHES)	1 & SMLR	1½	2	3	4	6	8	10	12
1 & SMLR	T								
1½	S	T							
2	S	S	T						
3	S	S	W	T					
4	S	S	W	W	T				
6	S	S	W	W	W	T			
8	S	S	W	W	W	UB	T		
10	S	S	W	W	W	UB	UB	T	
12	S	S	W	W	W	UB	UB	UB	T
14	S	S	W	W	W	UB	UB	UB	UB
16	S	S	W	W	W	UB	UB	UB	UB
18	S	S	W	W	W	UB	UB	UB	UB

BRANCH SIZES (INCHES)

BRANCH REINFORCEMENT

T = TEE

UB = UNREINFORCED BRANCH

S = SOCKOLET

W = WELDOLET

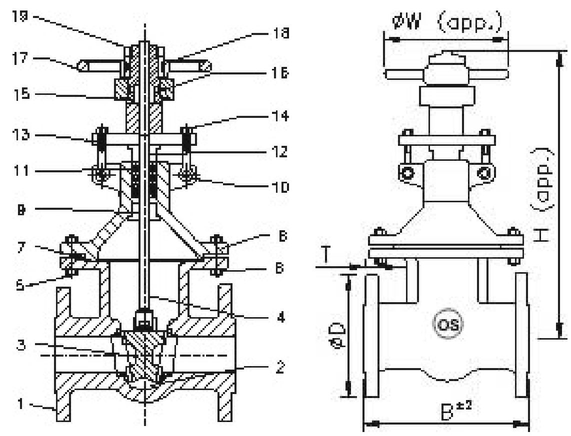
NOTE: FOR BRANCH DETAILS REFER TO BECHTEL STD DRG: AL-865

Appendix B British Standard Gate Valve Specifications

CAST STEEL GATE VALVE CLASS 150

MANUFACTURING STANDARDS	
DESIGN	BS:1414 / ANSI B16.34 /API 600
FACE TO FACE	ANSI B 16.10
FLANGE	ANSI B 16.5 R.F
TESTING	BS : 5146 / API 598

CLASS	TEST PRESSURE IN Kg / cm^2		
	HYDROSTATIC		AIR
	BODY	SEAT / BACK SEAT	SEAT
150	30	22	6



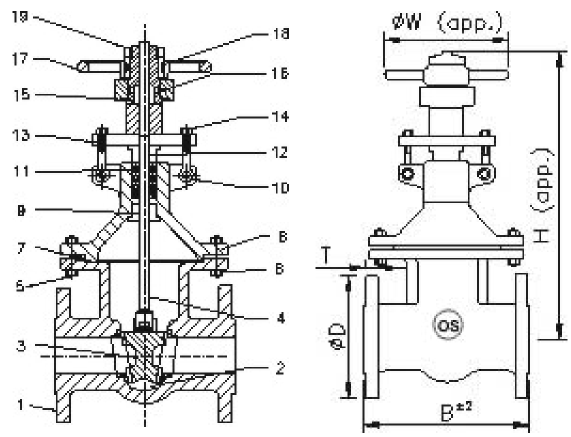
No.	PART	MATERIAL
1	Body	ASTM A216 Gr. WCB
2	Seat Ring	C. S. with 13% Cr. S.S.Facing
3	Wedge	C. S. with 13% Cr. S.S.Facing
4	Spindle	S.S. AISI 410
5	Bonnet Stud	ASTM A 194 Gr. B7
6	Bonnet Stud Nut	ASTM A 194 Gr. 2H
7	Gasket	Compressed Asbestos fibre
8	Bonnet	ASTM A216 Gr. WCB
9	Bonnet Bush	S. S. AISI 410
10	Cross Bolt & Nut	Carbon Steel
11	Gland Packing	Metallic Wire Rein. Graph. Asb.
12	Gland	S.S. AISI 410
13	Gland Flange	Carbon Steel
14	Eye Bolt & Nut	Carbon Steel
15	Yoke Sleeve	NI-Resisit / S.G. Iron
16	Yoke Bush	Carbon Steel
17	Hand Wheel	Malleable Iron / Cast iron
18	Key	Carbon Steel
19	Hand Wheel Nut	Carbon Steel

SIZE		DIMENSIONS (mm)				
Inch	mm	B	D	T	W	H
1.5	40	165	127	14	152	330
2	50	178	152	16	203	360
2.5	65	190	178	18	203	415
3	80	203	190	19	254	425
4	100	229	229	24	254	510
5	125	254	254	24	305	595
6	150	267	280	26	305	685
8	200	292	343	29	305	770
10	250	330	406	31	408	940
12	300	356	483	32	457	1030
14	350	381	533	35	457	1270
16	400	406	597	37	508	1450
18	450	432	635	40	508	1600
20	500	457	698	43	610	1810
24	600	508	813	48	610	2170

CAST STEEL GATE VALVE CLASS 300

MANUFACTURING STANDARDS	
DESIGN	BS:1414 / ANSI B16.34 /API 600
FACE TO FACE	ANSI B 16.10
FLANGE	ANSI B 16.5 R.F
TESTING	BS : 5146 / API 598

CLASS	TEST PRESSURE IN Kg / cm^2		
	HYDROSTATIC		AIR
	BODY	SEAT / BACK SEAT	SEAT
300	76	55	6



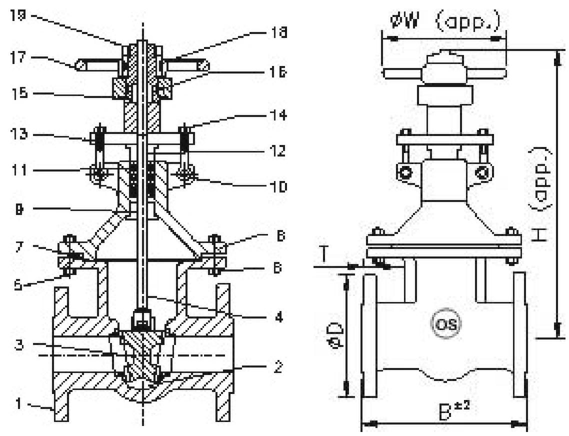
No.	PART	MATERIAL
1	Body	ASTM A216 Gr. WCB
2	Seat Ring	C. S. with 13% Cr. S.S.Facing
3	Wedge	C. S. with 13% Cr. S.S.Facing
4	Spindle	S.S. AISI 410
5	Bonnet Stud	ASTM A 194 Gr. B7
6	Bonnet Stud Nut	ASTM A 194 Gr. 2H
7	Gasket	Compressed Asbestos fibre
8	Bonnet	ASTM A216 Gr. WCB
9	Bonnet Bush	S. S. AISI 410
10	Cross Bolt & Nut	Carbon Steel
11	Gland Packing	Metallic Wire Rein. Graph. Asb.
12	Gland	S.S. AISI 410
13	Gland Flange	Carbon Steel
14	Eye Bolt & Nut	Carbon Steel
15	Yoke Sleeve	NI-Resisit / S.G. Iron
16	Yoke Bush	Carbon Steel
17	Hand Wheel	Malleable Iron / Cast iron
18	Key	Carbon Steel
19	Hand Wheel Nut	Carbon Steel

SIZE		DIMENSIONS (mm)				
Inch	mm	B	D	T	W	L
1.5	40	190	156	21	152	390
2	50	216	165	22	203	370
2.5	65	242	190	26	203	440
3	80	283	210	29	254	445
4	100	305	254	32	254	520
5	125	381	279	35	305	570
6	150	404	317	37	356	740
8	200	419	381	42	406	910
10	250	475	444	48	458	1100
12	300	502	521	51	508	1200
14	350	762	584	54	559	1415
16	400	839	648	58	610	1540
18	450	915	711	61	813	1670
20	500	991	775	64	965	1910
24	600	1143	914	70	508	GO

CAST STEEL GATE VALVE CLASS 600

MANUFACTURING STANDARDS	
DESIGN	BS:1414/ ANSI B16.34 /API 600
FACE TO FACE	ANSI B 16.10
FLANGE	ANSI B 16.5 R.F
TESTING	BS : 5146 / API 598

CLASS	TEST PRESSURE IN Kg / cm^2		
	HYDROSTATIC		AIR
	BODY	SEAT / BACK SEAT	SEAT
600	150	110	6



No.	PART	MATERIAL
1	Body	ASTM A216 Gr. WCB
2	Seat Ring	C. S. with 13% Cr. S.S.Facing
3	Wedge	C. S. with 13% Cr. S.S.Facing
4	Spindle	S.S. AISI 410
5	Bonnet Stud	ASTM A 194 Gr. B7
6	Bonnet Stud Nut	ASTM A 194 Gr. 2H
7	Gasket	Compressed Asbestos fibre
8	Bonnet	ASTM A216 Gr. WCB
9	Bonnet Bush	S. S. AISI 410
10	Cross Bolt & Nut	Carbon Steel
11	Gland Packing	Metallic Wire Rein. Graph. Asb.
12	Gland	S.S. AISI 410
13	Gland Flange	Carbon Steel
14	Eye Bolt & Nut	Carbon Steel
15	Yoke Sleeve	NI-Resisit / S.G. Iron
16	Yoke Bush	Carbon Steel
17	Hand Wheel	Malleable Iron / Cast iron
18	Key	Carbon Steel
19	Hand Wheel Nut	Carbon Steel

SIZE		DIMENSIONS				
Inch	mm	B	D	T	H	W
1.5	40	242	156	29	380	203
2	50	292	165	32	445	203
2.5	65	330	190	35	475	254
3	80	356	210	38	490	254
4	100	432	273	45	615	305
5	125	508	330	51	765	406
6	150	559	356	54	840	457
8	200	661	419	62	950	508
10	250	778	508	70	1290	610
12	300	839	559	73	GOP	406
14	350	889	603	77	GOP	508
16	400	991	686	83	GOP	508
18	450	1093	743	89	GOP	508
20	500	1194	813	96	GOP	508

Note. These standards are given as an example to show BS specifications for gate valves used by ADGAS. There are similar standards for other types of valves.

Exercises