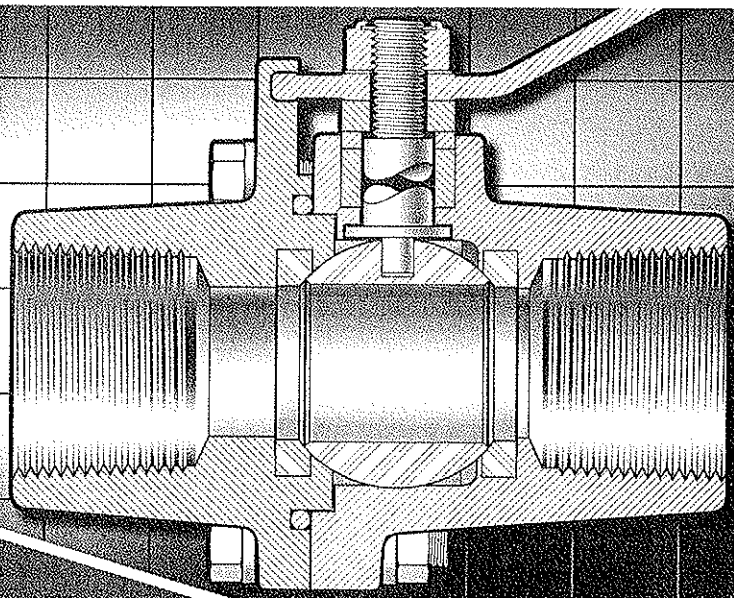
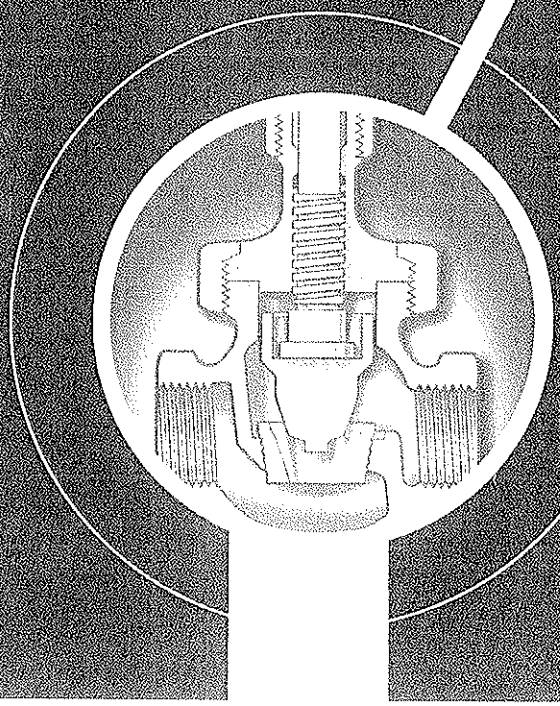
UNIVERSITY

Specialty Products

Industrial Valves©





BOOK #4

CERTIFICATE COURSE

FIRST EDITION

ProductPro®

The Standard in Product Knowledge Solutions

Specialty Products

Industrial Valves©

from the
American Supply Association Education Foundation

*Industrial Valves© provides new warehouse, counter, and sales personnel with an overview of industrial valves used in commercial applications. It is **NOT** intended to provide the kind of complex, technical data which would enable employees to design or install industrial valves. This course includes definitions of common industry terms, descriptions of the major types of industrial valves as well as the fittings and mounting methods for each type of valve. It also provides information that will help employees serve their customers more effectively.*

ProductPro®
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Welcome to the *ProductPro®* *Product Knowledge Training* series!

The Plumbing-Heating-Cooling-Piping (PHCP) and Industrial PVF industry is an important business channel. The products we sell keep people healthy, comfortable, and productive. In the United States, there are 4,000 PHCP/ Industrial PVF wholesaler-distributor locations; they generate billions of dollars in wholesale sales. It is an exciting and very competitive industry, and running a successful company requires cooperative efforts from educated and motivated employees.

To sell products in such a competitive atmosphere, it is crucial that all employees understand the products we sell. All of us need to be knowledgeable enough to pro-vide our customers with the products they need to keep their operations running smoothly and their employees productive.

What you will learn from this training

This *ProductPro®* course is designed to give you an overview of industrial valves used in commercial applications. This course includes definitions of common industry terms, descriptions of the major types of industrial valves, as well as the fittings and mounting methods for each type of valve. It also provides information that will help employees serve their customers more effectively.

Some of the products reviewed in this course may not be a part of your company's current inventory. Other products that may be stocked by your company may not be discussed in this course. Always refer to manufacturers' literature and recommendations on the products your company sells if unsure about a particular product.

To do your job well, it is important that you learn the details about specific items stocked by your company. The most complete and accurate information can be found in manufacturers' catalogs and materials. Be certain to spend time studying those materials.

While this course has been designed to provide you with the basic information you need, it is important that your read, understand, and use your manufacturers' literature on the valves your company sells. Each chapter in the course is designed to prepare you for the information distributed by valve manufacturers. Your main source of information should always be your individual valve manufacturers.

How the course is organized

The *ProductPro*® courses are divided into separate chapters. Within each chapter you will read about a particular category of product and then test your progress with a short quiz that you can correct yourself. The course provides a glossary of terms at the back of the book to help you develop the vocabulary needed to enhance your ability to communicate well with your customers and colleagues. The glossary terms are highlighted in the text.

At the end of each self-correcting quiz, you will find *Applying What You've Learned* exercises so you can use the new information that you have learned within your own company. Once you understand the basic concepts presented, know the important facts, and can confidently answer the questions correctly on all the quizzes, you are ready to take the final course exam.

THIS COURSE INCLUDES AN ONLINE FINAL EXAM

This course is limited to a single user. When you are ready to take the final exam to earn a Certificate of Completion, please contact ASA at info@asa.net. You will be contacted about hot to register for exam.

Seven simple hints for successful course completion

1. **Read the learning objectives**

   Read the learning objectives at the beginning of each chapter. They will tell you what you should know when you complete the chapter. Go back after you read the chapter and ask yourself whether you are confident in your command of the material. If you are not, re-read anything that you did not understand.

2. **Search for the important ideas**

   Use a highlighter marker or a pen to highlight or underline the most important points as you read. Think about how each idea relates to the rest of the chapter. Write notes in the margins about points you don't understand or about how the material you read applies to your own company.

3. **Ask questions**

   Ask your supervisor or mentor about any point you do not understand. Particular questions you'll want to ask include whether the products you are studying are carried by your company, how well they sell, and how important they are in the overall inventory.

4. **Apply what you are learning to your job**

   Always think about what you have just read or learned. Compare your company's products to the products you have read about in the book.

5. **Pace yourself in your studying**

   Don't try to complete the course all at once. You will remember what you learn more effectively if you make sure you understand each chapter thoroughly before you move on to the next. Take some time to "plug in" what you have just studied before acquiring more new information.

6. **Be proud of what you have accomplished**

   When you successfully complete the course, be sure to download, print, and proudly display your Certificate of Completion. You earned it!

7. **Commit to learning something new every day**

   This course is just one step in developing your professional knowledge and your career skills. Read industry trade journals, study the manufacturers' literature, and attend any training the manufacturers offer. Listen to what company and industry experts say. Enthusiastically take any additional training your company offers!

Visit the ASA Education Foundation website at asa.net regularly to find out about other learning opportunities to advance your career.

Acknowledgements

Developing new editions of the *ProductPro*® product knowledge training courses is an ambitious undertaking. During the creation and revision of this course, many individuals shared their expertise, input, and resources to significantly improve the interest and energy in the program.

We are grateful to David Quigley, Managing Director of Emerson Research, who acted as the primary author of this course and created a course that is accurate, relevant, and consistent with the *ProductPro*® brand. Mr. Quigley also is an active and contributing member of the Mechanical Contractors Association of America, Inc.

Special thanks to the reviewers from Bakersfield Pipe & Supply, Jomar Valve, NIBCO Inc., Perry Supply Co., Inc., and Traeger Brothers and Associates, Inc., who thoroughly and diligently reviewed the course text, quizzes, illustrations, and final exam to ensure accurate and highly readable instructions. Their expertise and experience ensure that the content demonstrates a high level of real world application that immediately can be put to use in employees day-to- day duties. We also appreciate the general reviews from Legend Valve & Fitting, Inc., and Southern Pipe & Supply Company, Inc.

The Foundation expresses it very special gratitude to the visionaries who established and led the charge to develop the Karl E. Neupert Endowment Fund. Contributions that established the Fund were provided by hundreds of manufacturers, wholesalers, and individuals who recognized the need for a permanent endowment fund that would ensure the ASA Education Foundation's ability to provide programs needed by the industry in perpetuity. Their generous contributions continue to make a major impact on the education and training opportunities available to the industry. We are deeply grateful for their commitment.

– The ASA Education Foundation

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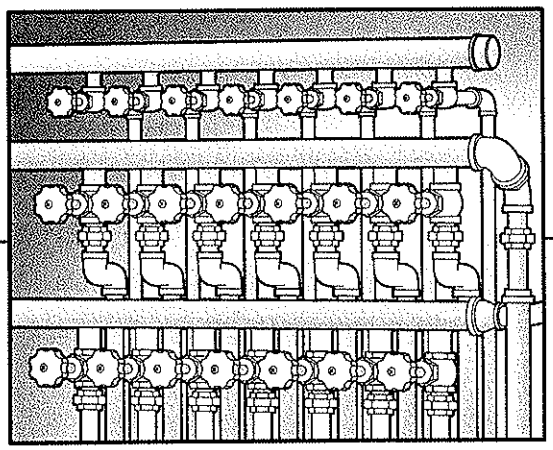
1 INTRODUCTION TO VALVES

LEARNING OBJECTIVES

When you successfully complete this chapter, you will be able to:

1. Define the term "valve" and identify the four main functions that valves provide.
2. Name the four basic operational categories of valves.
3. List the four types of valves that are multi-turn valves.
4. List the three types of valves that are quarter-turn valves.
5. Discuss the purpose of a check valve and how it affects flow.
6. Describe an actuator and explain its function.
7. Explain why throttling is an important function and list the types of valves that provide throttling.



VALVES

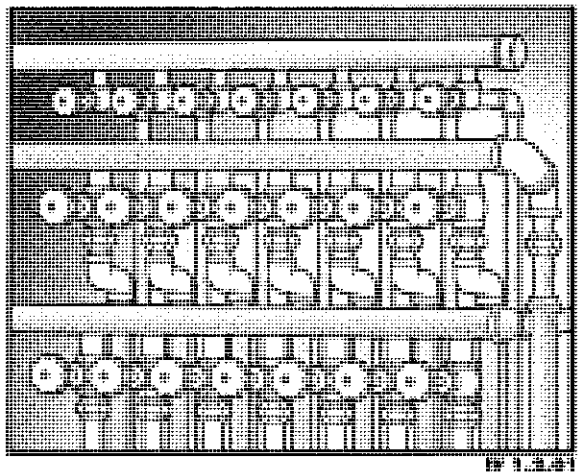
Overview of Valves

Although we seldom think about them, valves play an important role in the quality of our lives. Valves are almost as universal as electrical switches. Without modern valve systems, our lives would be far less comfortable. Fluid systems, such as water and natural gas lines in houses and other buildings, have valves. Some common household items such as liquid dispensers, spray devices, dishwashers, and clothes washers have valves. Often a valve is part of some object; faucets, taps, and spigots are all variations of valves.

Basically, a **VALVE** is a device that controls the flow of a fluid. Today's valves also control the rate, the volume, the pressure, or the direction of liquids, gases, or dry materials through a pipeline, chute, or similar passageway. They range in size from a fraction of an inch to 30 feet in diameter and can vary in complexity from a simple brass valve available at the local hardware store to a highly sophisticated coolant-system control valve in a nuclear reactor.

In its simplest form, your hand can become a valve when you squeeze a garden hose to stop the flow of water. In its most complex form, a valve has built-in electronics or other sensing devices that respond to real-time conditions, and the valve will control flow with extreme precision according to how it is programmed. The valves shown in the **PIPELINE VALVES** illustration are used to control the flow of a substance in a pipeline by on-off service, throttling service, or backflow prevention. You'll learn more about these functions in this course.

PIPELINE VALVES



Five Significant Questions

This course assumes that the secret to proper valve performance is choosing the proper valve for the service required. For example, a gate, butterfly, ball, or plug valve may be selected for starting or stopping service. When the service requirement is flow regulation or throttling, a globe, butterfly, or ball valve may be selected. When backflow prevention is required, a check valve is selected. In order to assist you in selecting valves that will give the proper service at the lowest operating and maintenance cost, you should ask the following five questions:

Question #1: What type of medium is to be controlled?

- Is it liquid or gas?
- Is it pure fluid or does it contain solids?
- Does the medium remain in its present state or does it change?
- Does it start as a liquid and vaporize and become a gas?
- Does it crystallize along the way?
- Is it corrosive?

Question #2: What temperature and pressure must it handle?

- These may vary throughout the system and must be considered.

Question #3: What type of operation is required?

- Fully open or fully closed? Throttling?
- Prevention of backflow?
- Is pressure drop critical?

Question #4: What will be the frequency of use?

- Will the valve normally be open? Will it normally be closed with intermittent use?
- If the valve will be operated repeatedly, will the design selected provide optimum wear?

Question #5: What size and end connections are required?

The term *end connection* refers to the ends of the valve body that are connected to pipe ends. The choice of end connections for connecting a valve to its associated pipework is dependent upon the pressure and temperature of the working fluid and the frequency of dismantling the pipeline or removing the valve from the line. The types of end connection in general use are as follows:

- *Threaded ends* are tapped with ANSI standard female taper pipe threads.
- *Flanged ends* make a strong, tight joint and are generally used for lines size about 3" and larger that are more easily disassembled and assembled.
- *Weld ends* are used on steel valves where high temperatures and pressures are encountered and absolutely tight, leak-proof connections must be maintained over a long period of time.
- *Solder ends* are used with types K, L, and M copper tubing for many low-pressure services. The use of solder joints is limited to a maximum temperature of 250°F because of the low melting point of the solder.
- *Grooved ends* are rolled or cut into the ends of the pipe. Fittings, valves, and other components are manufactured with the same grooves. Couplings with pressure responsive gaskets and shoulders to fit the grooves are used to join grooved pipe to grooved pipe or grooved components. When the grooved components are connected by the shouldered gasket couplings, the result is a pressure-tight pipe system.
- *Press-fit* ends take advantage of copper's excellent malleability and its proven increased strength when cold worked. The joints rely on the sealing capability of a special fitting that contains an elastomeric gasket or seal (such as EPDM) and the proper use of an approved pressing tool and jaws
- *Push or "Push-on"* ends are often associated with pipelines, water and sewer lines, and when large ductile iron pipe is required.
- *Fusion (thermoplastics)* ends requires a unique welding process which involves heating both pieces simultaneously and pressing them together. The two pieces then cool together and form a permanent bond. When done properly, the two pieces become indistinguishable from each other. This process is commonly used in plastic pressure pipe systems to join a pipe and fitting together, or to join a length of pipe directly to another length of pipe. Generally, polyolefins (such as polypropylene, polyethylene, and polybutylene) and PVC are used for these applications.

To do your job well, it is important that you learn the details about specific items that your company stocks. The most complete and accurate information can be found in manufacturers' catalogs and materials. Take the time to study these materials.

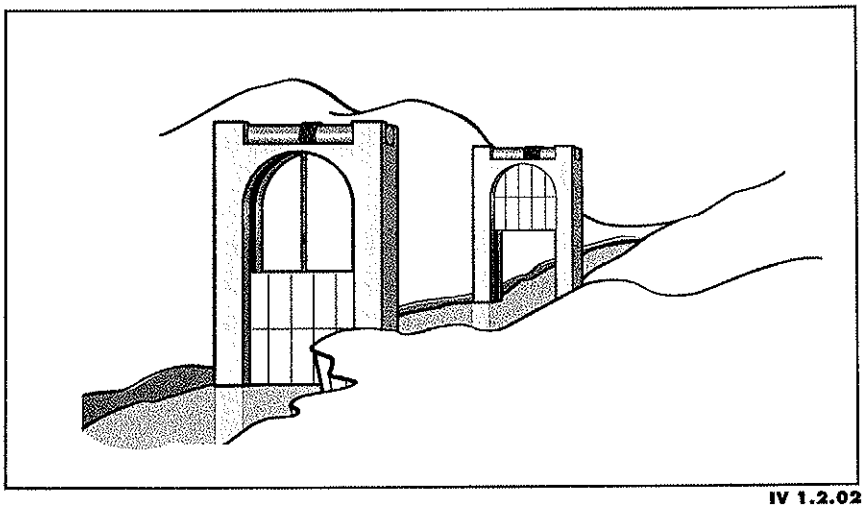
Valves are a very complex subject. Not only are they available in a wide variety of operational types to provide different control functions, but each valve type has many different designs. Valves are available in a wide variety of materials, end connections, and pressure and temperature ratings. You will need to know these valve characteristics in order to help your customers select the right valve for the service needed.

Early Valves

Valves were first used to control the flow of water. Ancient Egyptian and Greek cultures devised several types of primitive valves to divert water for public consumption or crop irrigation. It is the Romans, however, who are generally recognized as the developers of comparatively sophisticated water systems. Ancient Roman *aqueducts*, artificial channels through which water was carried, were built of stone, brick, or a mixture of limestone and volcanic dust. Roman aqueducts exploited the principles of gravity in order to deliver water to the city. Water traveled through a closed conduit to a distribution tank. From there, water could be channeled to public collecting tanks.

While early pipe and conduit was made from wood or earthenware, the system was later refined to lead. The word "plumbing" comes from the Latin term "plumbus" which means "lead." Roman plumbing was advanced enough to deliver water to individual buildings. **WOODEN GATE VALVES**, such as those illustrated here, were used to control water flow in canals. Today's gate valve still controls flow in the same manner.

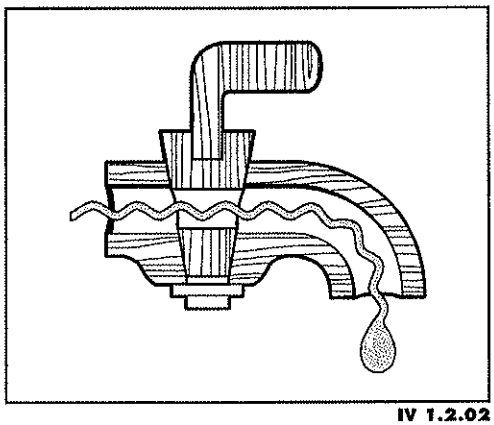
WOODEN GATE VALVES



IV 1.2.02

One of the oldest valves was the **WOODEN COCK VALVE**, similar in design to the one illustrated, which was developed in ancient Egypt around 1,000 B.C. and used in their plumbing systems to control water flow.

WOODEN COCK VALVES



IV 1.2.02

The Romans used **CHECK VALVES** to prevent backflow. For many years, valves were primarily used to reroute the flow of water for agricultural use and public consumption. In 1705, however, the introduction of the industrial steam engine gave valves even more importance. The steam engine, which required more sophisticated valves that could withstand high pressures and high temperatures, was central to the Industrial Revolution. Along with plug valve, metallic gate, and globe valves were widely used in new manufacturing processes in the period from about 1760 to sometime between 1820 and 1840. However, it wasn't until plastic and rubber compounding were developed that quarter-turn valves were widely used in the plumbing industry.

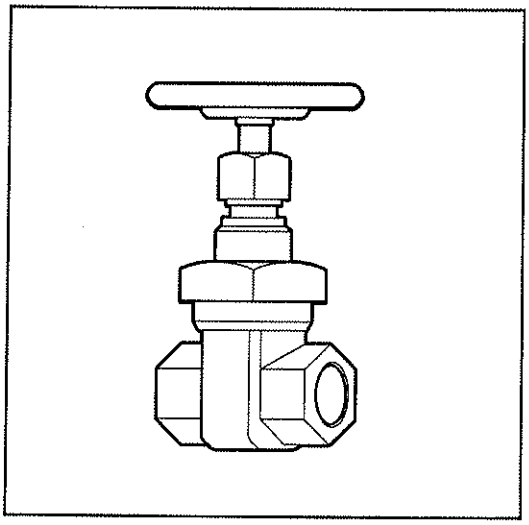
Valves can be identified both by their function and by their operation. On/off, start-stop, and throttling are the basic functions. The wooden versions of these valves were used to start or stop fluid flow. Today's valves are made of metal or plastic, and they are still used to provide the on/off function. This function today is known as the *on/off, start-stop function*. The type of flow they allow is referred to as *straight-through flow.*

While both the gate and the plug valve offer high flow rates, neither is designed to offer the functions that throttle or control backflow. Other valves, such as the globe valve, the check valve, and the pressure relief valve, provide these functions.

Basic Types of Valves

There are a variety of types of valves. In this chapter we will be taking a look at some, but not all, basic types of valves. The **GLOBE VALVE**, which gets its name from the globular shape of its body, is used for on/off service and handles throttling applications. The **CHECK VALVE** is designed to perform the single operation of preventing the reversal of flow or **BACKFLOW** in a piping system. Fluid flow in the desired direction opens the valve, while reversal of glow and gravity forces the valve closed. The **PRESSURE RELIEF VALVE** is designed to provide protection from over-pressure in steam, gas, air, and liquid lines. The valve "lets off steam" when safe pressures are exceeded and closes when pressure drops to a preset level.

GATE VALVE

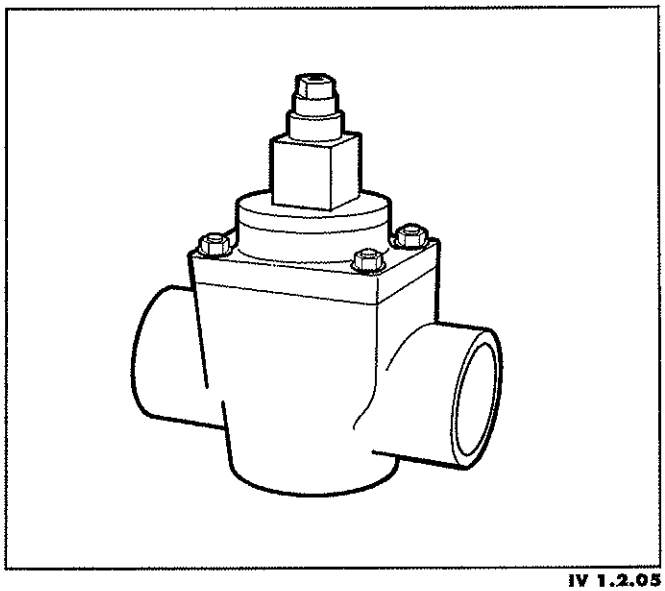


IV 1.2.04

The two earliest valves used for flow control are the gate valve and the plug valve. The **GATE VALVE**, seen in the illustration, is a general-service valve used primarily for on/off, non-throttling service. The valve is closed by a flat face, vertical disc, or "gate" that slides down through the valve to block the flow. Gate valves are designed to operate fully open or fully closed. Because they operate slowly, they prevent **WATER HAMMER** (or, more generally, **FLUID HAMMER**), which is detrimental to piping systems. There is very little pressure loss through a gate valve. In the fully closed position, gate valves provide a positive seal under pressure.

The **PLUG VALVE** is used primarily for on/off service and some throttling services. It controls flow by means of a cylindrical or tapered plug with a hole in the center that lines up with the flow path of the valve to permit flow. A quarter turn blocks the flow path. Similar to the gate valve, a plug valve has an unobstructed flow, yet requires only a 90-degree turn to open it. It also requires very little headroom. Stem corrosion is minimal because there are no screw threads. Plug valves are highly suitable for use in wastewater plants.

PLUG VALVE



IV 1.2.05

Four Basic Operational Categories

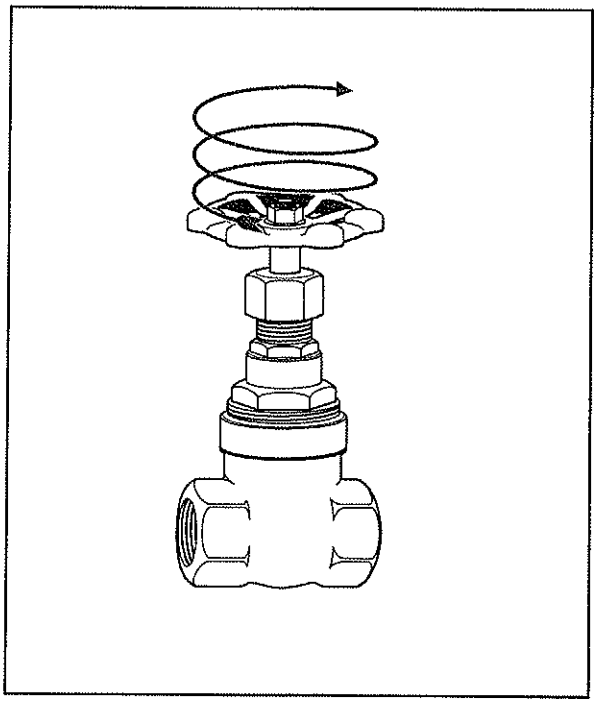
Valves are also divided into four basic operational categories: multi-turn, quarter-turn, check, and specialty. Let's further define each of the operation categories.

Multi-turn Valves

The gate valve is one type of multi-turn valve. Four other types of multi-turn valves are globe, diaphragm, needle, and pinch. These valves are discussed in more detail later.

MULTI-TURN VALVES get their name from the way they operate—by rotating the valve handle or hand wheel clockwise to close and counterclockwise to open. (Note: In some countries other than the United States, such as the U.K. and some parts of Canada, valves operate in the opposite direction. These patterns are also known as "open left" and "open right.") In either case, the handle must be rotated in a full circle several times to fully open or fully close the valve. Therefore, they are called "multi-turn valves" (see illustration).

MULTI-TURN VALVE

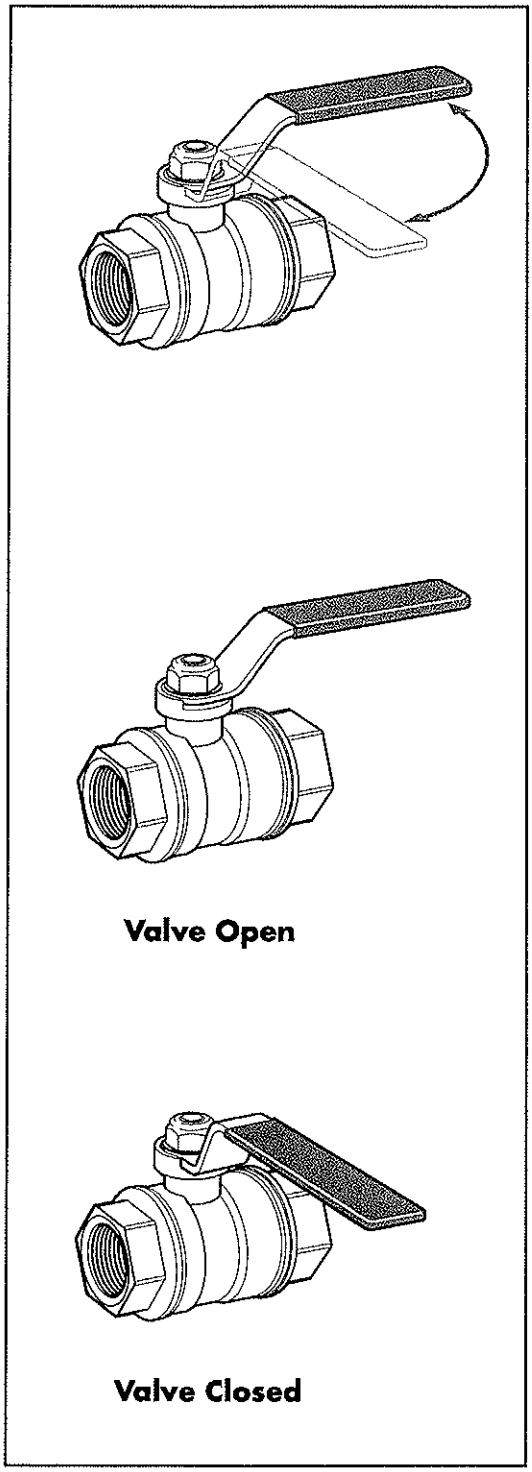


IV 1.2.06

Quarter-turn Valves

Like multi-turn valves, **QUARTER-TURN VALVES** get their name from the way they operate. These valves open and close by a 90-degree rotation, or one-quarter of a full circle (see illustration).

QUARTER-TURN VALVE



IV 1.2.07

PLUG VALVES belong to the category of quarter-turn valves. The plug valve is used primarily for on/off service and some throttling (or varying the amount of flow) services. It controls flow by means of a cylindrical or tapered plug with a hole in the center that lines up with the flow path of the valve to permit flow.

Other common types of quarter turn valves are the ball valve and the butterfly valve. The **BALL VALVE** is similar in concept to the plug valve but uses a rotating ball with a hole through it that allows straight-through flow in the open position and shuts off flow when the ball is rotated 90 degrees to block the flow passage. It is used for on/off and throttling services.

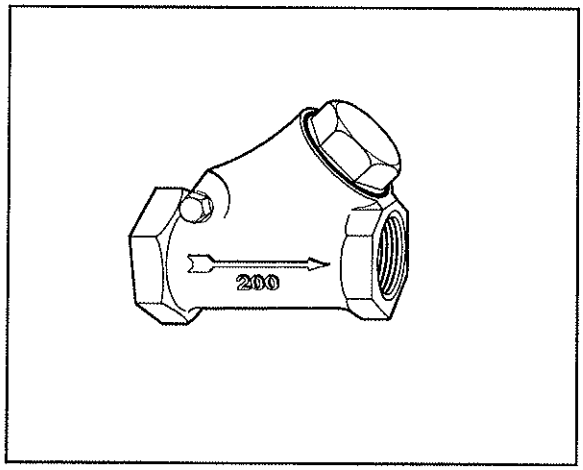
The **BUTTERFLY VALVE** controls flow by using a circular disc or vane with its pivot axis at right angles to the direction of flow in the pipe. The butterfly valve is used both for on/off and throttling services.

Check Valves

CHECK VALVES are another operational category of valves. As noted previously, they are designed to prevent backflow. Fluid flow in the desired direction opens the valve, while backflow forces the valve closed.

Check valves only permit flow through the valve in one direction. They are used to "check" the flow in a system to keep it from reversing direction. This is also known as **BACKFLOW PREVENTION**. You can see an example of a check valve illustrated. Note the flow direction arrow in the diagram.

CHECK VALVE SHOWING FLOW DIRECTION



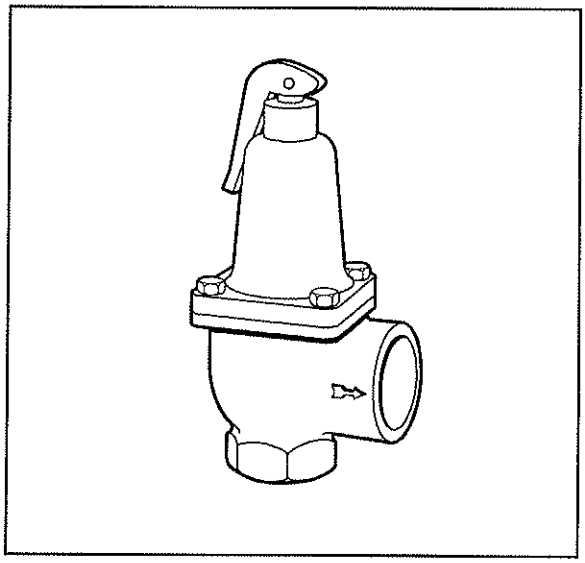
IV 1.2.08

Specialty Valves

The fourth operational category is a variety of regulator valves that known as **SPECIALTY VALVES**. These valves are used to provide control functions of pressure regulation, automatic flow control, and temperature regulation.

The pressure relief valve shown in the illustration is one type of specialty valve.

PRESSURE RELIEF VALVE

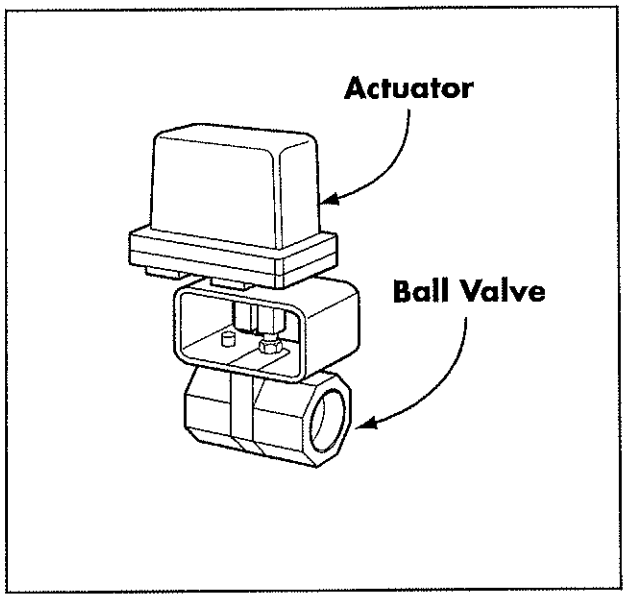


IV 1.2.09

Valve Accessories

We will also take a brief look at valve accessories, such as actuators, in this course. Valves that are particularly large may be impossible or impractical to operate manually simply because of the sheer horsepower requirements. Such valves often employ a valve **ACTUATOR**, which is any device that utilizes a source of power to operate a valve. This source of power can be a human being working a manual gearbox to open or close a valve or a smart electronic device with sophisticated control and measuring devices. With the advent of micro circuitry, the trend has been for actuators to become more sophisticated. Early valve actuators were no more than a geared motor with position-sensing switches.

ACTUATOR USED TO REGULATE GATE VALVE



IV 1.2.10

Today's valve actuators have much more advanced capabilities. They not only act as devices for opening and closing valves, but can also check on the wear and tear of a valve and provide predictive maintenance data.

These devices are called "actuators" because they "activate" or "move" the valve into action. Actions include opening the valve, closing the valve, or changing the throttling position. One type of actuator is shown in the illustration. This actuator is used to operate the ball valve.

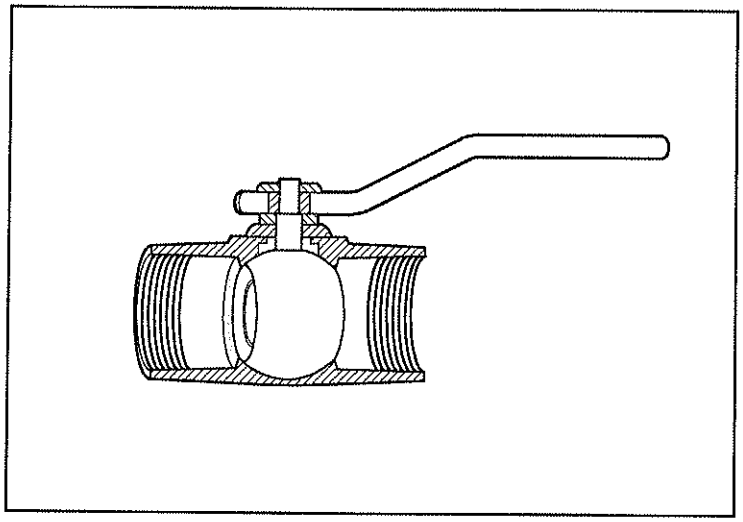
Main Functions of Valves

As explained previously, although they function in many ways, valves provide four main functions:

1. Starting and stopping flow
2. Regulating flow or throttling by change of direction or restriction
3. Preventing backflow
4. Relieving and regulating pressure

Generally speaking, all manually operated valves provide the on/off (start-stop) function, but flow capacity management (throttling) may vary greatly between valve types.

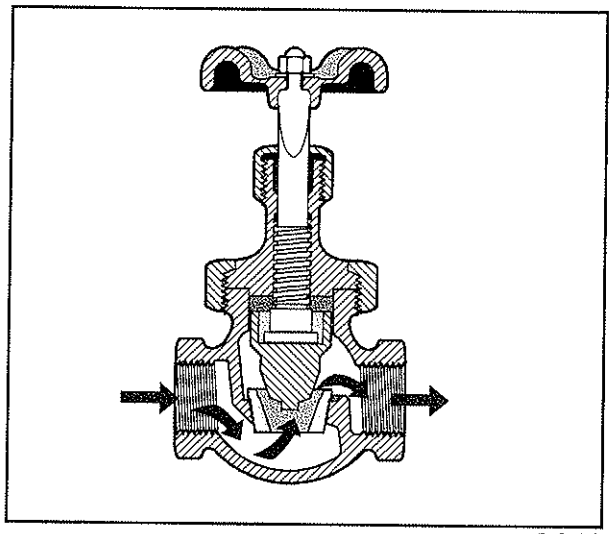
QUARTER-TURN BALL VALVE



IV 1.2.11

GLOBE VALVES, shown in the illustration, are multi-turn valves and are used to provide a different function. This function is known as **THROTTLING**, which means to regulate the flow. A **THROTTLE** is a valve used to control the flow of a fluid, for example, the amount of fuel and air entering the cylinders of an internal- combustion engine.

GLOBE VALVE WITH DIRECTIONAL FLOW ARROW

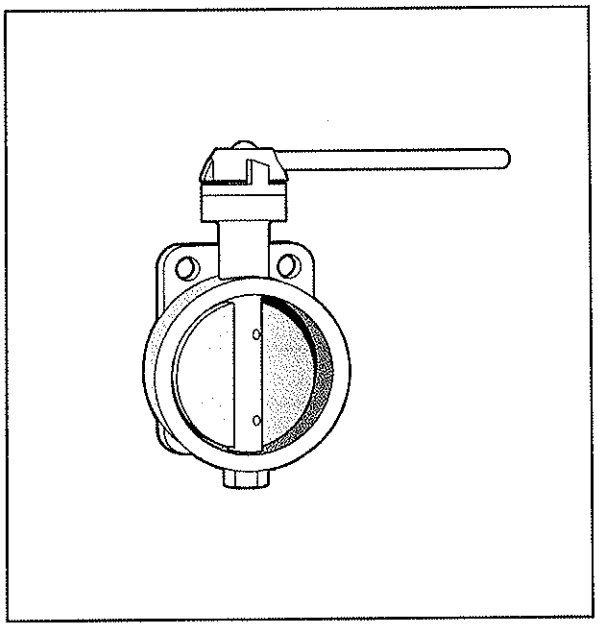


1.2.12

The **BUTTERFLY VALVE**, a quarter-turn valve, is another type of valve used for throttling, or regulating a fluid flowing through a section of pipe (see illustration). A flat circular plate is positioned in the center of the pipe. The plate has a rod through it connected to a handle on the outside of the valve. Rotating the handle turns the plate either parallel or perpendicular to the flow of water, shutting off the flow.

Some special plug and ball valves can be used for throttling, although for general purposes, these valves are not recommended for throttling.

BUTTERFLY VALVE



IV 1.2.13 Butterfly Valve

As explained earlier, more than one type of valve can provide the same function, and some valves provide more than one function. However, the correct valve selected for a service will depend on whether the valve's main function is to provide on/off service or another function, such as throttling. Valves must be properly selected to operate safely, efficiently, and reliably without excessive maintenance. It is important to select the most cost-effective valve type that is suitable for the given application. Proper valve selection is also based on the appropriate pressure/temperature rating; materials of construction, end connections, and actuation based on the service conditions and system requirements.

Now, let's look at a chart that illustrates how the functions and operations interrelate (see table on following page).

VALVE OPERATIONS AND FUNCTIONS

Valve Name	Operation/Category	Function
Gate	Multi-turn	Start-stop, Straight-thru Flow
Globe	Multi-turn	Start-stop and throttle
Diaphragm	Multi-turn	Start-stop and throttle
Pinch	Multi-turn	Start-stop and throttle
Plug	Quarter-turn	Start-stop
Ball	Quarter-turn	Start-stop
Butterfly	Quarter-turn	Start-stop and throttle
Check valve	Flow in one direction	Prevention of back flow
Specialty control valves	Regulator valves; Relief and safety valves	Pressure or temperature regulation

Today valves are used in a wide variety of industries. If you do not know which industries your firm distributes valves, ask your supervisor.

Major Industry Government Initiative – "Lead Free"

As stated in the Environmental Protection Agency's (EPA) "Summary Of The Reduction Of Lead In Drinking Water Act And Frequently Asked Questions":

> The Reduction of Lead in Drinking Water Act was enacted on January 4, 2011 to amend Section 1417 of the Safe Drinking Water Act (SDWA or Act) respecting the use and introduction into commerce of lead pipes, plumbing fittings or fixtures, solder, and flux. The Act established a prospective effective date of January 4, 2014, which provided a three-year timeframe for affected parties to transition to the new requirements. Section 1417(a)(1) prohibits the "use of any pipe, any pipe or plumbing fitting or fixture, any solder, or any flux, after June 1986, in the installation or repair of (i) any public water system; or (ii) any plumbing in a residential or non-residential facility providing water for human consumption, that is not lead free" as defined in Section 1417(d). ...

> By definition, the EPA interprets "potable services" to be services or applications that provide water suitable for human ingestion (e.g. drinking, teeth brushing, food preparation, dishwashing, maintaining oral hygiene)....
>
> Both point-of-use and point-of-entry devices are covered by the lead free requirements because the terms used by Congress are commonly understood to include kitchen and bathroom faucets and the pipes leading to such faucets. These devices are typically integrated into a faucet or plumbing system that delivers drinking water and as such is considered to be covered by the new lead free requirements. ... [This does not include] stand-alone, non-plumbed, appliances or devices that do not logically fit within the statutory reference to non-potable pipes, fittings, or fixtures that are not plumbed in or part of the drinking water distribution system. The focus of SDWA Section 1417 is to prevent the contamination of the drinking water in the distribution system by lead leached from pipes, faucets and other fixtures incidental to the delivery of potable water.

As of 2014, most, if not all, valve manufactures are no longer manufacturing valves for potable water usage that contain lead. Most if not all valve suppliers and distributors should have also removed all potable valve inventories that had been manufactured with lead. To see the full version of the Summary Of The Reduction Of Lead In Drinking Water Act And Frequently Asked Questions, written by the EPA, please visit http://water.epa.gov/drink/info/lead/upload/epa815s13001.pdf.

In the next chapters, you'll learn more basic information about industrial valves used in commercial applications. You'll learn that valves are available in a wide range of materials, end connections, and pressure and temperature ratings. You will need to know these valve characteristics in order to help your customers select the right valve of the service needed. In Chapter 2, you'll learn more about multi-turn valves.

REVIEW QUIZ – INTRODUCTION TO VALVES

Answers appear on page 22

DIRECTIONS: Carefully read each question and circle the correct answer. There is only one correct answer per question. When you have finished, check your answers.

1. Which of the following is the best definition of the word "valve"?
   a. Machine used to stop the flow of water
   b. Mechanical object used to control the movement of water
   c. Device that controls movement of liquids or gases
   d. Device that prevents the return flow of fluid

2. Ancient civilizations originally designed and used valves to
   a. divert the flow of water for agricultural and human use.
   b. protect their cities from flooding by changing the course of rivers.
   c. change the landscape to make land more valuable.
   d. operate small machines in factories.

3. Which of the following valve types was first used for on/off services and straight through flow?
   a. Ball valve
   b. Gate valve
   c. Butterfly valve
   d. Pinch valve

4. Which of the following valves opens and closes by the circulation rotation of the handle?
   a. Check valve
   b. Regulator valve
   c. Globe valve
   d. Plug valve

REVIEW QUIZ – INTRODUCTION TO VALVES

Answers appear on page 22

5. Which category of valves opens and closes by a 90 degree rotation?
   a. Multi-turn valves
   b. Check valves
   c. Quarter-turn valves
   d. Specialty valve

6. To which valve category does the globe valve belong?
   a. Multi-turn
   b. Quarter-turn
   c. Check
   d. Specialty

7. To which valve category does the butterfly valve belong?
   a. Multi-turn
   b. Quarter-turn
   c. Check
   d. Specialty

8. Which of the following categories of valves are generally used for throttling services?
   a. Gate and plug valves
   b. Plug and ball valves
   c. Globe and butterfly valves
   d. Gate and ball valves

9. Which of the following valves allows flow though the valve only in one direction?
   a. Check valve
   b. Regulator valve
   c. Ball valve
   d. Gate valve

REVIEW QUIZ – INTRODUCTION TO VALVES

Answers appear on page 22

10. Which of the following valves is used to provide control functions of pressure control, automatic flow control, and temperature control?
    a. Check valve
    b. Regulator valve
    c. Diaphragm valve
    d. Pinch valve

APPLYING WHAT YOU HAVE LEARNED:

By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.

A. List at least three types of valves that your company sells.

_____

_____

_____

B. Based on your reading and general knowledge of valves, list at least three things a customer should consider before purchasing any valve.

_____

_____

_____

ANSWERS TO REVIEW QUIZ

CHAPTER 1

INTRODUCTION TO VALVES

Answers to Review Questions: Introduction to Valves

1. c. Device that controls movement of liquids or gases.
2. a. Divert the flow of water for agricultural and human use
3. b. Gate valve
4. c. Globe valve
5. c. Quarter-turn valves
6. a. Multi-turn
7. b. Quarter-turn
8. c. Globe and butterfly valves
9. a. Check valve
10. b. Regulator valve

APPLYING WHAT YOU HAVE LEARNED:

A. Answers will vary by company

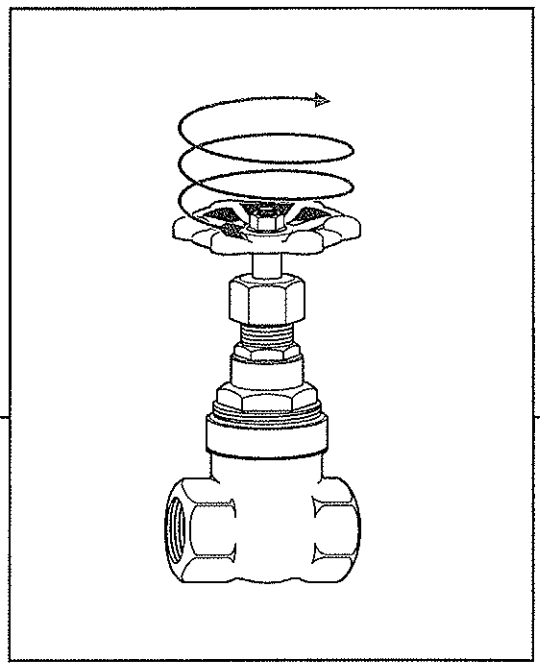
B. Answers may vary but might include the type of media to be controlled, the temperature and pressure it must handle, the type of operation required, the frequency of use, and the size and end connections required.

2 MULTI-TURN VALVE OVERVIEW

LEARNING OBJECTIVES

When you successfully complete this chapter, you will be able to:

1. Identify the five types of multi-turn valves.
2. Discuss the different valve body shapes for multi-turn valves.
3. Discuss the major factors which affect the multi-turn valve body selection for an application or service.



MULTI-TURN VALVES

Review of Multi-turn Valves

As explained in Chapter 1, valves can be classified into four major groups: multi-turn, quarter-turn, check, and specialty valves. In this section, you will take a closer look at multi-turn valves and their design variations. Let's review what you learned about multi-turn valves. The most common types of multi-turn valves in our industry are gate, globe, needle, and diaphragm valves.

MULTI-TURN VALVES get their name from the way they operate. These valves operate by rotating the valve handle or hand wheel clockwise to close and counterclockwise to open. (Note: In some countries, and in some parts of Canada, valves operate in the opposite direction.) In either case, the handle must be rotated in a full circle several times to fully open or fully close the valve. Therefore, they are called "multi-turn valves."

Multi-turn valves have either rising or non-rising stems. In other words, they require multiple turns to move the valve closure element from open to close. This group would include globe valves, gate valves, diaphragm valves, pinch valves, knife gates, and sluice gates.

Valves are classified by type, material, function, design variations, end connections, and pressure-temperature ratings. You'll be introduced to all of these classifications in this course.

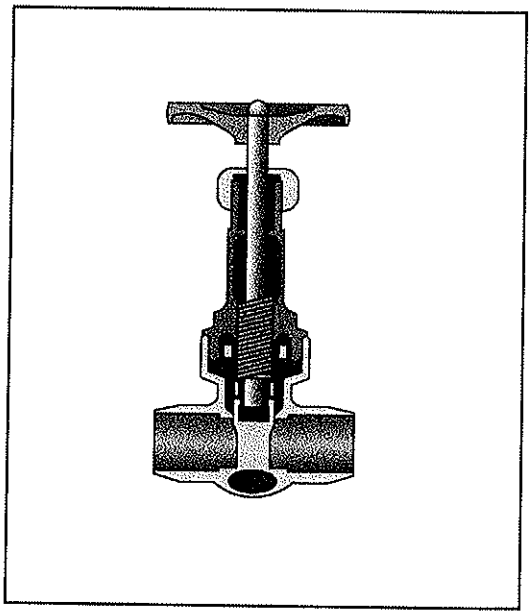
Types of Multi-turn Valves

There are different types of multi-turn valves with different functions and various design options. In Chapter 1, you were introduced to the five main types of multi-turn valves. A brief description of each multi-turn valve type follows.

On the following page are examples of the most common types of multi-turn valves. We have used cutaway drawings so that you can easily identify the valves.

1. The **GATE VALVE** is a general service valve used primarily for on/off, non-throttling service. The valve is closed by a flat face, vertical disc, or gate that slides down through the valve to block the flow.

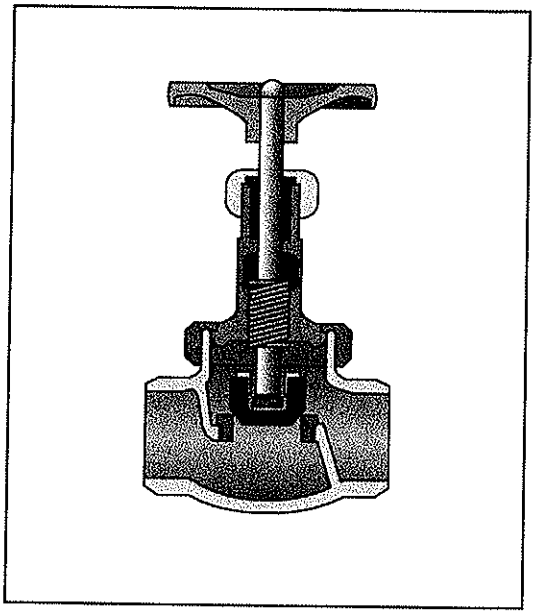
CUTAWAY OF GATE VALVE



IV 3.2.01

2. The **GLOBE VALVE** effects closure by a plug with a flat or convex bottom lowered onto a matching horizontal seat located in the center of the valve (see illustration). Raising the plug opens the valve, allowing fluid flow. The globe valve is used for on/off service and handles throttling applications.

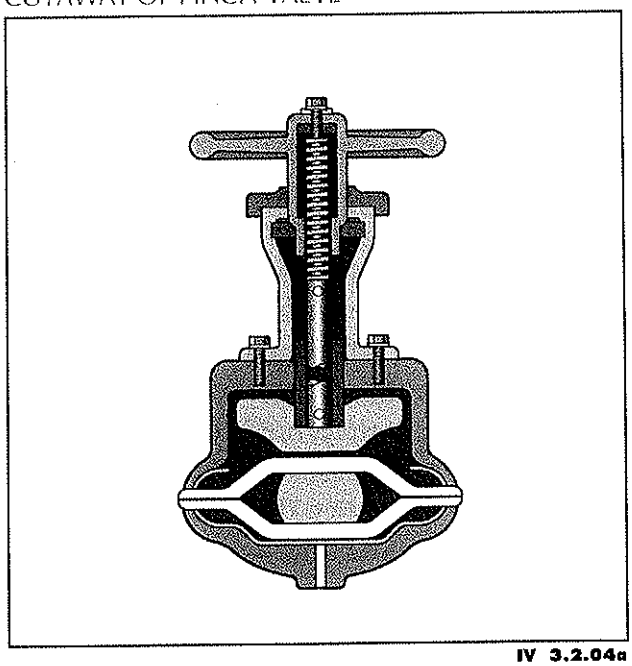
CUTAWAY OF GLOBE VALVE



IV 3.2.02

3. The **PINCH VALVE** is particularly suited for applications of slurries or liquids with large amounts of suspended solids (see illustration). It seals by means of one or more flexible elements, such as a rubber tube, that can be pinched to shut off flow.

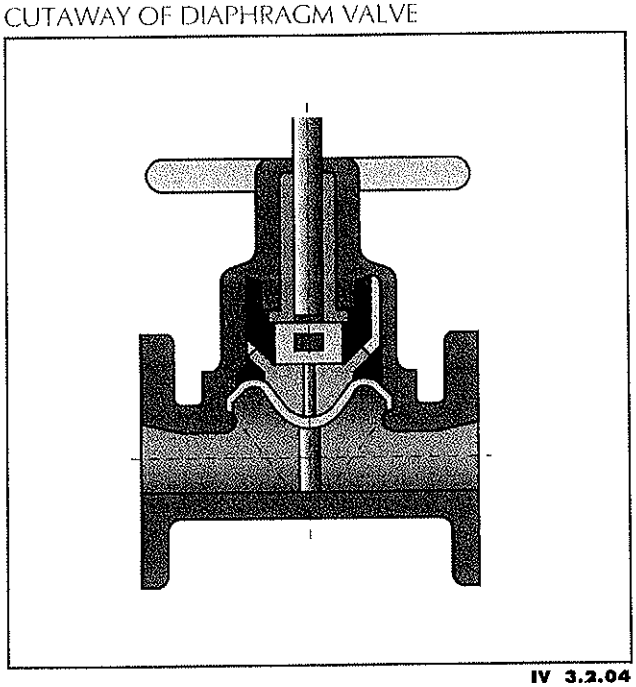
CUTAWAY OF PINCH VALVE



IV 3.2.04a

4. The **DIAPHRAGM VALVE** closes by means of a flexible diaphragm attached to a compressor (see illustration). When the compressor is lowered by the valve stem onto a weir, the diaphragm seals and cuts off flow. The diaphragm valve handles corrosive, erosive, and dirty services.

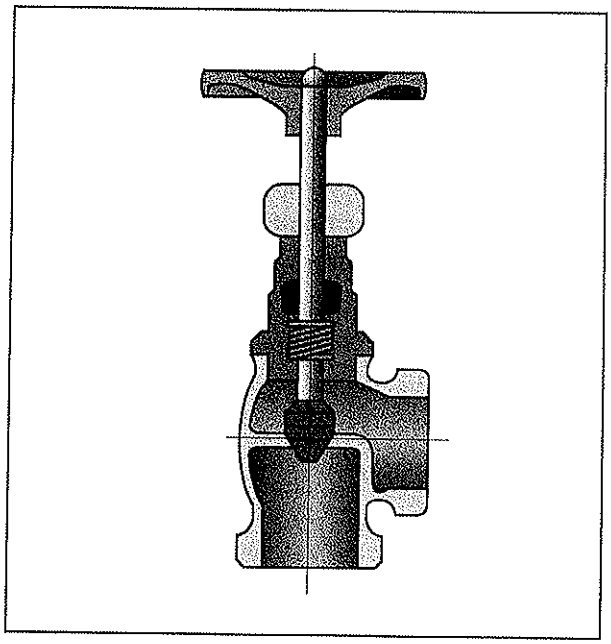
CUTAWAY OF DIAPHRAGM VALVE



IV 3.2.04

5. The **NEEDLE VALVE** is a volume-control valve that restricts flow in small lines with the majority manufactured in a "T" pattern. In addition, and highlighted in the illustration, some needle valves are manufactured with a 90-degree turn. In the figure, media passes through an orifice that is the seat for a rod with a cone-shaped tip. The size of the orifice is changed by positioning the cone in relation to the seat.

CUTAWAY OF NEEDLE VALVE



IV 3.2.03

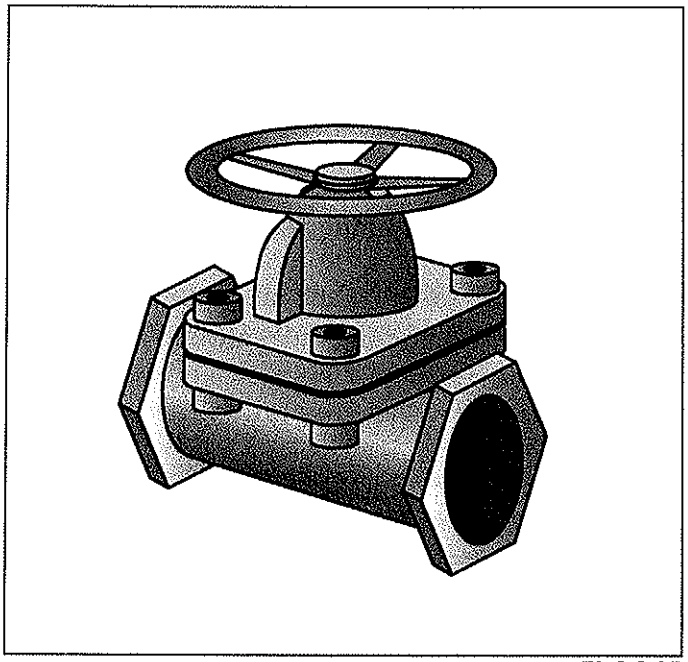
Valve Material and Valve Functions

The "material" classification refers to the valve body materials such as bronze, brass, cast iron, ductile iron, carbon steel, stainless steel, and plastic. Each valve material has physical and chemical properties that make the material more suitable for handling the certain types of flow media. Some materials are better suited for their corrosion-resistance, while others are more suited for higher temperature-pressure applications. The valve material and the line size will determine the type of end connection. The **END CONNECTIONS** refer to the ends of the valve body, which are connected to pipe ends. There are a number of different types of end connections available on today's valves.

Each valve type is used to provide certain functions. Some valves are used for throttling. This is the function of globe valves. The gate valves are used for on/off applications. Needle valves are used for very precise flow regulation control.

Some types of multi-turn valves are better suited to handle certain kinds of flow media. For instance, **DIAPHRAGM VALVE** in the illustration is recommended for handling some *slurries*, which are thin mixtures of an insoluble substance, as cement, clay, or coal, with a liquid, as water or oil.

DIAPHRAGM VALVE



IV 3.2.05

Design Variations Meet Service Applications

Within each valve type you will find a number of design variations covering the body, the bonnet, the stem, and the closure member. These design variations help the valve meet specific service applications.

We will take a closer look at each variant of multi-turn valves and the applications for which they are best suited. First, let's look at the differences in valve bodies.

The **VALVE BODY**, sometimes called the *shell*, is the primary boundary of a pressure valve. It serves as the main element of a valve assembly because it is the framework that holds all the parts together. The body, the first pressure boundary of a valve, resists fluid pressure loads from connecting piping. Valve bodies are cast or forged in a variety of forms and each component have a specific function and constructed in a material suitable for that function. The valve body may be produced with one material and the **TRIM** may or may not be made of the same material.

Gate Valve Body

A **GATE VALVE** is a valve that opens by lifting a round or rectangular gate/wedge out of the path of the fluid. The distinct feature of a gate valve is the sealing surfaces between the gate and seats are flat, so gate valves are often used when a straight-line flow of fluid and minimum restriction is desired. The gate faces can form a wedge shape or they can be parallel. Because of their ability to cut through liquids, gate valves are often used in the petroleum industry.

Gate valves are used to provide the on/off function and are not recommended for throttling service. Their straight-through design causes erosion and possible corrosion of the closure member (or gate) when put in a partially opened/closed position. They are only designed to be fully opened or fully closed.

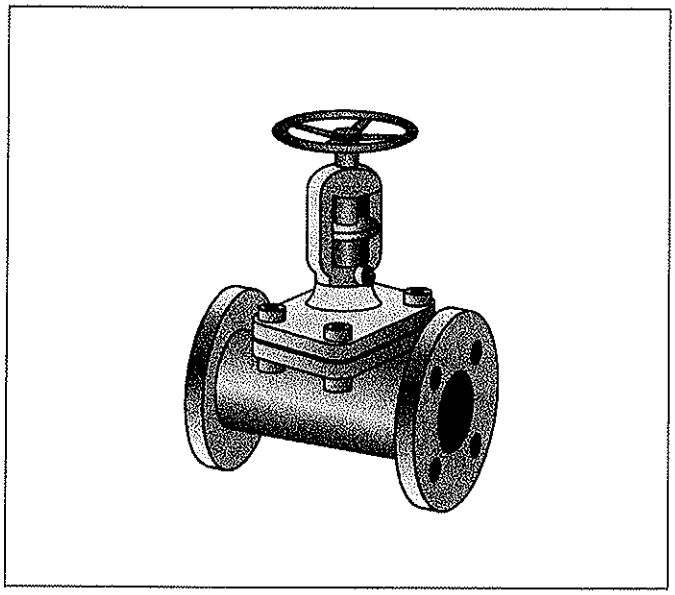
When the valve is on or opened, flow is allowed through the valve. When the valve is off or closed, flow is blocked by the closure member. Each type of valve has a different type or design of closure member.

Globe Valve Body Shapes

Gate valves, which are used for on/off applications, and globe valves, which are used for throttling applications, are similar in body shapes, as an inverted "T" shape. The globe valve also can have two additional designs: the "Y" pattern; and the angle design. These body design variations are shown here.

The **INVERTED T SHAPE** illustration is the most traditional design.

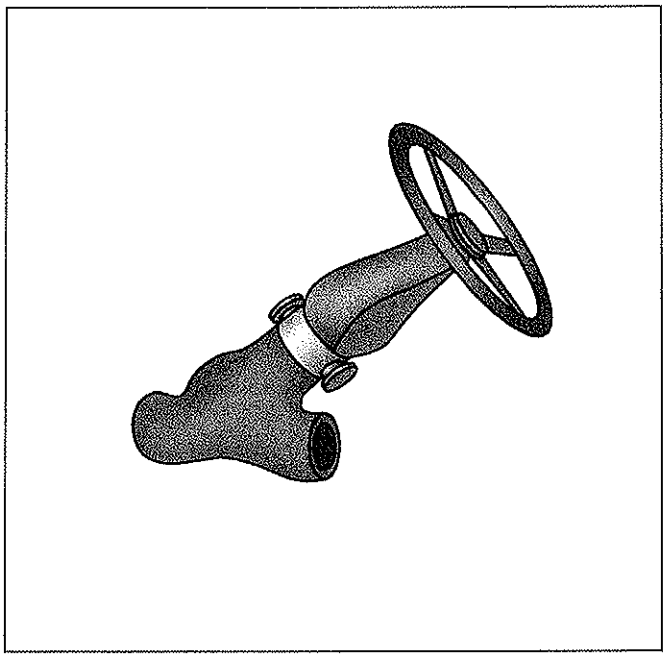
INVERTED T SHAPE VALVE



IV 3.2.06

The angled **"Y " PATTERN** helps to reduce pressure drop experienced with the traditional "T" shape globe valve (see illustration).

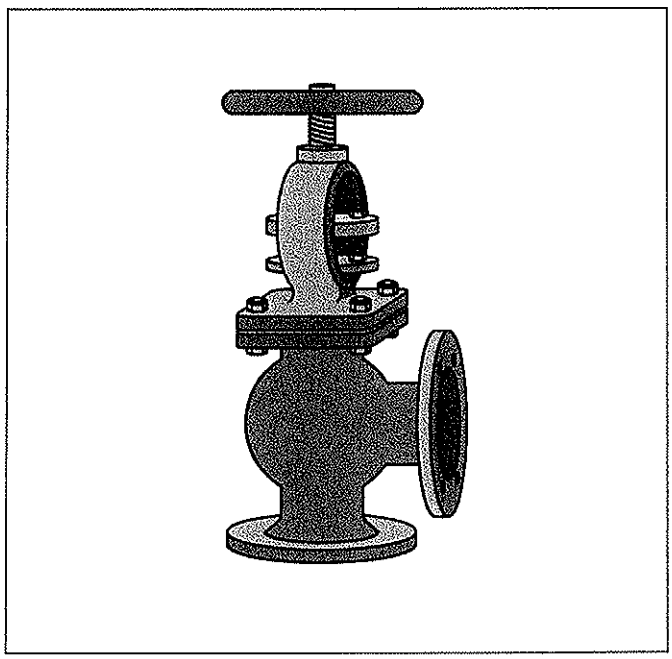
Y PATTERN VALVE



IV 3.2.07

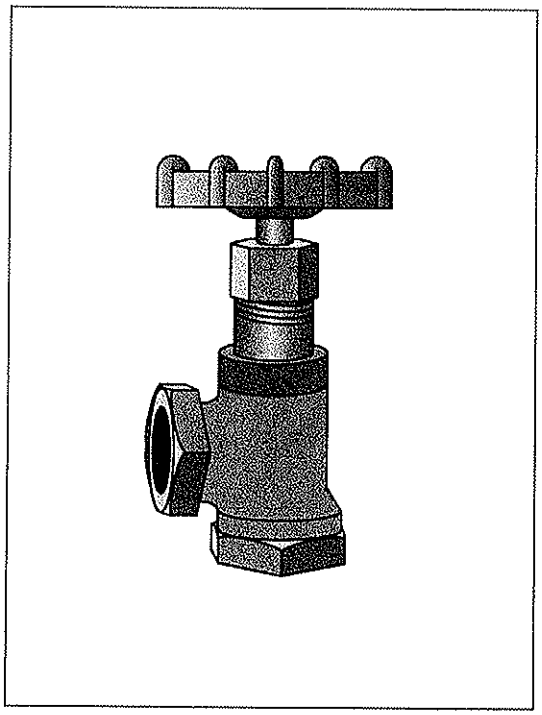
The **ANGLE VALVE** is used in place of a valve with an elbow and makes a 90-degree line connection (see illustration). Both the angle valve and the "Y" pattern are particularly suited to minimize pressure drop.

ANGLE VALVE



IV 3.2.08

NEEDLE VALVE



IV 3.2.09

Needle Valve Body

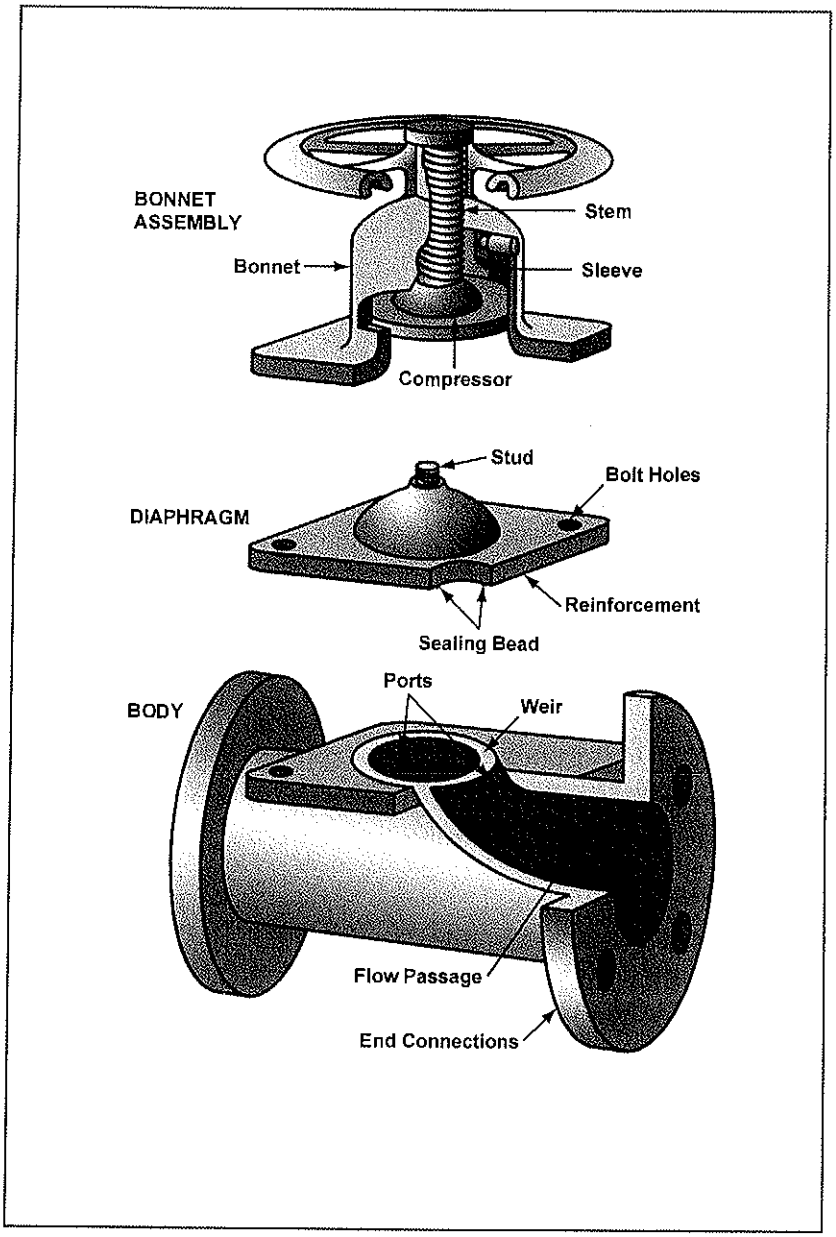
The **NEEDLE VALVE**, which gets its name from a needle-like closure member, is a variation of the globe valve. The needle valve is commonly used in instrumentation. Instrument valves are smaller valves designed to control or regulate flow accurately. Needle valves are available in the conventional globe body design and in the angle body design.

Diaphragm Valve Bodies

The **DIAPHRAGM VALVE** is often used in the chemical industry and it primarily used for throttling services. As with most valves, the diaphragm valve gets its name from the type of closing mechanism it has—a flexible diaphragm.

Diaphragm valves are constructed a little differently from gate and globe valves. Diaphragm valves have three main parts: the **BONNET** assembly, the **DIAPHRAGM**, and the **BODY**. The illustration on page 33 displays a diaphragm valve and its construction.

DIAPHRAGM VALVE CONSTRUCTION



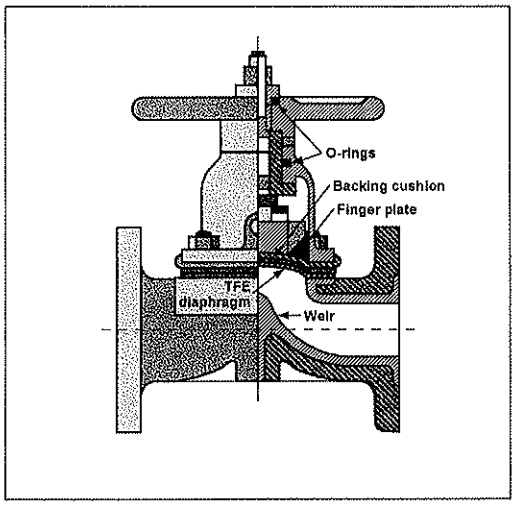
IV 3.2.10

The cover for the opening in the body is the **BONNET**, and it is the second most important boundary of a pressure valve. Like valve bodies, bonnets are in many designs and models available. The bonnet houses the valve stem and compressor. Rotation of the stem moves the compressor toward the diaphragm to close the valve and away from the diaphragm to open the valve.

The design of the bonnet assembly makes it easy to replace the diaphragm when necessary. Only the bonnet needs to be removed from the line in order to replace the diaphragm. This type of maintenance is called **IN-LINE MAINTENANCE**.

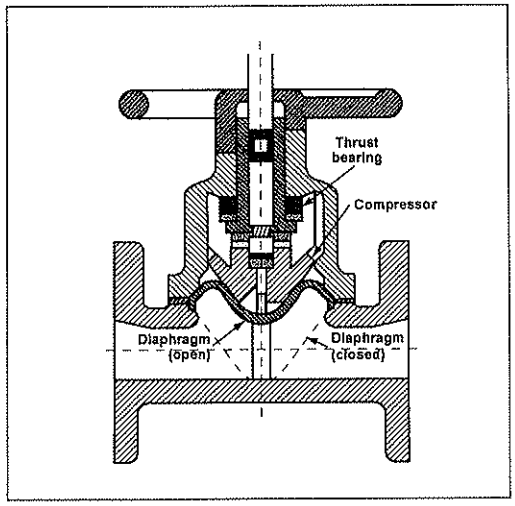
You can see two types of diaphragm valve bodies in the two illustrations. One design provides for **STRAIGHT-THROUGH FLOW** when little pressure drop is required. The other body design is more suited for **THROTTLING** applications when pressure drop is not a primary concern.

DIAPHRAGM VALVE: THROTTLING



IV 3.2.11

DIAPHRAGM VALVE: STRAIGHT THROUGH



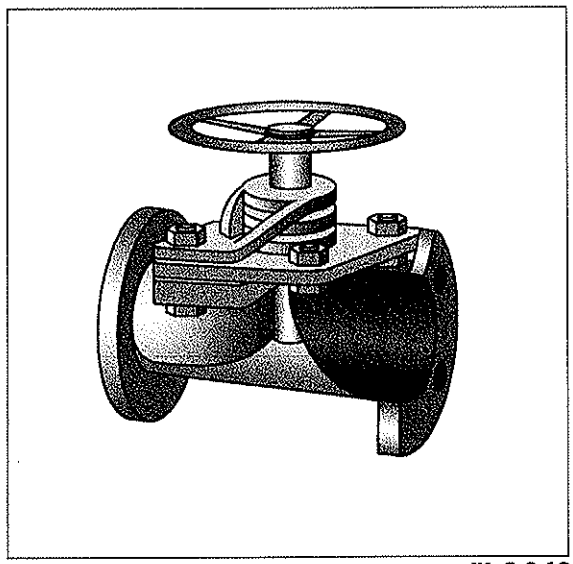
IV 3.2.12

The diaphragm valve body may be lined or unlined. **LINED VALVES** are used when flow media is corrosive to metal. The lining material may be rubber, Teflon™, glass, or other material.

The illustration shows an inside view of a Teflon™ lined diaphragm valve. The inside valve body walls and flange faces are covered in a plastic lining. The lining protects these valve parts from flow media contact and corrosion. Sometimes even the outer valve body is coated.

In the next chapter, you'll learn more about valve components such as various bonnet configurations, stem design variations, and closure members.

TEFLON™ LINED DIAPHRAGM VALVE



IV 3.2.13

REVIEW QUIZ – MULTI-TURN VALVE OVERVIEW

Answers appear on page 40

DIRECTIONS: Carefully read each question and circle the correct answer. There is only one correct answer per question. When you have finished, check your answers.

1. What determines the type of flow media a valve can handle?
   a. The bonnet
   b. Valve type
   c. Valve material
   d. Corrosion resistance
2. Valve material determines a valve's
   a. end connection.
   b. design.
   c. usefulness.
   d. type.
3. Which of the following valve types is used for on-off services and straight-through flow?
   a. Ball valve
   b. Gate valve
   c. Butterfly valve
   d. Pinch valve
4. Which of the following valves opens and closes by the circulation rotation of the handle?
   a. Check valve
   b. Regulator valve
   c. Globe valve
   d. Plug valve

REVIEW QUIZ – MULTI-TURN VALVE OVERVIEW

Answers appear on page 40

5. All of the following are design variations for globe valves EXCEPT
   a. Angle pattern
   b. "X" pattern
   c. "T" pattern
   d. "Y" pattern

6. To which valve category does the globe valve belong?
   a. Multi-turn valves
   b. Quarter-turn valves
   c. Check valves
   d. Specialty valves

7. All of the following are main parts of a diaphragm valve EXCEPT
   a. Stem
   b. Bonnet
   c. Diaphragm
   d. Body

8. A customer asks whether gate valves should be used for throttling service. What is your repsonse?
   a. What size do you need?
   b. They should not be used because they have a straight-through design causes erosion and possible corrosion of the closure member (or gate) when put in a partially opened/closed position.
   c. They can be used if there size is correct.
   d. They can be used if the correct design variation is made, which will reduce the corrosion of the valve.

9. Which of the following valves is typically used for precise flow regulation control?
   a. Diaphragm valve
   b. Globe valve
   c. Needle valve
   d. Gate valve

REVIEW QUIZ – MULTI-TURN VALVE OVERVIEW

Answers appear on page 40

10. Which type of diaphragm valve body would be needed for an application where the flow media would corrode a metal valve body?
    a. Inverted "T"
    b. Angle
    c. Lined
    d. Unlined

APPLYING WHAT YOU HAVE LEARNED:

By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.

A. Which companies manufacturer the types of valves that your company recommends and sells?

_____

_____

_____

B. List several types of multi-turn valves that your company recommends and sells.

_____

_____

_____

ANSWERS TO REVIEW QUIZ

CHAPTER 2

MULTI-TURN VALVE OVERVIEW

Answers to Review Questions: Multi-turn Valve Overview

1. b. Valve type
2. a. end connection.
3. b. Gate valve
4. c. Globe valve
5. b. "X" pattern
6. a. Multi-turn valves
7. a. Stem
8. b. They should not be used because they have a straight-through design causes erosion and possible corrosion of the closure member (or gate) when put in a partially opened/closed position.
9. c. Needle valve
10. c. Lined

APPLYING WHAT YOU HAVE LEARNED:

A. Answers will vary by company.

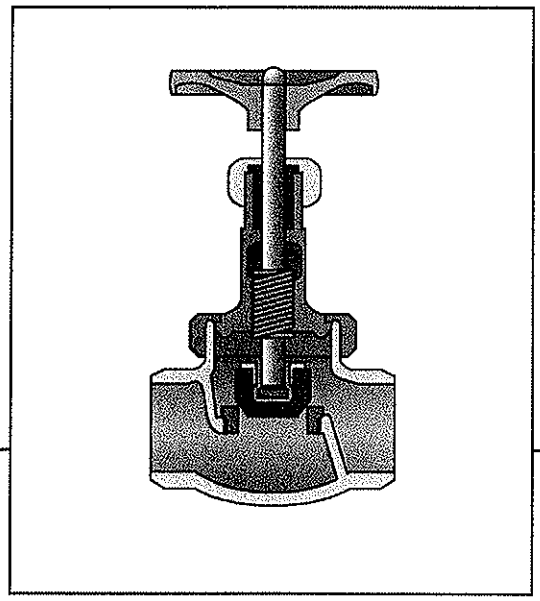
B. Answers will vary by company.

3 MULTI-TURN VALVE DETAILS

LEARNING OBJECTIVES

When you successfully complete this chapter, you will be able to:

1. Name and compare the different bonnet configurations used on gate valves and globe valves.
2. Identify the applications for which the different bonnet configurations are best suited.
3. Describe the different stem configurations used on gate, globe, and diaphragm valves.
4. Explain the applications for which the different stem configurations are best suited.
5. Discuss the different types of closure members (valve discs and seats) used on gate, globe, and diaphragm valves.
6. Identify the applications for which the different closure members of gate, globe, and diaphragm valves are best suited.



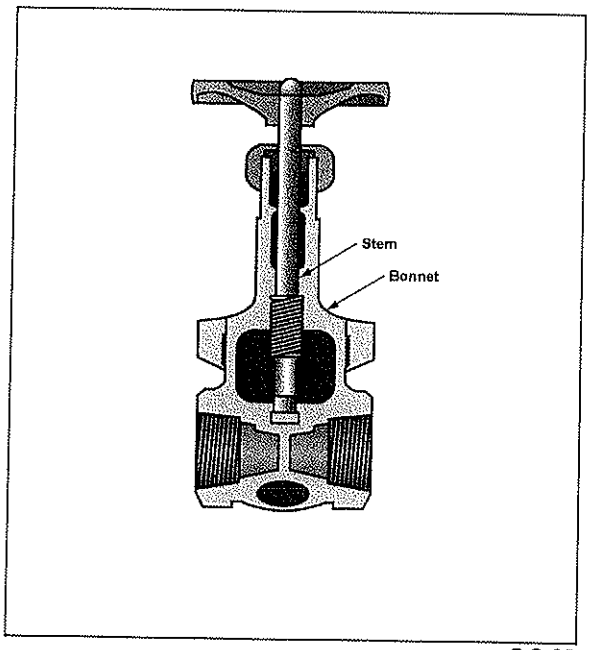
MULTI-TURN VALVE DETAILS

BONNET DESIGN VARIATIONS

A **BONNET** is a removable metal plate that sits on top of the valve body and helps support the valve stem (which is one of the primary moving parts). A bonnet provides leak-proof closure for the valve body. The threaded section of stem goes through a hole with matching threads in the bonnet.

This chapter covers the following bonnet joint designs and relates them to their application: screwed bonnets, union bonnets, bolted bonnets (flanged bonnets), U-bolt bonnets, and pressure-seal bonnets. The difference among them is in how each bonnet style is attached to the valve body. As you can see in the **GATE VALVE** illustration, the bonnet houses the stem.

GATE VALVE-BONNET DESIGN CUTAWAY



3.3.01

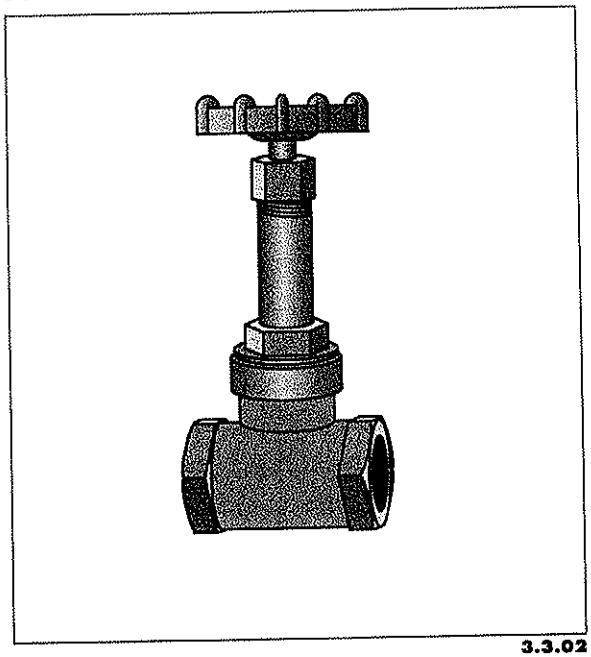
Screwed Bonnets

Gate and globe multi-turn valves are available with many different bonnet designs. The two types of valves may have a **SCREWED, UNION**, or **BOLTED BONNET**. A screwed bonnet is the simplest bonnet, offering a durable, pressure-tight seal. Three reasons for selecting a screwed bonnet are cost, valve size, and low-pressure service. A union bonnet is suitable for applications requiring frequent inspection or cleaning. It also gives the body added strength. A bolted bonnet is attached with bolts and used for larger or higher-pressure applications.

A **SCREWED BONNET** is shown in the illustration. This design is the most economical and generally found on smaller-sized valves. However, it is limited to low-pressure services.

There are two basic types of screwed bonnets: "screwed-in" and "screwed-over" bonnets. Cutaway drawings of these bonnet types are shown in the next two illustrations.

SCREWED BONNET GATE VALVE

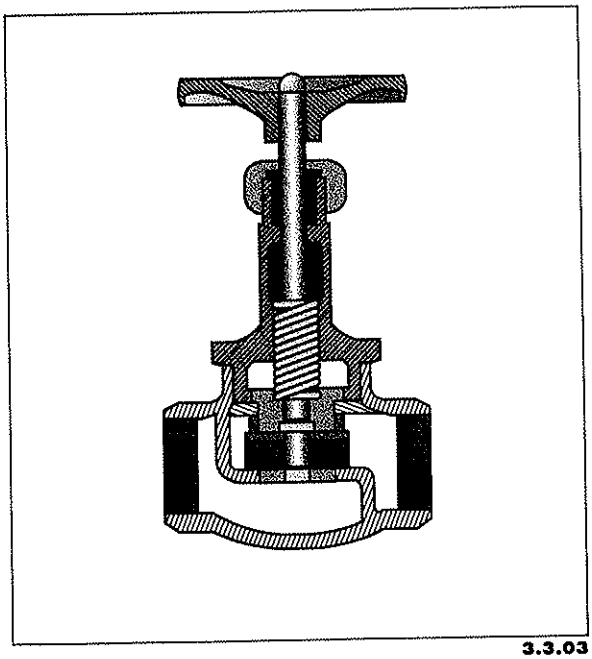


3.3.02

Screwed-in Bonnet

The outside base of the bonnet screws into the inside neck of the valve body (see illustration). The bonnet attaches to an internal body thread.

SCREWED-IN BONNET



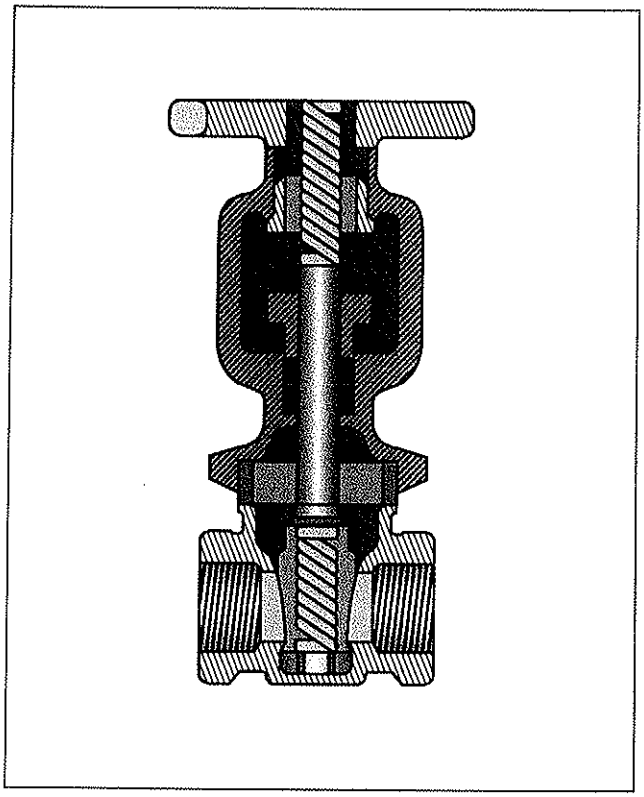
3.3.03

Screwed-over Bonnet

The inside base of the bonnet is threaded to screw on the outside body neck threads. The bonnet attaches to an external body thread.

A screwed-over bonnet must be screwed on the valve body firmly to make a tight seal (see illustration). Over-torqueing the assembly tends to distort the threads and may damage the sealing surfaces. If the valve must be disassembled, it should be reassembled carefully, preferably with light oil applied to the threads.

CUTAWAY OF SCREWED-OVER BONNET



3.3.04

Union Bonnets

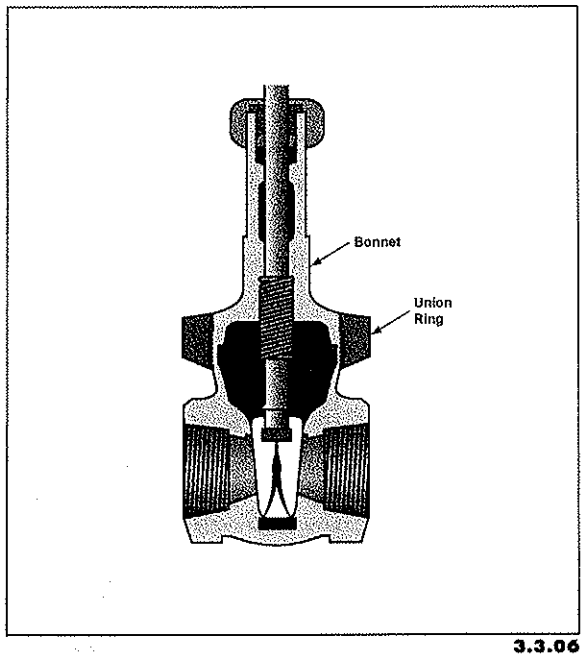
A union bonnet provides assurance of a tight bonnet joint. This is because the sealing surfaces are not in rubbing contact at assembly and the union ring tends to reinforce the structure.

A **UNION NUT** or a screwed **UNION RING** couples the bonnet to the valve body. This bonnet joint is similar in principle to a pipe union. It is generally found on smaller valves. The illustration is an inside view of a gate valve with a union bonnet.

This cross-section drawing shows that the union ring is actually a separate part from the body or the bonnet. The union ring makes it easy to frequently dismantle and reassemble the joint without galling the sealing surfaces.

This type of joint provides a lesser chance of damaging the sealing surfaces upon assembly than a screwed bonnet because there is no movement between body-bonnet joint sealing surfaces.

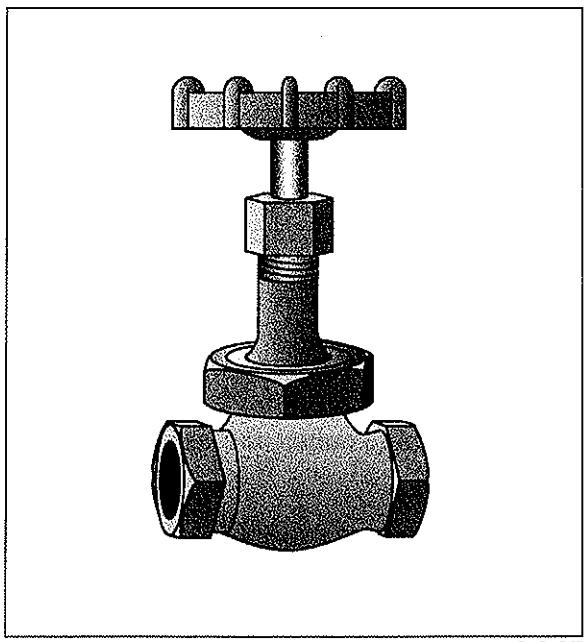
INSIDE VIEW OF GATE VALVE WITH UNION BONNET



3.3.06

The following illustration shows a **1/2" BRONZE GLOBE VALVE**. It is often used in applications where a soft-seated disc may have to be replaced frequently.

BRONZE GLOBE VALVE



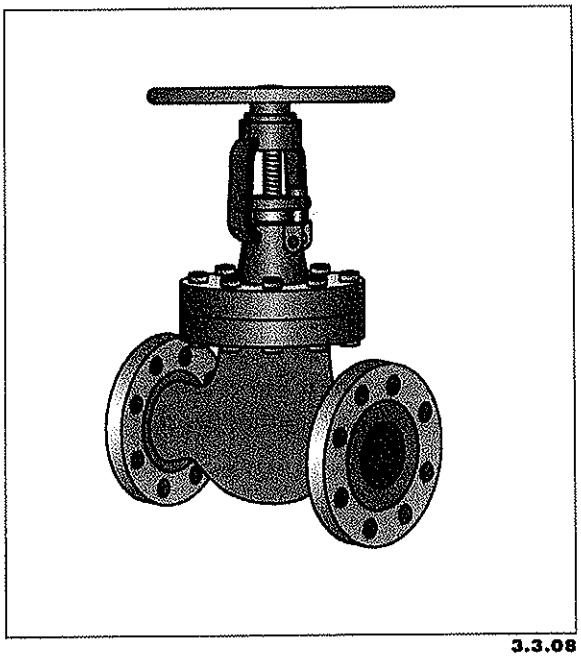
3.3.07

Bolted or Flanged Bonnets

The illustration is an example of another type of globe valve. This valve has a bolted bonnet joint. **BOLTED BONNETS** are commonly used for larger valves or higher pressure applications. The bolted bonnet may also be called a **FLANGED BONNET**.

There are three types of flanged bonnet joints: flat-faced joints, male and female joints, ring-type joints. While each type is used for particular applications, they all seal in much the same manner.

VALVE WITH BOLTED BONNET JOINT

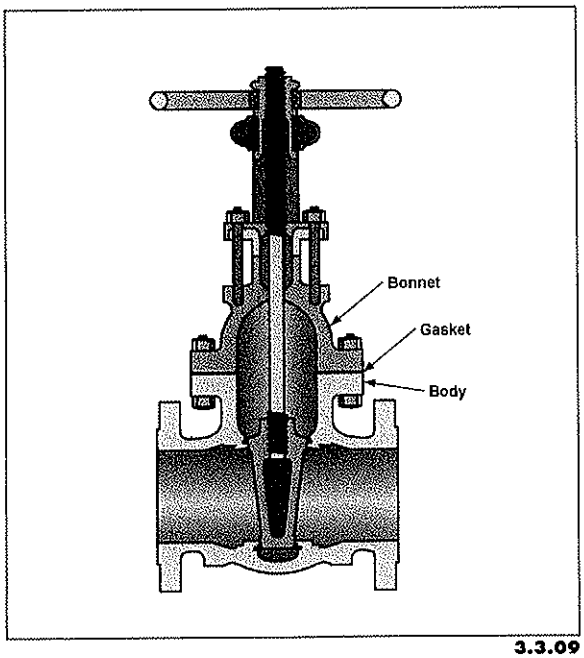


3.3.08

Flat-faced Joints

The illustration is a **CUTAWAY OF A FLAT-FACED JOINT**. The bonnet and body flanges are bolted together. A gasket between the flange faces provides a tight seal. The flat-faced joint is generally used in lower pressure and lower temperature applications. Most iron valves use this type of joint.

CUTAWAY OF FLAT-FACED JOINT



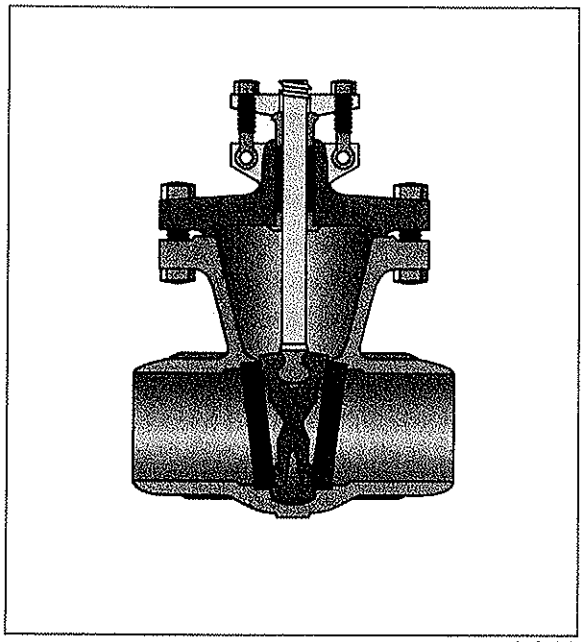
3.3.09

Male and Female Bonnet Joints

The illustration shows a cutaway of the male and female bonnet joints. These joints are found on valves used in high temperature-pressure applications. They would likely be made of steel.

The male and female bonnet joint is used for perfect alignment of the bonnet onto the valve body.

CUTAWAY OF MALE AND FEMALE BONNET JOINT

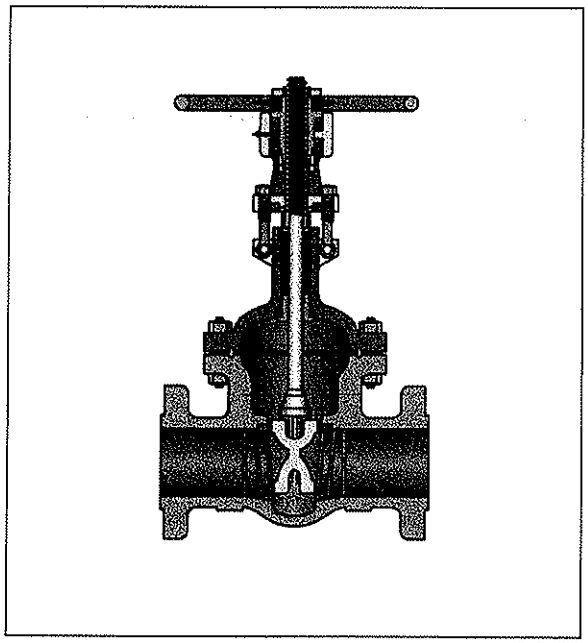


3.3.10

Ring-type Bonnet Joints

The illustration shows a **RING-TYPE BONNET JOINT**. These bolted bonnet joint assemblies are the same designs found on another valve joint location: the end connections.

CUTAWAY OF RING-TYPE BONNET JOINT



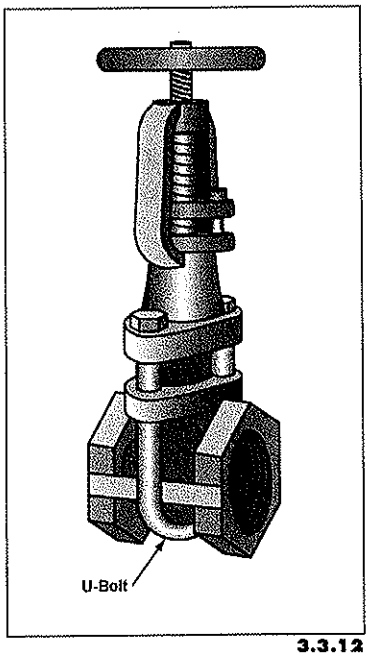
3.3.11

U-bolt / Clamp-type Bonnets

The **U-BOLT BONNET** illustrated is a variation of the bolted bonnet. A U-shaped clamp that passes around the valve body is secured to the bonnet. Thus, it is also called a **CLAMP-TYPE BONNET** or a *clip gate*.

The U-bolt bonnet gate valve can be used for a wide variety of fluid services that requires on/off application, ease of replacement, and a lower-cost valve.

U-BOLT BONNET

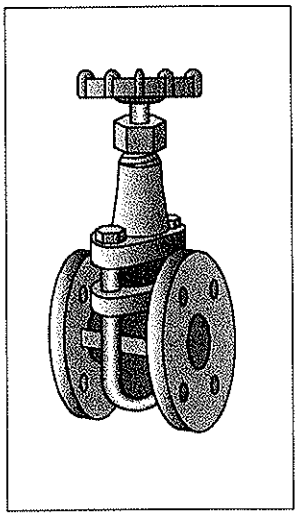


3.3.12

CLAMP-TYPE BONNETS in the illustration are found on gate valves used in lower temperature and lower pressure applications for oil and chemical services, as well as for general services such as steam, water, or air. It is an economical construction.

This design is particularly good for viscous services like tar or paint, where valve internals must be frequently cleaned.
It is a good practice to replace the gasket whenever the bonnet assembly is dismantled.

CLAMP-TYPE BONNET

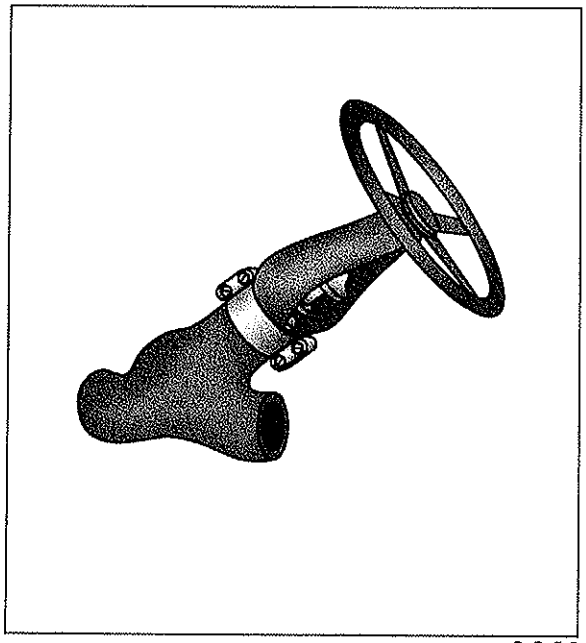


3.3.13

Pressure-Seal Bonnets

Other bonnet designs are used for high-pressure and high-temperature service. The **PRESSURE-SEAL BONNET** is one design used for these applications (see illustration).

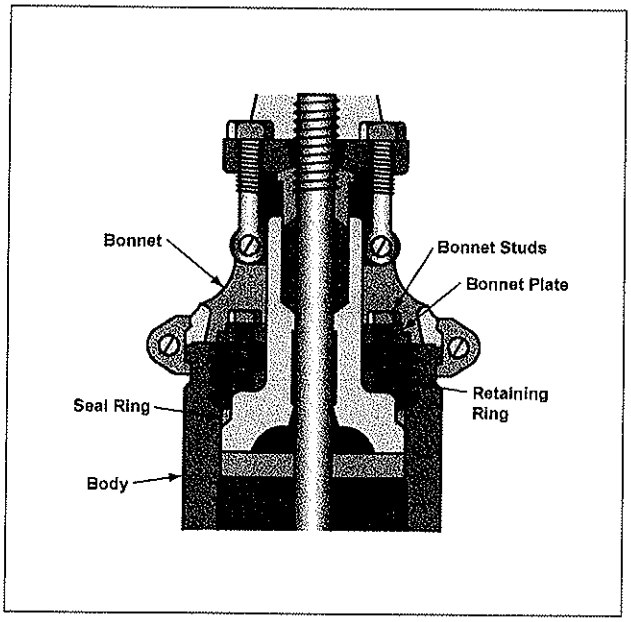
PRESSURE-SEAL BONNET



3.3.14

Instead of relying on conventional sealing methods, this joint design uses line pressure to make a tight seal; the greater the pressure, the tighter the seal. The illustration is an inside view of a pressure-seal bonnet joint.

INSIDE VIEW OF A PRESSURE-SEAL BONNET



3.3.15

The actual seal is made between the valve body wall and the bonnet. When in service, internal line pressure forces the underside of the bonnet against the gasket or seat ring to make the seal.

Stem Design Variations

This section focuses on the different stem designs for globe, gate, and diaphragm valves. The design is matched to its application. The **VALVE STEM** provides the necessary movement to the disc, plug or the ball for opening or closing the valve, and is responsible for the proper positioning of the disk. It is connected to the valve hand wheel, actuator, or the lever at one end and on the other side to the valve disc.

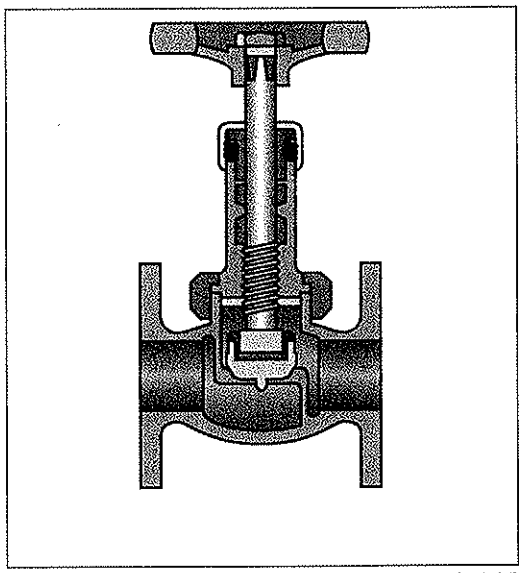
Gate and globe valves may have rising stems (RS), non-rising stems (NRS), or sliding (spring-loaded) stems. Stems may be of an outside screw design or an inside screw design.

Diaphragm valve bonnet assemblies may have indicating or non-indicating stems. These serve the same purposes as rising and non-rising stems in gate and globe valves. The non-indicating stem and non-rising stem are appropriate when overhead space is limited.

Rising and Non-rising Stems

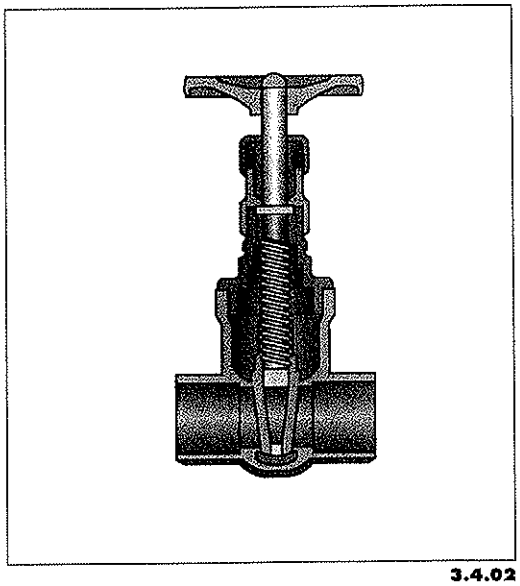
In the previous section, we reviewed the union and screwed designs for bonnets for gate valves. Both the union bonnet and screwed bonnet gate valves are available with two types of stems, **RISING STEM (RS)** and **NON-RISING STEMS (NRS)** as seen in the following illustrations.

UNION BONNET WITH RISING STEM



3.4.01

SCREWED BONNET WITH NON-RISING STEM



3.4.02

Non-Rising Inside Screw Design

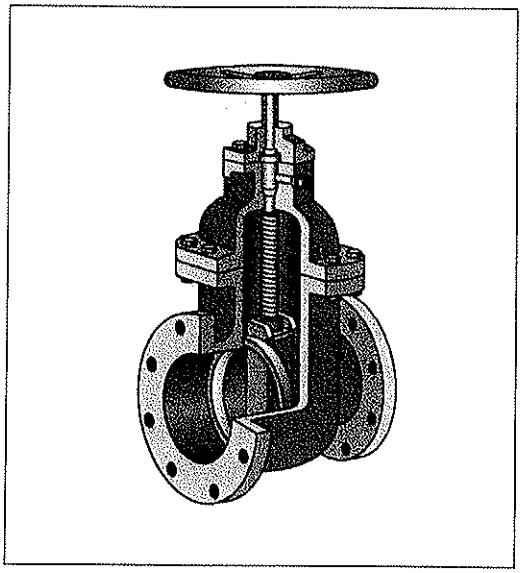
The illustration to the right shows a **NON-RISING STEM WITH AN INSIDE SCREW**.
Non-rising stems are generally only found on gate valves.

Rotating the stem causes the disc to move up or down the stem threads. Because the stem is only rotated, packing maintenance may not be required as frequently as with rising and sliding stem constructions.

Keep in mind when specifying rising stem valves, there must be enough overhead clearance to open and close the valve.

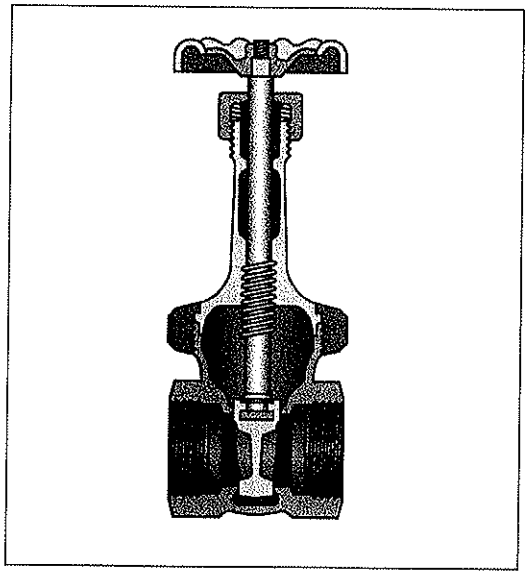
Rising stem valves may have inside or outside screw stem threads. The illustration below is a **RISING STEM GATE VALVE WITH INSIDE SCREW** stem construction for smaller sized bronze gate and globe valves.

NON-RISING STEM WITH INSIDE SCREW



3.4.03

RISING STEM WITH INSIDE SCREW



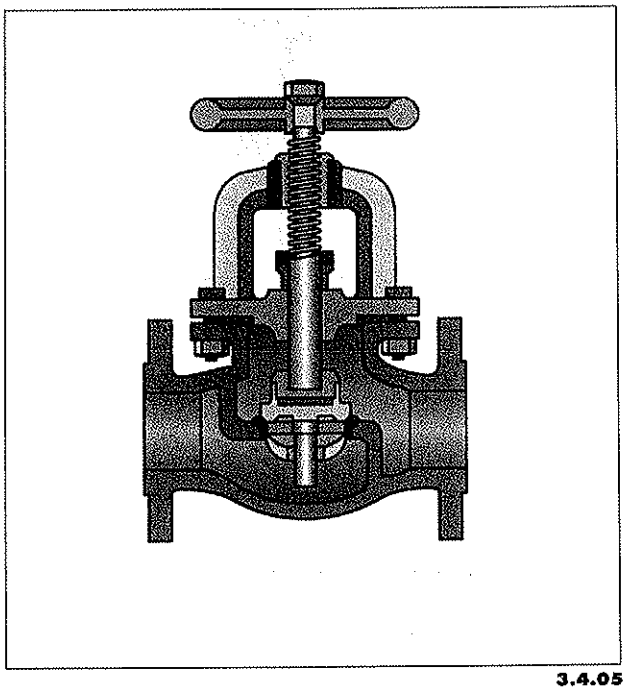
3.4.04

The advantage of the rising stem design is that it allows the user to visually determine whether the valve is open or closed.

Rising Outside Screw Design

The bolted bonnet on the valve shown in the following image houses a rising stem. This is an outside screw design called **OUTSIDE SCREW AND YOKE (OS&Y)**. The stem threads are located above the bonnet assembly. This type of bonnet and stem design is especially recommended in applications that handle corrosive media, because the threads are outside the fluid containment area. It also differs from other designs in that the hand wheel is attached to a bushing at the top of the valve yoke, and not to the stem itself, thus the hand wheel does not rise as the valve is opened.

OUTSIDE SCREW AND YOKE (OS&Y)



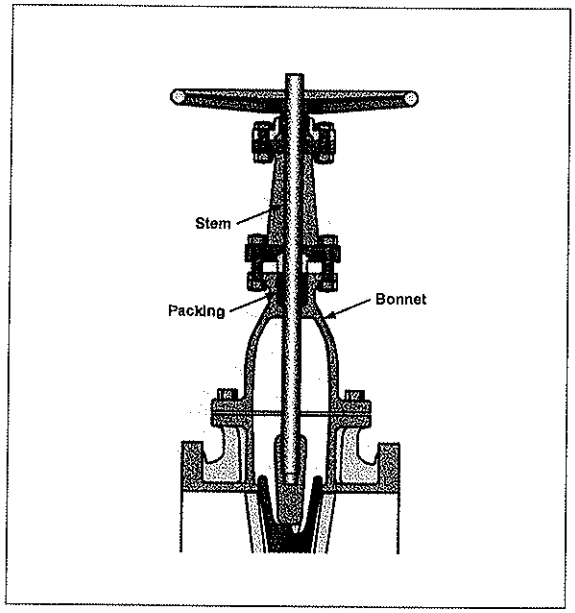
3.4.05

Valve Packing

The following illustration is a closer view of the stem area. **PACKING**, such as Teflon™, elastomeric material, fibrous material, etc., is used to prevent flow media from leaking around the stem area.

Most valves use non-asbestos materials for valve packing. You should become familiar with the type of packing materials available for the valves your firm sells.

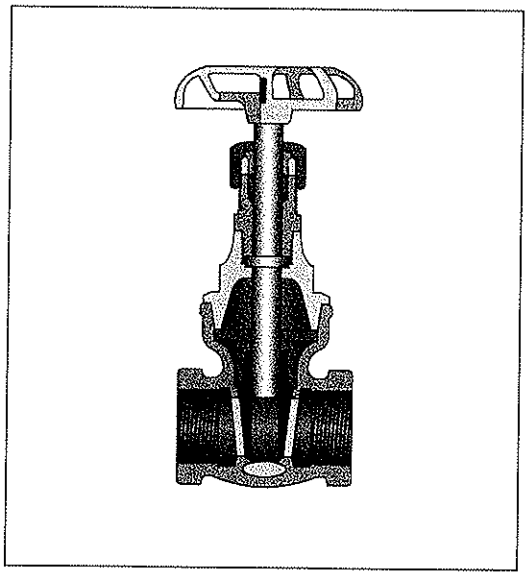
CLOSE-UP OF STEM AREA



3.4.06

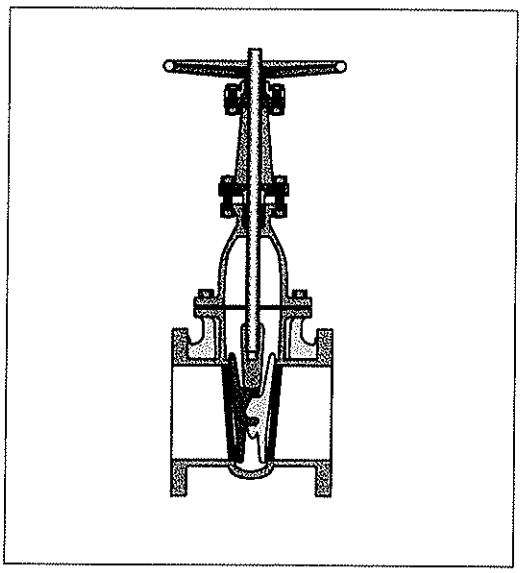
Frequent opening and closing cycles on any valve will require frequent packing adjustment. **RISING STEM VALVES** shown in the following illustrations may require more frequent packing adjustment than **NON-RISING STEM (NRS) VALVES**.

CUTAWAY OF NON-RISING STEM VALVE



3.4.07

CUTAWAY OF RISING STEM VALVE



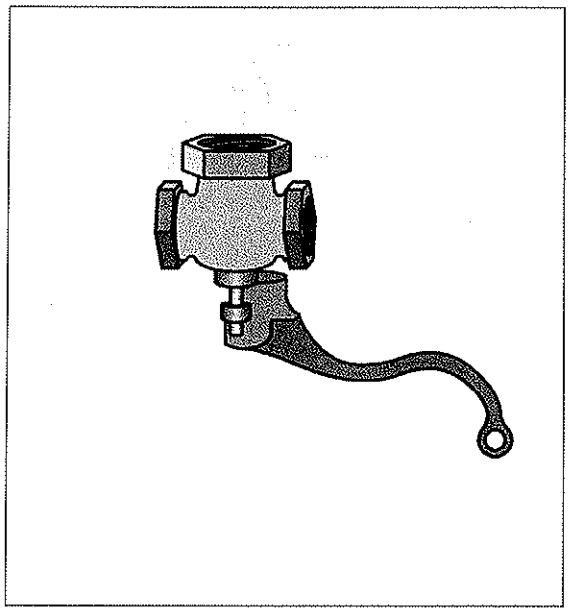
3.4.08

Sliding Stems

Another rising stem design found on small, low-pressure globe valves is the **SLIDING STEM** shown in the illustration.

This spring-loaded stem configuration eliminates the hand wheel, bonnet, and stem threads and allows quick on/off applications. Sliding stems can also be offered in a self-closing or dead-man design.

SLIDING STEM CONFIGURATION



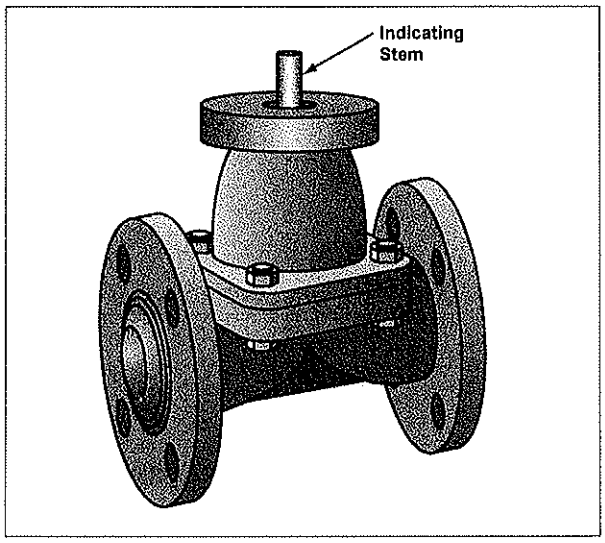
3.4.09

Diaphragm Valve Stems

Diaphragm valve bonnet assemblies may have two types of stem designs: indicating and non-indicating. These are similar in function to the gate and globe valve's rising and non-rising stems.

Indicating stems can show at a glance whether the valve is open or closed. The diaphragm valve in the image has an **INDICATING STEM**. The indicating stem valve is identical to the non-indicating stem valve except that a longer stem is provided to extend up through the hand wheel.

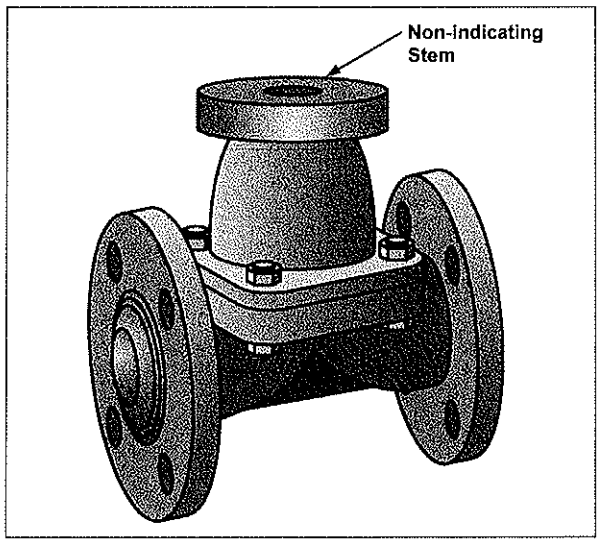
DIAPHRAGM VALVE BONNET WITH INDICATING STEM



3.4.10

A bonnet assembly with a **NON-INDICATING STEM** is shown in the next image. For the non-indicating stem design, the hand wheel rotates a stem bushing that engages the stem threads and moves the stem up and down. As the stem moves, so does the compressor that is pinned to the stem. The diaphragm, in turn, is secured to the compressor. This type of bonnet assembly is used when overhead space is limited. This is the same difference as between rising and non-rising stem gates.

DIAPHRAGM VALVE BONNET WITH NON-INDICATING STEM



3.4.11

CLOSURE MEMBERS

CLOSURE MEMBERS are the discs and seats of valves. The five types of multi-turn valves—gate, globe, pinch, needle, and diaphragm—use different closure member designs that are suited to the specific application they are intended for.

Gate Valve Closure Members

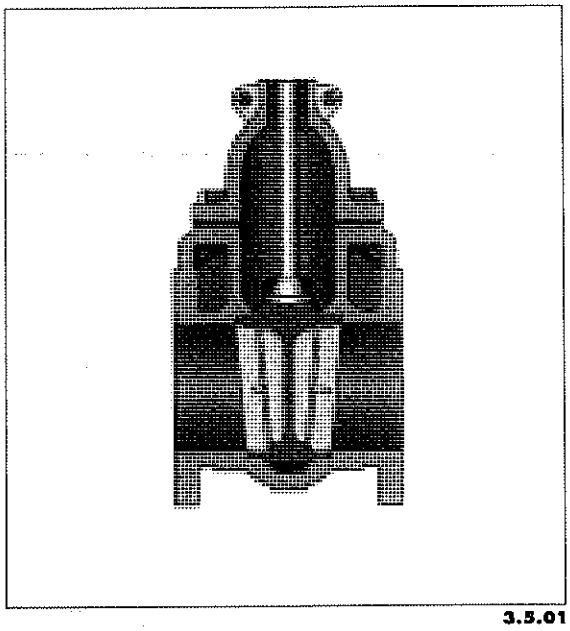
Let's take a closer look at the different types of closure members used with gate valves. Gate valves are available with four basic types of discs: solid wedge discs, flexible wedge discs, split wedge discs, and double parallel wedge discs. The solid wedge disc is shown in the next illustration.

Solid Wedge Discs

Gates valves use various wedges or disc. The **SOLID WEDGE DISC** is the most commonly used disc because of its strong, simple design. It can be installed in any position without danger of jamming due to misalignment of parts. A gate valve with this type of wedge can be installed in each position and it is suitable for almost all liquids. The solid wedge is a single-piece solid construction, and is practically for turbulent flow.

This valve in this illustration has a **RISING STEM**. Solid wedge gate valves are also available with non-rising stems and inside or outside screw designs.

SOLID WEDGE GATE VALVE WITH RISING STEM



3.5.01

Solid wedge gate valves are not best suited for applications that require shutoff under high temperatures. If closed with excessive force when the valve is hot, the wedge can become jammed between the valve seats. Upon cooling, the valve body and disc will contract and may further jam the wedge disc.

Thus, when selecting solid wedge gate valves, be aware of possible problems caused by thermal expansion and contraction.

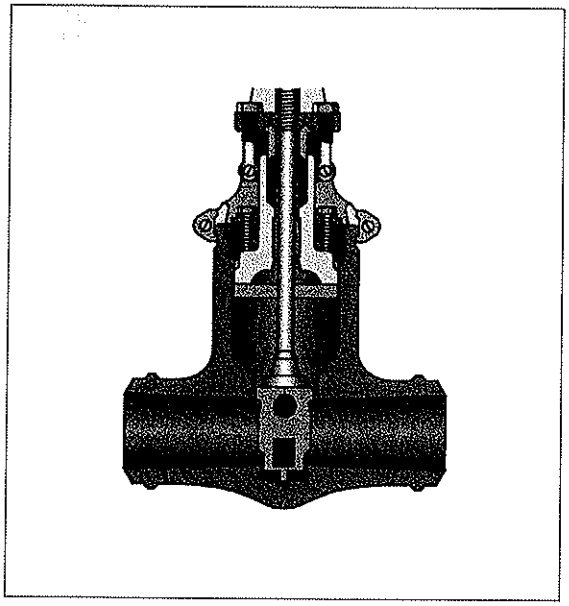
Resilient Wedge Gate Valve

A variation of the solid wedge disc is the **RESILIENT WEDGE DISC**. This design uses a solid wedge disc which is encapsulated in rubber. It is being used for low temperature applications and in fire protection systems.

Flexible Wedge Gate Valve

The **FLEXIBLE WEDGE DISC** shown in the illustration is recommended when thermal expansion becomes a factor and solid wedge discs are no longer suitable. The flexible wedge disc is similar in design to the solid wedge disc and is interchangeable with the solid wedge disc in many instances.

CUTAWAY OF FLEXIBLE WEDGE DISC



3.5.02

The valve seating faces are flexible to permit easy seating and opening over a wide variety of temperature and pressure conditions. The flexible wedge disc is available in both inside and outside screw designs. Given its potential for handling high temperatures, it is likely to be made of steel.

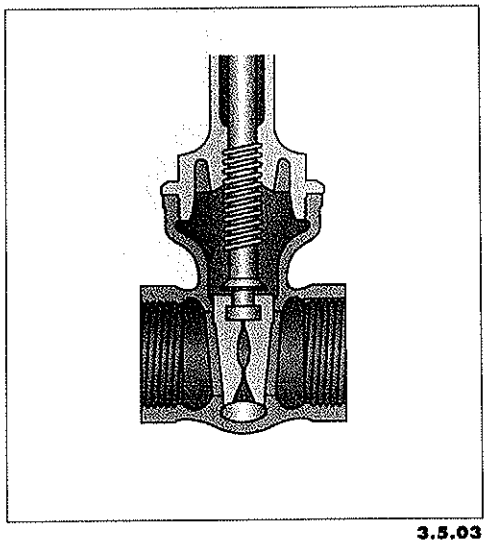
Split Wedge Disc

The **SPLIT WEDGE** shown in the illustration is another type of disc configuration. The design is similar to the flexible wedge. The opposite seating faces split into two separate parts.

The design has freedom of movement for both disc halves, uniform seating force and prevents galling of seating surfaces. It is widely used on bronze and stainless steel valves. This type of wedge is suitable for the treatment of non-condensing gases and liquids at normal temperatures, particularly corrosive liquids.

Ball valves have replaced this valve in most applications.

CUTAWAY OF SPLIT WEDGE DISC

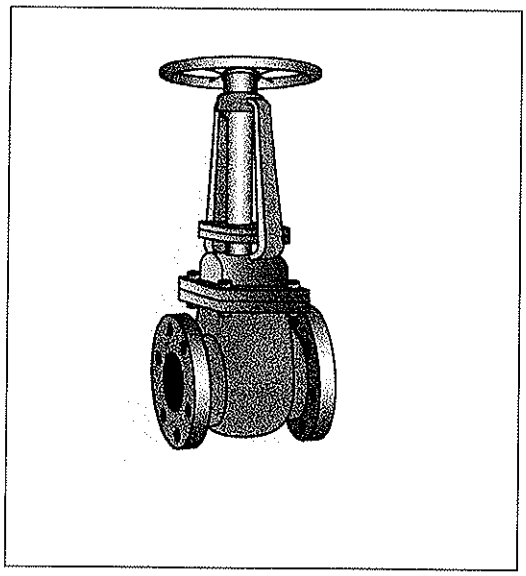


3.5.03

Double Parallel Disc

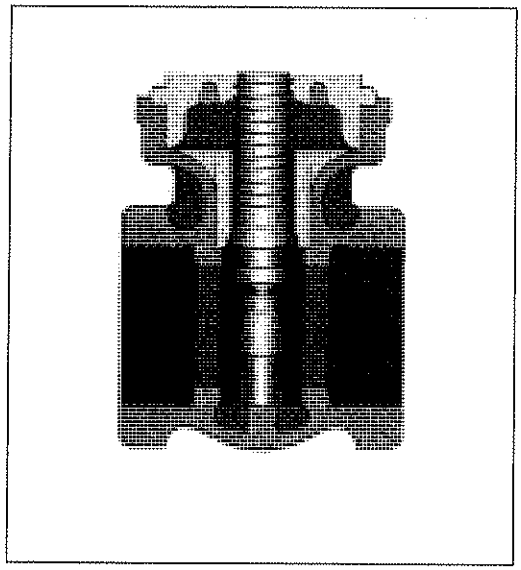
The double parallel disc is available in both large and small gate valves with outside or inside screw design and non-rising stems, as shown in the following illustrations. Most non-rising stems and outside screw iron gate valves use a double parallel disc.

LARGE IRON GATE VALVE



3.5.04

CUTAWAY OF SMALL IRON GATE VALVE



3.5.05

Gate valves are linear motion valves in which a flat closure element slides into the flow stream to provide shutoff. Gate valves and knife valves are designed to minimize pressure drop across the valve in the fully opened position and stop the flow of fluid completely.

Gate valves are usually divided into two types: parallel and wedge-shaped. The **PARALLEL GATE VALVE** uses a flat disc gate between two parallel seats, upstream and downstream. Knife valves are of this type, but with a sharp edge on the bottom of the gate to shear entrained solids or separate slurries.

In the double-disk parallel-seat type, the valve is closed by lowering the disks from the valve neck to a height equal to that of the valve seats. Once positioned, an inclined plane mounted between the two disks converts downward stem force into axial force and presses the parallel disks firmly against the valve seats sealing the two openings. These types of valve design can accommodate asymmetric or angularly misaligned valve seats.

Wedge-shaped gate valves and knife valves use two inclined seats and a slightly mismatched inclined gate to allow for tight shutoff. Disk flexibility is inherent to the split wedge design. This flexibility allows the split wedge to seal more easily and reduces stickiness between the sealing surfaces in cases where the valve seats are angularly misaligned.

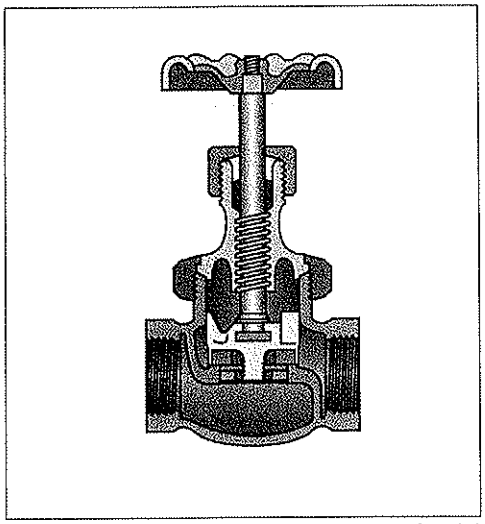
Globe Valve Closure Members

Globe valves are available in three basic disc configurations: composition (Teflon™), metal, and integral. The metal discs are in two forms: spherical and plug.

The **COMPOSITION** (or **TEFLON™**) **DISC** is used in some iron globe valves up to 8" and in bronze globe valves. The disc is flat and held in place by a disc holder attached to the stem and shown in the illustration. The disc is made of a non-metallic material, usually Teflon™ or synthetic rubber.

The composition disc is replaceable when necessary. You should know that the disc material will limit the valve in high-temperature applications.

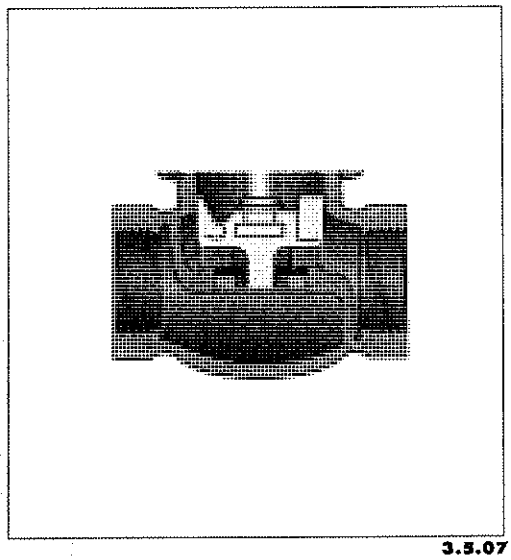
CUTAWAY OF GLOBE VALVE COMPOSITION DISC



3.5.06

The seat for the composition disc is flat to mate tightly with the flat disc face, as shown in the image. This construction design is particularly suitable for water, oil, or gas service when tight shutoff is needed. This design is not recommended for throttling purposes.

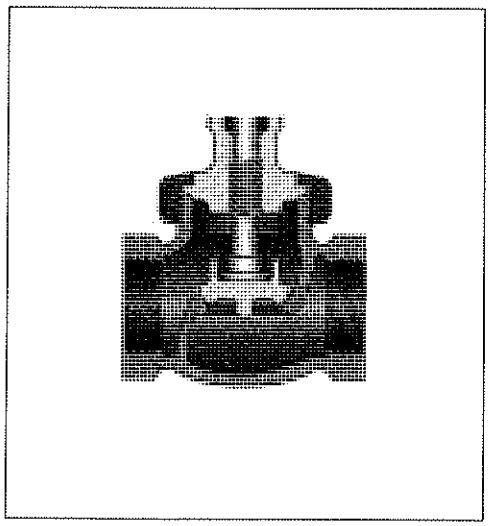
SEAT FOR COMPOSITION DISC



3.5.07

The globe valve also uses metal discs for closure member assembly. The **METAL DISC**, shown in the illustration, is particularly suited for throttling and tight shutoff applications. The metal-to-metal contact seating action can break up deposit particles that form on the seat. Notice the metal disc has a spherical surface. The conventional metal disc has a spherical surface.

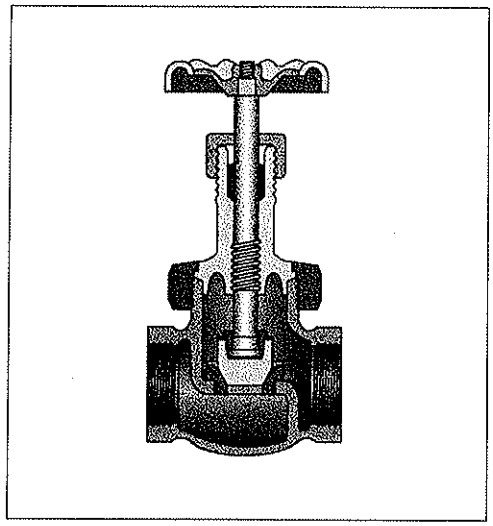
CONVENTIONAL METAL DISC CLOSURE MEMEBER



3.5.08

CUTAWAY OF PLUG-TYPE DISC

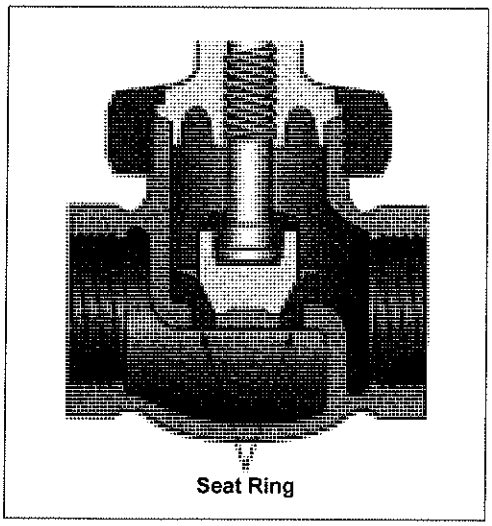
In the cutaway illustration you can see another metal disc, called a **PLUG** or **PLUG-TYPE DISC**. There are the two types of metal discs for globe valves: spherical and plug. This disc has a tapered surface that mate with a beveled seat surface.



3.5.09

CLOSE-UP VIEW OF PLUG-TYPE DISC

As with a composition disc, a metal disc may need to be replaced or reground for maintenance purposes. The subsequent illustration offers a closer view of a plug-type disc. As you can see by the cutaway drawing, this valve has a renewable seat ring. When needed, the seat ring may be replaced for maintenance purposes.

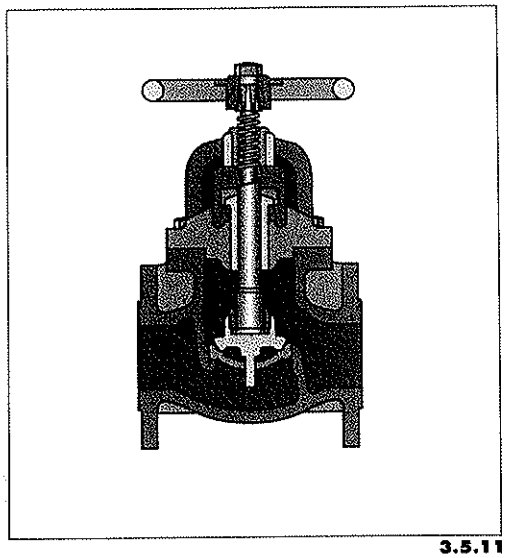


3.5.10

Look at the spherical disc shown in the next image. Note that a disc guide and pin help the disc and seat mate tightly for shutoff. Because the seat ring is threaded into the valve body, it can easily be replaced with the disc when maintenance is necessary.

Some globe valve spherical discs and seats, like the one shown in this illustration, use a hardened alloy for the disc and seat ring. The hard metal makes the valve more suitable for throttling services, services requiring frequent on/off conditions, and higher temperature-pressure applications.

GLOBE VALVE: SPHERICAL DISC

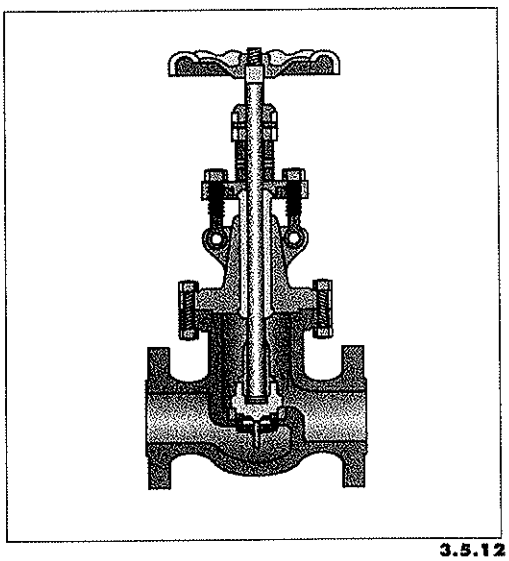


3.5.11

The plug disc, like the spherical disc as shown in the image, is also available with a disc guide and pin to ensure smooth mating. The use of hard trim metals and plug design helps resist erosion of the trim area produced from throttling.

The globe valve in the next illustration is recommended for use with high temperature liquids or gases requiring flow regulation.

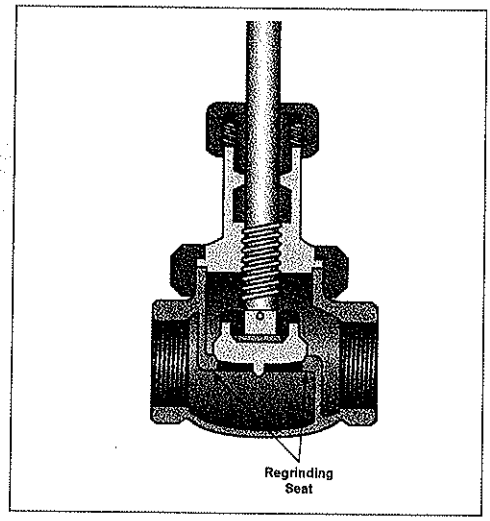
GLOBE VALVE: PLUG DISC



3.5.12

The **INTEGRAL METAL SEAT VALVE** in the following illustration gets its name from the way it is designed. The seat is an integral part of the valve body. The disc can be reground to the seat using a grinding or lapping compound.

INTEGRAL METAL SEAT VALVE



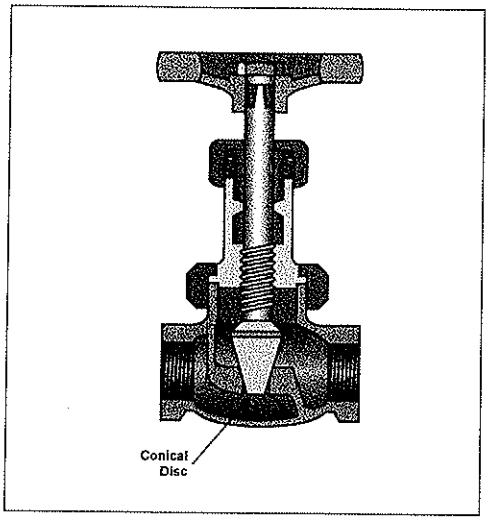
3.5.13

Needle Valve Closure Members

Needle valves are used in instrumentation to control and measure flow very accurately. A **CONICAL-SHAPED DISC** and seat design along with a fine stem thread allow flow to be finely regulated.

The valve illustrated is a 1/4" globe valve and it is suitable for accurate throttling control of flow media in a high pressure line.

GLOVE VALVE WITH CONICAL-SHAPED DISC



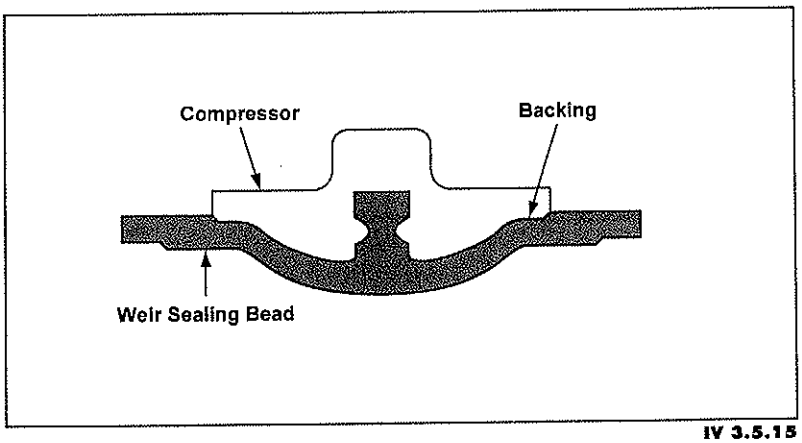
3.5.14

Diaphragm Valve Closure Members

The three major types of closure members used on diaphragm valves are based on the construction materials: Teflon™, elastomer with Teflon™, and elastomer.

The valve shown is a solid **TEFLON™ DIAPHRAGM VALVE**. The sealing bead, stud, and backing are made of Teflon™.

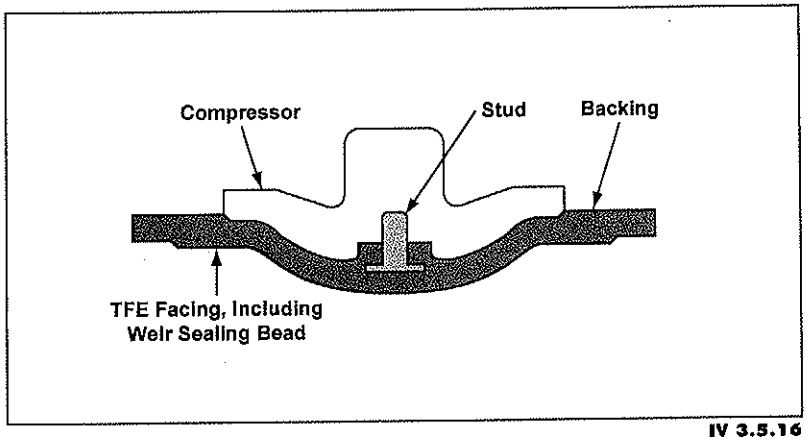
TEFLON™ CLOSURE MEMBER FOR DIAPHRAGM VALVE



IV 3.5.15

The next image is the second type of closure member, a **TEFLON™ FACED DIAPHRAGM VALVE WITH AN ELASTOMER BACKING**. A metal stud is embedded in the elastomeric backing. This backing is generally made of EPM (ethylene propylene copolymer). It is a rubber-like compound. The sealing bead is Teflon™ faced.

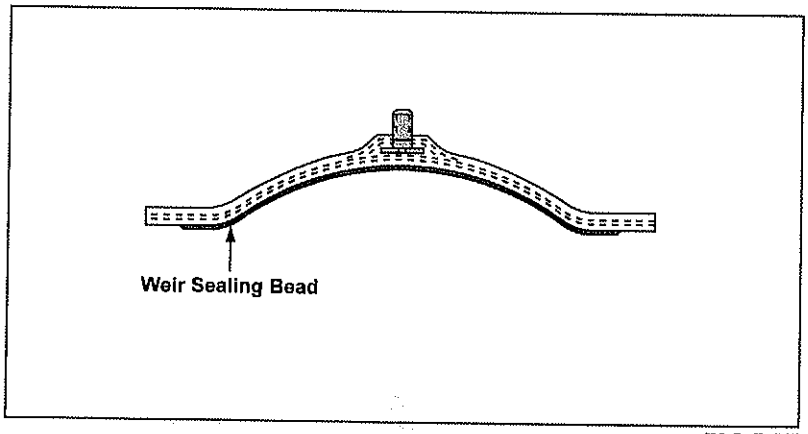
TEFLON™ FACED DIAPHRAGM VALVE WITH ELASTOMER BACKING



IV 3.5.16

An **ELASTOMER DIAPHRAGM VALVE** is shown in this illustration.

ELASTOMER DIAPHRAGM VALVE



IV 3.5.17

The closure member of the diaphragm valve is made of elastomer. This rubber-compound material is resilient and especially suited for heavy use.

Diaphragm Valves and End Connections

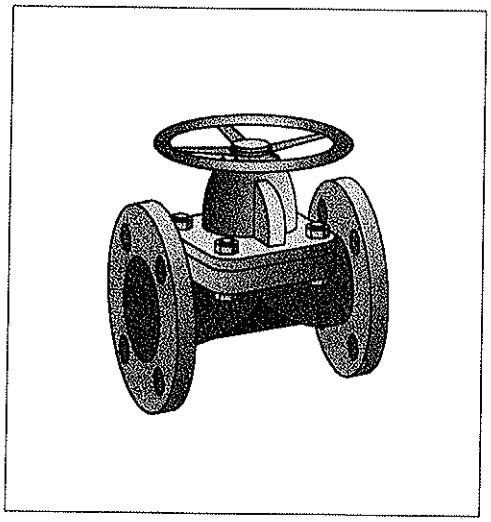
The type of end connection will generally depend on the valve size and valve material. Smaller diaphragm valves are available with flanged, threaded, socket weld and butt weld, and grooved end connections.

Diaphragm valves 3" (NPS 3) and larger are only available with flanged or grooved ends.

IRON DIAPHRAGM VALVES like the one illustrated are commonly supplied with flat faces. Steel and stainless steel diaphragm valve bodies may be supplied with flat or raised-face flanges.

The type of flange face will depend on the lining material. Rubber-lined (elastomer-lined) diaphragm valves are furnished with flat face flanges. Teflon™ lined valves are furnished with a type of raised-face flange.

IRON DIAPHRAGM VALVE



3.5.18

REVIEW QUIZ – MULTI-TURN VALVE DETAILS

Answers appear on page 72

DIRECTIONS: Carefully read each question and circle the correct answer. There is only one correct answer per question. When you have finished, check your answers.

1. Which bonnet design provides a tight bonnet joint because the sealing surfaces are not in rubbing contact and a ring reinforces the structure?
   a. Screwed bonnet
   b. Bolted bonnet
   c. Union bonnet
   d. U-bolt bonnet
2. The flat-faced joint is particularly suitable for iron valves which are used for
   a. higher temperature and lower pressure applications.
   b. lower temperature and higher pressure applications.
   c. lower temperature and lower pressure applications.
   d. higher temperature and higher pressure applications.
3. With the U-bolt bonnet design, what secures the bonnet to the body?
   a. U-shaped clamp
   b. U-bolt
   c. Union ring
   d. Retaining ring
4. What type of gate valve provides a visual view of the stem position to indicate the position of the wedge?
   a. Spherical disc
   b. Non-metallic disc
   c. Non-rising stem (NRS)
   d. Rising stem (RS)

REVIEW QUIZ – MULTI-TURN VALVE DETAILS

Answers appear on page 72

5. Which type of stem would be used for restricted overhead?
   a. Non-rising stem (NRS)
   b. Rising stem (RS)
   c. Plug disc
   d. Metallic disc
6. The design of the bonnet assembly for the diaphragm valve makes it
   a. suited for applications of slurries or liquids with large amounts of suspended solids.
   b. particularly suited to minimize pressure drop.
   c. interchangeable with a globe or gate valve.
   d. easy to replace the diaphragm when necessary.
7. What is the purpose of packing?
   a. Requires less maintenance because the stem only rotates with no vertical movement.
   b. Prevent flow media leakage in the stem area
   c. Prevent flow straight through the valve
   d. Provide a tight seal and closure of the valve
8. What type of globe valve disc has a tapered surface?
   a. Spherical disc
   b. Solid wedge disc
   c. Plug disc
   d. Double parallel wedge disc
9. What type of disc design is used in needle valves?
   a. Spherical disc
   b. Conical disc
   c. Plug disc
   d. Solid wedge disc

REVIEW QUIZ – MULTI-TURN VALVE DETAILS

Answers appear on page 72

10. The major types of closure members used on diaphragm valves include all of the following EXCEPT
    a. Teflon™
    b. CPVC
    c. Elastomer
    d. Elastomer with Teflon™

APPLYING WHAT YOU HAVE LEARNED:

By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.

A. List the types of closure members that your company recommends and sells.

_____

_____

_____

B. Based on your reading and general knowledge of valves, explain the applications for which the different closure members your company sells are best suited.

_____

_____

_____

ANSWERS TO REVIEW QUIZ

CHAPTER 3

MULTI-TURN VALVE DETAILS

Answers to Review Questions: Multi-turn Valve Details

1. c. Union bonnet
2. c. lower pressure and lower temperature applications.
3. b. U-bolt
4. a. Spherical disc
5. a. Non-rising stem (NRS)
6. d. easy to replace the diaphragm when necessary.
7. b. Prevent flow media leakage in the stem area
8. c. Plug disc
9. b. Conical disc
10. b. CPVC

APPLYING WHAT YOU HAVE LEARNED:

A. Answers will vary by company.

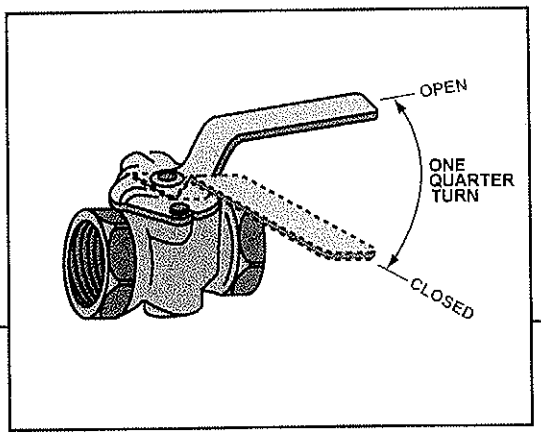
B. Answers will vary by company.

4 QUARTER-TURN VALVE OVERVIEW

LEARNING OBJECTIVES

When you successfully complete this chapter, you will be able to:

1. Identify and compare the different types of quarter-turn valves.
2. Explain the function of floating ball and trunnion ball valves.
3. Compare the three types of butterfly bodies.
4. Identify the type of closure member of a butterfly valve.
5. Describe how a butterfly valve differs from a comparable gate valve.
6. Identify the two basic types of plug valves and name three different types of closing elements on plug shapes.
7. Describe the three closure member designs for quarter-turn valves.
8. Explain why quarter-turn valves have lower temperature limits than multi-turn valves.



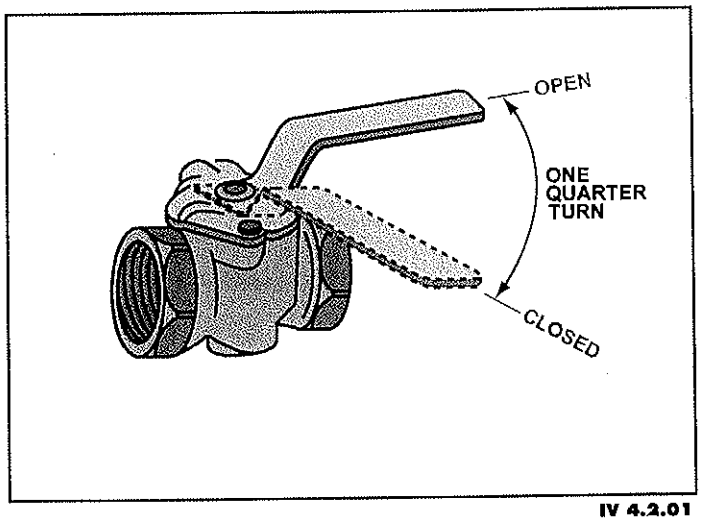
QUARTER-TURN VALVE OVERVIEW

QUARTER-TURN VALVES

As you learned earlier, quarter-turn valves get their name from the way they operate. These valves open and close by a 90 degree rotation or one-quarter of a circle. The common types of quarter-turn valves are the ball valve, the butterfly valve, and the plug valve. The conditions under which the valve is expected to perform must be understood before selecting a valve for a specific application. Proper valve selection depends on the medium to be controlled, material used in the pipe, and the pipe design.

Quarter-turn valves open and close by a 90-degree rotation, or one-quarter of a full circle. The position of the handle or indicator mark at the top of the valve shows whether the valve is opened or closed (see illustration).

QUARTER-TURN VALVE SHOWING OPEN AND CLOSED POSITIONS



IV 4.2.01

Ball Valves

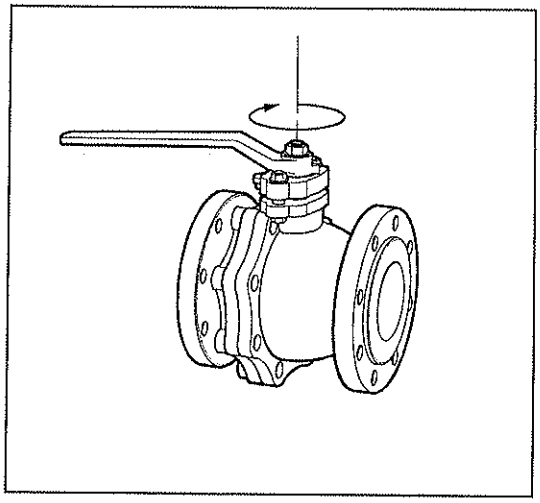
The **BALL VALVE** is one of the more common quarter-turn valves. A ball valve opens by turning a handle attached to a ball inside the valve. The ball has a hole, or port, through the middle so that when the port is in line with both ends of the valve, flow will occur. When the valve is closed, the hole is perpendicular to the ends of the valve, and flow is blocked. The handle position lets you "see" the valve position.

Ball valves are a significant part of the valve designs in use today. Two important types of ball valves are the **TRUNNION BALL VALVE** and the **FLOATING BALL VALVE**. Both valves are designed for flow control and isolation or shutoff, but their construction is very different.

In the **FLOATING BALL VALVE** design, the ball inside the valve is compressed between two or more valve seats. The valve seats are what provide the sealing mechanism. In a floating-ball design the ball is resting or "floating" on the seats and a stem is attached to the top of the ball only, which is operated by the handle.

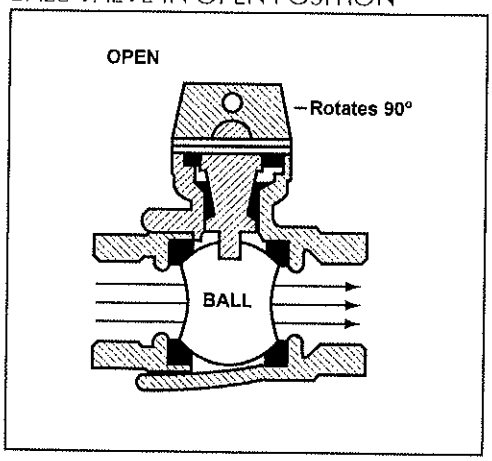
In floating ball valves, line pressure provides a seat seal by forcing the ball against the seats. Therefore in the closed position, the port opening is perpendicular to flow allowing upstream pressure to "float" the ball into the downstream seat which assures positive shutoff and high performance (see illustrations).

FLOATING BALL VALVE



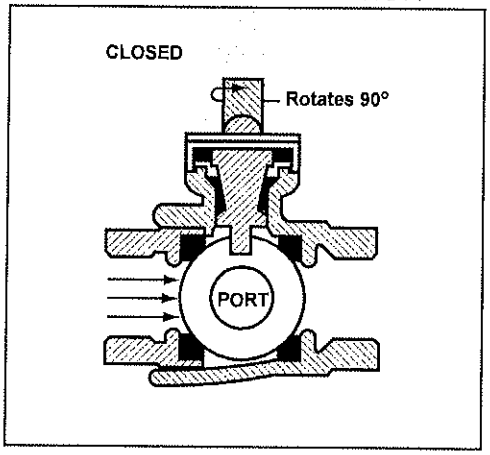
IV 1.4.26

BALL VALVE IN OPEN POSITION



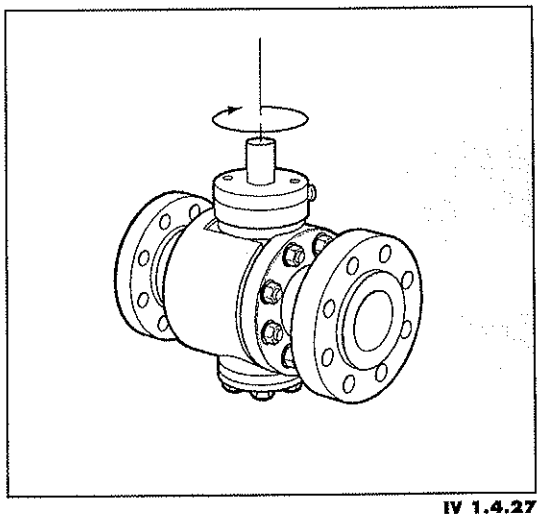
IV 4.4.02

BALL VALVE IN CLOSED POSITION



IV 4.4.03

TRUNNION BALL VALVE

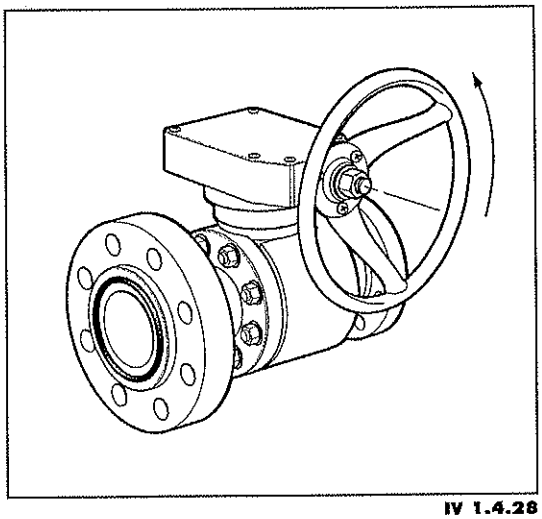


IV 1.4.27

Similarly to the floating-ball design, in a **TRUNNION BALL VALVE** design the ball inside the valve is compressed between two or more valve seats. But the ball is held in place and rotates on an axis. This axis is formed by the valve stem at the top and the trunnion assembly located at the bottom of the valve, which is what the ball rests on. The trunnion style of mounting the disc or ball on the valve shaft or stub shaft with two bushings diametrically opposed is the main difference to the floating-ball design.

Most trunnions provide a rugged design and therefore are often used in larger diameter applications and can most commonly be found in a flanged end connection. The floating ball valve design can be in many different small to large diameter valve applications and can come in a wide variety of end connections. As mentioned, ball valves can be used to service a variety of applications and therefore can be prepared for special services such as chlorine, oxygen, high vacuum, and more. Also ball valves can be 'built to' and carry a wide range of industry standards and certifications such as NACE, UL CSA, NSF, API, MSSP, UPC and FM.

TRUNNION BALL VALVE

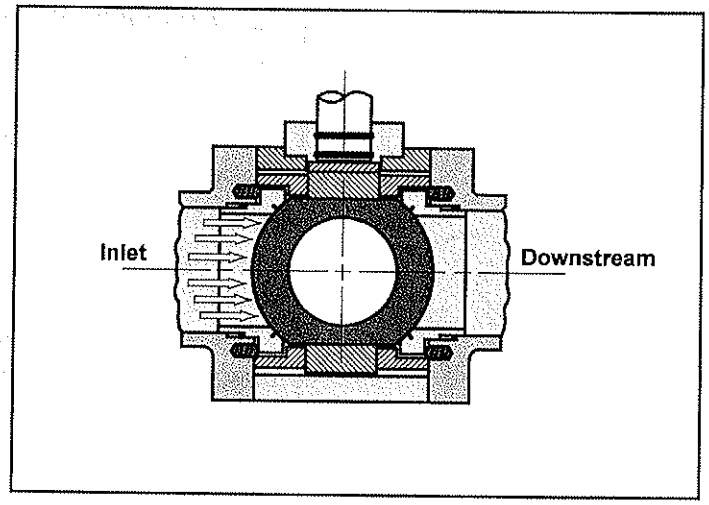


IV 1.4.28

Moving parts inside a ball valve are the ball and stem. They rely on seats and seals for their sealing qualities in the valve seating area and on the stem. Unlike the plug valve, a ball valve needs no lubrication. The ball rotates between the two seats. Seating material is typically Teflon™ but can come in a variety of other materials that can change or enhance the valves pressure-temperature performance.

Some advantages of ball valves include ease of operation, high flow capacity, high pressure/temperature capabilities, and ability to service many different types of applications.

BALL VALVE IN CLOSED POSITION

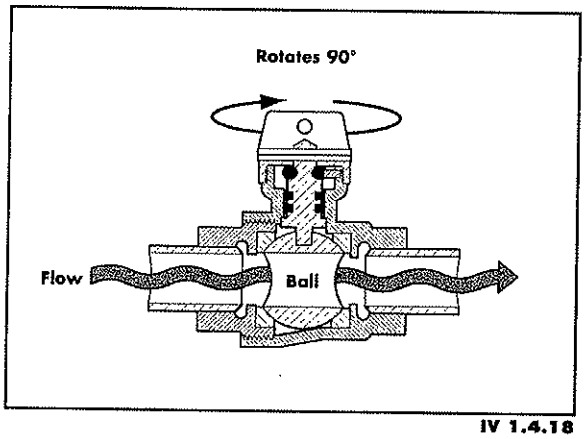


Ball valves are durable and usually work to achieve perfect shutoff even after years of disuse. They are therefore an excellent choice for shutoff applications (and are often preferred to globe valves and gate valves for this purpose). They do not offer the fine control that may be necessary in throttling applications. Note that special designs such as a "V-Ball" valve alter the port opening and provides better regulation of flow.

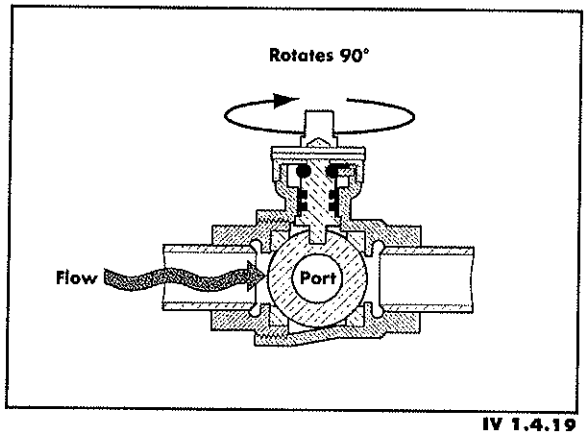
The ball valve operates similar to the plug valve. A quarter turn opens or closes the valve. A port in the ball allows fluid to flow through the valve. In the close position, the port is oriented perpendicular with the flow, allowing pressure to "float" the ball into the downstream seat.

In the next couple of images you can see two inside views of ball valves. The illustration on the left shows an open valve. The illustration on the right shows a valve blocking fluid flow.

BALL VALVE OPEN



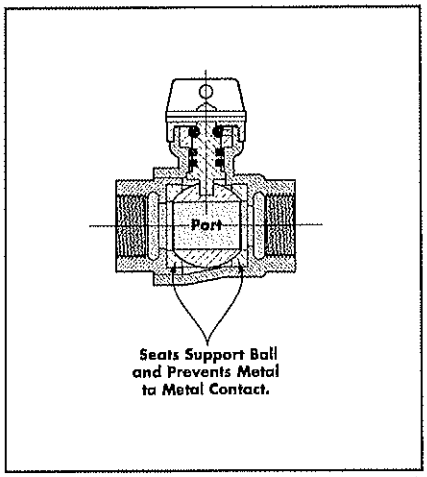
BALL VALVE CLOSED



The image on the right provides a closer view of the ball. The ball rests between two seats. The seats provide tight seals when the valve is closed. The seats are generally made of a plastic or elastic material.

Because of the temperature limitations of the non-metallic ball seat material, these valves are not recommended for very high temperatures. However, ball valves can come with a wide variety of seat materials, such as PEEK, Graphite, Derlin, and different grades of Teflon™ that can allow the valve to be operated in high temperature applications such as steam.

CLOSE-UP OF A BALL VALVE AND PORT



IV 1.4.20

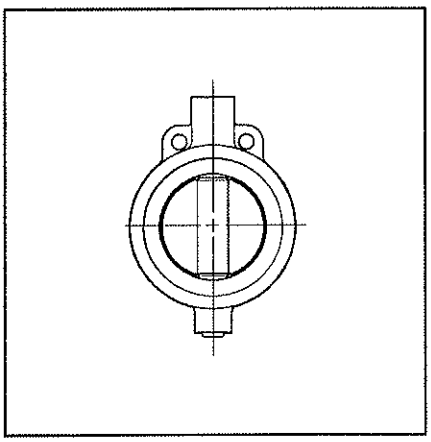
Note: Advances in seat technology and use of metal-seated valves have enhanced the technology considerably.

Ball valves are a significant part of the valve designs in use today. Ball valves provide positive sealing despite fluctuations across the entire body pressure and temperature rating of the valve. The size of the port opening in the ball can affect pressure drops across a valve as well as the valve's overall pressure rating. Full port valve are typically the most common valve offered because they provide the maximum flow and the least amount of pressure drop. Yet standard or reduced port valves can many times increase the maximum pressure rating of the valve which is sometimes necessary in some industrial applications

Butterfly Valves

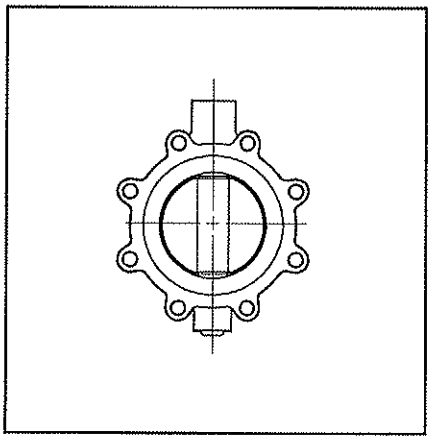
Another common quarter-turn valve is the **BUTTERFLY VALVE** (see illustrations). These valves are used for on/off and throttling purposes. The butterfly valve has a very distinctive shape which makes it easy to recognize. The "butterfly" is a metal disc mounted on a rod. When the valve is closed, the disc is turned so that it completely blocks off the passageway. When the valve is open, the disc is rotated a quarter turn to allow unrestricted passage. The position of the disc is effected from outside the valve.

BUTTERFLY VALVE



IV 1.4.29

BUTTERFLY VALVE WITH A LUG WAFER BODY

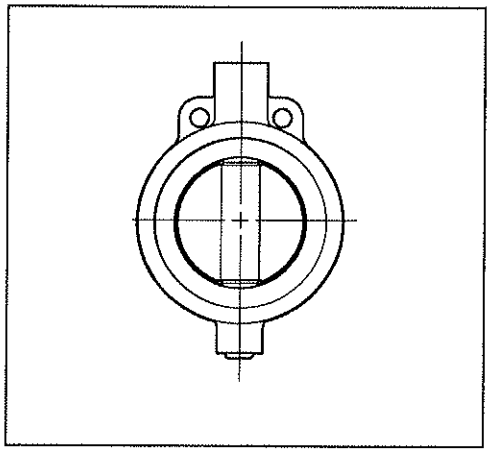


IV 1.4.30

Types of Butterfly Bodies

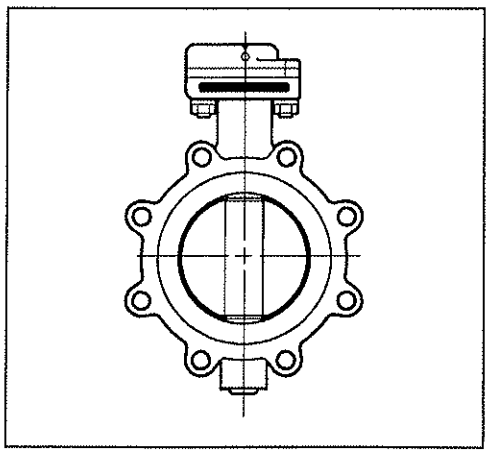
There are three different kinds of butterfly bodies: wafer style, lug style and grooved style. Each is adapted for different pressures and different usage. The **WAFER TYPE BUTTERFLY VALVE** is less expensive than the **LUG STYLE** and **GROOVED STYLE** but the lug style is more commonly used. Wafer style and lug style valves are typically installed between two flanges using bolts or studs and nuts. While the grooved end style is installed using grooved end couplings. The valve shown in the **WAFER TYPE BUTTERFLY VALVE** illustration has a wafer body.

WAFER TYPE BUTTERFLY VALVE



IV 4.4.31

LUG WAFER BUTTERFLY VALVE



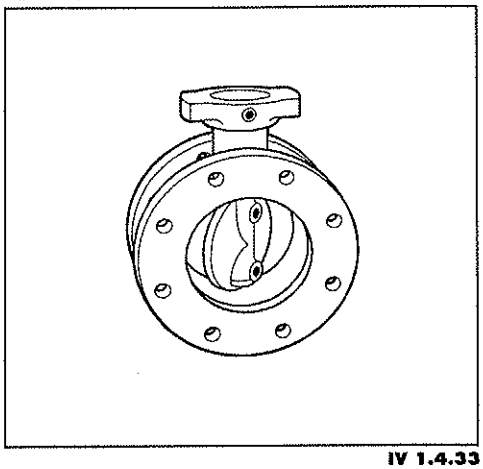
IV 1.4.32

The butterfly valve shown illustrated is a **LUGGED TYPE** or **FULL LUG STYLE BUTTERFLY VALVE**. Lug style valves have integral tapped bolt holes. The valve body is tapped on both sides allowing them to be installed into a system using two sets of bolts and no nuts. The valve is installed between two flanges using a separate set of bolts for each flange. This setup permits either side of the piping system to be disconnected without disturbing the other side. Lug Butterfly valves can also be installed for "dead-end service" where they are mounted on the end of a flanged pipe and act as a drain valve holding back flow.

As you will see in the next section, the difference between these two valve bodies is in the design of the outer diameter or rim of the valve body.

A **FLANGED BUTTERFLY VALVE** shown in the illustration is used in all sizes of valves.

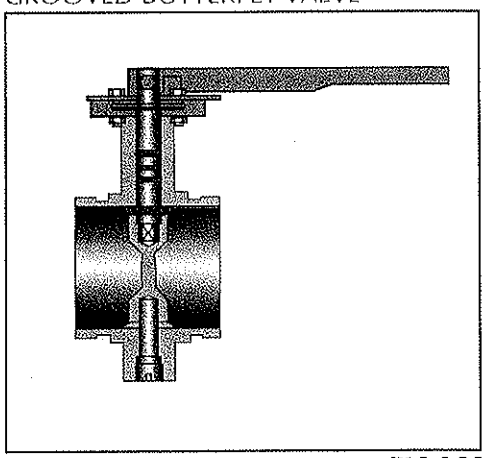
FLANGED BUTTERFLY VALVE



IV 1.4.33

GROOVED BUTTERFLY VALVES are ideally suited for use in mechanical rooms, process lines, condenser water lines, demineralized water lines, and chilled and hot water lines. The valve provides for efficient control of on/off or throttling/balancing service, fluid flow, and "bubble tight" shut-off in piping systems. Bubble tight is when no bubbles penetrate the closed valve, for a defined amount of time. Their rugged ductile iron body is epoxy coated on all wetted surfaces and all surfaces exposed to the atmosphere. This provides both internal and external corrosion protection.

GROOVED BUTTERFLY VALVE



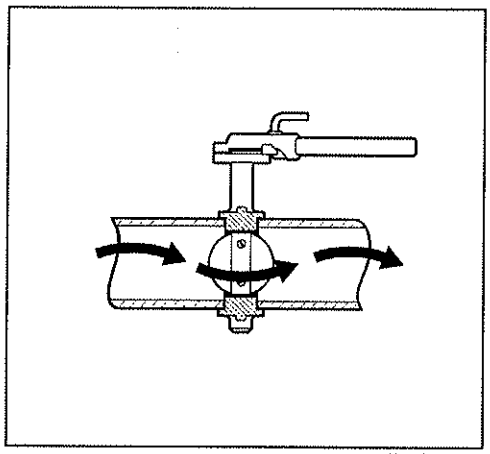
IV 1.4.36

Butterfly Valve Operation

Butterfly valves are used in every facet of fluid control. Their light-weight, positive shutoff, and ease of operation make them the valve of choice for applications that involve low to medium pressure and temperature.

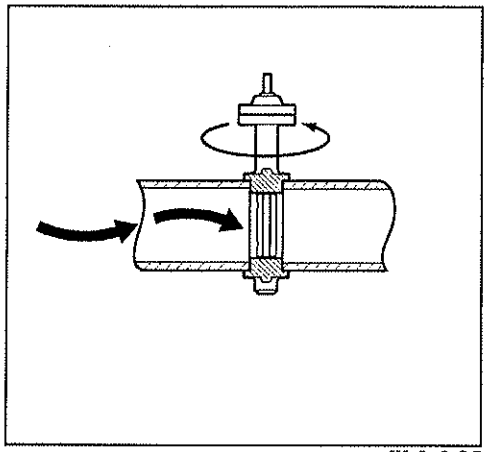
The next couple of illustrations are views of a butterfly valve in operation. Butterfly valves have a circular disc for the closure member. The disc is attached to a stem. When the valve is operated by turning the stem, the disc pivots or turns on the stem axis.

BUTTERFLY VALVE OPEN SHOWING CIRCULAR DISC



IV 1.4.34

BUTTERFLY VALVE CLOSED



IV 1.4.35

This valve is particularly suited for handling fluids at low pressures and throttling services. The design of the valve allows the disc to make a 90-degree rotation. When fully open the valve disc profile obstructs flow.

Butterfly valves may be rubber-lined or high performance. High-performance butterfly valves handle an extremely wide range of media, including liquids, slurries, petroleum products, acids, caustics, air, water and steam. Butterfly valves are built with a flexible lip seating system, which allows bi-directional flow and a tight shutoff.

Butterfly valves may be the best choice when installation costs are important. Let's compare butterfly valves and gate valves, and assume the need is not for throttling, but for on/off services. On the next page you can see size and dimension charts for butterfly valves and gate valves.

An advantage the butterfly valve has over a comparable gate valve is its end-to-end measurement and lower weight. The two tables that follow compare the specifications for a 3" butterfly valve and a 3" gate valve. The first table shows that the butterfly valve weighs 9 pounds and has an end-to-end measurement of 1.82 inches. The gate valve weighs 65 pounds and has an end-to-end measurement of 8.0 inches.

Please note that the weights presented in the tables are approximate and vary by manufacturer. The ones included in the table are used to highlight the difference between the two valves.

BUTTERFLY (IN INCHES)

Size (inches)	Weight (lbs.)	A	B	C
2	6	5.40	1.64	2.50
3	9	6.24	1.82	2.50
4	17	7.00	2.07	2.62
6	23	8.32	2.20	2.75
8	37	10.24	2.39	3.25
10	58	11.50	2.70	3.50
12	95	13.00	3.07	3.62

GATE (IN INCHES)

Size (inches)	Weight (lbs.)	A	B	C
2	34	7	11.75	7.00
3	65	8	14.75	8.00
4	102	10	18.00	9.00
6	185	12	22.50	10.50
8	311	14	27.50	11.50
10	475	16	32.25	13.00
12	685	18	36.00	14.00

EXAMPLE:

Your customer needs a 10" valve for on/off purposes. You find that a gate valve or a butterfly valve will provide the best service for your customer's application. However, it is important that the valve not weigh over 200 pounds and that it not measure more than 20" end-to-end. Using the tables, which valve would you recommend?

The correct answer is the 10" butterfly valve because the weight for the gate valve exceeds 200 pounds.

Double and Triple Offset Options

Double and triple offset option for the butterfly valve is growing in popularity specifically when the design requires high performance.

The **DOUBLE ECCENTRIC (OFFSET) DESIGN** uses a different type of material for the seat and the disc and features a slight offset in the way the disc is positioned, which increases the valve's sealing ability and decreases its tendency to wear.

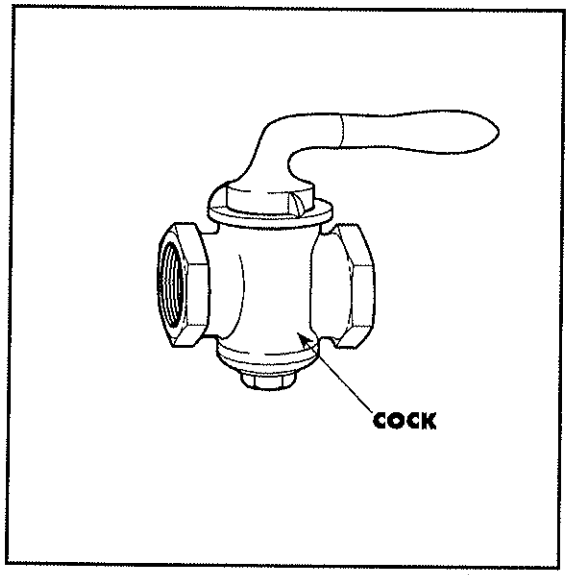
TRIPLE ECCENTRIC (OFFSET) DESIGN prevents galling and scratches between the metal seat and the metal disc due to its unique design. The only time where the disc comes into contact with the seat is at the point of complete closure. Triple offset butterfly valves are generally used in applications which require bi-directional tight shut-off in oil and gas, LNG/NPG terminal and tanks, chemical factories, and shipbuilding. They are also used for dirty/heavy oil to prevent extrusion.

Plug Valve

The **PLUG VALVE** is generally used for on/off service. Special designs are capable of throttling service. It controls flow by means of a cylindrical or tapered plug with a hole in the center that lines up with the flow path of the valve to permit flow. A quarter turn blocks the flow path.

The plug cock you saw in Chapter 1 was made of wood. Today's industrial plug valves are generally made of metal, and some are still called cocks. This valve, too, is named after the type of closure member it has (see illustration).

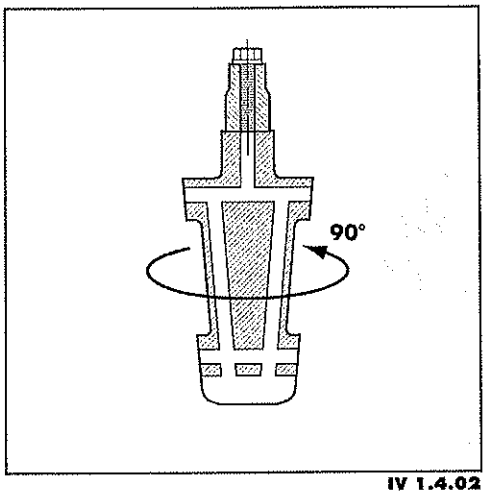
PLUG VALVE



IV 1.4.01

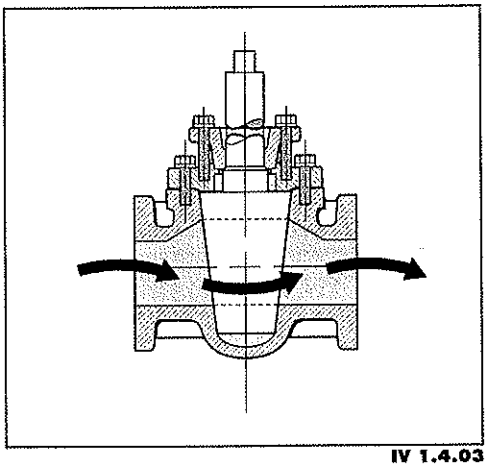
The next image shows an inside view of a plug valve. The closure member is called a **PLUG**. By rotating the plug in the valve body, you can start or stop flow through the valve.

INSIDE VIEW OF A PLUG VALVE WITH 90-DEGREE COUNTERCLOCKWISE ARROW



IV 1.4.02

CLOSE-UP VIEW OF THE PLUG IN AN OPEN POSITION WITH FLOW

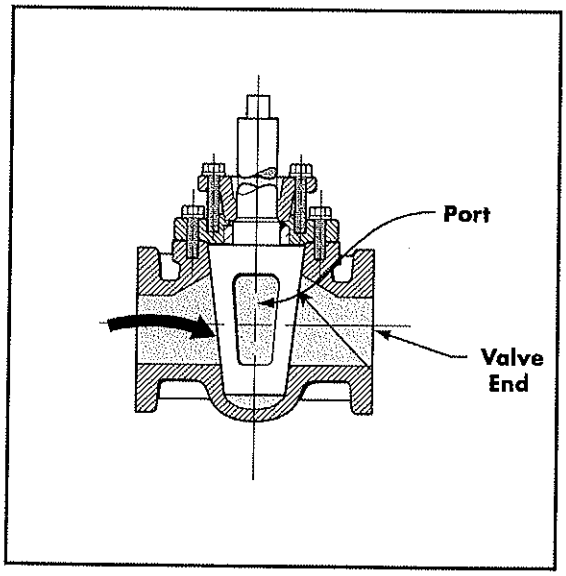


IV 1.4.03

This illustration provides a closer view of the plug. The hole in the plug is called the **PORT**. When the valve is on or open, the port openings face the valve ends.

When the valve is off or closed the port openings face the inside walls of the valve body (see illustration). The position of the plug stops flow through the valve.

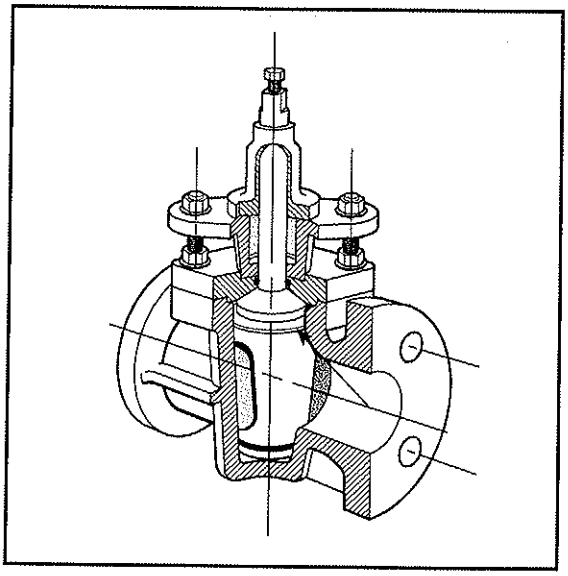
CLOSE-UP VIEW OF THE PLUG IN A CLOSED POSITION WITH LABELS



IV 1.4.04

The next image illustrates the view of the plug when the valve is closed.

CLOSE-UP SECTIONAL VIEW OF A PLUG VALVE

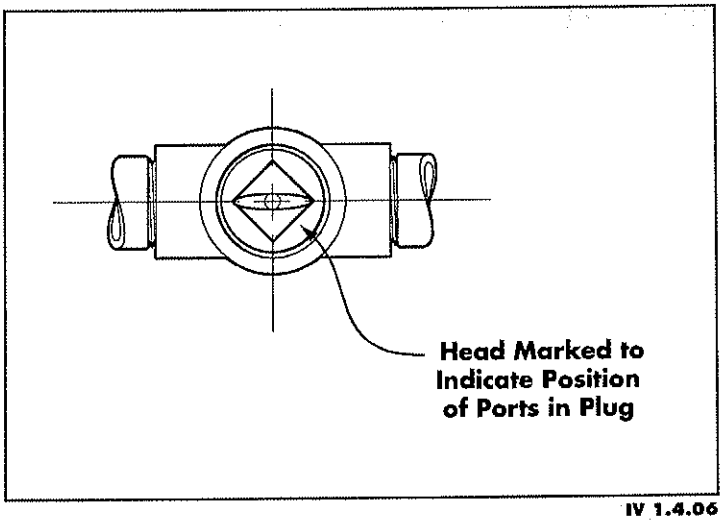


IV 1.4.05

Many plug valves have an indicator at the top of the valve body to show whether the valve is open or closed.

In the illustration the marking on the top of the plug stem indicates the direction the port openings are facing.

TOP VIEW OF A PLUG VALVE DEPICTING THE HEAD MARK INDICATION



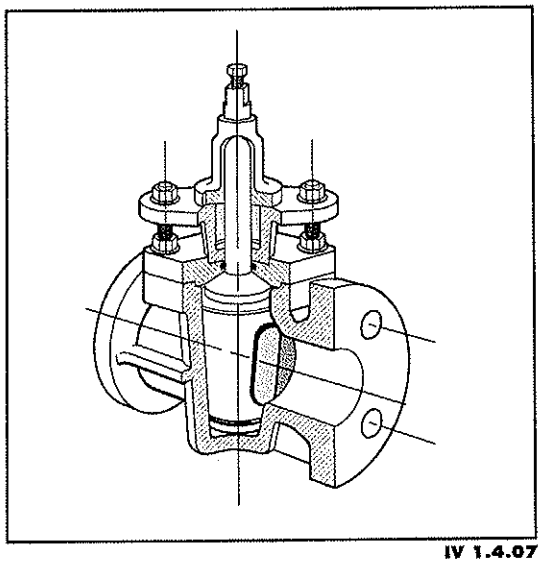
IV 1.4.06

Basic Types of Plug Valves

There are two basic types of plug valves: lubricated and non-lubricated (see upcoming illustrations).

LUBRICATED PLUG VALVES require a lubricant between the plug and the valve body walls. Lubricated plug valves are used in applications where the lubricant will not contaminate the process. Mining, gas, and petroleum are typical applications.

LUBRICATED PLUG VALVE



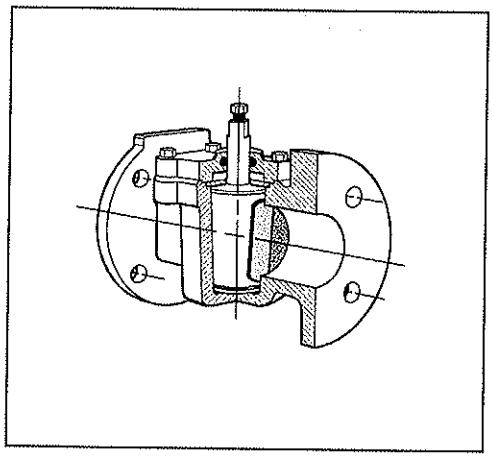
IV 1.4.07

Parallel plug valves use lubricant as sealant, which can be added to increase sealing capability. Taper plug valves depend on lubricant to allow movement and the metal seat to provide sealing.

NON-LUBRICATED PLUG VALVES are used in chemical and process services. The plug rides in a PTFE sleeve or liner. Several types of non-lubricated plug valves are made:

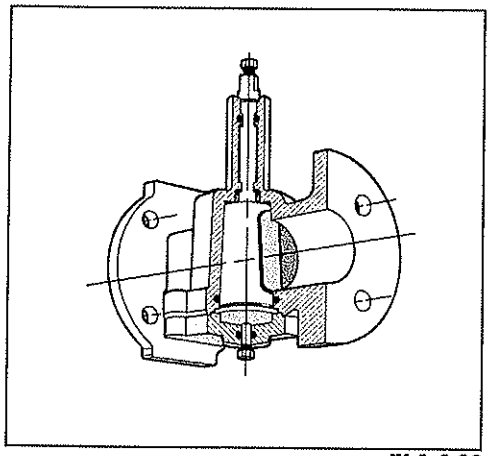
- Eccentric plug type
- Sleeve type
- Lift type

NON-LUBRICATED PLUG VALVE



IV 1.4.08

NON-LUBRICATED PLUG VALVE WITH A TEFLON SLEEVE



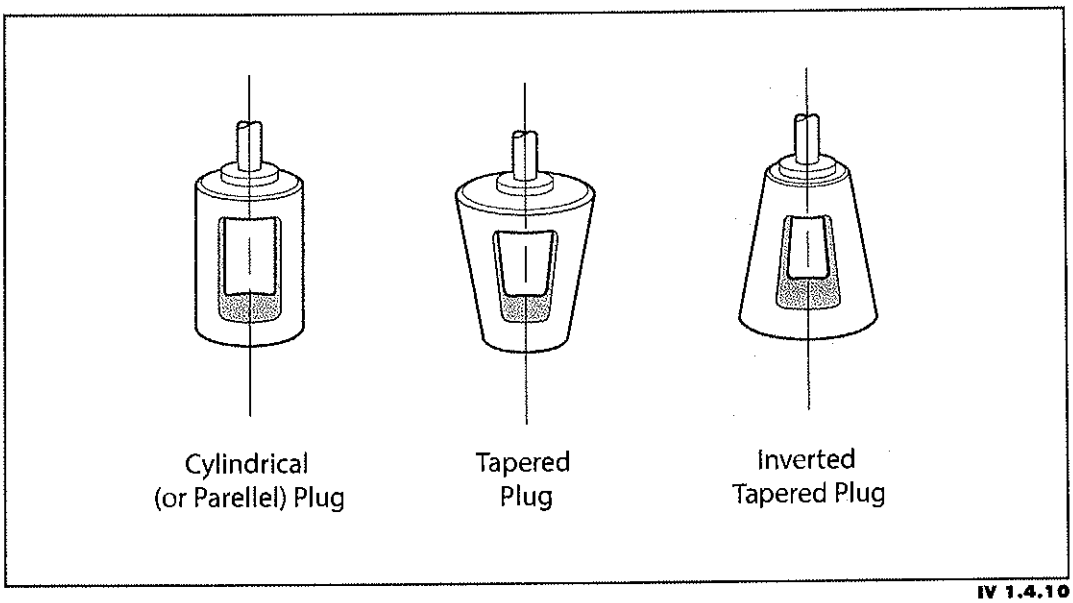
IV 1.4.09

Non-lubricated plug valves often use plastic sleeves. This illustration shows a sleeve type. It has a plastic sleeve surrounding the plug. A common type of plastic material used for the sleeve material is called **TFE (TETROFLUROETHELENE)**, more commonly known as Teflon™.

Plug Shapes

Plugs come in three different shapes, which are shown in the illustration: cylindrical, tapered, and inverted tapered.

PLUG SHAPES



IV 1.4.10

Valve Materials

Quarter-turn valves are available in the same materials as multi-turn valves: bronze, brass, cast iron, ductile iron, carbon steel, stainless steel, and thermoplastics. These materials tend to be economical and compatible with most water-based media; however, you should refer to a corrosion resistance chart if the medium is a corrosive chemical. Most quarter-turn valves use special non-metallic materials for the valve seats, such as Teflon™ or elastomeric compounds.

An elastomer is any type of polymer that has rubber-like properties. An **ELASTOMERIC COMPOUND**, consisting of a base polymer and other ingredients, is basically rubber that is designed to meet specific functional requirements. Teflon™ (plastic) or elastomeric (rubber-like) compounds will typically be the valve's limiting factor in a high temperature service application.

REVIEW QUIZ – QUARTER-TURN VALVE OVERVIEW

Answers appear on page 94

DIRECTIONS: Carefully read each question and circle the correct answer. There is only one correct answer per question. When you have finished, check your answers.

1. How far must you turn a plug valve to fully open or close the valve?
   a. 25 degrees or a quarter turn
   b. 50 degrees or a half turn
   c. 90 degrees or a quarter turn
   d. 100 degrees or a full turn

2. Which of the following is the main purpose of the trunnion ball flanged valve design?
   a. Maximum flow capacity
   b. High performance
   c. Positive shutoff
   d. Unobstructed pipeline flow

3. Which type of valve uses a TFE or Teflon™ sleeve?
   a. Ball valve
   b. Gate valve
   c. Lubricated plug valve
   d. Non-lubricated plug valve

4. How can you tell whether a valve is opened or closed?
   a. By the position of the indicator mark at the top of the valve
   b. By the position of the indicator mark at the bottom of the valve
   c. By the way the port openings face the inside walls of the valve body
   d. By the way the port openings face the valve end

REVIEW QUIZ – QUARTER-TURN VALVE OVERVIEW

Answers appear on page 94

5. What is the purpose of using a venturi port plug valve?
   a. To compress the flexible diaphragm against the seat
   b. To provide closure or throttling control
   c. To provide a plug valve shutoff at a low valve price
   d. To allow fluid to flow through the valve
6. To which valve category does the plug valve belong?
   a. Multi-turn
   b. Quarter-turn
   c. Check
   d. Specialty
7. All of the following are closing elements on plug valves EXCEPT
   a. Tapered
   b. Inverted tapered
   c. Cylindrical
   d. Horizontal
8. The butterfly valve may be used for
   a. compressing the flexible diaphragm against the seat.
   b. providing directional flow.
   c. blocking the flow passage.
   d. on/off and throttling services.
9. Which of the following valves permit either side of a piping system to be disconnected?
   a. Ball valve
   b. Short-pattern plug valve
   c. Flanged-lugged butterfly valve
   d. Venturi pattern plug valve

REVIEW QUIZ – QUARTER-TURN VALVE OVERVIEW

Answers appear on page 94

10. Which of the following is a possible disadvantage of a ball valve?
    a. The valve's greater weight requires more material to make the valve
    b. Reduced flow results in a loss of pressure
    c. A lubricant must be used between the plug and valve body walls
    d. The seat material may have temperature limitations

APPLYING WHAT YOU HAVE LEARNED:

By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.

A. Give at least two uses for plug valve.

_____

_____

_____

B. Based on your reading and general knowledge of valves, explain why it might be difficult to select the proper plug valve for a project.

_____

_____

_____

ANSWERS TO REVIEW QUIZ

CHAPTER 4

QUARTER-TURN VALVE OVERVIEW

Answers to Review Questions: Quarter-turn Valve Overview

1. c. 90 degrees or a quarter turn
2. a. Maximum flow capacity
3. d. Non-lubricated plug valve
4. a. By the position of the indicator mark at the top of the valve
5. c. To provide a plug valve shutoff at a low valve price
6. b. Quarter-turn
7. d. Horizontal
8. d. On/off and throttling services.
9. c. Flanged-lugged butterfly valve
10. d. The seat material may have temperature limitations

APPLYING WHAT YOU HAVE LEARNED:

A. Answers may vary but could include that plug valves are used for fluid control for industrial and municipal processing facilities worldwide. They are used in many slurry, sludge, and liquid handling services.

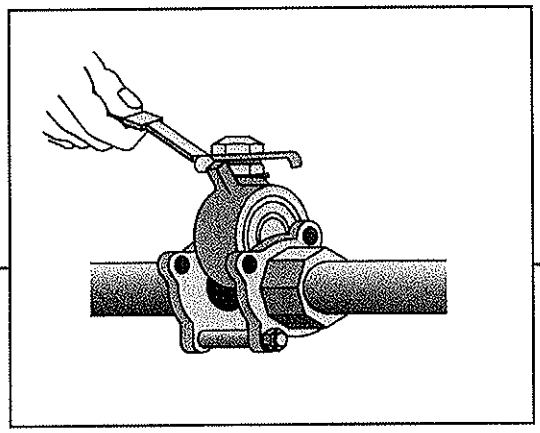
B. Answers may vary could include that selecting the correct design and materials of construction when abrasive, corrosive, scale, or plugging prone conditions prevail is complicated by unknown or changing process conditions.

5 QUARTER-TURN VALVE DETAILS

LEARNING OBJECTIVES

When you successfully complete this chapter, you will be able to:

1. Identify the major parts of a ball valve.
2. Describe the different ball valve port patterns, valve entry-designs.
3. Compare the variations in handle designs and identify when they are used.
4. Identify the different types of butterfly valves and when they are used.
5. Explain flow regulation for butterfly valves.
6. Describe actuator selection principles.
7. Identify pressure-temperature ratings for plug, ball, and butterfly valves.
8. Discuss the difference between lubricated and non-lubricated plug valves.
9. Describe the port patterns for lubricated plug valves.
10. Compare and contrast the different types of non-lubricated plug valves.



QUARTER-TURN VALVE DETAILS

Quarter-turn Valves

In this chapter, we expand on what you learned in Chapter 4 with more details about each of the three valve types: the ball valve, the butterfly valve, and the plug valve. The conditions under which the valve is expected to perform must be understood before selecting the right for the specific application. Proper valve selection depends on the media to be controlled, material used in the pipe, and the pipe design.

Quarter-turn valves open and close by a 90-degree rotation, or one-quarter of a full circle. The position of the handle or indicator mark at the top of the valve shows whether the valve is opened or closed.

Ball Valve End Connection Types

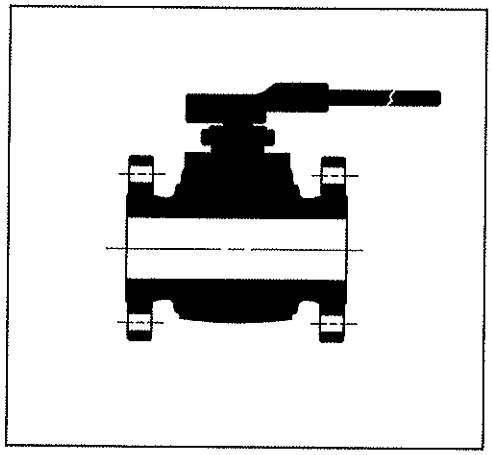
Ball valves also come in a number of joint types. The joint connection is sometimes specific to the application industry that the valve is being used in. The end connection is primarily dictated by the type of piping and pipe connections being used in a system. End connections conform to national and international standards allowing for a uniform fit across industries and manufacturers. Ball valve end connections include FPT (female thread), MPT (male thread), solder (copper or CXC), socket, weld, flanged, union, compression, and PEX (barb and grooved).

Port Openings in Ball Valves

Like plug valves, ball valves are also available in different port sizes. While manufacturers may use different names to describe the port size, it is important to understand that the smaller the port opening the greater the reduction of flow through the valve.

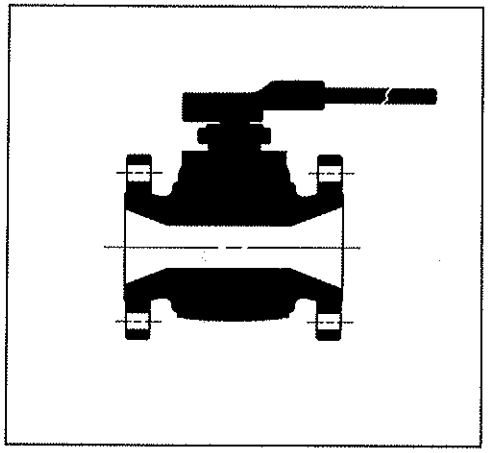
There are three types of port openings in ball valves: full (100%), conventional or regular (75%), and reduced (62%). You can see an inside view of the full port and the conventional port patterns in the next couple of images.

FULL PORT BALL VALVE



IV 1.4.21

CONVENTIONAL PORT BALL VALVE



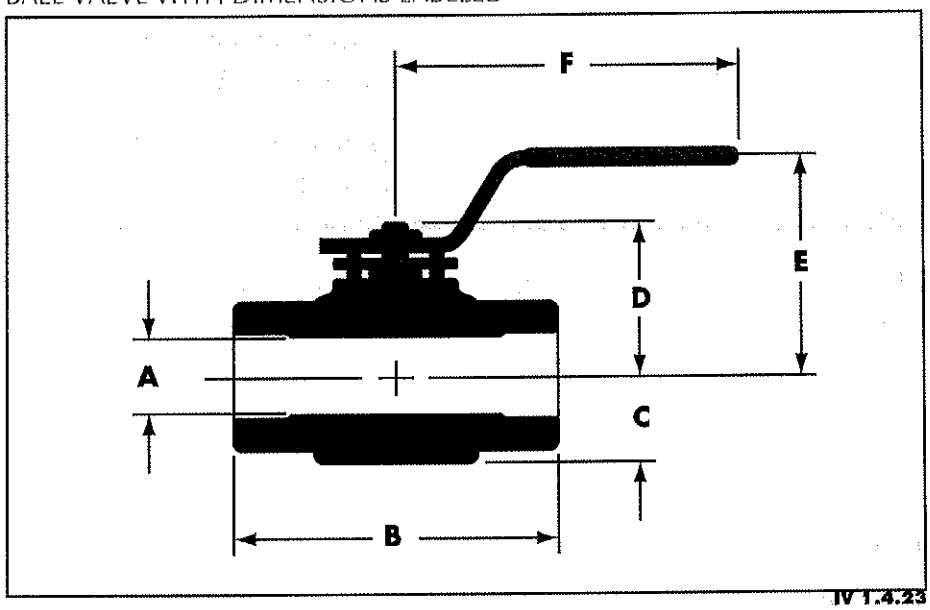
IV 1.4.22

The full port design provides for a larger bore through the ball. In the full port pattern, the inside diameter of the bore is equal to the inside diameter of the pipe.

The conventional and reduced port patterns have a smaller bore inside diameter than the inside diameter of the pipe. The reduced and conventional port patterns restrict flow which creates a pressure drop through the valve more than the full port pattern.

The next image illustrates one type of ball valve. The table identifies the valve dimensions for this valve with a full port or with a regular port. Dimension A gives you the inside diameter of the ball port.

BALL VALVE WITH DIMENSIONS LABELED



VALVE DIMENSIONS (IN INCHES)

Size	A	B	C	D	E	F
1/2	3/8	5-1/2	5/8	1-3/8	2-3/4	4-1/4
3/4	1/2	6	3/4	1-3/4	3-1/2	5-3/4
1-1/4	1	7	1-1/4	2-7/8	4-1/8	7
1-1/2	1-1/4	7-1/2	1-1/2	3	4-1/8	7

TABLE 5.1 VALVE DIMENSIONS (IN INCHES)

Please note that the weights presented in the table are approximate and vary by manufacturer. The ones included in the table are used to highlight the difference between the two.

Special Services

Ball valves are also made for special services such as fire safety, safety exhaust, oxygen, and chlorine.

Fire-safe ball valves have backup metal seats that allow them to be opened or closed one time after a fire. Safety exhaust ball valves are used to relieve pressure in process equipment and are designed to meet OSHA standards.

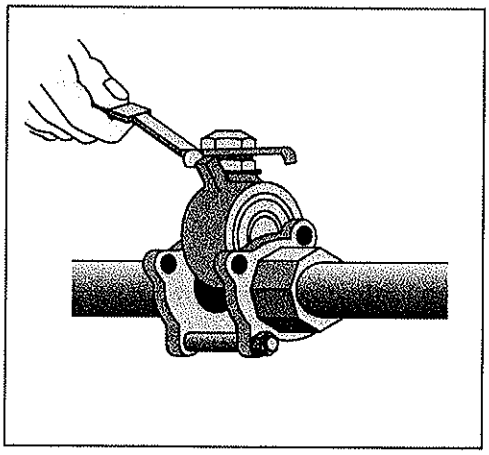
Ball valves made for oxygen service are specially prepared. These valves are carefully cleaned and degreased at the factory. The valves are then packaged in a clean manner— usually in a plastic bag—to prevent contamination.

Check your manufacturer's literature for the special service ball valves your firm sells.

Ball Valve Handles

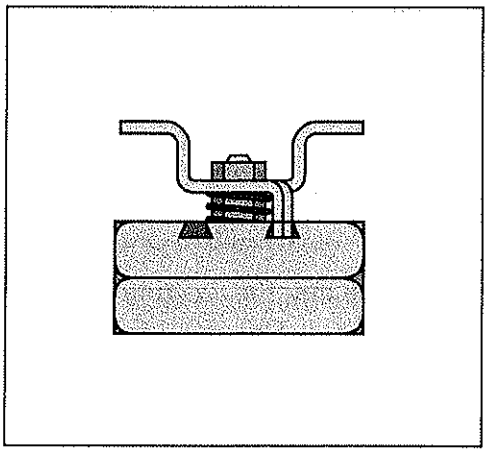
You will also find a variety of handles in ball valves (see the next four images). Each type of handle is used for specific purposes. A **T HANDLE** or **ROUND HANDLE** is used for safety purposes. Valve handles can also be self-locking or adapt to locking accessories to provide extra security.

THREE-PIECE BALL VALVE



IV 4.4.14

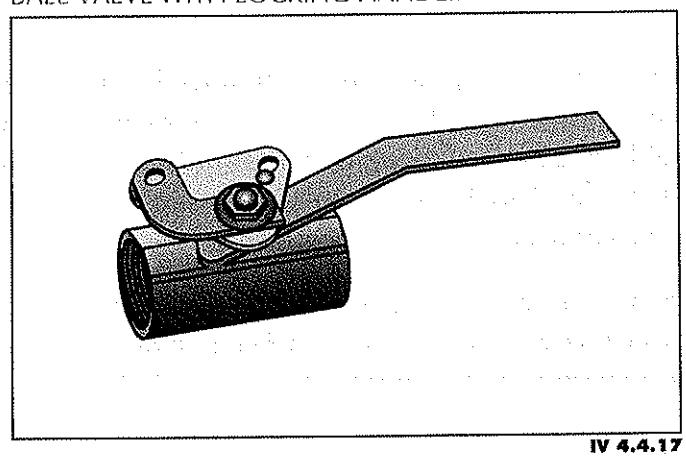
BALL VALVE WITH T HANDLE



IV 4.4.15

T-handle or round handle designs limit accidental dislodging or moving of the handle. In some process applications, accidental movement of the handle could be dangerous. The only disadvantage of the round handle is that you cannot determine visually whether the valve is open or closed.

BALL VALVE WITH LOCKING HANDLE

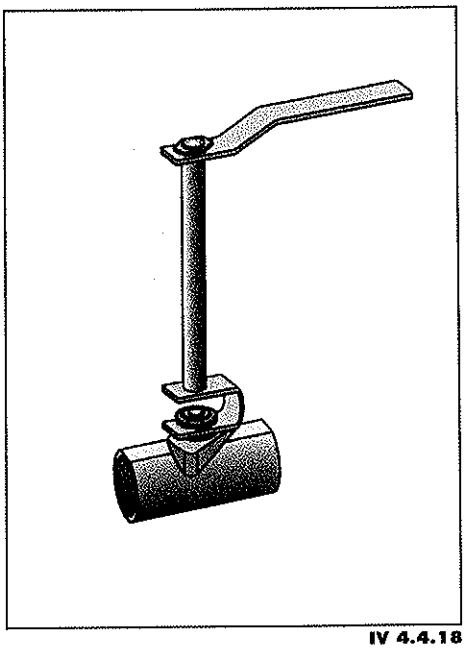


IV 4.4.17

Locking handles is used to let an operator know that the valve must not be tampered with.

Ball valves may also have extended stems. **STEM EXTENSIONS** are used in services where piping is insulated or located in a position where accessibility is difficult, such as in an underground pit. The piping may be insulated to prevent heat loss or to prevent a chilled water line from temperature loss. The insulation may be applied around the valve up to the handle. The valve handle can still be used but the valve remains insulated.

BALL VALVE WITH STEM EXTENSION



IV 4.4.18

Pressure-Temperature Ratings

Pressure-temperature ratings are the maximum allowable working pressures at specified temperatures. For steel valves, the ratings are defined by classes and found in ASME B16.34. Each class number is further identified as Standard, Special, or Limited Class. For iron, steel, bronze and brass valves, the ratings are defined in the applicable MSS specifications.

The valve body, bonnet or cover, body joint bolting, and body-bonnet or cover bolting may be made from a variety of different materials. The materials are listed in the respective ASTM specifications listed in the applicable standard. Although body material is rarely a factor with ball valves, it is important to know its rating. We know that selection of the body material will depend on the flow media and the pressure-temperature requirements. The table is a pressure-temperature rating chart for carbon steel.

PRESSURE-TEMPERATURE RATING (CARBON STEEL)

Temp in °F	Working Pressure in psig by Classes		
	150	300	600
-20 to 100	285	740	1480
200	260	675	1350
300	230	655	1315
400	200	635	1270
500	170	600	1200

The existing standard is ASME B16.34 – 2004 Valves—Flanged, Threaded, and Welding End. The standard applies to new valve construction and covers pressure-temperature ratings, dimensions, tolerances, materials, nondestructive examination requirements, testing, and marking for cast, forged, and fabricated flanged, threaded, and welding end, and wafer or flangeless valves of steel, nickel-base alloys, and other alloys. Wafer or flangeless valves, bolted or through-bolt types that are installed between flanges or against a flange are treated as flanged-end valves. Standards are periodically updated, and it is important to use the most current standard.

The Standard for Classes 25, 125, and 250 is ASME B16.1 - 1998 Cast Iron Pipe Flanges and Flanged Fittings. This standard covers these items:

- Pressure-temperature ratings
- Sizes and method of designating openings of reducing fittings
- Marking
- Minimum requirements for materials
- Dimensions and tolerances
- Bolt, nut, and gasket dimensions
- Tests

Again, this standard is periodically updated and the most recent edition should be used as a reference. The next table illustrates one manufacturer's pressure-temperature seat rating for a Class 150 flanged-end steel ball valve. At 100°F, Teflon™ seat material has a pressure limit of 230 psi.

CLASS 150 – FLANGED END, STEEL BALL VALVE / VALVE SEAT RATINGS

Working Pressure (psi)				
Max. Oper. Temp. °F	Teflon™ D.I. & C. S	Teflon™ (316SS)	Reinf. D.I. & C.S.	Reinf. (316SS)
100	275	230	275	230
180	250	230	250	230
200	240	230	240	230
250	225	225	225	225
300	210	210	210	210
350	190	190	190	190
400	85	85	150	150
450	0	0	10	10

As the table shows, the pressure drops as the temperature rises. The next table illustrates another manufacturer's valve seat rating chart for a Class 300 flanged-end steel ball valve.

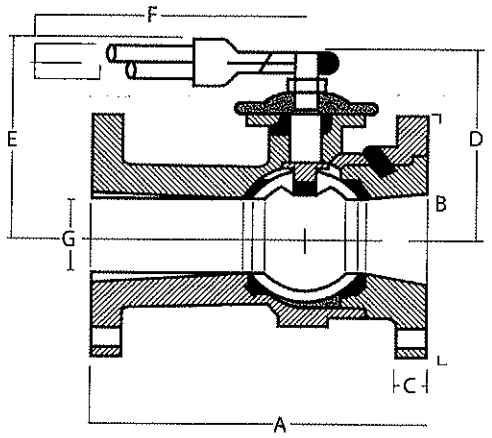
CLASS 300 – FLANGED-END STEEL BALL VALVE / VALVE SEAT RATINGS

	Working Pressure (psi)	
Maximum Operating Temp °F	Teflon™ D.I. & C. S	Reinforced Teflon™
100	720	720
180	705	705
200	675	700
250	500	685
300	340	530
350	200	350
400	90	180
450	0	10

As the pressure rating increases, the weight and size the dimensions of the valve increase. The illustration contains the dimensions of an 8" class 150 ball valve and the following image contains the dimensions of an 8" class 300 ball valve.

CLASS 150 BALL VALVE

CLASS 150	Dimensions (in inches)
A. Face-to-face	11-1/2
B. Flange Diameter	13-1/2
C. Flange Thickness	1-1/8
D. Center of valve to top of valve	
G. Port	5-11/16

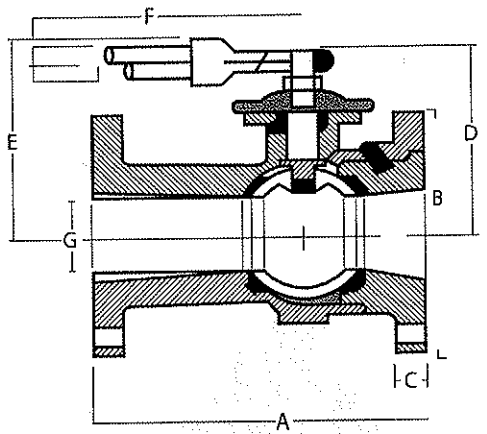


IV 4.4.23a

Refer to the **CLASS 300 BALL VALVE** chart on the following page. You'll see that the size of the port is not affected by the class rating. Note: For larger sizes and higher pressure class ratings, this may not be true.

CLASS 300 BALL VALVE

CLASS 300	Dimensions (in inches)
A. Face-to-face	16-1/2
B. Flange Diameter	15
C. Flange Thickness	1-5/8
D. Center of valve to top of valve	
G. Port	5-11/16



IV 4.4.23b

The Weight Chart For Class 150 and Class 300 steel ball valves is a weight chart for Class 150 and Class 300 steel ball valves.

WEIGHT CHART FOR CLASS 150 AND CLASS 300 STEEL BALL VALVES

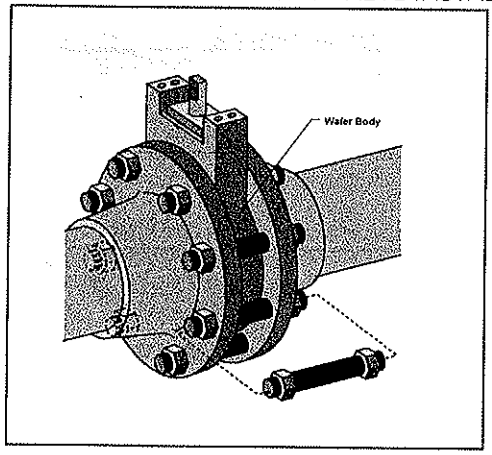
Size	Class 300	Class 150
3″	50	42
4″	80	64
6″	150	108
8″	235	187

Butterfly Valve Gasket Requirements

Resilient seated butterfly valves do not require gaskets. The valve seals provide natural gasket to insure a tight shutoff. Liners in resilient seated butterfly valves will act as a gasket, so additional gaskets are not required. High performance butterfly valves require either a flat ring composite or metallic gasket.

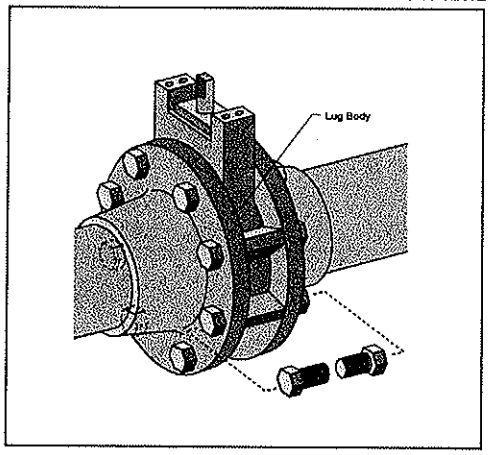
Cast-iron flange-type butterfly valves should be installed only between flat-face flange connections. Gaskets are needed at each joint to assure a tight seal.

WAFER BODY BUTTERFLY VALVE INSTALLED



IV 4.5.04

LUG BODY BUTTERFLY VALVE INSTALLED



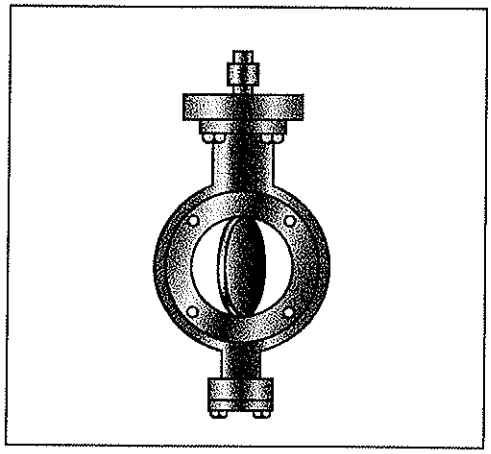
IV 4.5.05

High Performance Butterfly Valves

Some butterfly valves are called **HIGH PERFORMANCE BUTTERFLY VALVES** and are often referenced as either:

- Doubly-eccentric butterfly valve, (referenced often as a "high performance butterfly valve" or "double offset butterfly valve") or
- Triply-eccentric butterfly valve (referenced often as a "triple-offset butterfly valve").

HIGH PERFORMANCE BUTTERFLY VALVE



IV 4.5.06

An example can be seen in the illustration. These valves are designed for higher pressure-temperature applications than resilient-sleeve butterfly valves. Resilient-sleeve butterfly valves are generally limited to 200 psi.

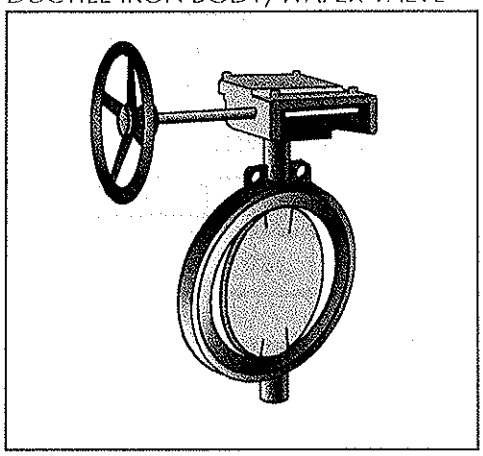
Butterfly Valve Disc

The butterfly valve disc may or may not be made of the same material used for the valve body. The next image illustrates one type of ductile iron body, wafer butterfly valve.

The disc for this valve must be metal and may be made of the following materials:

1. Stainless steel
2. Bronze
3. EPDM coated ductile iron
4. Carbon steel
5. Aluminum
6. Ductile iron

DUCTILE IRON BODY, WAFER VALVE



IV 4.5.07

Temperature-Ratings of Seat Materials

You will find a number of different seat materials from which to choose. Remember, though, the seat material is governed by different temperature limits than the valve body or disc materials. Chemical compatibility is also a major concern when selecting the seat material.

The following Temperature Chart is one manufacturer's temperature rating chart for some of the more common butterfly valve seat materials.

TEMPERATURE CHART

Seat Material	Temperature Range (°F)
EPDM	-20 ° to 250°
Hypalon™	-20° to 220°
Neoprene	-20° to 180°
Nitrile (Buna-N)	-20° to 180°
Viton™	-20° to 350°

***Trademark of E.I. Dupont**

Flow Regulation

The design construction of the butterfly valve eliminates the need for variations in port size or opening to reduce flow or for throttling applications. Instead, flow regulation is controlled by the degree the valve is opened or closed.

The following table for one manufacturer's valve illustrates what percentage of flow will pass through the valve at various open positions. For example, if the valve opening is 50 degrees, the percentage of flow is 27.

FLOW ALLOWED BY DEGREES OPEN

0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
0	3%	6%	12%	18%	27%	40%	56%	80%	100%

IV 4.5.09g

Look at the table again. At what angle of opening is the percentage flow equal to 100%?

The percentage flow is needed to determine the Cv factor in throttling applications. Manufacturers give you the Cv factor for a fully open valve. In the table labeled "degrees open," you can see one manufacturer's Cv factor for different sizes of butterfly valves.

To find the Cv factor in throttling applications, you need to multiply the Cv for the partially open valve by the percentage flow.

DEGREES OPEN

Size	C_V Factor
8	3,600
10	6,000
12	8,000
14	9,500
16	13,000
18	18,000
20	22,500
24	32,600

For example, as shown in the next table, the Cv factor for a 12" butterfly valve at 60% open is 3,200. This has been calculated using previous temperature charts.

EXAMPLE

Fully Open C_V Factor	X	Percentage Flow	=	Throttling C_V Factor
8,000	X	.40	=	3,200

The formulas and Cv factors calculated previously are for illustration purposes only. They should not be used to determine precise flow measurement. For exact calculations and data, contact your manufacturer.

You have reviewed some examples of the various factors and conditions that must be considered for the appropriate valve to meet the service conditions. It is important that the valve body, disc, and trim materials are compatible with the flow medium. Although the pressure-temperature requirements can be met by more than one material, these materials may not be compatible with the flow medium or service conditions.

Cost

You should also remember that cost may be an important factor in valve selection. For example, bronze is generally the most economical valve material for smaller-sized valves. When selecting seal and sleeve materials, Buna-N costs less than Viton™ or Teflon™.

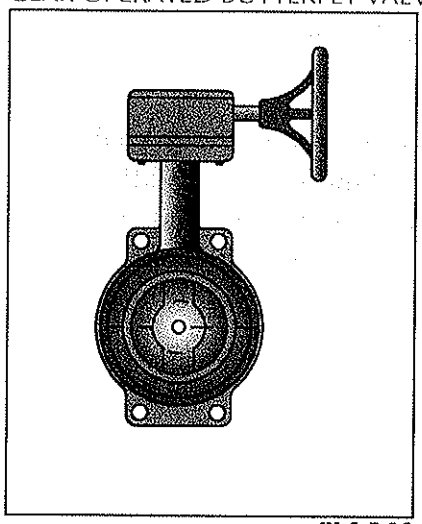
However, remember that the valve material must be compatible with the flow medium. The following Valve Materials Recommendations table is a portion of one manufacturer's corrosion resistance chart recommending various valve materials.

VALVE MATERIALS RECOMMENDATIONS

	Metal Resistance				Seals/Sleeves Resistance			
Media	Bronze	Cast Iron	WCB Steel	316 S.S.	BUNA N	EPOM	VITON	Teflon™
Borax (Sodium Borate)	G	G	F	E	G	G	E	E
Boric Acid	F	U	U	G	E	G	E	E
Calcium Bisulfite	F	U	U	G	E	U	E	E
Calcium Hydroxide	U	U	U	G	E	E	E	E

E = Excellent | G = Good | F = Fair | U = Unsatisfied

GEAR OPERATED BUTTERFLY VALVE



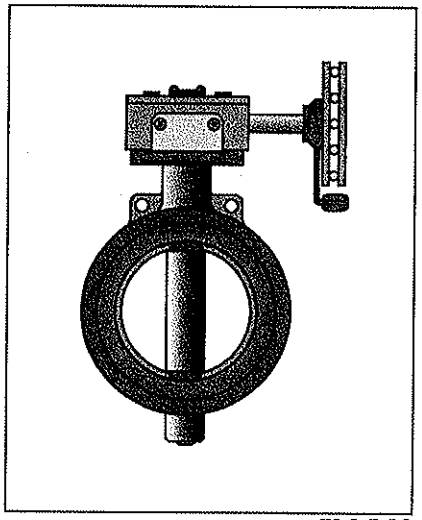
IV 4.5.12

Actuators

Butterfly valves can also be furnished with **ACTUATORS**, such as gear operators. Gear operators (see illustration) are used when the **OPERATING TORQUE** is sufficient to require assistance in operating the valve or when the medium has a high velocity. Operating torque is the force needed to produce rotation of the valve stem.

Generally, gear operators are used on butterfly valves 8" and up. But, they may also be used on smaller valves.

BUTTERFLY VALVE WITH CHAINWHEEL

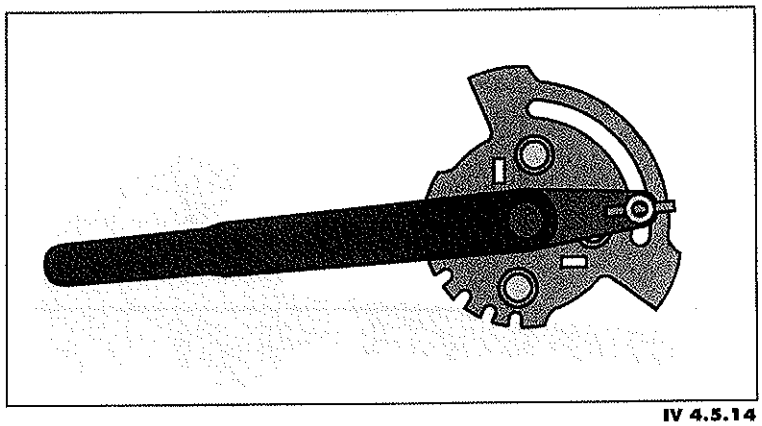


IV 4.5.13

CHAINWHEELS are often used on gear operators when the valve is installed overhead and out of reach. A chainwheel on the gear shaft with sufficient chain in a loop allows operation from below the valve.

Butterfly Valve Handles

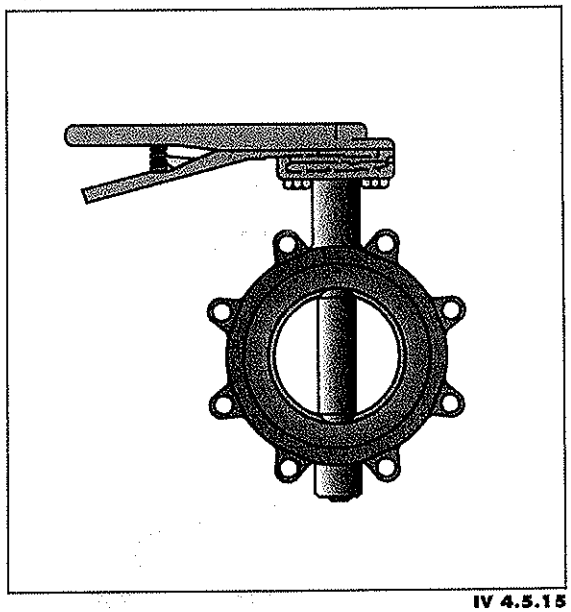
BUTTERFLY VALVE-INFINITE POSITION



IV 4.5.14

Butterfly valves may also be ordered with different types of handles. The handle and positioning plate in the butterfly valve-infinite position illustration allows for multiple positions of the disc in throttling applications.

LEVER-OPERATED BUTTERFLY VALVE



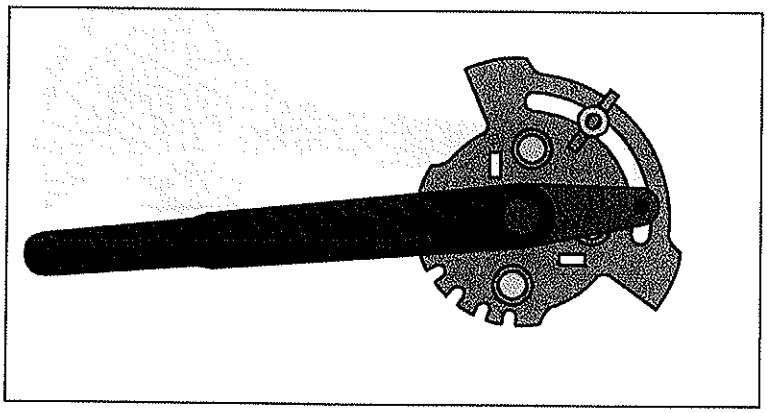
IV 4.5.15

A **LEVER-OPERATED BUTTERFLY VALVE** (illustrated) normally has multi-position handle plates. The **INFINITE POSITION HANDLE** allows finer throttling than can be achieved by the lever-operated handle.

Butterfly valves may also have memory stops that return the disc to the same throttling position.

A **MEMORY STOP** is shown on the butterfly valve illustration.

BUTTERFLY VALVE-MEMORY STOP



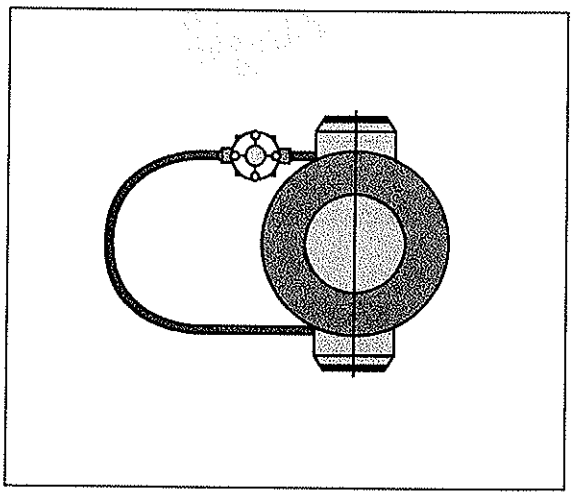
IV 4.5.16

Bypasses

There are a number of accessories available for today's valves. We have covered some of those accessories. You should also be aware that valves may also be furnished with bypasses (see illustration).

BYPASSES are used to either warm up lines downstream or to equalize pressures when there is a high pressure differential.

ONE -VALVE BYPASS



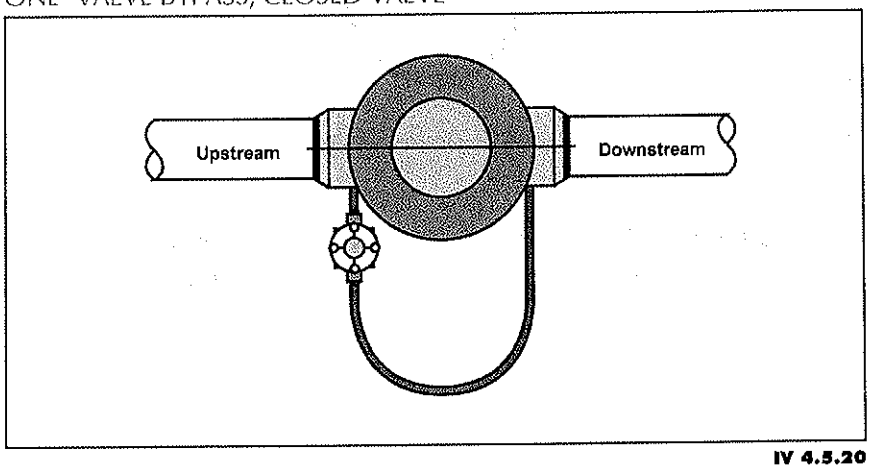
IV 4.5.17

Normally, bypasses are used in pipe sizes of 8" and up.

The one-valve bypass, closed valve illustration assumes the valve is closed. This image further assumes a high pressure differential when the valve is closed. The upstream pressure is 1500 psi, and the downstream pressure is 0 psi. The pressure differential is 1500 psi, which is the difference between the upstream pressure and the downstream pressure, or 1500 – 0 = 1500.

The bypass has a valve to open and close the bypass line when needed. When the bypass is opened, it bleeds pressure from the upstream side to the downstream side. This action eventually equalizes the pressure on both sides of the valve in the line, thus reducing the effort needed to open the line valve.

ONE -VALVE BYPASS, CLOSED VALVE

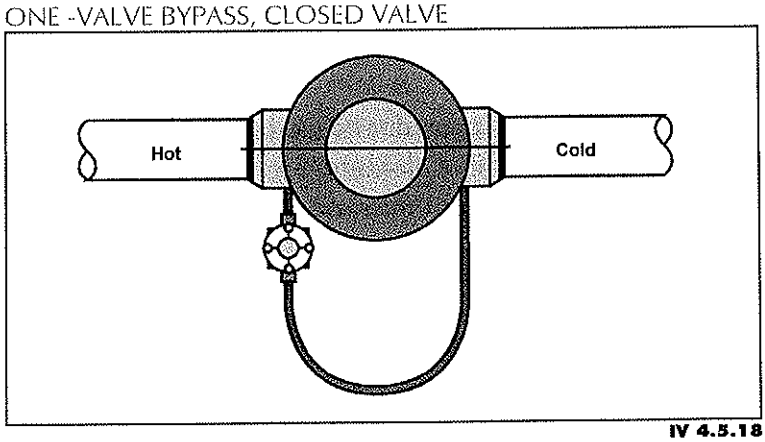


IV 4.5.20

Bypasses are also used to warm up lines downstream of the valve when there are high temperature differentials. In the second one-valve bypass, closed valve illustration, the valve is assumed to be closed. Hot fluids create high temperatures on the upstream side of the valve, while the downstream side of the valve has been allowed to cool.

In this situation, a bypass may be used to warm up the downstream side. Opening the bypass bleeds the hot fluid to the downstream side.

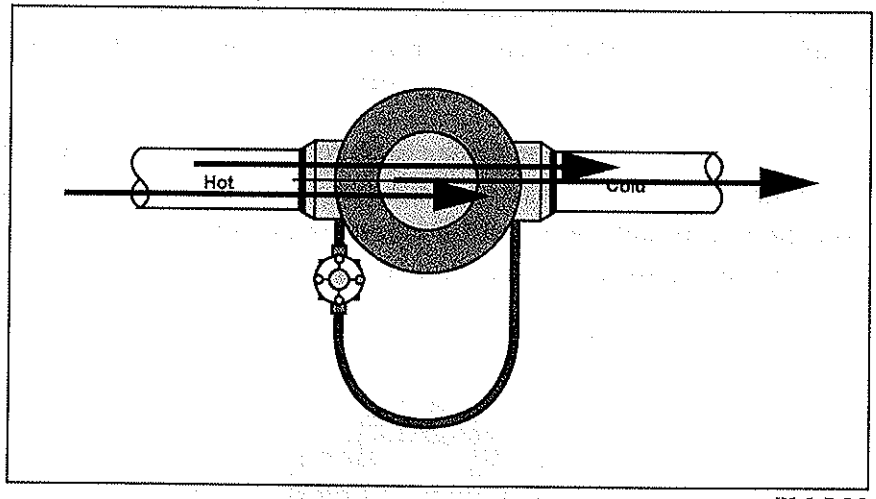
ONE -VALVE BYPASS, CLOSED VALVE



IV 4.5.18

Sizing Actuators

ONE -VALVE BYPASS, CLOSED VALVE



IV 4.5.19

Pressure differential is an important factor in sizing actuators. SIZING refers to the actuation torque or thrust required to operate the valve. In the third one-valve by-pass, closed valve illustration, the upstream pressure and the downstream pressure is indicated for the closed valve. The direction of the flow is indicated by the arrow.

While the valve must be capable of handling the maximum pressure, the actuator is sized according to the pressure differential.

A number of factors are used in sizing actuators. We have only discussed pressure differential. Other factors include the following:

1. Size of valve
2. Media
3. Pressure-temperature requirements
4. Required cycle time
5. Type of actuation—electric, pneumatic/hydraulic
6. Valve torque
7. Characteristics of power source for actuator

There are additional factors to consider based on the type of actuator used. Always check your manufacturer's literature for information on sizing and selecting the most appropriate actuator to suit the service or application requirements.

In addition to the factors we have already mentioned, there may be specific reasons for selecting one type of actuator over another. For example, some valves should not be operated quickly when there is a possibility of creating **WATER HAMMER** or line shock. This situation could result from a sudden change in flow through the valve as a result of fast valve closure.

Some water systems, such as fire protection, require gear operators on all sizes 2-1/2" and up. The gear operator helps to prevent the possibility of water hammer or line shock by increasing the closure time.

External Indicators

Valves may also have **EXTERNAL INDICATORS** that indicate the position of the valve. The disc position pointer on a gear head can be used for a butterfly valve. The pointer provides visual indication of the disc position.

Other valves, such as a plug valve, may have an arrow on the top of the valve to indicate position of the ports. You should become familiar with the types of external indicators available for the valves you sell.

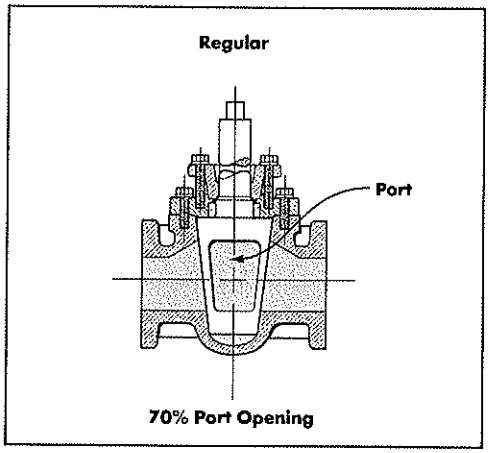
Types of Ports in Plug Valves

The flow area through the valve is called a **PORT**. It varies in size. It can be the same size or smaller than the pipe to which it is attached. The port opening in the plug matches the valve end connection openings. You will also find different types of plug ports.

Some manufacturers will list the type of plug port using percentages. For instance, the **FULL PORT PLUG VALVE** has a 100% port opening. The regular or Venturi port generally provides approximately 70% and 40% of port opening, respectively.

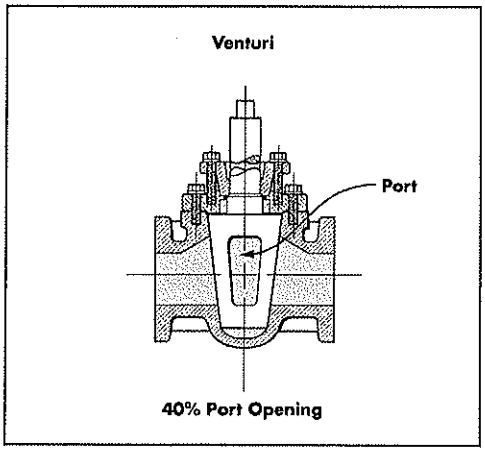
REGULAR PORT or **VENTURI PORT** valves are used when pressure loss through the valve is important. The more the flow is reduced, the greater the loss of pressure. Examples of these two plug ports are shown in the following illustrations.

REGULAR PORT PLUG VALVE



IV 1.4.13

VENTURI PORT PLUG VALVE

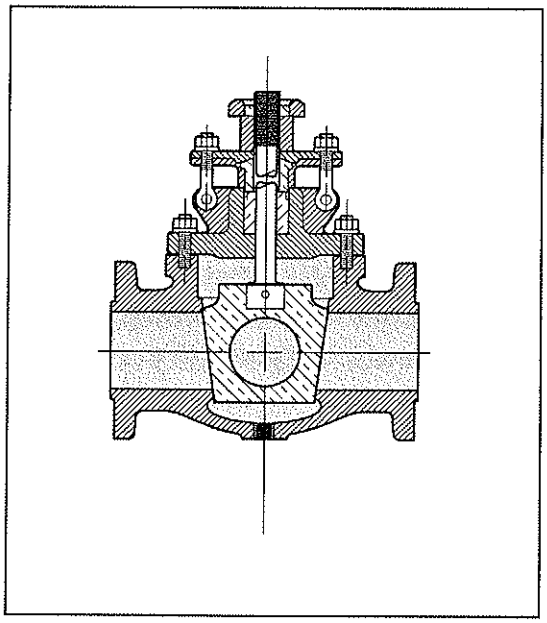


IV 1.4.14

The Venturi or regular ports reduce the flow area at the plug location. Do not confuse this type of flow reduction with throttling. These two port patterns decrease flow area through the valve port, a fixed proportion of the attached pipe flow area.

Some plug valves have a **FULL PORT** opening instead of the Venturi or regular ports. The full-port plug valve (see image) are used when flow area through the valve must match flow area through the attached pipe.

FULL-PORT PLUG VALVE



IV 1.4.15

The size of the port opening in the plug matches the valve end connection openings. Valves are sized according to the nominal pipe size of the installation line.

In the following table, you will see that the full port plug weighs more and has larger dimensions than the other two plug ports for a valve in the same line size.

PORT DIMENSION CHART

Valve	Full Port	Regular Port	Venturi Port
Size	12	12	12
Weight	2665	1262	972
A	20-1/2	20-1/2	20-1/2
B	38	19-3/4	19-3/4
C	40-13/16	35-1/2	29-1/8

Weight is given in pounds. All other dimensions are in inches.

And more weight and larger dimensions mean that more material has been used to make the valve, thus making it cost more than a smaller plug port.

REVIEW QUIZ – QUARTER-TURN VALVE DETAILS

Answers appear on page 122

DIRECTIONS: Carefully read each question and circle the correct answer. There is only one correct answer per question. When you have finished, check your answers.

1. What port pattern has a ball bore equal to the inside diameter of pipe?
   a. Venturi port
   b. Full port
   c. Regular port
   d. Conventional port

2. What information does the Cv factor provide?
   a. Flow coefficient
   b. Flow media
   c. Gallons per minute
   d. Pressure

3. For frequent operation of low pressure steam service and line sizes 2" and under, which type of quarter-turn valve is the most economical?
   a. Plug
   b. Ball
   c. Butterfly
   d. Wafer butterfly

4. Which ball valve design eliminates the possibility of body joint leaks?
   a. Three-way, two-port design
   b. Two-piece, bottom-entry design
   c. One-piece body, end-entry design
   d. One-piece, top-entry design

REVIEW QUIZ – QUARTER-TURN VALVE DETAILS

Answers appear on page 122

5. What type of butterfly valve does NOT use a gasket to make the end connection?
   a. High performance butterfly valves
   b. Cast iron flanged valves
   c. Wafer or lug type with resilient sleeves
   d. Wafer butterfly valve
6. What is the percentage flow if the valve is open 60°?
   a. Different percentages per manufacturer
   b. 60 percent
   c. 40 percent
   d. 20 percent
7. What is the largest valve opening called?
   a. U-shaped
   b. Full-port
   c. Disc
   d. Plug
8. How many sets of connecting lines can a four-way, four-port valve service at the same time?
   a. Two
   b. Four
   c. Six
   d. Eight
9. What is done prior to attaching a pressure relief valve to a valve to relieve pressure?
   a. Fluid is forced through the valve.
   b. The valve is frequently disassembled.
   c. A hole is drilled though one side of the plug
   d. The plug is completely removed.

REVIEW QUIZ: QUARTER-TURN VALVE DETAILS

Answers appear on page 122

10. All of the following are types of patterns for lubricated plug valves EXCEPT

    a. Regular

    b. Bolted

    c. Short

    d. Venturi

APPLYING WHAT YOU HAVE LEARNED:

By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.

A. List several types of plug valve design variations that your company recommends and sells.

_____

_____

_____

B. Based on your reading and general knowledge of valves, describe how glands are used to provide a tight seal in a plug valve.

_____

_____

_____

ANSWERS TO REVIEW QUIZ

CHAPTER 5

QUARTER-TURN VALVE DETAILS

Answers to Review Questions: Quarter-turn Valve Details

1. b. Full port
2. a. Flow coefficient
3. b. Ball
4. c. One-piece body, end-entry design
5. c. Wafer or lug type with resilient sleeves
6. c. 40 percent
7. b. Full-port
8. a. Two
9. c. A hole is drilled though one side of the plug
10. b. Bolted

APPLYING WHAT YOU HAVE LEARNED:

A. Answers will vary by company.

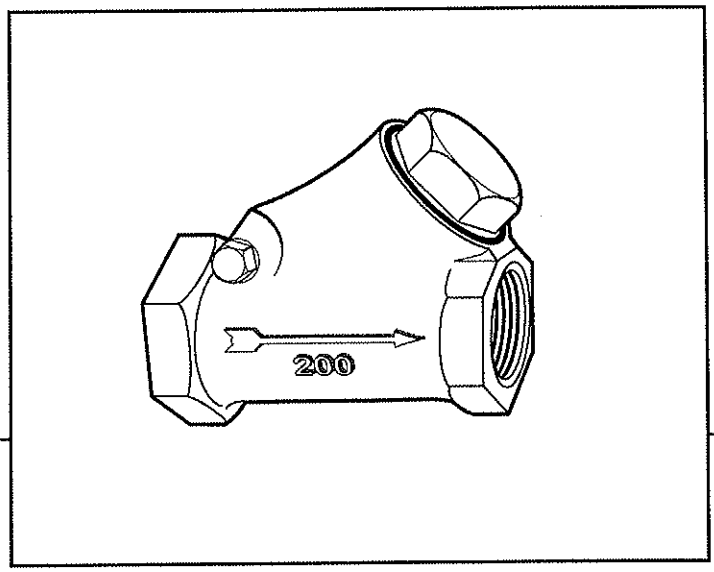
B. Answers may vary but the gland generally locks the stem assembly to the valve body.

6 CHECK VALVES

LEARNING OBJECTIVES

When you successfully complete this chapter, you will be able to:

1. Explain the purpose of a check valve.
2. Discuss why installation is critical to the operation of a check valve.
3. Identify the four types of check valves.



CHECK VALVES

Check Valves

Check valves are another operational category of valves. **CHECK VALVES** get their name from the way they control the flow. These valves permit flow through the valve in only one direction. They are used to check the flow in a system to keep it from reversing direction. You can see an example of a check valve below. Note the flow direction arrow in the diagram.

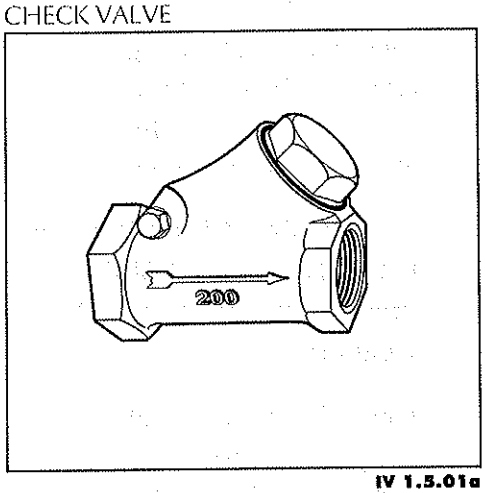
The check valve is used to prevent backflow or reverse flow in a line. The unidirectional design of the check valve is why it has flow arrows on the body (see illustration).

The check valve must always be installed so that upstream flow keeps the valve open. You can see how a check valve operates in the **CHECK VALVE OPERATION** image.

If the flow downstream should reverse direction, the valve would close and prevent backflow.

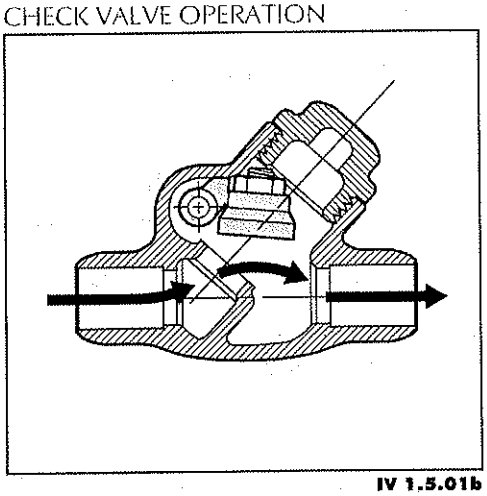
In the next section, you will see how these valves "check" the flow in a system and why they must be installed properly in order to work correctly.

CHECK VALVE



IV 1.5.01a

CHECK VALVE OPERATION

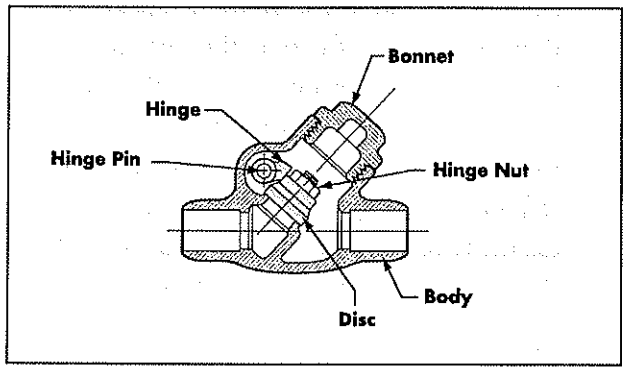


IV 1.5.01b

Types of Check Valves

There are four different types of check valves: (1) swing, (2) lift, (3) ball, and (4) wafer. The difference is in the design of the closing mechanism.

CUTAWAY DRAWING OF A SWING CHECK VALVE



IV 1.5.02

A **CUTAWAY DRAWING OF A SWING CHECK VALVE** is shown in the illustration. It is a Y pattern.

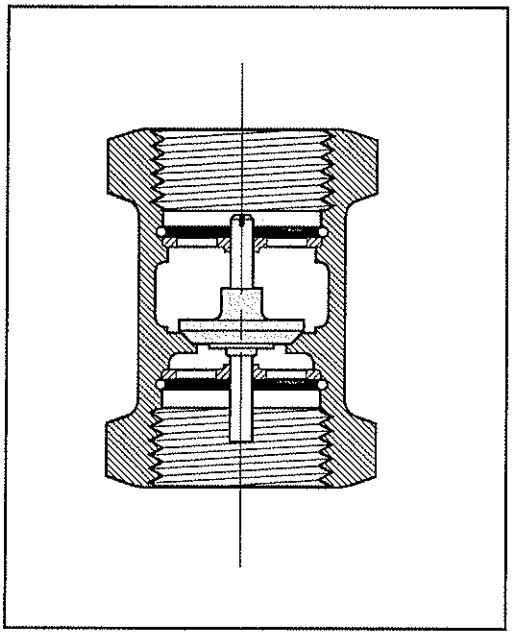
This valve has a disc attached to a pin at the top of the valve body. The valve has been illustrated for horizontal installation though it can also be used in a vertical installation where normal flow is upward. When the valve is open, flow through the valve pushes the disc up toward the top of the valve body.

If flow were to reverse direction, the flow and pressure would force the disc down against the seat and block flow through the valve.

Note the regular pattern check valve operates in the same manner. This valve prevents the flow from reversing direction, too.

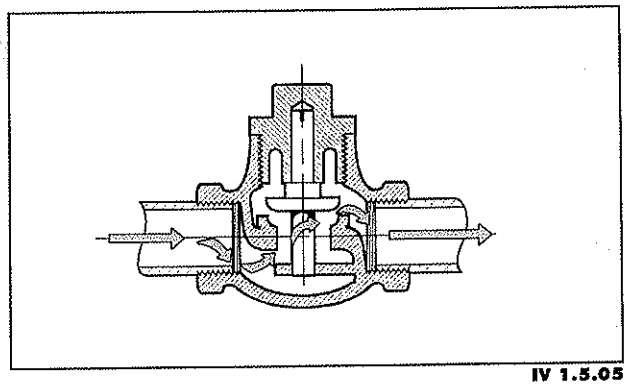
The **VERTICAL LIFT CHECK VALVE** has a guided disc that slides away from the seats when open. The type of lift check valve used in a system must always match the direction of the pipe run where it is installed. The **CUTAWAY DRAWING OF A VERTICAL CHECK VALVE** illustration shows an upward flow vertical lift check valve.

CUTAWAY DRAWING OF A VERTICAL CHECK VALVE



IV 1.5.04

CUTAWAY DRAWING OF A HORIZONTAL CHECK VALVE

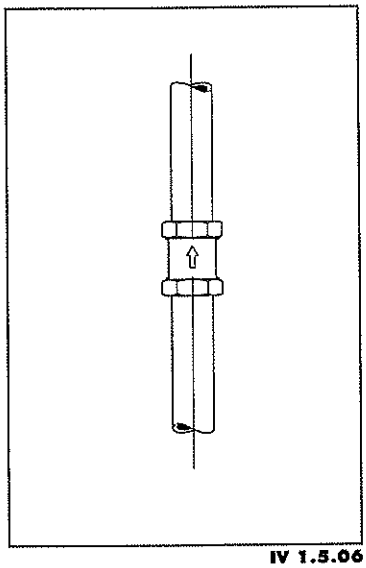


IV 1.5.05

The **CUTAWAY DRAWING OF A HORIZONTAL CHECK VALVE** illustration shows a **HORIZONTAL LIFT CHECK VALVE**. This valve has a disc for the closure member. Many horizontal lift check valves are spring loaded in design and can be used in either a horizontal or vertical service.

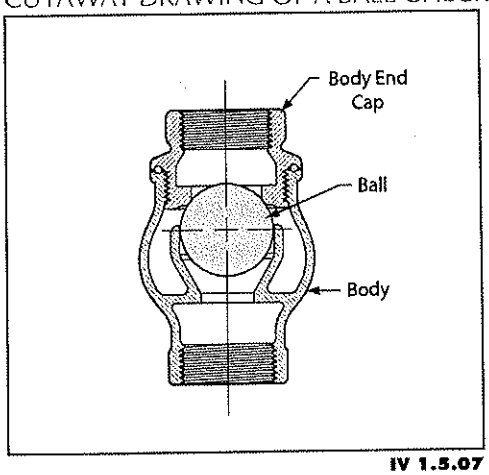
The flow must always exert pressure under the closing mechanism in order for the check valve to work properly. This design has the same flow characteristics of a globe valve when open.

CHECK VALVE INSTALLED IN A PIPING SYSTEM



IV 1.5.06

CUTAWAY DRAWING OF A BALL CHECK VALVE



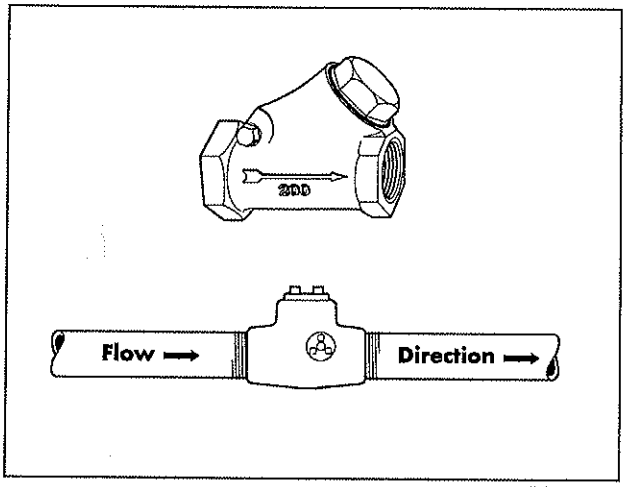
IV 1.5.07

The first illustration above shows a check valve installed in a piping system. The second image above illustrates a cut-away drawing of a ball check valve. It is illustrated for vertical installation.

When the valve is open, fluid pushes the ball away from the seats. If the flow were to reverse direction, flow would push the ball back against the body seat.

When modified with special provisions such as springs or lever and weight, the lift check valve and the swing check valve can also be used for vertical installations. The important point to remember when installing these check valves is that the upstream flow pressure is always exerted under the closing element.

CHECK VALVE



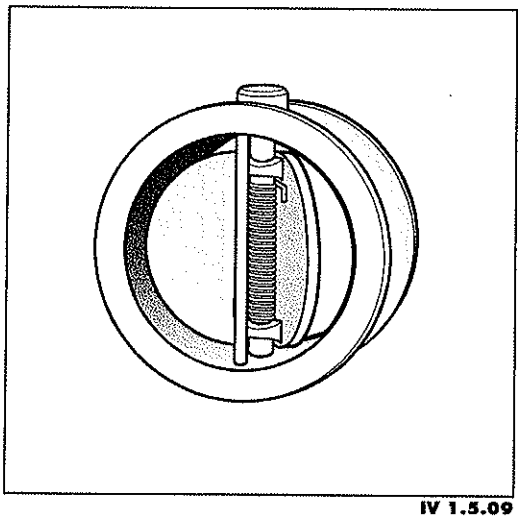
IV 1.5.08

Most manufacturers have a marking on the outside valve body to indicate correct flow direction for installation. On the valve shown above, the arrow indicates the correct flow direction.

WAFER CHECK VALVES are also available. These valves have a closing element placed in the flow stream.

The **DOUBLE DISC WAFER VALVE** is a cutaway drawing of a wafer check valve. When the valve is open, the disc halves turn on the stem axis. However, if flow direction were to reverse, flow would cause the discs to seat and block the flow.

DOUBLE DISC WAFER VALVE



IV 1.5.09

The simplicity of the check valve should not hide the importance of its function or its potential to cause problems. Check valves are installed to protect piping systems, equipment, and our health. Improperly installed check valves can result in costly repairs and system shutdowns. Check valves should be installed at least 5 to 7 pipe diameters downstream from pumps, elbows, or other turbulence inducing devices.

REVIEW QUIZ – CHECK VALVES

Answers appear on page 134

DIRECTIONS: Carefully read each question and circle the correct answer. There is only one correct answer per question. When you have finished, check your answers.

1. Which of the following is the best description of the function of a check valve?
   a. Machine used to stop the flow of water
   b. Object used to control the movement of water
   c. Device that controls movement of liquids or gases
   d. Device that prevents the return flow of fluid
2. Which of the following is critical to the function of a check valve?
   a. Whether the water is used for agricultural or human use
   b. The position in which it is installed
   c. The material from which it is made
   d. The amount of fluid that passes through the valve
3. Which of the following valve types is used keep the flow in a system from reversing?
   a. Ball valve
   b. Gate valve
   c. Butterfly valve
   d. Check valve
4. All of the following are types of check valves EXCEPT
   a. Ball valve
   b. Swing valve
   c. Lift valve
   d. Plug valve

REVIEW QUIZ – CHECK VALVES

Answers appear on page 134

5. Which type of valve has a guided disc which slides away from the seats when open?
   a. Wafer check valve
   b. Vertical lift check valve
   c. Swing check valve
   d. Lift check valve

6. To which valve category does the globe valve belong?
   a. Multi-turn
   b. Quarter-turn
   c. Check
   d. Specialty

7. A ball check valve is different from a ball valve because it
   a. has a hole or port through the middle of it.
   b. does not have a hole or port through the middle of it.
   c. allows pressure to be exerted above the closing element.
   d. has a different type of closure member.

8. Based on what you learned earlier in this course, which of the following categories of valves are generally used for throttling services?
   a. Gate and plug valves
   b. Globe and butterfly valves
   c. Globe and gate valves
   d. Gate and ball valves

9. Which of the following valves may be installed may be installed in either a horizontal or vertical position?
   a. Vertical lift check valve
   b. Horizontal life check valve
   c. Swing check valve
   d. None of the above

REVIEW QUIZ – CHECK VALVES

Answers appear on page 134

10. What does the arrow on a check valve indicate?
    a. Whether the valve show be installed horizontally or vertically
    b. The position of the closing element
    c. The correct flow direction
    d. The reverse flow direction

APPLYING WHAT YOU HAVE LEARNED:

By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.

A. List the types of check valves that your company recommends and sells.

_____

_____

_____

B. Based on your reading and general knowledge of valves, why is the installation position critical to the operation of a check valve?

_____

_____

_____

ANSWERS TO REVIEW QUIZ

CHAPTER 6

CHECK VALVES

Answers to Review Questions: Check Valves

1. d. Device that prevents the return flow of fluid
2. b. The position in which it is installed
3. d. Check valve
4. d. Plug valve
5. b. Vertical lift check valve
6. a. Multi-turn
7. b. does not have a hole or port through the middle of it.
8. b. Globe and butterfly valves
9. c. Swing check valve
10. c. The correct flow direction

APPLYING WHAT YOU HAVE LEARNED:

A. Answers will vary by company.

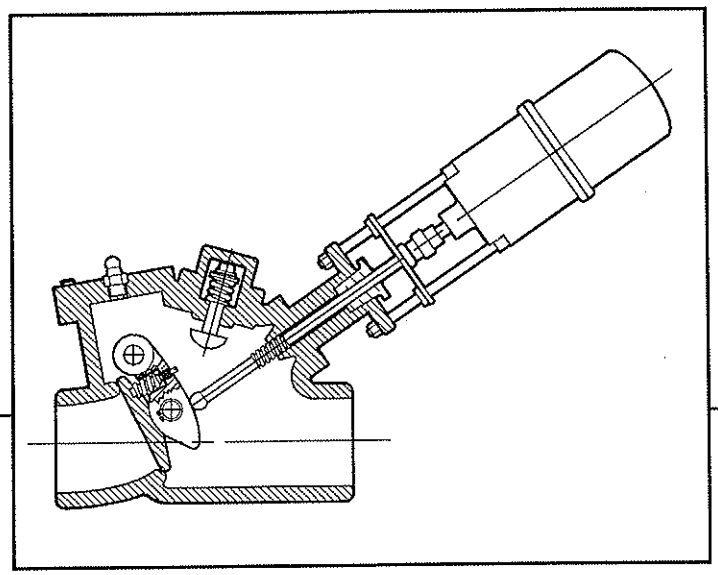
B. Check valves must always be installed so that the upstream flow keeps the valve open.

7 SPECIALTY VALVES

LEARNING OBJECTIVES

When you successfully complete this chapter, you will be able to:

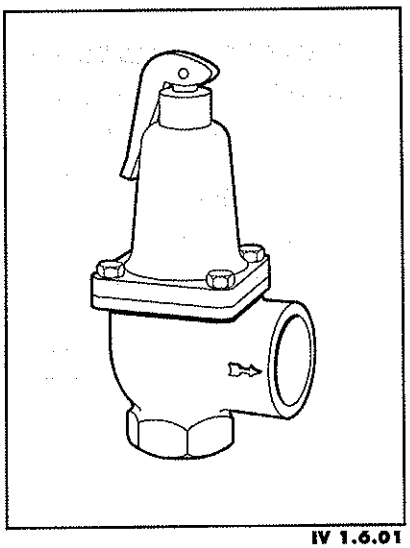
1. Explain the purpose of regulator/specialty valves and identify three typical kinds of specialty valves.
2. Differentiate between nuclear valves and other safety valves.
3. Identify an actuator and discuss the four advantages of using actuators on regular valves.
4. Compare a semi-automatic operation of a valve to an automatic operation.
5. Name three kinds of actuators and explain their function.



SPECIALTY VALVES

Specialty Valves

PRESSURE RELIEF VALVE



IV 1.6.01

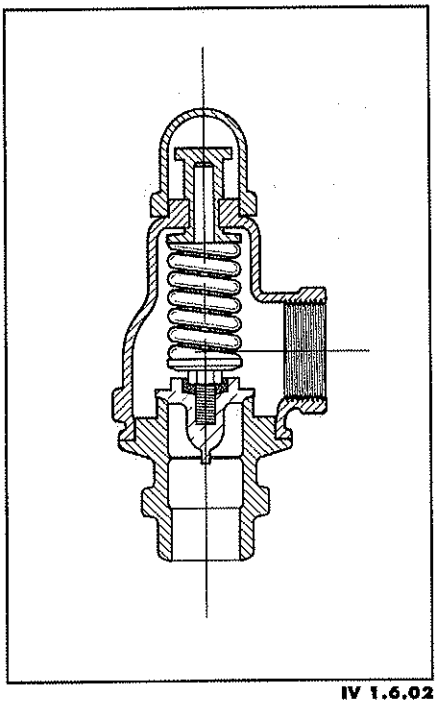
A variety of valves belong to the specialty category of regulator valves. These valves are used to provide control functions of pressure regulation, automatic flow control, and temperature regulation.

There are three typical kinds of specialty valves: (1) pressure relief valves, (2) safety valves, and (3) nuclear valves. The **PRESSURE RELIEF VALVE** (see illustration) is one type of specialty valve. You will take a closer look at these valves in this section.

Valve accessories, such as actuators, are also briefly discussed. An **ACTUATOR** is a device used to operate a valve semi-automatically or automatically.

Relief and Safety Valves

CUTAWAY OF A RELIEF VALVE



IV 1.6.02

Relief and safety valves fall into the category of specialty valves. These valves are designed to relieve excess pressure and/or temperature in a piping system or a vessel.

This valve prevents the pressure or temperature in a system from becoming too high. Many safety and relief valves use a disc and spring to open or close the valve, as shown in the illustration. The spring holds the disc against the seat in normal conditions. If pressure in the system were to exceed the limit set, the pressure would force the disc away from the seat and open the valve.

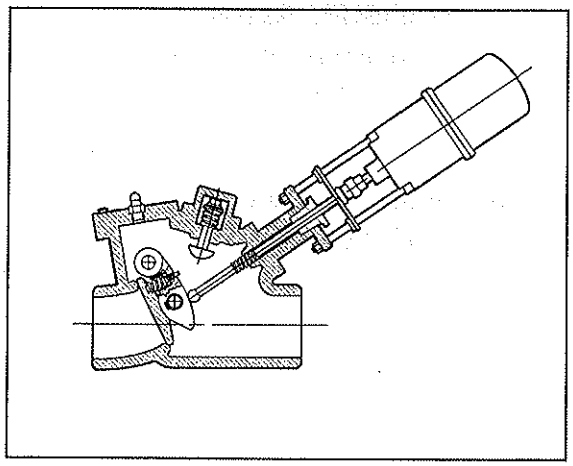
With the valve open, excess pressure would escape until the "safe zone" was reached. At this level, the force of the spring would push the disc back against the seat, closing the valve.

Nuclear Valves

NUCLEAR VALVES are specially designed for use in nuclear power plants. While distributors do not carry nuclear valves, you should be aware that they are available. Safety-related nuclear valves are shipped directly to the user by the manufacturer.

These valves are often design variations of the more common valves we have seen. Nuclear valves are subject to more rigorous manufacturing control than the more common valves.

NUCLEAR VALVES



IV 1.6.03

Control Valves and Actuators

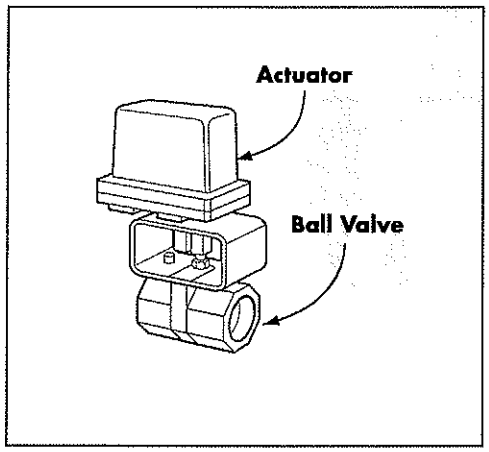
CONTROL VALVES are designed to control flow rate, line pressure, differential pressure, or to offer surge and pressure relief functions. They provide more precise operation than regular valves.

These valves often resemble the more common valve types. However, instead of being manually operated, these valves are operated by an actuator. An **ACTUATOR** is a mechanical or electrical device that operates the valve automatically. Acutators receive their names because they "activate" (or move) the valve into action. Actions include opening the valve, closing the valve, and changing the throttling position.

You can see the **ACTUATOR AND BALL VALVE** illustration on the next page which shows one type of actuator. This actuator is used to operate the ball valve.

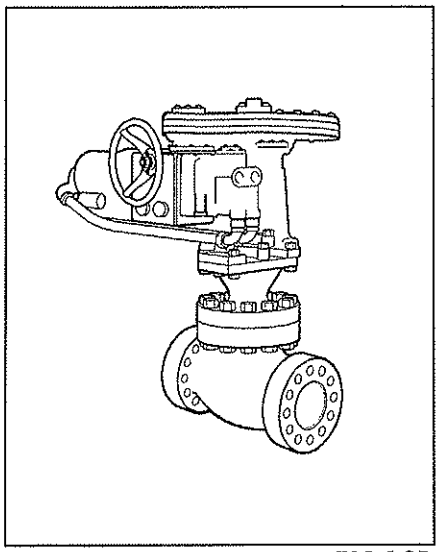
There are a variety of actuators used on today's valves. Generally speaking, most actuators operate automatically or semi-automatically. The difference is in whether the actuator is controlled by a person or a computer. A person controlling the actuator would imply *semi-automatic control*, while a computer operating the actuator would imply *automatic control*. For our purposes, when we discuss actuators in this section, we are referring to these devices as being semi-automatic.

ACTUATOR AND BALL VALVE



IV 1.6.04

SEMI-AUTOMATIC ACTUATOR



IV 1.6.05

Almost every common valve type can be operated by use of an actuator. The main purpose of an actuator is to operate a valve faster with less manpower and to provide for remote operation. An actuator can make valve operation more effective and even reduce manpower.

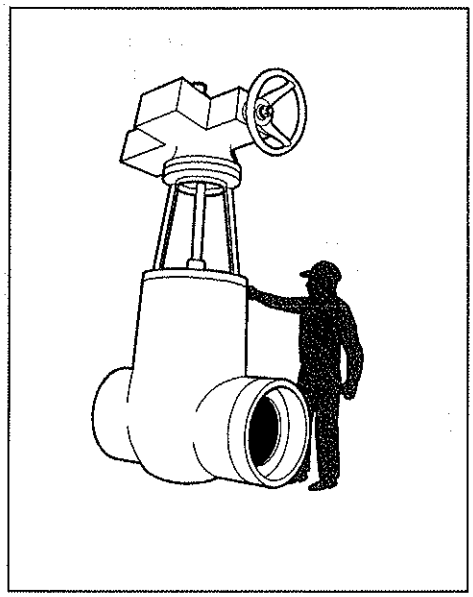
For example, one person may have to turn a 24" multi-turn gate valve hand wheel 75 full turns. That is 75 times in a complete circle, which requires a great deal of effort. With an actuator, the valve could be opened or closed much faster and with only the press of a button.

Also, the force required in large valves (or high pressures) make actuation the preferred option.

It would take a conventional electric geared motor actuator 3 to 4 minutes to operate this type of valve. Imagine how long it could take a person to operate the valve.

The actuator can operate a large valve instead of requiring a number of people to turn the handle to open or close the valve (see illustration).

ACTUATOR OPENING VALVE



IV 1.6.06

Types of Actuators

There are a number of different actuators for valves. The **SOLENOID VALVE** is a valve type that activates the valve with an electric solenoid. Solenoid valves are commonly used as control valves with pneumatic actuators.

There are several kinds of actuators. A **MANUAL ACTUATOR** uses levers, gears, or wheels to assist movement; an **AUTOMATIC ACTUATOR** has an external power source to provide the force and motion to operate a valve remotely or automatically. Power actuators are a necessity on valves in pipelines located in remote areas: they are also used on valves that are frequently operated or throttled. Valves that are particularly large may be impossible or impractical to operate manually simply by the sheer horse- power requirements. Some valves may be located in extremely hostile or toxic environments, which preclude manual operation. Additionally, as a safety feature, certain types of power actuators may be required to operate quickly, shutting down a valve in case of emergency.

HYDRAULIC and **PNEUMATIC ACTUATORS** are often simple devices with a minimum of mechanical parts, used on linear or quarter-turn valves (see illustration). Sufficient air or fluid pressure acts on a piston to provide thrust in a linear motion for gate, globe, or ball valves.

Alternatively, the thrust may be a rotary motion to operate a quarter-turn valve. Fluid power actuators can be supplied with fail-safe features to close or open a valve under emergency circumstances. For example we could use a normally open pneumatic valve in a hot water heating situation. This way if pneumatic power to the actuator is lost, the valve would open and still provide heat to a building.

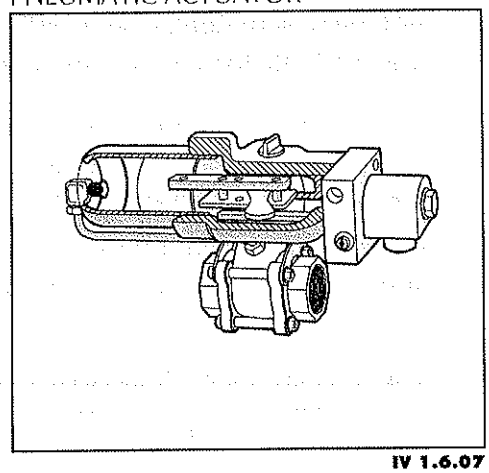
The **ELECTRIC ACTUATOR** has a motor drive that provides torque to operate a valve (see illustration). Electric actuators are frequently used on multi-turn valves such as gate or globe valves. With the addition of a quarter-turn gearbox, they can be utilized on ball, plug, or other quarter-turn valves.

Another kind of actuator is a **GEAR ACTUATOR** (see illustration). The gear actuator uses mechanical force to open or close the valve; it cannot be operated automatically. Its low cost probably makes this the most economical type of actuator.

The advantage of the gear actuator is that it permits valve operation with reduced manual effort for a relatively low price.

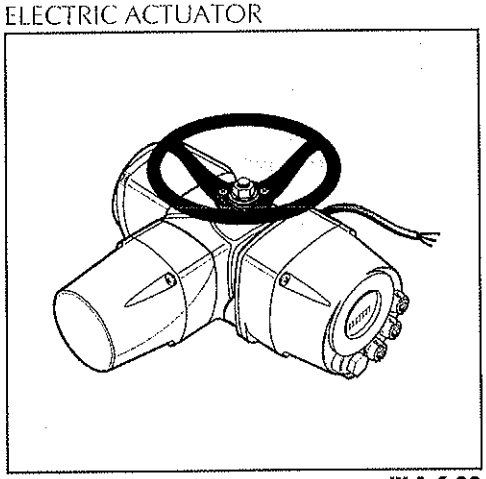
You have just seen some of the basic types of actuators available. You should become familiar with the actuators available for the valves your company sells.

PNEUMATIC ACTUATOR



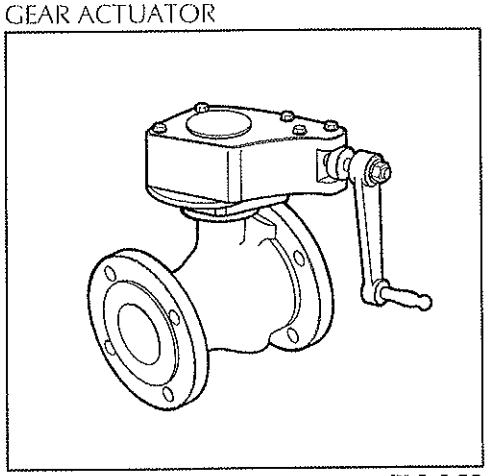
IV 1.6.07

ELECTRIC ACTUATOR



IV 1.6.08

GEAR ACTUATOR



IV 1.6.09

Many manufacturers can recommend a type of actuator for their valves if they do not make actuators. Check with your manufacturer to see what types of actuators are available for your company's line of valves.

You can provide better service to your customers by being able to help them in their needs and by providing them with the correct information. The **VALVE OPERATIONS AND FUNCTIONS** table serves as a summary of the information covered thus far. It encapsulates information on how the functions and operations of valves interrelate.

VALVE OPERATIONS AND FUNCTIONS

Valve Name	Operation / Category	Function
Gate	Multi-turn	Start-stop
		Straight-thru
Globe		Flow
		Start-stop and Throttle
Diaphragm		Start-stop and Throttle
Pinch		Start-stop and Throttle
Plug	Quarter-turn	Start-stop
Ball		Start-stop (limited throttle)
Butterfly		Start-stop and Throttle
Check	Flow in one direction	Prevention of back flow
Specialty	Regulator valves	Pressure or temperature
	Relief and safety valves	Regulation

You now know how valves are classified by type, design variations, and function. The next chapters cover how valves are classified by material, end connections, and pressure-temperature ratings.

REVIEW QUIZ – SPECIALTY VALVES

Answers appear on page 148

DIRECTIONS: Carefully read each question and circle the correct answer. There is only one correct answer per question. When you have finished, check your answers.

1. All of the following are typical types of specialty valves EXCEPT
   a. Pressure relief valve
   b. Safety valve
   c. Temperature valve
   d. Nuclear valve
2. What is the primary purpose of a relief valve?
   a. Divert the flow of water for agricultural and human use
   b. Protect cities from flooding by changing the course of rivers
   c. Ease excess pressure in a piping system or vessel
   d. Operate small machines in factories
3. What special feature on an automatic control valve makes it different from the more common valve types?
   a. Wedge disc
   b. Ball valve
   c. Pressure relief valve
   d. Power actuator
4. An actuator is best described as a device which semi-automatically or automatically
   a. controls the flow of liquid through a piping system.
   b. activates a valve into action.
   c. assures an unobstructed pipeline flow.
   d. exerts pressure under the closing mechanism.

REVIEW QUIZ – SPECIALTY VALVES

Answers appear on page 148

5. All of the following are advantages of using actuators on valves EXCEPT
   a. Reduce manpower
   b. Operate larger valves
   c. Cut energy costs
   d. Operate remotely

6. Which of the following is a special advantage of using a gear actuator on a valve?
   a. Allows valve operation with reduced effort
   b. Permits the operation of smaller valves
   c. Automatically opens and closes valves
   d. Uses manual effort to move the valve

7. To which valve category does the pneumatic actuator belong?
   a. Multi-turn
   b. Quarter-turn
   c. Check
   d. Specialty

8. Which of the following is the BEST source for providing information about the valves your company sells?
   a. Salespeople
   b. Manufacturers
   c. Supervisors
   d. Counter people

9. Which of the following is an energy source for a pneumatic actuator?
   a. Electricity
   b. Nuclear power
   c. Compressed air
   d. Solar power

REVIEW QUIZ – SPECIALTY VALVES

Answers appear on page 148

10. Which of the following devices in a relief and safety valve is used to hold the disc against the seat in normal conditions?
    a. Disc
    b. Actuator
    c. Stem
    d. Spring

APPLYING WHAT YOU HAVE LEARNED:

By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.

A. List the types of actuators that your company recommends and sells.

_____

_____

_____

B. Based on your reading and general knowledge of valves, list at least three uses for an actuator.

_____

_____

_____

ANSWERS TO REVIEW QUIZ

CHAPTER 7

SPECIALTY VALVES

Answers to Review Questions: Specialty Valves

1. c. Temperature valve
2. c. Ease excess pressure in a piping system or vessel
3. d. Power actuator
4. b. activates a valve into action.
5. c. Can cut cost energy costs
6. a. Allows valve operation with reduced effort
7. d. Specialty valves
8. b. Manufacturers
9. c. Compression
10. d. Spring

APPLYING WHAT YOU HAVE LEARNED:

A. Answers will vary by company

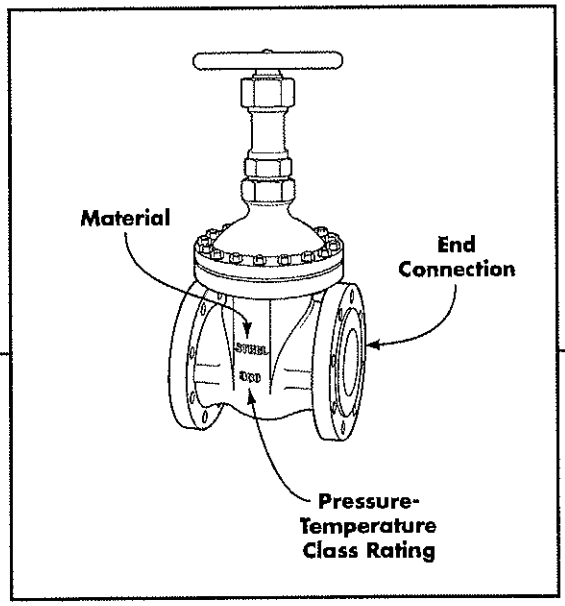
B. Answers will vary but may include that an actuator is a mechanism that causes a device to be turned on or off, adjusted, or moved. The motor and mechanism that move the head assembly on a disk drive or an arm of a robot is called an actuator. Actuators can move or position valve doors in an HVAC system.

8 VALVE CLASSIFICATION

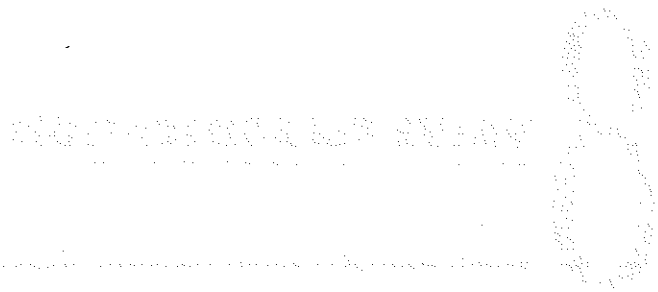
LEARNING OBJECTIVES

When you successfully complete this chapter, you will be able to:

1. Describe the parts of the valves on which material classification of valves is based.
2. Compare how manufacturers' catalogs organize multi-turn valves and quarter-turn valves.
3. Explain how the NPS of a valve end connection is related to the NPS of the line in which it is to be installed.
4. Identify the location of valve material pressure-temperature application limits.
5. Identify the location of standards for taper pipe thread.
6. Name organizations which set standards.



VALVE CLASSIFICATION



Valve Classification

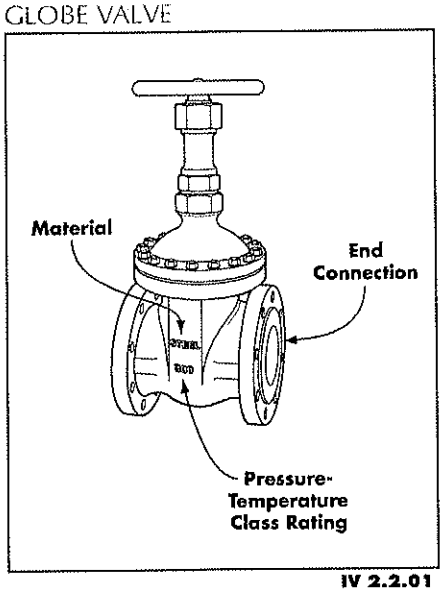
The previous chapters looked at the basic valve designs and the functions valves serve. You have already studied how valves are classified by type, design variations, and function. Now you will study how valves are classified by material, end connections, and pressure-temperature ratings. You'll also learn about the various organizations that set standards.

Some common valve problems are discussed, as well as how to prevent those problems from occurring. Let's begin by taking a closer look at valve materials.

Material as a Valve Classification

Manufacturers generally organize valve catalog literature for multi-turn valves differently from quarter-turn valves. In the multi-turn category, the literature is usually organized by **VALVE MATERIAL**, such as bronze, brass, cast iron, ductile iron, carbon steel, stainless steel, and thermoplastics. In the quarter-turn category, the literature is usually organized by **VALVE TYPE**, such as ball, butterfly, or plug.

GLOBE VALVE



IV 2.2.01

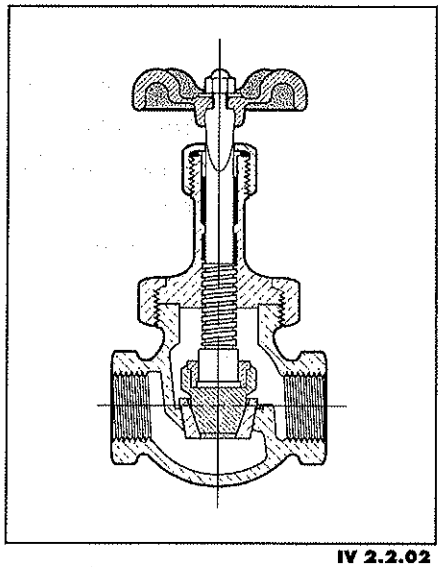
The internal elements of a valve are collectively known as **VALVE TRIM** and are usually made of different material from the valve body. The trim typically includes a disk, seat, stem, and sleeves needed to guide the stem.

The illustration on the next page shows an **INSIDE VIEW OF ONE TYPE OF BRONZE GLOBE VALVE**. The valve body and bonnet are made of bronze. Bronze is a term used for some copper alloys. The bonnet houses the packing that helps seal the stem.

The trim is composed of different materials. In this case, the trim includes the stem, the seat ring, and the disc/wedge. The stem is usually made of a copper alloy other than that used for the body.

The separate seat ring design is specified for throttling, blow-off, and frequent operation. The seat ring and disc are usually made of hardened stainless steel. The material classification, based on the valve body of this valve, is bronze.

INSIDE VIEW OF BRONZE GLOBE VALVE

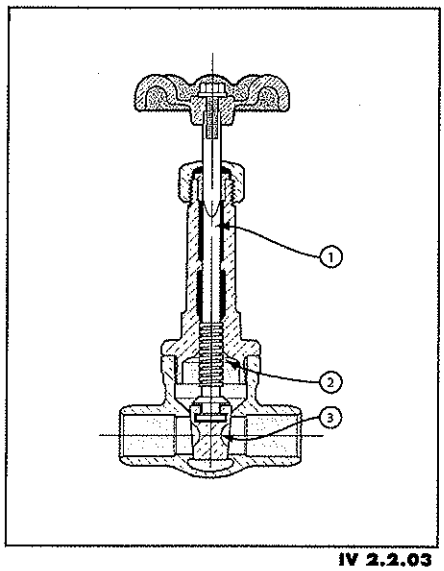


IV 2.2.02

When selecting a valve, you must consider the valve body and bonnet materials and the trim material. Valve trim is exposed to flow media and is subject to wear during operation. The trim is selected to have equal or better corrosion resistance than the valve body.

To help prevent corrosion of the parts, plastic or rubber-like compounds can be used for seats and seals instead of metal. Most quarter-turn valves use these materials for valve seats, while multi-turn valves are more likely to use corrosion-resistant metal seating materials. If the flow media is a corrosive fluid, all valve parts that come into contact with the flow media must be considered for material selection.

INSIDE VIEW OF BRONZE GATE VALVE



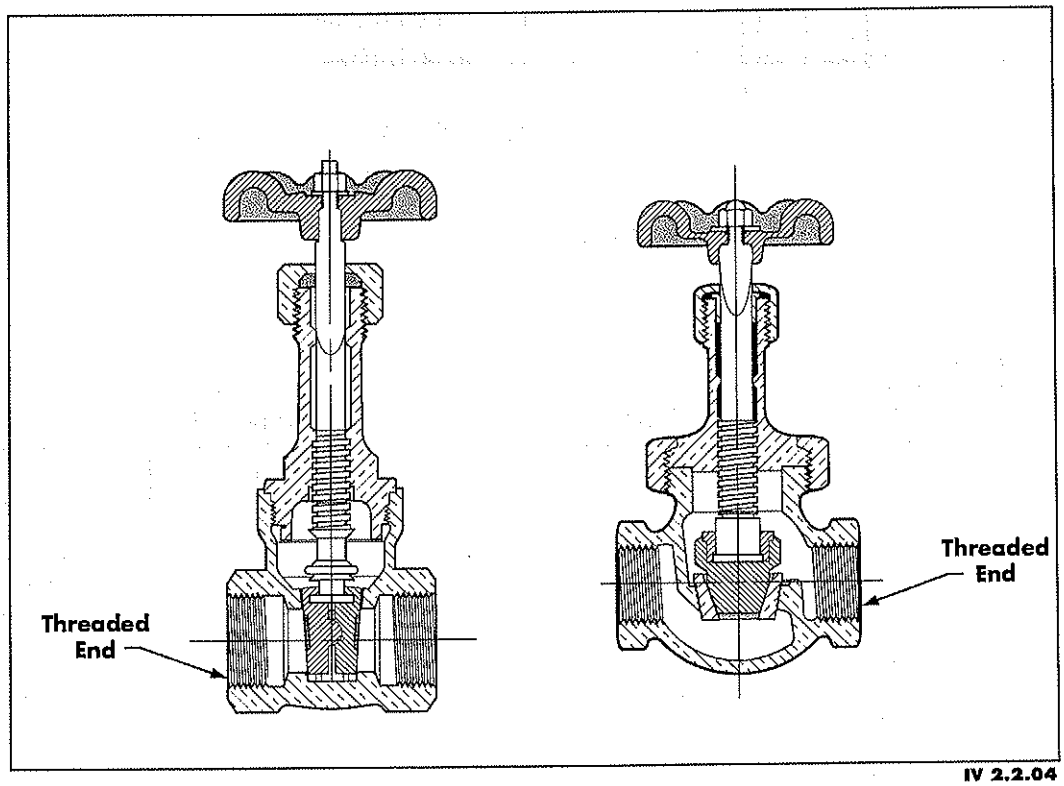
IV 2.2.03

The following illustration presents an **INSIDE VIEW OF A BRONZE GATE VALVE**. Here the trim includes the (1) stem, (2) integral stem backseat, and (3) wedge disc.

End Connection as a Valve Classification

Valve size is stated by the **NOMINAL PIPE SIZE (NPS)** of the ends of the valve body, which are connected to the pipe ends. NPS has a consistent outside diameter which stays consistent regardless of pipe schedules (wall thickness.) The valve material and the line size will determine the type of end connection. There are a number of different types of end connections available.

VALVE WITH THREADED ENDS

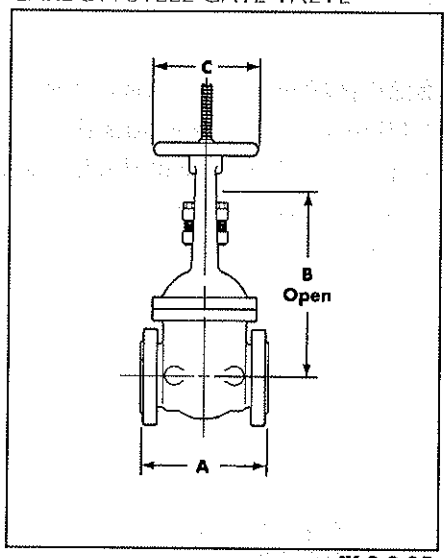


The illustration shows two views of a **VALVE WITH THREADED ENDS.** Threaded ends may also be called "screwed" ends. Generally, the term "threaded" is more commonly used today than "screwed."

The NPS of the valve end connections must always match the NPS of the line in which it is to be installed (i.e., 3-inch valve matches up with 3-inch pipe.)

When the end connection is threaded, National Pipe Thread (NPT) and International Pipe Standard (IPS) are size standards used to define the outside diameter of the pipe and of the thread. IPS is most commonly used.

CARBON STEEL GATE VALVE



IV 2.2.05

Let's look now at the dimensions of the different size valves, using NPS to identify the sizes. Assume that your client has a **CARBON STEEL GATE VALVE** as shown in the illustration. If the client has an NPS 24 line, a 2,610-lb valve with these dimensions is needed:

A. 20.00 inches
B. 104.00 inches
C. 36.00 inches

The NPS 24 line requires an NPS 24 valve-end connection.

CHART

Valve	Weight	Dimensions (in.)		
NPS	(lbs.)	A	B	C
18	1,560	17.00	83.00	30.00
20	1,780	18.00	91.00	30.00
24	2,610	20.00	104.00	36.00
30	4,250	24.00	127.62	36.00
36	6,300	28.00	149.75	36.00
42	9,975	32.00	176.12	36.00
48	13,000	36.00	205.50	42.00

Pressure-Temperature Ratings as a Valve Classification

Each type of valve material has published pressure and temperature limits. If the valve is exposed to pressures and temperatures that exceed the specified limits, the valve will not work properly. In addition, it will probably not be covered by the valve manufacturer's warranty.

When pressure or temperature limits have been exceeded, there is danger of damaging or ruining the valve. In some cases, there is a danger of harmful and even fatal accidents occurring from pressure explosions.

Temperature limits for valve materials are established by codes and standards bodies such as ASME and MSS. Manufacturers also list these limits in their catalogs. Temperature limitations on valve materials are shown in the chart on the right.

TEMPERATURE LIMIT CHART

Range	Temperature (F)	Material
Very high	2,000	Refractory
High	1,600 1,200	High Tempearture Alloy Steels
Intermediate	1,000 650 550 450 150	Carbon Steel Ductile Iron Bronze Cast Iron Plastic
Low	-250	Low Alloy Steel Bronze
Very low (Cryogenic)	-450	Bronze, Austenitic Ductile Iron, Austenitic Stainless Steel

Standards Developed for Valves

A **STANDARD** can be defined as a set of technical definitions and guidelines, "how to" instructions for designers, manufacturers, and users. Standards promote safety, reliability, productivity, and efficiency in almost every industry that relies on engineering components or equipment. Standards can run from a few paragraphs to hundreds of pages, and are written by experts with knowledge and expertise in a particular field who sit on many committees.

Plastic valves are governed by different standards than metal valves. We will not discuss the rating systems for plastic valves in this course. Contact your plastic valve manufacturers for more information about these valves. In addition to the previously described valve classifications, valves are further described by standards developed by national standardization bodies so that the valve can be classified as to its limiting pressure and temperature service.

Founded in 1880 as the **AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)**, today's ASME is a 140,000-member professional organization in 51 countries focused on technical, educational, and research issues of the engineering and technology community. ASME conducts one of the world's largest technical publishing operations, holds numerous technical conferences worldwide, and offers hundreds of professional development courses each year. ASME sets internationally recognized industrial and manufacturing codes and standards that enhance public safety and cover pressure-temperature ratings, materials, dimensional requirements, limitations, and testing. This also includes standards for end connections, pipe threads, and end-to-end dimensions.

Standards are considered voluntary because they serve as guidelines, but do not have the force of law. ASME cannot force any manufacturer, inspector, or installer to follow ASME standards. Standards become mandatory when they have been incorporated into a business contract or regulations.

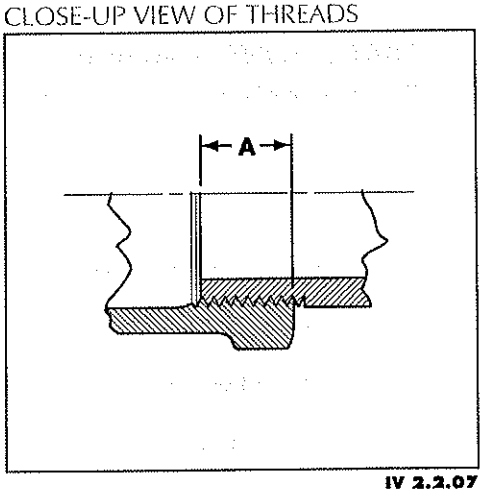
Founded in 1924, the **MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)** is a non-profit technical association organized for development and improvement of industry, national, and international codes and standards for valves, valve actuators, pipe fittings, valve modification, flanges, pipe hangers, and associated seals. The primary function of MSS is to provide its members the means to develop engineering standard practices for the use and benefit of the industry and users of its products.

Organized in 1898, **ASTM INTERNATIONAL**, originally known as the American Society for Testing and Materials (ASTM), is a globally recognized leader in the development and delivery of international voluntary consensus standards. Today, some 12,000 ASTM standards are used around the world to improve product quality, enhance safety, facilitate market access and trade, and build consumer confidence. It began when a group of engineers and scientists got together to address frequent rail breaks in the burgeoning railroad industry. ASTM International is a not-for-profit organization that sets technical standards for materials, products, systems, and services, including the chemical and physical properties of valve materials. You should be familiar with the general specification areas governed by these groups.

Other important valve specification writing groups include various industry sectors. Established in 1881, the **AMERICAN WATER WORKS ASSOCIATION (AWWA)** is the largest nonprofit, scientific and educational association dedicated to managing and treating water, the world's most important resource. With approximately 50,000 members, AWWA provides solutions to improve public health, protect the environment, strengthen the economy and enhance our quality of life.

Threaded end valves are threaded with taper pipe threads that conform to American Society of Mechanical Engineers (ASME) standards.

CLOSE-UP VIEW OF THREADS



IV 2.2.07

These threads have been identified as **NATIONAL PIPE THREAD (NPT)**. Threads frequently are identified by their **INTERNATIONAL PIPE STANDARD (IPS)**. A male IPS or female IPS defines the thread and the diameter of the pipe.

Another key standards organization is the **AMERICAN PETROLEUM INSTITUTE (API)**. It is the only national trade association that represents all aspects of America's oil and natural gas industry. Our more than 600 corporate members, from the largest major oil company to the smallest of independents, come from all segments of the industry. They are producers, refiners, suppliers, pipeline operators and marine transporters, as well as service and supply companies that support all segments of the industry. There are some API standards concerning the design and testing of various valve types for use in the petroleum and chemical industries. Many times API standards will also be dimensional such as end-to-end dimension. End-to-end is the same on all cast steel valves.

You will also find valves designated as NACE valves. **NACE** stands for the **NATIONAL ASSOCIATION OF CORROSION ENGINEERS**, which was founded in 1943. Now called "NACE International, The Worldwide Corrosion Authority," it serves nearly 33,000+ members in 116 countries and is recognized globally as the premier authority for corrosion control solutions. Although NACE valves are generally not standard stock items for distributors, you should know a little about the NACE valves your company may sell.

NACE valves may look like the traditional valves we have seen, but they comply with NACE standard MR-01-75 for some service. They meet all the material requirements outlined therein.

One of the requirements for NACE valves is the special valve-bolting material for use in gas and oil production. This material enables the valve to resist sulfide stress-corrosion cracking that might be caused by high sulfur crudes.

In the next chapter, you'll look at some factors that determine valve material and how an application is matched to valve material.

REVIEW QUIZ – VALVE CLASSIFICATION

Answers appear on page 162

DIRECTIONS: Carefully read each question and circle the correct answer. There is only one correct answer per question. When you have finished, check your answers.

1. Valves may be classified in all of the following ways EXCEPT
   a. Type
   b. Material
   c. Substance
   d. Function

2. When valve material is used to classify valves, the classification generally refers to the valve's
   a. stem.
   b. body.
   c. trim.
   d. seat ring.

3. The valve's trim includes all of the following parts EXCEPT
   a. Stem
   b. Seat ring
   c. Bonnet
   d. Disc

4. When selecting a valve, why must you also consider the trim material?
   a. It comprises the largest part of the valve.
   b. It helps prevent corrosion during operation.
   c. It is exposed to flow media and subject to wear during operation.
   d. It is usually made of different material than the body.

REVIEW QUIZ – VALVE CLASSIFICATION

Answers appear on page 162

5. In what way is valve catalog literature organized differently for multi-turn and quarter-turn valves?
   a. Multi-turn valves appear first in most manufacturer's catalogs.
   b. Multi-turn valves are organized by function.
   c. Quarter-turn valves are listed by valve material.
   d. Quarter-turn valves are organized by valve type.
6. What does the Nominal Pipe Size (NPS) measure?
   a. Outside diameter of the pipe
   b. Length of the pipe
   c. Inside diameter of the pipe
   d. Width of the pipe
7. It is important to know the pressure and temperature limits of a valve to
   a. explain the uses to customers.
   b. prevent unnecessary valve damage or accidents.
   c. properly select the need valve.
   d. cover the manufacturer's warranty.
8. Which of the following groups writes standards for the chemical and physical properties of valve materials?
   a. ASTM International
   b. American Society of Mechanical Engineers (ASME)
   c. Manufacturers Standardization Society (MSS)
   d. American Water Works Association (AWWA)
9. What does International Pipe Standard (IPS) define?
   a. Design of the pipe and pipe thread
   b. Size of the pipe and valve end connection
   c. Specifications for pipe and pipe thread
   d. Dimensions of stock pipe

REVIEW QUIZ – VALVE CLASSIFICATION

Answers appear on page 162

10. NACE valves conforming to MR-01-75 are different from general purpose valves because they must
    a. provide pressure control functions.
    b. withstand more rigorous tests.
    c. meet special material requirements.
    d. be standard stock items.

APPLYING WHAT YOU HAVE LEARNED:

By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.

A. Which national standards body develops standards for most of the valves your company sells?

_____

_____

_____

B. Based on your reading and general knowledge of valves, why are plastic valves governed by different standards than metal valves?

_____

_____

_____

ANSWERS TO REVIEW QUIZ

CHAPTER 8

VALVE CLASSIFICATION

Answers to Review Questions: Valve Classification

1. c. Substance
2. b. body.
3. c. Bonnet
4. c. It is exposed to flow media and subject to wear during operation.
5. d. Quarter-turn valves are organized by valve type.
6. c. Inside diameter of the pipe
7. b. prevent unnecessary valve damage or accidents.
8. a. ASTM International
9. b. Size of the pipe and valve end connection
10. c. meet special material requirements.

APPLYING WHAT YOU HAVE LEARNED:

A. Answers will vary by company.

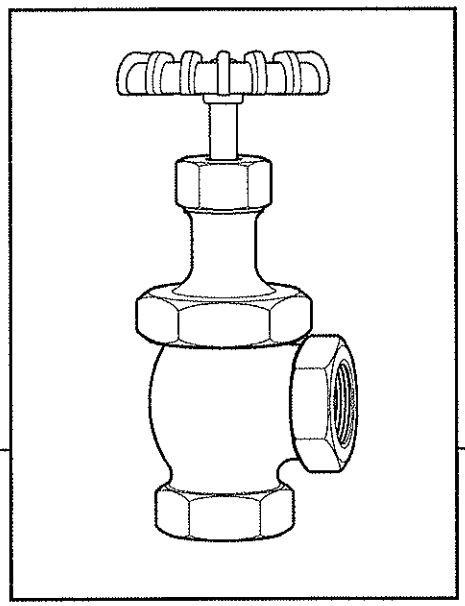
B. Answers may vary but students should note that there are many variables that affect the success or failure of plastic material with any given chemical, including concentration, temperature, and the specific compound of plastic. Not every pipe is suitable for every application. Plastic compounds vary among manufacturers and the design also affects compatibility.

9 VALVE MATERIAL

LEARNING OBJECTIVES

When you successfully complete this chapter, you will be able to:

1. Identify the factors that determine valve material.
2. Demonstrate how a chart can assist in the selection of valve material that matches material applications.
3. Compare and contrast the uses of the following valve materials: bronze, iron, steel, and plastic.



VALVE MATERIAL

Valve Material

To start this section on valve materials, let's look at factors that can determine the valve material. We will then look at a chart that matches the valve's application to the valve material. Finally, we will look at the various materials used for valves. You will see that valve bodies may be of different material than valve trim.

Factors that Determine Valve Material

Factors that can determine valve material include flow media, corrosion resistance, temperature limits, function, and cost. Each factor should be carefully considered.

Manufacturers will provide information to aid your customers in selecting the right valve for an application. For example, valve materials recommended for use with flow media that is corrosive can be supplied in the form of reference selection charts similar to the Service Condition Factors table shown below. Such charts cover a limited number of materials. It is safest to double-check the application with the valve manufacturer.

SERVICE CONDITION FACTORS

The substance or media flowing through a valve will often determine the type of valve material.	FLOW MEDIA: Liquids, gases, liquids with solids
Some valve materials are best suited for corrosion resistance to fluid substances.	CORROSION RESISTANCE: Crystallizing, corrosion, erosion
Some materials are better suited for high temperatures.	TEMPERATURE LIMITS: High or low temperatures High or low pressure
Function is important in valve selection.	FUNCTION: On/off or throttling
Some materials are selected when low cost is important.	COST: Higher or lower

Look at the **Corrosive Media Selection Chart** that follows. If the flow media were ethers, more than one type of valve material would be suitable. Always try to select the best valve material recommended. Remember, however, that the decision is best left to qualified engineers.

CORROSIVE MEDIA SELECTION CHART

	Metal Resistance				Seals / Sleeves Resistance			
Media	Bronze	Cast Iron	WCB Steel	316 S.S.	BUNA	EPDM	Viton™	Teflon™
Acetate Solvents	G	G	G	G	U	U	U	E
Aceton	E	G	G	E	U	E	U	E
Alcohol, Methyl	E	G	G	E	U	E	U	E
Ammonium Chloride	U	U	U	F	G	G	E	E
Ammonium Sulfate	F	U	F	F	E	E	E	E
Beet Sugar Liquors	G	G	G	E	E	G	E	E
Borax (Sodium Borate)	G	G	F	E	G	G	E	E
Boric Acid	F	U	U	G	E	G	E	E
Calcium Bisulfate	F	U	U	G	E	U	E	E
Calcium Hydroxide	U	U	U	G	E	E	E	E
Carbon Tetrachloride	G	F	G	E	F	U	E	E
Chlorinated Solvents (Dry)	G	U	G	G	U	U	F	E
Chlorine gas-Wet	U	U	U	U	U	U	G	E
Ethers	E	G	G	E	U	U	F	E
Ethyl Chloride	G	G	G	E	U	U	F	E
Formaldehyde	E	G	G	E	G	U	G	G
Fuel Oil	G	G	G	E	E	U	E	E
Glycerine	E	E	G	E	E	U	E	E
Lacquers	E	G	G	E	U	U	U	E
Natural gas	G	G	G	E	E	U	E	E
Nitric-Acid-Deluxe	U	U	U	G	U	F	E	E
Sodium Carbonate	G	G	F	E	E	G	E	E
Toloul; Tolvene	E	E	E	E	U	U	G	E
Water, Fresh	E	G	F	E	G	E	E	E

E = Excellent | G = Good | F = Fair | U = Unsatisfied

Types of Valve Material

Valve materials include:

- bronze
- iron: both cast and ductile
- steel: forged, cast, or stainless
- plastic: for valves and seals

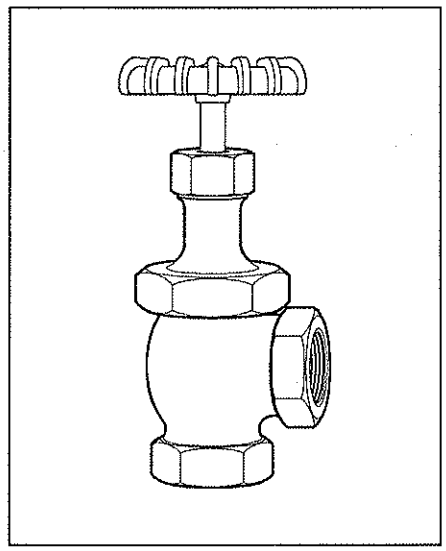
Each of these materials is described briefly in the sections that follow.

Bronze Valves

Bronze valves are usually made by pouring a copper alloy into sand molds. This is a cost-effective manufacturing process. The castings are then machined, assembled, and tested. Brass is a specific bronze alloy.

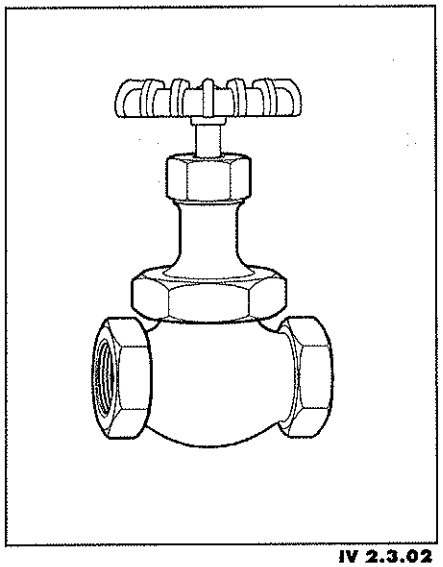
Bronze valves for large line sizes are generally made as specials. Bronze is also commonly used as trim material in iron valves.

ANGLE VALVE



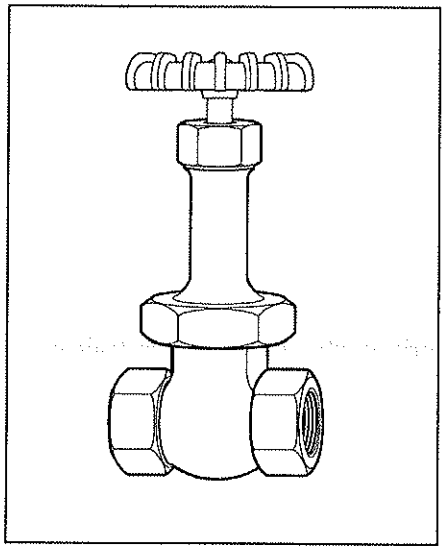
IV 2.3.01

GLOBE VALVE



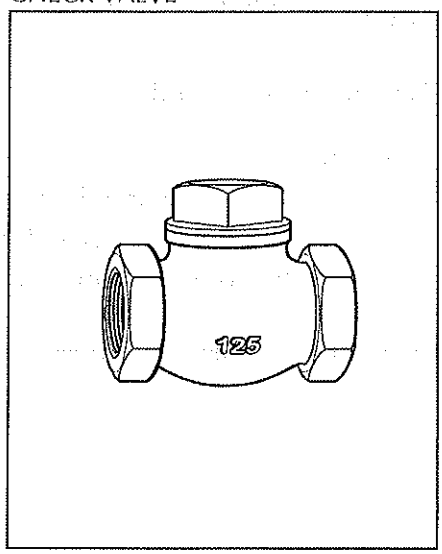
IV 2.3.02

GATE VALVE



IV 2.3.03

CHECK VALVE



IV 2.3.04

Bronze valves are commonly used for plumbing, heating and air-conditioning non-spec applications or for use in water supply systems. Bronze valves are generally selected when the line size is under 3" and low cost and availability are important. The most common types of bronze valves are shown in the first four illustrations of this chapter.

Cast Iron Valves

Valves are also made of iron. These may be gray cast iron, ductile cast iron, or malleable cast iron. Most often, iron valves are made of gray cast iron.

Some of the trim material used for cast iron valves may be made of the same material as that used for the valve body. In some cases trim material selection is a matter of valve size.

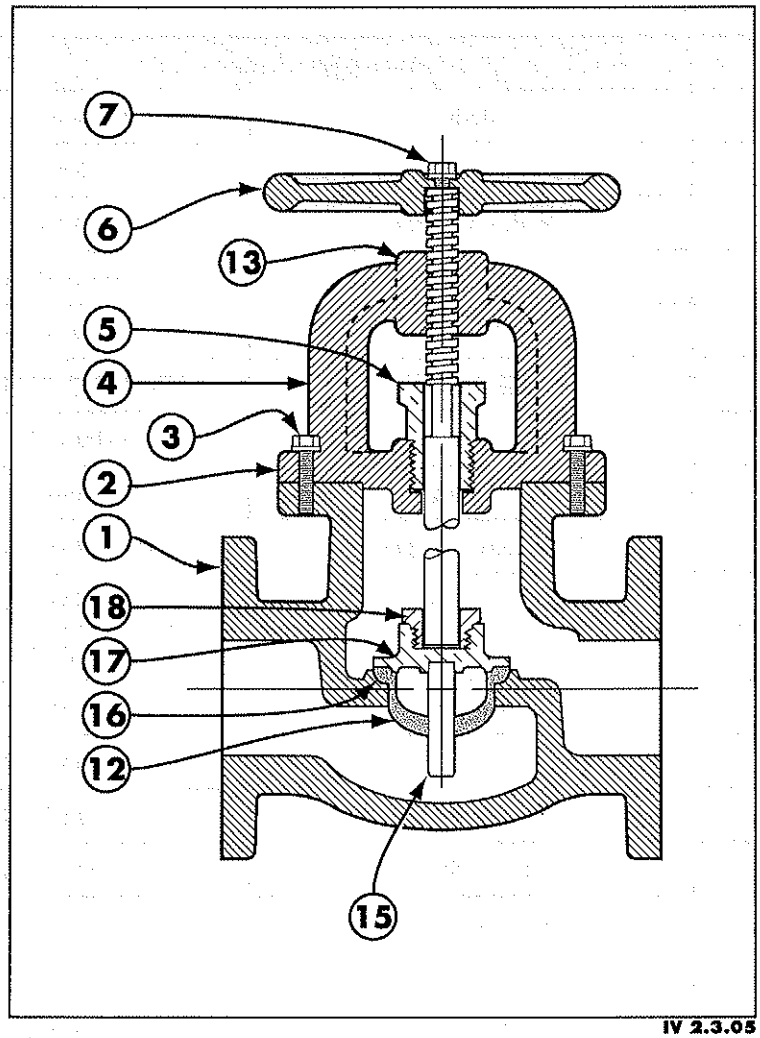
Look at one manufacturers' **GRAY CAST IRON SPEC SHEET** on the next page.

GRAY CAST IRON SPEC SHEET

Material Specifications		
1	Body	ASTM A126 CL B Iron
2	Gasket	Non-asbestos
3	Body Cap Screw	ASTM A307 Gr B Steel
4	Bonnet	ASTM A126 Cl B Iron
5	Gland	ASTM A126 Cl B Iron
6	Hand wheel	ASTM A47 Gr 32510 Malleable Iron
7	Nut	ASTM A307 Gr B Steel
8	Packing	Graphited Non-asbestos
9	Gland Stud (Zinc plated)	ASTM A575 Gr 1015-1023 Steel
10	Yoke Nut	ASTM B62 Bronze
11	Stem	ASTM B584 Alloy 564 Bronze
12	Seat Ring	ASTM B61 Bronze
13	Yoke nut locknut 3-1/2" & up	ASTM B62 Bronze
14	Gland Stud Nut	ASTM B16 Rod Brass
15	Guide Stem	ASTM B16 Rod Brass
16	Disc Ring 5" & up	ASTM B61 Bronze
17	Disc 2" - 4"	ASTM B61 Bronze
	5" & up	ASTM A126 CL B Iron
18	Swivel Nut	ASTM B62 Bronze

Use the gray cast iron valve spec sheet to identify what valve parts are made of the valve body material in the following cutaway of a cast iron valve. The answers appear at the bottom of the page.

CUTAWAY OF A CAST IRON VALVE



Iron Valves

While there are no size limitations for iron valves, these valves have temperature limits. Subject to any manufacturers' imposed limit, gray cast iron has a temperature limit of approximately 450°F and ductile iron has a limit of 650°F.

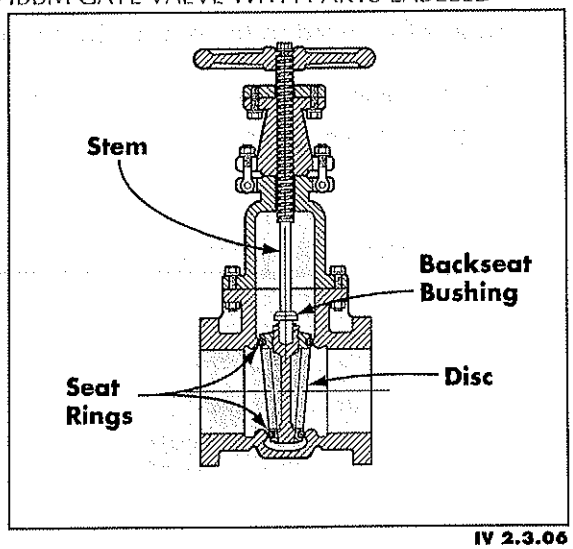
Answers: (1) Body; (2) Bonnet; (3) Gland; (4) Disc

Cast Iron and Bronze Trim

Gate and globe valves will often be furnished with trim materials that are different from the body-bonnet materials.

A common trim material combination for gray cast iron valves is known as **IBBM**, which refers to "iron body, bronze mounted." An IBBM gate valve (shown in illustration) has a gray cast iron body and bonnet. However, the seat rings, disc facings, stem and backseat bushing are all made with bronze. "Bronze mounting" is also known as "bronze trim." Trim materials are used to prolong the life of mounted seating parts and valve stems.

IBBM GATE VALVE WITH PARTS LABELED



IV 2.3.06

All-iron Valves

Another common name for gray cast iron valves is "all-iron." These valves have iron bodies, gray cast iron disc and seat trim faces, and carbon steel stems.

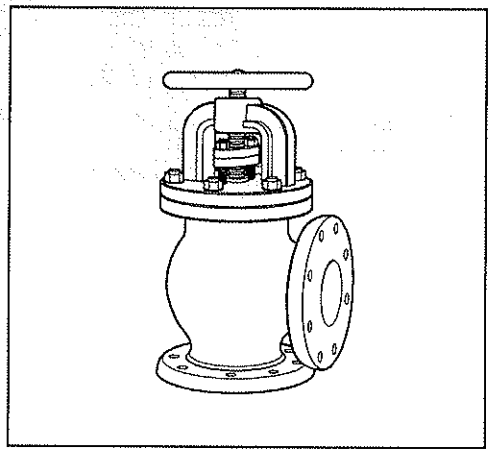
All-iron valves are used for situations in mostly alkaline or acid solutions. These valves make a better choice when media being handled would corrode bronze internal trim items. Consult the valve manufacturer avout specific applications.

Ductile Iron

DUCTILE IRON is also used to make valves. Other names for ductile iron are **NODULAR IRON** (see illustration) and **SPHEROIDAL IRON**. Ductile iron is most often used in the marine industry and for underground pipelines.

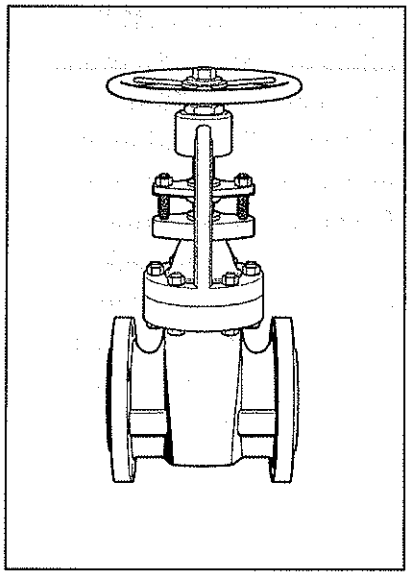
Ductile iron has good corrosion resistance in a marine environment and is less brittle than cast iron.

NODULAR IRON VALVE



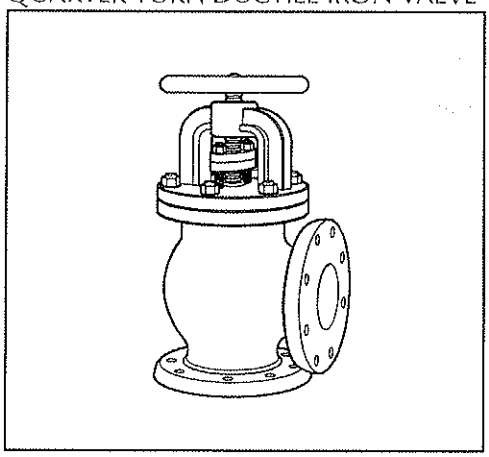
IV 2.3.07

DUCTILE IRON VALVE



IV 2.3.08

QUARTER TURN DUCTILE IRON VALVE



IV 2.3.09

Valves made of ductile (nodular) iron include the gate, globe, check, and angle valves (multi-turn valves). Some quarter-turn valves can also be made of ductile iron. You may find some butterfly, ball, and plug valves made of ductile iron. A type of quarter-turn valve that can be made of ductile iron is shown in the **QUARTER TURN DUCTILE IRON VALVE** illustration above.

Ductile Iron and Different Trim

When ductile iron is used in making resilient-seated butterfly valves, some manufacturers use ductile iron for the valve body and may use another material for the valve disc. The discs may be made of aluminum bronze, ductile iron, stainless steel, or other materials.

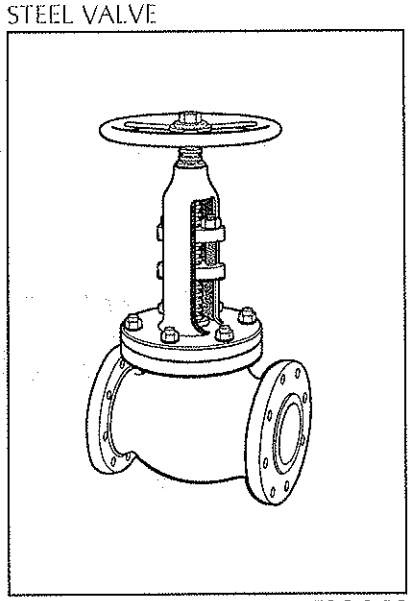
Butterfly valves can also be provided with different stem material, such as stainless steel (types 410, 416, or 316). Seats are also furnished in a variety of materials, such as Buna-N, Teflon™, EPDM, Hypalon™ and Viton™.

Steel Valves

Valves are also made of steel. In the vocabulary of the valve industry, "steel" carries two meanings. It is often used to identify carbon steel valves and is also used to identify a broad range of steel materials that include carbon steels, low-alloy steels, and high-alloy steels. The latter are frequently identified as stainless steel.

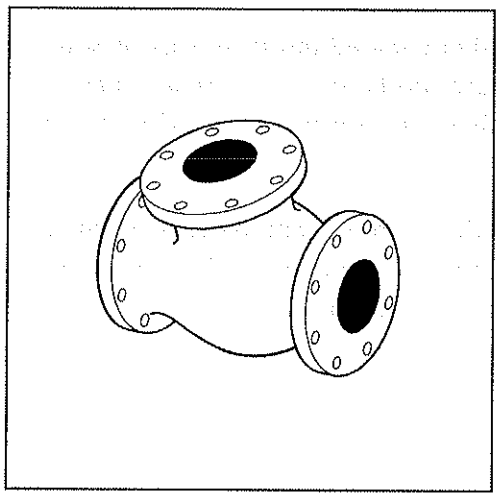
STEEL VALVES can be further identified by how the valve is made: forged steel or cast steel. The former applies mostly to small steel valves.

STEEL VALVE



IV 2.3.10

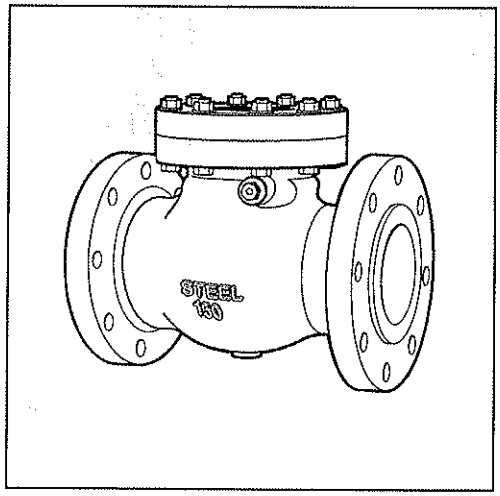
FORGED STEEL VALVE



IV 2.3.11

Forged steel is formed from heated slugs, which are forged into the valve shape by huge forging hammers and presses. **FORGED STEEL VALVES**, such as the one illustrated, are used when high pressures and temperatures are involved and the line size is generally under NPS 2 or NPS 2-1/2. It is not cost effective to forge over NPS 2-1/2, but it may be preferable because of the higher structural integrity of the forgings.

STEEL CHECK VALVE FOR THE PETROLEUM INDUSTRY



IV 2.3.12

Cast Steel Valves

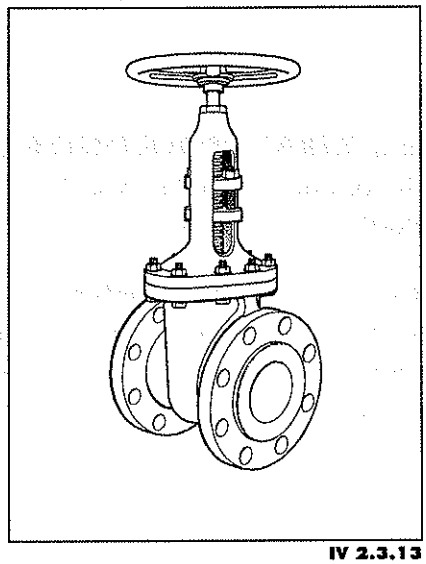
CAST STEEL VALVES (see illustration) are generally used on line sizes over NPS 2 when higher pressures and temperatures demand the use of carbon or alloy steel, and casting is more cost effective than forging. Cast steel is melted in a furnace and then poured into molds in a foundry.

Stainless Steel Valves

STAINLESS STEEL VALVES are also frequently used for industrial applications. Stainless steel is used when corrosion is a problem. Gate, globe, and check valves are three common types of stainless steel corrosion-resistant valves.

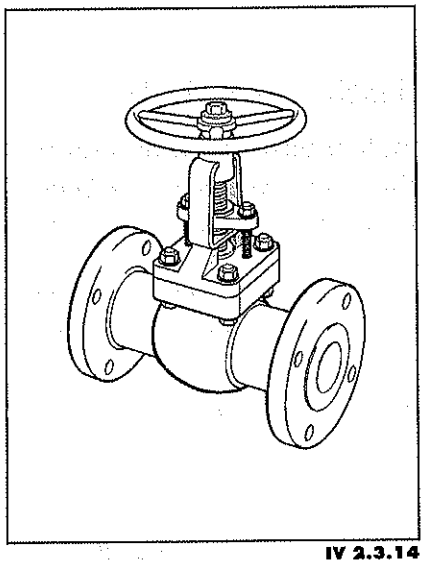
These corrosion-resistant valves are used in chemical process industries, petroleum refining, petrochemical, pulp and paper, and electric utility industries. The following images illustrate two views of a stainless steel valve.

STAINLESS STEEL VALVE



IV 2.3.13

STAINLESS STEEL VALVE (ALTERNATE VIEW)



IV 2.3.14

There are many grades of stainless steel; AISI Type 316 is the most common.

Plastic Valves

The chemical industry and other industries use plastic valves. The most common types of thermoplastic used are **CHLORINATED POLYVINYL CHLORIDE (CPVC), POLYVINYL CHLORIDE (PVC), KYNAR (PVDF)**, and **POLYPROPOLENE**.

PVC is the most common plastic used in manufacturing valves. It is the most economical and can be used for more applications than other plastics. PVC's strength, durability, easy installation, and low cost have made it one of the most widely used plastics in the world. However, PVC is limited to temperatures of 140°F.

CPVC, a "cousin" of PVC, is altered by a free radical chlorination reaction that effectively increases the chlorine content of the material. This difference in makeup allows CPVC to withstand a wider range of temperatures. The CPVC valve can handle temperatures of up to 200°F.

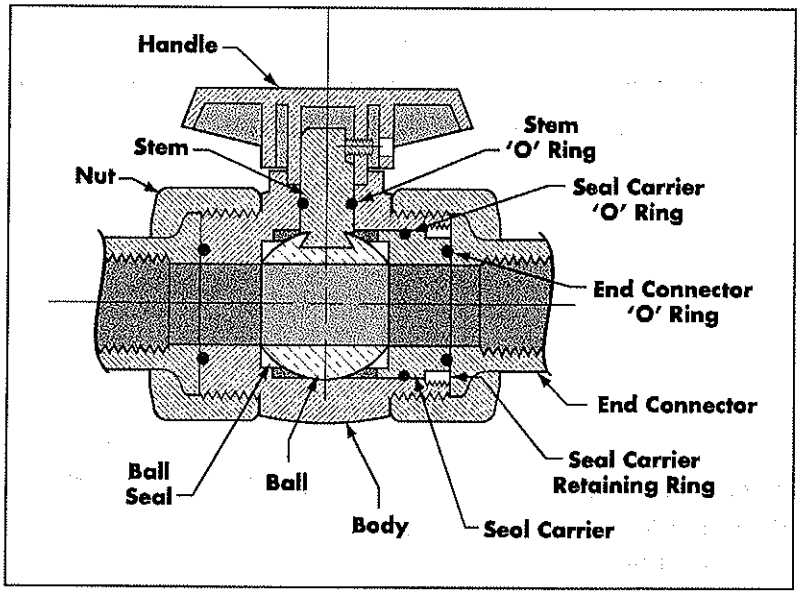
Though PVC and CPVC both are resistant to many of the same chemicals, some are best handled by one or the other. Consult a chemical compatibility chart to be sure the piping materials you choose will work with your unique application.

Plastic Seals, TFE

Another term you'll find for plastic seals is **TETRAFLUOROETHELYENE (TFE)**, which is better known as Teflon™. TFE is commonly used as a seal material in quarter-turn valves such as the ball, butterfly, or plug valve.

At one time, the industry used synthetic rubber elastomers for the seal material in metal ball valves. Plastic materials are more commonly used today because the material has a higher temperature limit. Synthetic rubber may be limited to 200°F, while plastics such as TFE may be used to 450°F .

PLASTIC SEAL, TFE



IV 2.3.15

REVIEW QUIZ – VALVE MATERIAL

Answers appear on page 182

DIRECTIONS: Carefully read each question and circle the correct answer. There is only one correct answer per question. When you have finished, check your answers.

1. All of the following are reasons to select bronze valves EXCEPT
   a. Low cost
   b. Line size
   c. Availability
   d. Low temperature
2. Which kind of iron is most often used for valves?
   a. Ductile cast iron
   b. Gray cast iron
   c. Malleable cast iron
   d. All-iron
3. Under what temperature conditions would ductile iron serve as a better valve material than cast iron?
   a. When the application temperature limit exceeds 450° but is under 650°
   b. When the application temperature limit exceeds 650°
   c. When the application limit is lower than 450°
   d. When the application limit is 500°
4. What is the difference between IBBM and all-iron valves?
   a. IBBM valves are used for marine applications; all-iron valves are not.
   b. All-iron valves have a carbon steel stem.
   c. The trim material of IBBM valves is different from its body.
   d. IBBM are a better choice for fluids that could corrode bronze.

REVIEW QUIZ – VALVE MATERIAL

Answers appear on page 182

5. Which type of valve is frequently used in a marine environment?
   a. Grey cast iron valves
   b. Steel valves
   c. Plastic valves
   d. Ductile iron valves

6. All of the following quarter-turn valves can be made of nodular iron EXCEPT
   a. Butterfly valve
   b. Globe valve
   c. Plug valve
   d. Ball valve

7. In which of the following conditions should a customer select a forged steel valve?
   a. When low pressure and low temperatures are involved
   b. When the line size is over NPS 2 or NPS 2-1/2
   c. When high pressure and high temperatures are involved
   d. When low cost is an important consideration

8. In applications where corrosion is a problem, what type of material is frequently used for valves?
   a. Cast steel
   b. Stainless steel
   c. Cast iron
   d. Ductile iron

9. When low cost is important and temperatures are below 140°, which of the following materials are commonly used for valves?
   a. All-iron
   b. Cast steel
   c. Stainless steel
   d. Plastic

REVIEW QUIZ – VALVE MATERIAL

Answers appear on page 182

10. What is the approximate temperature limit of a CPVC valve?
    a. 140° F to 160° F
    b. 160° F to 185° F
    c. 185° F to 200° F
    d. 185° F to 250° F

APPLYING WHAT YOU HAVE LEARNED:

By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.

A. Based on your experience and what you have read, why is it important for you to select the valve material that best fits the application?

_____

_____

_____

B. Based on your reading and general knowledge of valves, list the five factors a customer should consider when purchasing any valve.

_____

_____

_____

ANSWERS TO REVIEW QUIZ

CHAPTER 9

VALVE MATERIAL

Answers to Review Questions: Valve Material

1. d. Low temperature
2. b. Gray cast iron
3. a. When application temperature limit exceeds 450° but is under 650°
4. c. The trim material of IBBM valves is different from its body.
5. d. Ductile iron valves
6. b. Globe valve
7. c. When high pressure and high temperatures are involved
8. b. Stainless steel
9. d. Plastic
10. c. 185° F to 200° F

APPLYING WHAT YOU HAVE LEARNED:

A. The material determines whether the valve can handle the application.

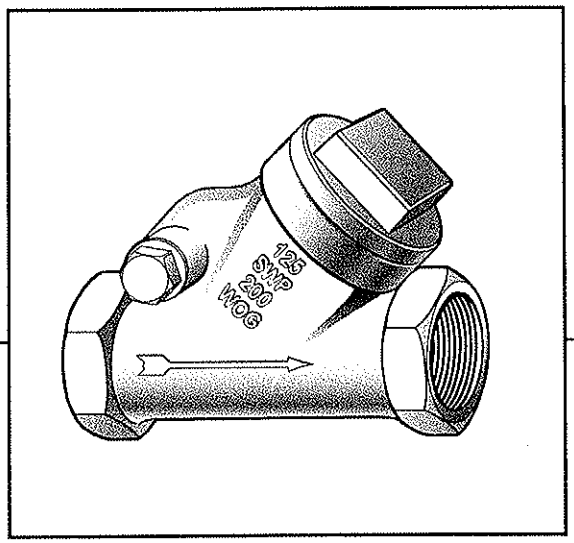
B. Flow media, corrosion resistance, temperature limits, function, and cost.

10 END CONNECTIONS

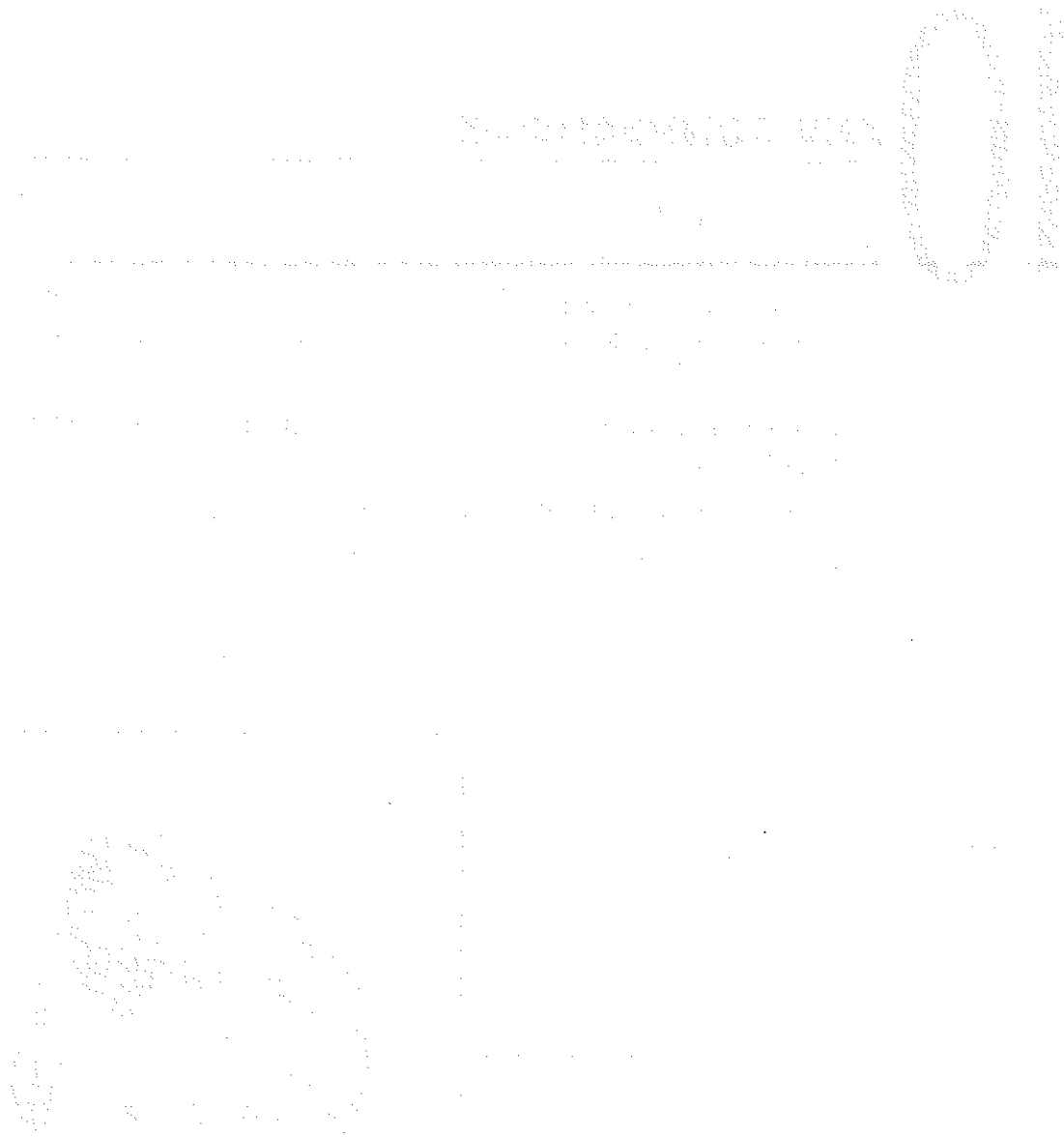
LEARNING OBJECTIVES

When you successfully complete this chapter, you will be able to:

1. Compare the following end connections and their uses: threaded end, grooved end, solder or brazed end, and flanged end connections, and welding.
2. Distinguish among the various facings of flanged-end connections and their functions.
3. Compare wafer butterfly valves to flanged gate valves.
4. Describe the two types of welding connections and their uses.



END CONNECTIONS



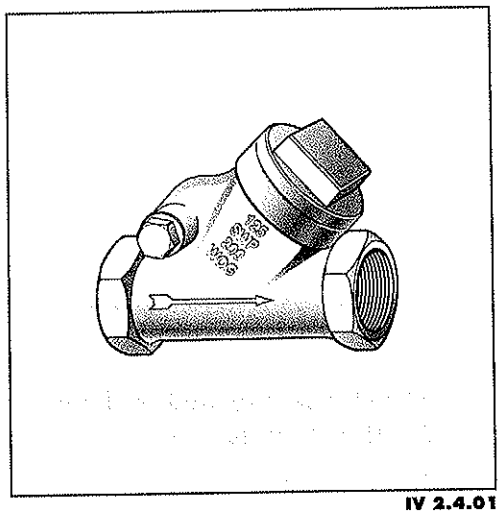
End Connections

This section focuses on valve end connections. Facings, gaskets, and bolting specs are also covered. Five major types of end connections are discussed here: threaded, grooved, soldered or brazed, flanged, and welding end connections.

Threaded End Valve Connections

THREADED END CONNECTIONS are the least expensive connections, are easily installed, and are suitable for low pressure piping systems. In some cases, these connections may be welded around the joint after they are assembled. However, this is not usually done as it may cause some troubles in the efficient use of these types of valve end connections. The threaded ends have internal taper pipe threads for joining to threaded pipe. It is important not to over-tighten the pipe into the valve. The valve illustrated on the right has threaded ends.

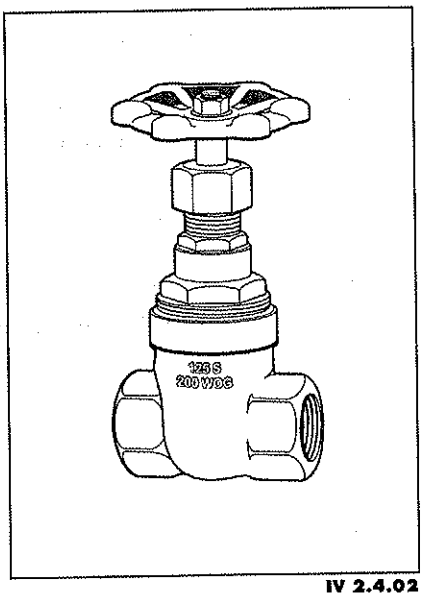
CHECK VALVE WITH THREADED ENDS



IV 2.4.01

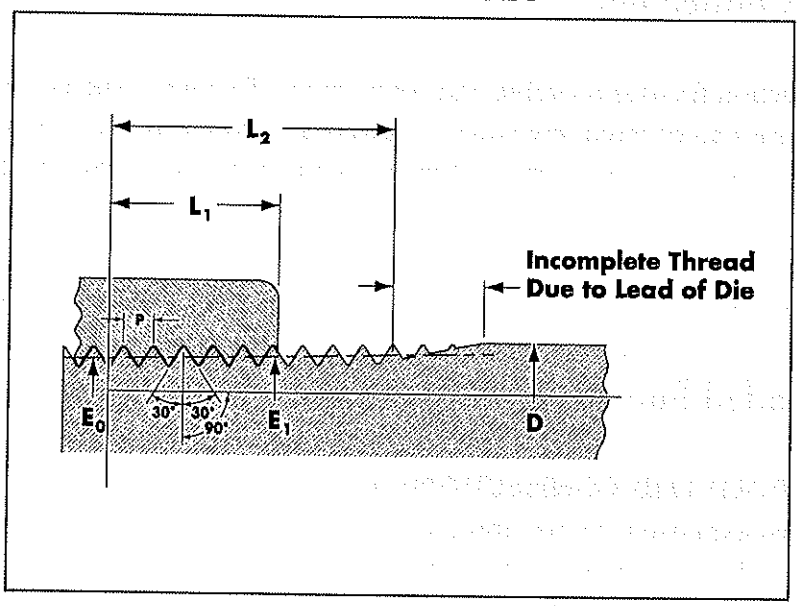
Generally speaking, the line size often governs the type of end connection. Threaded end connections and solder or brazed ends are used on valves NPS 3 or smaller. The threaded end connections are tapped with ANSI Standard female taper pipe threads.

NPS 1-1/2 BRONZE VALVE



IV 2.4.02

ASME STANDARD INTERNAL PIPE THREADS



IV 2.4.03

Grooved End Connections

Sometimes threaded or flanged connections are replaced by **GROOVED END CONNECTIONS**. It is easy to cut or roll a groove in a pipe, and grooved connections are convenient to use for valve replacement and maintenance.

Grooved connections are found on many types of valves, such as the plug, butterfly, and gate valves. Grooved end connections are used in fire protection situations such as sprinkler systems.

Grooved end valves, including the end clamps and gaskets, may be more costly than threaded or flanged valves. However, the savings in labor for pipe preparation and in installation time may make the grooved product a better buy. Grooved end valves are also easy to replace.

Grooved connection is limited to lower temperature and pressure applications. It requires a gasket and coupling clamps to seal each end. Because the gasket is made of a rubber-like compound material, this type of end connection must be used for lower-temperature applications.

Solder or Brazed End Connections

Some piping systems, particularly hot and cold water, may be more cost-effective with copper tubing fittings and valves, which are assembled with **SOLDER JOINTS** rather than with threaded ends. Their use is limited to maximum temperatures of 250°F because of the low melting point of the solder. With soldering, the heat applied may possibly damage the plastic or elastomeric valve seats if not properly controlled.

BRAZED END CONNECTIONS are used with Class B copper pipe for higher pressure or industrial applications. Solder end connections are more often used for normal water-distribution pressure systems with Types K, L, or M copper tubing. Solder and brazed ends use similar joining techniques.

1. First, flux is applied to the cleaned and reamed tube end and fitting socket. Flux cleans the surfaces and protects them when heat is applied.

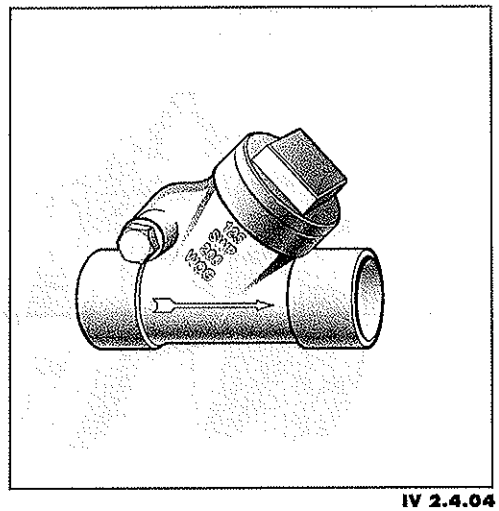
2. After the flux is applied, the tube is inserted into the valve socket until it reaches the end stop.

3. Then heat is applied around the joint.

4. The brazing wire or solder is applied where the socket and tube meet.

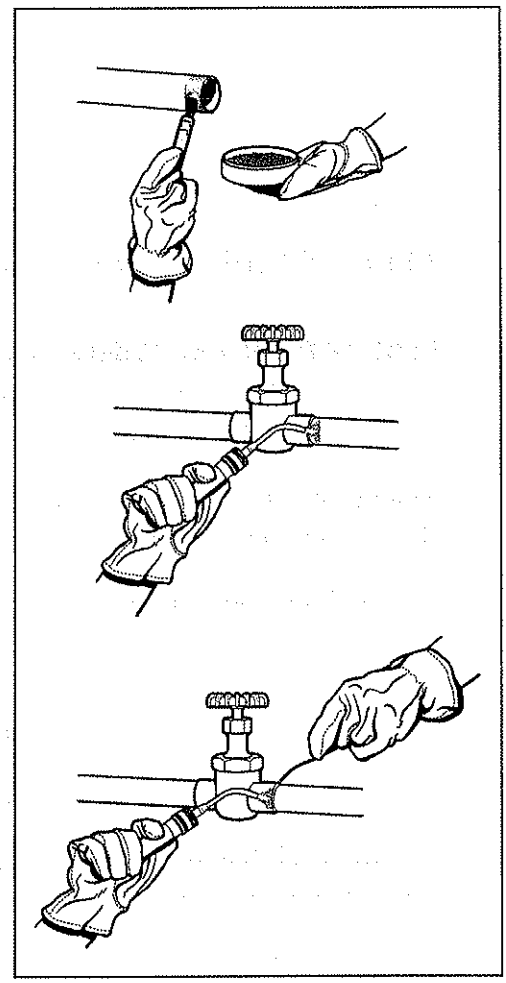
5. Heat is applied to the end connection, but not to the wire. When melted metal can be seen around the joint, the wire doesn't have to be fed in anymore.

CHECK VALVE



IV 2.4.04

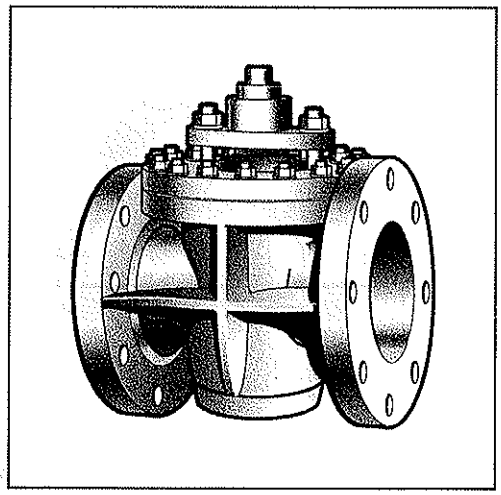
FLUX BEING APPLIED TO A TUBE AND SOCKET



IV 2.4.05

Flanged End Connections

FLANGED VALVE



IV 2.4.06

For line sizes above 2" that are frequently assembled and disassembled, **FLANGED END CONNECTIONS** are used. They make a strong, tight joint. This type of connection is generally used on line sizes larger than NPS 2 where ease of replacement is a consideration and where threading pipe would be cost prohibitive. An example of a **FLANGED VALVE** is shown in the illustration.

Flanged valves are easier to replace in an existing installation than most other types of end connections. When valve replacement is necessary, the flange bolts are removed. The valve can then be readily replaced. End-to-end dimensions must be the same in the replacement valve for it to fit in the pipe space.

Flanged End Bolting Connections

FLANGED END BOLTING must be secured in a specific order to assure a tight gasket seal. The flanges should be carefully aligned and a suitable lubricant applied to the bolt threads.

The numbers in the illustration on the next page indicate the order in which the flange end connections should be tightened.

1. The flange bolt in the no. 1 position is drawn up first.

2. Then the flange bolt in the no. 2 position is drawn up.

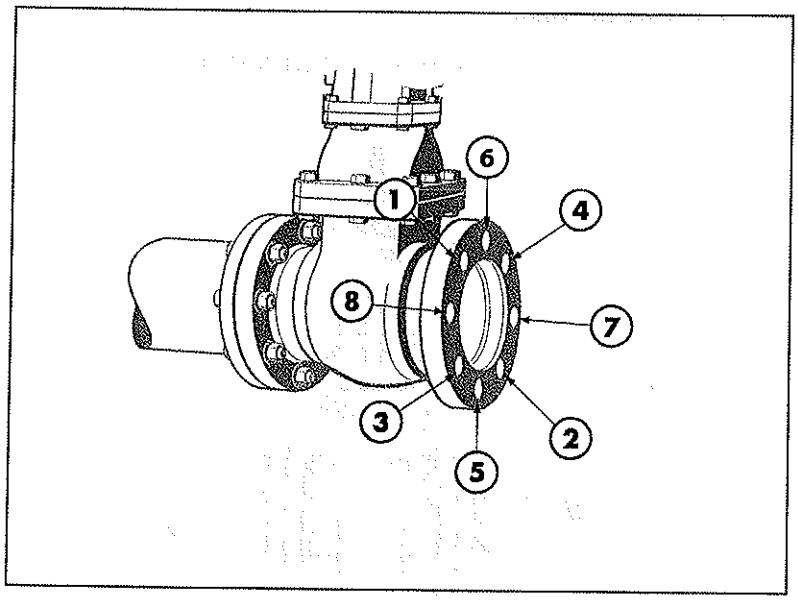
3. The flange bolt in the no. 3 position is drawn up.

4. Then the no. 4 flange bolt is drawn up.

5. After each flange bolt is drawn up snugly, the flange bolt directly opposite or across from it is snugly drawn up next.

6. When all bolts are snugged evenly, proceed to tighten each bolt to the specified bolt torque. It is best to use a torque wrench.

FLANGED END BOLT WITH ORDER OF CONNECTION LABELED



IV 2.4.07

This procedure places uniform load on the gasket at each end connection, thus properly loading the gasket.

The description illustrates only one way to tighten flange end connections. Always check your manufacturer's literature to find the method suggested by the individual manufacturer.

Comparisons Between Flanged Gate and Butterfly

When butterfly valves and flanged gate valves are compared, if both types are equally suited for the application, a butterfly valve may be a better choice. From an installation standpoint, a gate valve is heavier and therefore more difficult to handle, requires more time to install, and costs more.

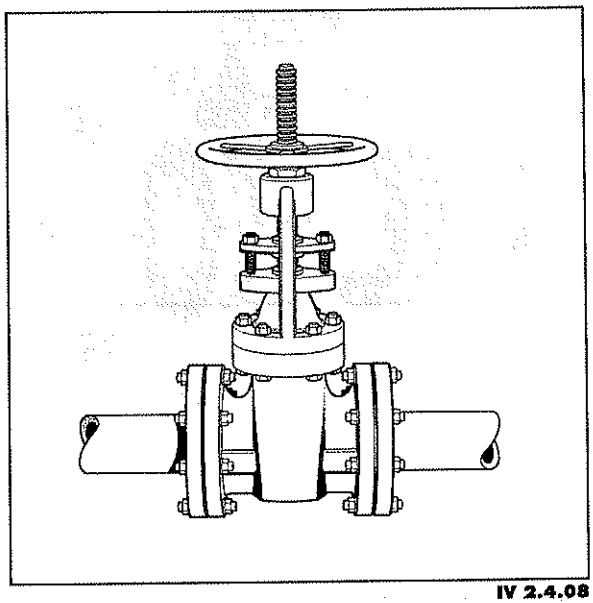
The **GATE VALVE** (see illustration on the following page) requires two gaskets and two sets of bolting fasteners, one for each flange end and additional pipe support for its heavier weight.

An elastomeric seated butterfly valve requires no end flange gaskets because the seat liner provides the flange seal.

And, only one set of fasteners are needed because the face-to-face dimensions are much shorter than the end-to-end dimensions on the gate valve. However, the bolts for the butterfly valve are much longer than regular flange bolts.

A butterfly valve can be used for throttling or shutoff. This would save money if the valve had to be actuated.

END CONNECTIONS FOR GATE VALVE

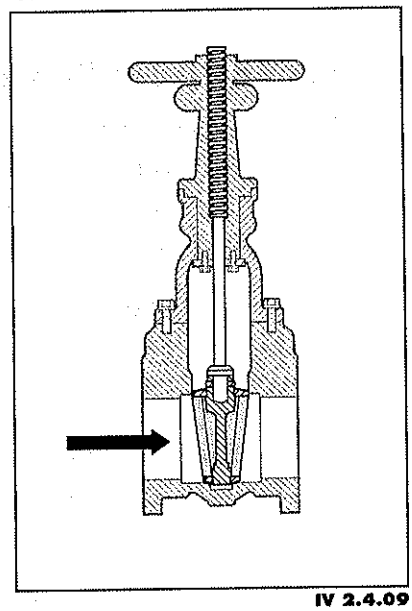


IV 2.4.08

Valve Comparisons

Gate valves weigh more and have longer end-to-end dimensions than comparable butterfly valves. Keep in mind, however, that elastic or plastic seats or seals limit the application of butterfly valves to lower pressures and temperatures than the gate valve.

GATE VALVE WEDGE DISC IN A CLOSED POSITION



IV 2.4.09

Use the **GATE VALVE** and **LUG BODY, BUTTERFLY VALVE DIMENSIONS** tables to compare the weight and size dimensions of an **NPS 12 GATE VALVE WITH FLANGE ENDS** to an **NPS 12 LUG-TYPE BUTTERFLY VALVE** (see illustration on the following page), both without gears. Then answer the questions that follow.

For the NPS 12 gate valve in the illustration, find the valve size first to determine the weight and face-to-face.

GATE VALVE

Size	Weight	A	B	C
2	37	15	1/2	7
3	65	8	18-3/4	8
4	110	10	23-1/8	9
6	188	12	31-11/16	10-1/2
8	318	14	40-3/8	11-1/2
10	479	16	49	13
12	720	18	56-13/16	14
14	1,023	20	64-7/8	15

IV 8.4.09

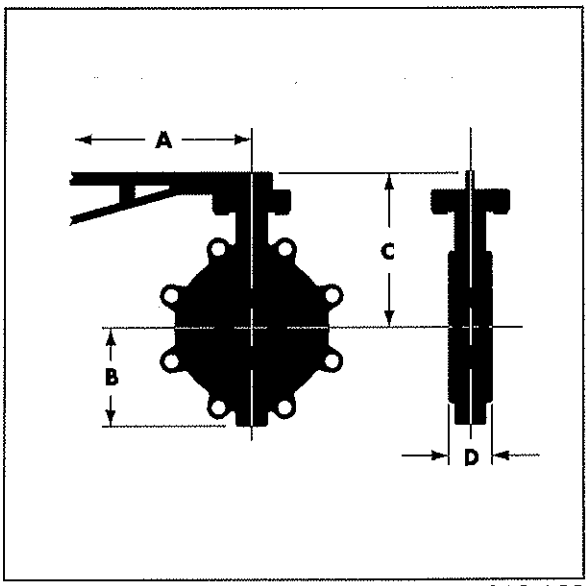
GATE VALVE, NPS 12

What is the weight? _____

What is the face-to-face? _____

Answers appear on page following the butterfly valve question.

BUTTERFLY VALVE, NPS 12



IV 2.4.10

LUG BODY, BUTTERFLY VALVE DIMENSIONS

Size	Weight	A	B	C	D
2	9.6	9	3-1/8	6-1/2	1-3/4
3	12.1	9	3-11/16	7-1/4	1-7/8
4	20.6	9	4-3/8	8-1/8	2-1/8
5	31.0	11	5-15/16	9-9/16	2-1/4
8	50.0	14	7-1/16	10-7/8	2-1/2
10	76.2	14	8-1/2	12-3/16	2-13/16
12	117.0	14	9-5/8	13-3/4	3-3/16

IV 8.4.10

BUTTERFLY VALVE, NPS 12

What is the weight? _____

What is the face-to-face? _____

Answers appear on the following page.

Both of these valves provide the on/off function. Remember, too, that the proper valve materials must be selected for the specific application, and the pressure-temperature ratings must be observed for either valve.

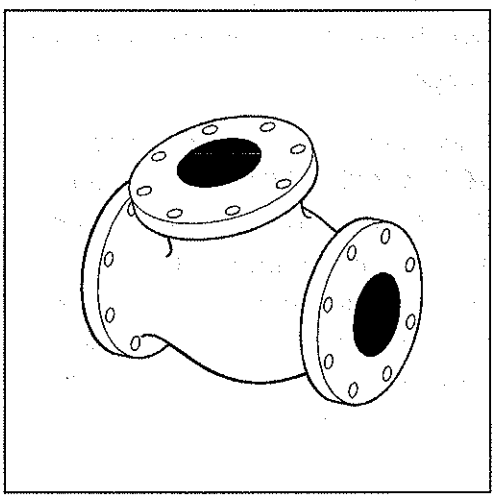
ANSWERS:

Gate valve: Weight: 720 lbs., F-to-F: 14"

Butterfly valve: Weight: 117 lbs., F-to-F: 3-3/16"

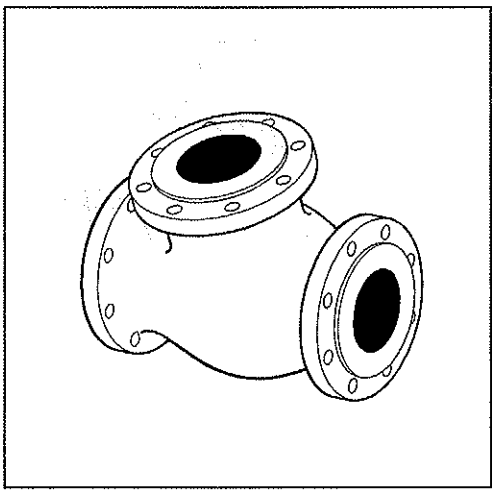
Flanged Valve Facings

FLAT FACED FLANGE END



IV 2.4.11

RAISED FACED FLANGE END



IV 2.4.13

There are two major types of facings found on flanged valves: flat and raised. **FACING** refers to the type of face that is machined on the flanged end. The dimensional details of these are included in National Standards. Refer to ASME 816.1 for cast iron flanges and ASME 816.5 for steel flanges.

The **FLAT FACE** flange has a gasket surface in the same plane as the bolting circle face. Applications using flat face flanges are frequently those in which the mating flange or flanged fitting is made from a casting. The illustration shows a **FLAT FACE FLANGE END**. When bolted together with a full-face gasket, this type of end connection will match flush, face-to-face.

The following illustration presents a **RAISED FACE** facing, which is the most common type used in process plant applications, and is easily to identify. It is referred to as a "raised face" because the gasket surfaces are raised above the bolting circle face. The protruding face is the face that comes in contact with the gasket when bolted together.

How do you choose which facing to use? First of all, refer to the ASME/ ANSI – Standards of Pipe and Fittings. Flange facing finishes are specified in standards such as ASME B16.5 for steel, ASME B16.24 for bronze, ASME B16.1 for iron.

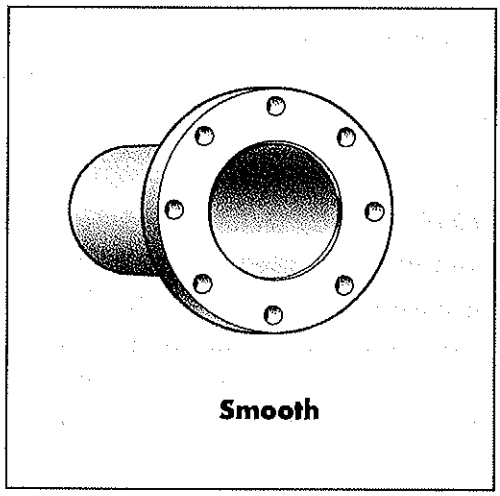
- ASME B16.5 refers to steel flanges only. Most steel valves are raised faced.
- ASME B16.24 refers to all bronze valves. All bronze valves are flat faced to avoid braking or bending of the flange.
- Iron valves are governed by the ASME B16.1 cast iron flange standard. It requires a flat-faced flange for cast iron of Class 125. It requires a raised-faced flange for gray cast iron of Class 250.

When iron is rated to handle steam pressure of 250 lbs. and up, thicker flanges of stronger iron are used. So raised-face flanges can handle the greater pressure.

The smaller area of contact with a raised flange allows pressure to increase with a greater chance of the flange flexing. It will be less brittle and more resistant to cracking as the bolt is tightened on the flange.

Do not confuse the type of facing machined on the end with the type of surface finish required on the end. The **FLANGE FACING FINISH** is generally measured by visual and tactile means. The ASME B16.5 code requires that the flange face (raised face and flat face) has a specific roughness to ensure that this surface be compatible with the gasket and provide a high quality seal refers to the surface texture on the flange surface in contact with the gasket. Smooth finish flanges are more common for low pressure and/or large diameter pipelines and primarily intended for use with solid metal or spiral wound gaskets. (see illustrations).

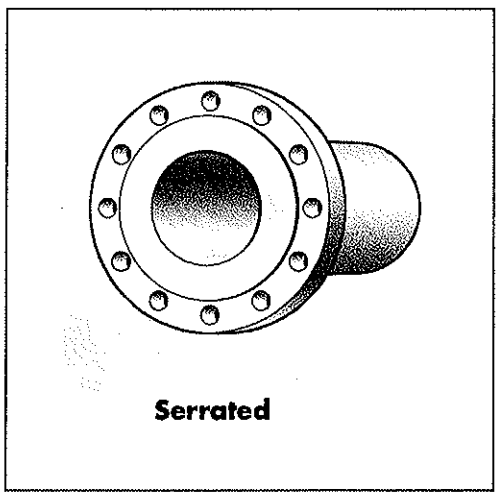
SMOOTH FLANGED VALVE FACING



Smooth

IV 2.4.14

SERRATED FLANGED VALVE FACING



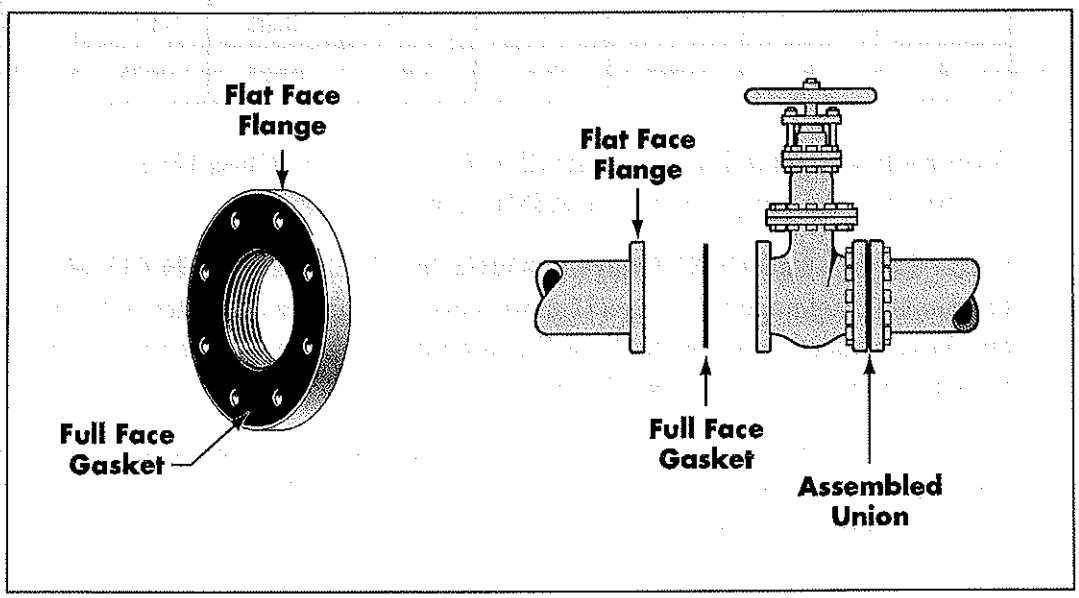
Serrated

IV 2.4.15

Wholesale distributors often furnish gaskets, bolting, flanges, and pipe to install along with flanged valves. While you do not need to know all of the specs and dimensions covering flanged connections, there are some important points to remember.

First, use valves with flat faces with mating pipeline flanges, which also have flat faces.

FLANGED VALVE FACINGS



IV 2.4.16

Second, in joining flat-faced flanges a full-face gasket is used. A **FULL FACE GASKET** (see illustration) is so called because the outside diameter of the gasket extends to the outside diameter of the flange face. The flanges, the drilling, and the bolting are defined by the Standards ASME B16.1 for iron, ASME 616.24 for bronze, and ASME 616.5 for steel.

Bolting Specs

In joining together NPS 4 gray cast iron, Class 125, flat-face flanges, for example, eight bolts and nuts are required. The bolts are 0.625" in diameter and 3.5" long. The **CLASS 125 CAST IRON FLANGE WITH DIMENSION CHART** presents the particulars published for NPS 4 flanges in ASME B16.1.

CLASS 125 CAST IRON FLANGE WITH DIMENSION CHART

Size	U	N	W	Number Bolts	Diameter Bolts	Diameter Holes	Length Bolts
4	9	0.934	7.5	8	0.625	0.75	3.5

A properly assembled flange joint will safely withstand Class 125 pressure-temperature ratings published in ASME standards.

In the **CLASS 125 CAST IRON FLANGE WITH DIMENSION CHART**, N represents the flange thickness, U represents the outside diameter of the flange, and W represents the bolt circle or the imaginary circular centerline for drilling the equally spaced flange bolt holes.

When writing specs for the bolts for a flanged valve, you need to specify the bolt size and quantity needed. The bolt size is specified by the diameter of the bolt and the length of the bolt.

Gaskets

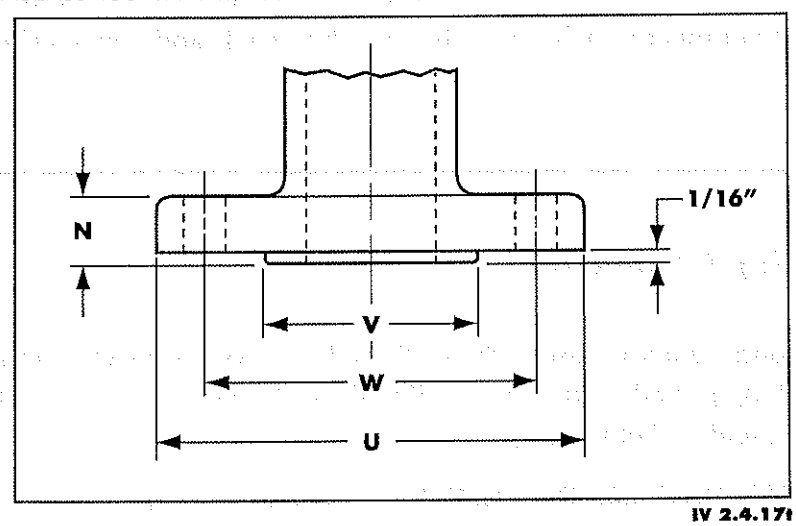
In specifying a full face gasket needed for a flanged joint, you need to state the type of gasket, the pipe diameter, the pressure class, and the quantity.

ASME, in ASME 816.21, publishes information for bronze and iron flat-face flanges and cast-iron raised face flanges. You will not find any bronze raised-face flanges.

Raised-face flanges require flat-ring gaskets that extend beyond the raised face.

In the **CLASS 125 CAST IRON RAISED FACE FLANGE END** illustration, U represents the flange face diameter, N represents the flange thickness, V represents the diameter of the raised face and W represents the bolt circle or the imaginary circular centerline for drilling the equally spaced bolt holes.

CLASS 150 CAST IRON RAISED FACE FLANGE END



IV 2.4.17t

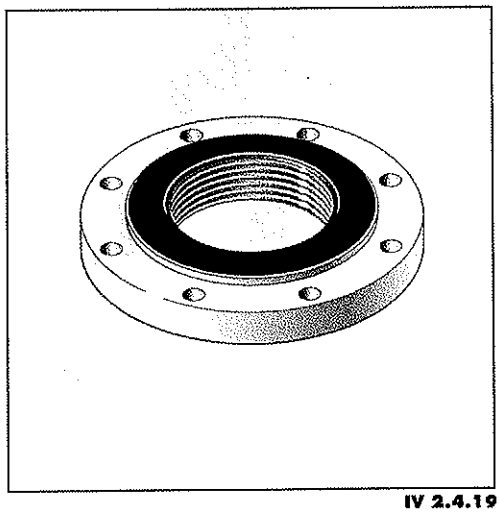
CLASS 150 CAST IRON RAISED FACE FLANGE END DIMENSION CHART

Size	U	N	V	W	Number Bolts	Diameter Bolts	Diameter Holes	Length Bolts
6	10.98	1.06	8.5	9.51	8	0.75	0.87	4

For example, the above **DIMENSION CHART** reveals the best size and quantity needed for a Class 150 cast-iron flanged globe valve is a bolt size of 3/4" x 4" and a quantity of 8.

Steel valves normally have raised-face (RF) flanges. **FLAT-RING GASKETS** (see illustration) are sometimes used with steel valves with RF flanges. Flat-ring gaskets are not to be confused with metal rings used with ring type joints (RT J).

RING GASKET



IV 2.4.19

Flanges

In addition to furnishing proper gaskets, it is important to furnish proper **FLANGES**.

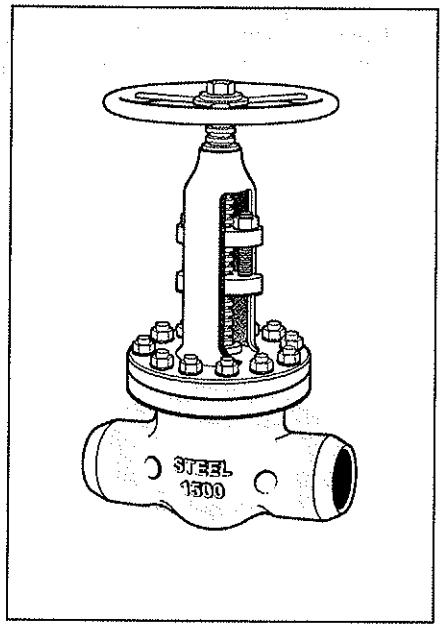
Here's why: An NPS 3 flat-faced flanged bronze valve, Class 150, is to be installed. It has four bolt holes, on a 6" bolt circle, with an O.D. on the flange of 7-1/2". An NPS 3 Class 150 steel raised-face flange is furnished to be used. It has the same number of bolt holes, the same bolt circle and flange O.D. as the valve.

Welding Connections

Weld connections are used when a tight, leak-proof connection must be provided over a long period of time. You will find two types of weld connections—butt welding and socket welding.

BUTTWELDING CONNECTIONS are used on large valves and piping. Socket welding connections are recommended for small-sized valves and piping.

WELD END (BUTTWELD) CONNECTION

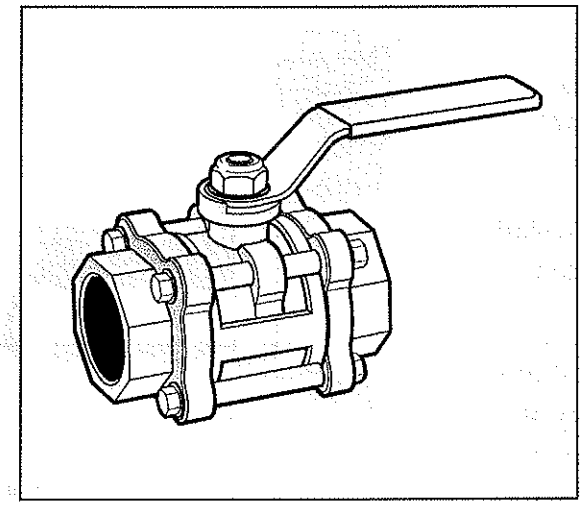


IV 2.4.20

A **WELD END (BUTTWELD) CONNECTION** is shown in the illustration. Weld connections are generally used on high-pressure and high-temperature applications. You should know that only certain materials are weldable, such as carbon steel, alloy steel, and stainless steel.

You should remember that the valve material will often restrict the type of end connection.

SOCKET WELD

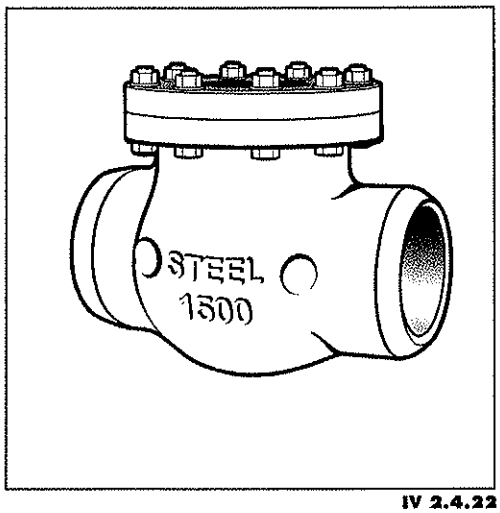


IV 2.4.21

Weld end connections (see illustration) are often used on steel valves in pipelines where flange connection maintenance might be a problem or end connection joint leakage might be hazardous.

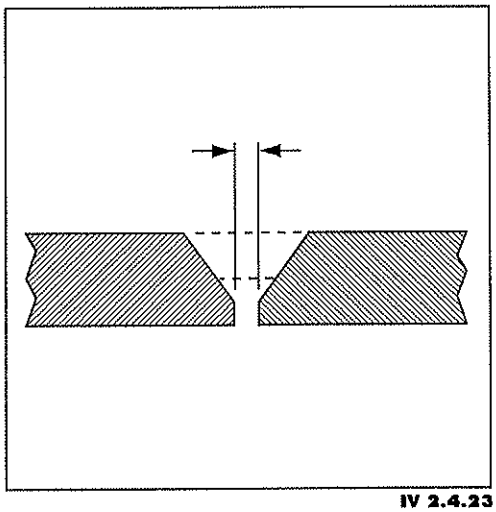
The valve in the illustration has a buttwelding connection. To facilitate welding, the ends are cut on an angle, or **BEVELED** (see illustration). Dimensional requirements for the beveled ends are to be found in ASME standard ASME 816.25.

BUTTWELDING CONNECTION



IV 2.4.22

BEVELED END CUT AT ANGLE



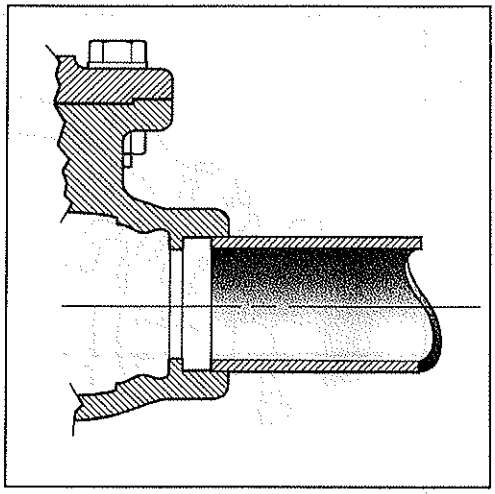
IV 2.4.23

SOCKET WELDING CONNECTIONS utilize deep sockets at each valve end (see illustration). To make the connection, pipe is inserted into each valve socket, backed out about 1/16", and then welded to the valve.

Piping construction codes require a slight gap between the pipe end and socket shoulder prior to welding.

The most common types of plastic shutoff valves used in the chemical industry are the ball and the butterfly valves. These valves may have threaded or solvent (or glued) weld end connections.

SOCKET WELDING CONNECTION



IV 2.4.24

CHAPTER 10 REVIEW QUIZ – END CONNECTIONS

Answers appear on pg 206

DIRECTIONS: Carefully read each question and circle the correct answer. There is only one correct answer per question. When you have finished, check your answers.

1. Which of the flowing valve end connections are the least expensive and easy to install?
   a. Grooved end connections
   b. Brazed end connections
   c. Flanged end connections
   d. Treaded end connections
2. What type of end connections may save time in installation and labor?
   a. Threaded
   b. Grooved
   c. Soldered
   d. Flange
3. Which of the following is a benefit of a butterfly to a contractor who installs piping systems?
   a. Lower initial cost for the valve
   b. Longer installation time
   c. Tight gasket seal
   d. Minimal joint maintenance
4. What type of welding connection would most likely be found on a valve for a NPS 1 line?
   a. Weld end
   b. Buttweld
   c. Socket welding
   d. Braze welding

CHAPTER 10 REVIEW QUIZ – END CONNECTIONS

Answers appear on pg 206

5. Why would a weld connection be used with steel as the valve material?
   a. Avoids hazardous fluid leaks
   b. Lower initial cost
   c. Easier installation process
   d. Permits the use of bronze or iron valves

6. Although grooved end connections are more costly than threaded end connection valves, they may be a better buy because grooved end connections
   a. can be used under any temperature and pressure condition.
   b. have internal taper pipe threads for joining to threaded pipe.
   c. are easier to install which reduces labor cost.
   d. last substantially longer than any other connection.

7. Which type of end connections are used with normal water distribution pressure systems with Types K, L, or M copper tubing?
   a. Brazed
   b. Solder
   c. Flanged
   d. Gasket

8. The types of end connections used on plastic ball valves designed for use in the chemical industry are
   a. brazed and solder welding.
   b. threaded and socket weld.
   c. buttwelding and socket weld.
   d. weld end and brazed.

9. In specifying a full face gasket needed for a flanged joint, you need to state all of the following EXCEPT
   a. Type of gasket
   b. Outside diameter of the gasket
   c. Number of gaskets needed
   d. Total cost for the gaskets

CHAPTER 10 REVIEW QUIZ – END CONNECTIONS

Answers appear on pg 206

10. Why does the ASME B16.5 code requires that the both the raised and flat flange face have a specific roughness?
    a. To ensure that the surface is compatible with the gasket
    b. To reduce overall costs of joining the valves
    c. To comply with state and federal regulations
    d. To ensure that the pipe is not over-tightened into the valve

APPLYING WHAT YOU HAVE LEARNED:

By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.

A. List several types of gaskets, bolting, flanges, and pipe that your company recommends and sells along with flanged valves.

_____

_____

_____

B. If installation time and cost were important to a customer and both valves are equally suited for the application, would you recommend a flanged gate valve over a butterfly valve? Why or why not?

_____

_____

_____

ANSWERS TO REVIEW QUIZ

CHAPTER 10

END CONNECTIONS

Answers to Review Questions: End Connectors

1. d. Threaded end connections
2. b. Grooved
3. a. Lower initial cost for the valve
4. c. Socket welding
5. a. Avoids hazardous fluid leaks
6. c. are easier to install which reduces labor costs.
7. b. Solder
8. b. threaded and socket weld.
9. d. Total cost for the gaskets
10. a. To ensure that the surface is compatible with the gasket

APPLYING WHAT YOU HAVE LEARNED:

A. Answers will vary by company.

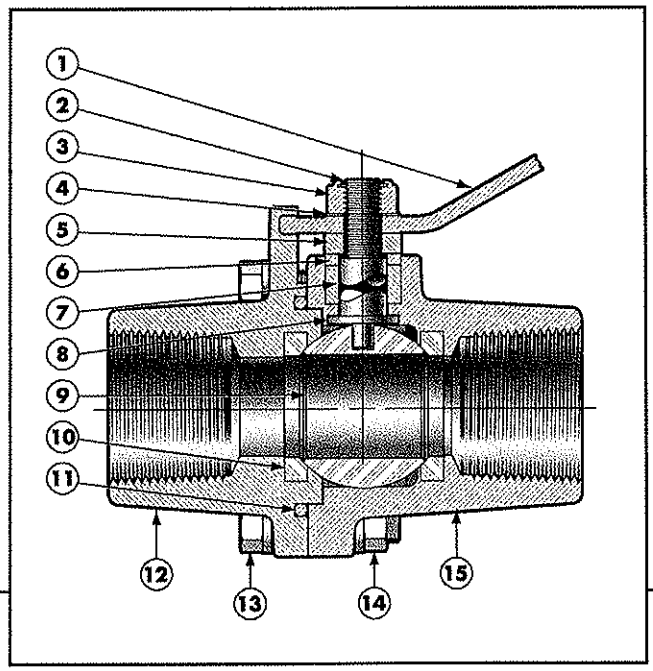
B. No. Gate valves weigh more and have longer end-to-end dimensions than comparable butterfly valves.

11 TEMPERATURE AND PRESSURE VALVES

LEARNING OBJECTIVES

When you successfully complete this chapter, you will be able to:

1. Explain how valves are classified by their pressure-class rating schedules.
2. Identify and solve common valve problems.



TEMPERATURE AND PRESSURE VALVES

PRODUCTPRO® – INDUSTRIAL VALVES©

Temperature and Pressure Valves

In addition to knowing the valve material, end connections, and facings, it is important to know the valve's temperature and pressure limits.

This section focuses on characteristics of valves that limit or enhance a valve's ability to handle high pressure and temperatures.

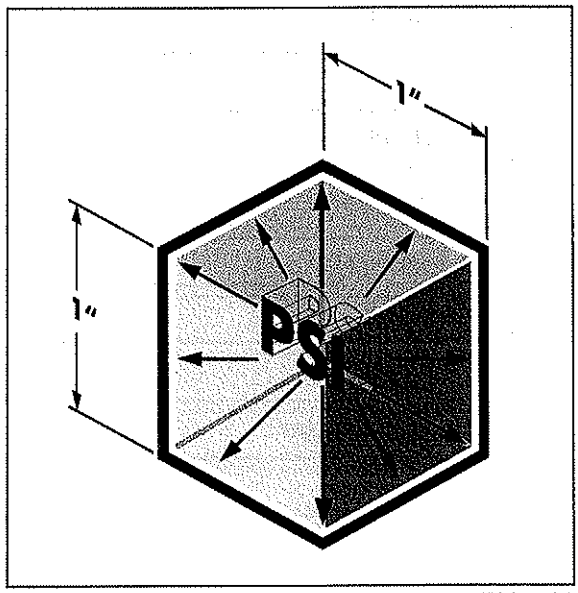
We will first look at how valves are grouped by the temperature-pressure class rating schedules used today. We will then take a look at how valves were first classified in terms of saturated steam. Common valve problems will be explored.

Understanding Pressure

PRESSURE is the force per unit area applied to the interior valve parts by the contained fluid. So, when we talk about valve pressure limits we are talking about the maximum pressure that the flow media can exert either inside the valve or across the valve closure mechanism.

Different valve materials have different pressure-temperature ratings. Some materials can hold more pressure than other materials. Some materials are better suited for extreme temperatures. Let's take a look at how these temperature and pressure ratings are used for industrial valves.

ILLUSTRATION OF POUNDS PER SQUARE INCH (PSI)



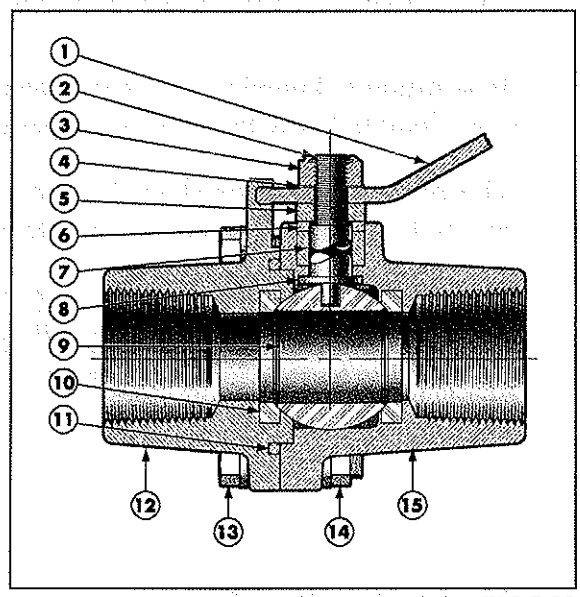
IV 2.5.01

The stronger a valve material is, the more pressure can be applied to the valve. Pressure is often measured in **POUNDS PER SQUARE INCH**, or **PSI**. Pressure is measured in the amount of force that is exerted against a unit area (see illustration).

Trim affects the temperature-pressure rating of a valve. While a ball valve may be made of stainless steel to resist corrosion, the valve may be limited in applications because of the temperature limits of the packing, gasket, or other trim material. In the illustration, you can see a **CUTAWAY OF A BALL VALVE.**

If you check the parts list in the **MATERIALS LIST** table for the valve shown in the illustration, you will find that the seats and seals (gaskets) are made of Teflon™.

CUTAWAY OF BALL VALVE



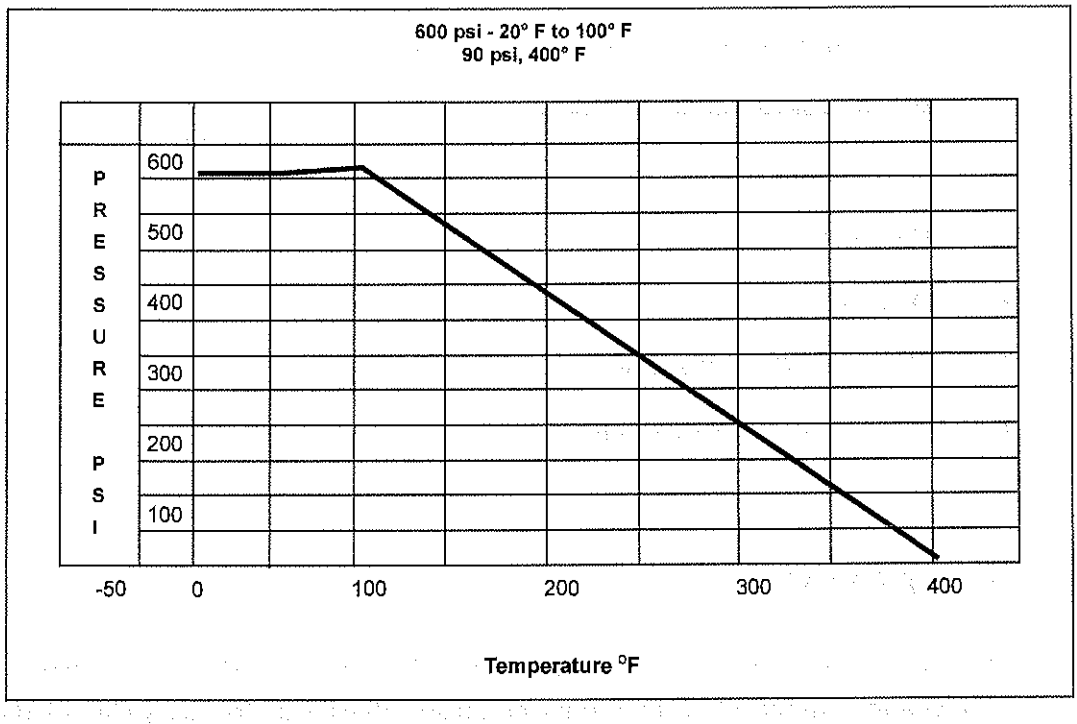
IV 9.5.02

MATERIALS LIST

Part	Specification
1 Handle	Cadmium Plated Steel with Plastic Grip
2 Stem	Type 316 Stainless Steel
3 Handle Nut	Type 303 Stainless Steel
4 Lockwasher	Cadmium Plated Steel
5 Packing Nut	Type 303 Stainless Steel
6 Gland	Type 316 Stainless Steel
7 Packing	Teflon
8 Thrust Washer	Glass Filled Teflon
9 Ball	Type 316 Stainless Steel
10 Seat	Teflon
11 D-Ring Gasket	Teflon
12 Cap	Type 316 Stainless Steel
13 Cap Bolt	Type 304 Stainless Steel
14 Cap Bolt Nut	Type 303 Stainless Steel
15 Body	Type 316 Stainless Steel

The **VALVE SEAT PRESSURE-TEMPERATURE RATING** chart gives the pressure and temperature limits for the valve shown in the illustration. If the flow media temperature falls in the -50°F to 100°F range, the valve can withstand up to 600 psi. This relationship between pressure and temperature is true of all valves.

VALVE SEAT PRESSURE-TEMPERATURE RATING



iv 2.5.03g

Pressure Drop

When a liquid flows through a piping system, the flow is resisted by friction. This friction is a result of fluid particles rubbing against one another and the surface of the pipe. This resistance results in a loss of energy, which is measured as a loss in pressure and is called **PRESSURE DROP**.

Six factors affect pressure drop in a piping system:

1. Roughness of the pipe surface
2. Pipe diameter
3. Flow velocity
4. Density
5. Change of flow direction
6. Viscosity of the flow media

Rating Systems

The pressure and temperature rating systems for some industrial valves have been changed in recent years. Bronze and iron valves were formerly classified by saturated steam rating. **SATURATED STEAM** is pure steam in direct contact with the water from which it was generated and at the water temperature at the existing pressure. For example, saturated steam at 50 psig has a temperature of 298°F.

The unit of pressure relative to atmospheric pressure at sea level is psig (pound-force per square inch) . By contrast, psi measures pressure relative to a vacuum (such as that in space). Most pressure gauges, such as tire gauges, are calibrated to read zero at sea level, because most applications require the difference of pressure. Pressure is commonly expressed either as pounds per square inch absolute (psia) or as pounds per square inch gauge (psig) above the standard atmospheric pressure of 14.7 psia. Thus, psig is equal to psia minus 14.7 psi.

Latent heat, expressed in BTU per pound, is the amount of heat needed (absorbed) to convert a pound of boiling water to a pound of steam. The same amount of heat is liberated when a pound of steam condenses back to a pound of water. Latent heat varies with temperature.

We will take a look at how they are grouped by the pressure-class rating schedules used today. ASME publishes these pressure class ratings in various ASME B16 standards for valves, flanges, and fittings.

For threaded and solder end bronze valves not covered by ASME standards, MSS publishes pressure-temperature ratings in their standard, MSS-SP-80. One of these standards covers the industrial valves your company sells.

The purpose of a pressure-class rating schedule is to provide the pressure and temperature limits for a given valve.

In the upcoming tables you can see pressure-temperature rating schedules for bronze, iron, and steel valve materials. Pressure is measured along the horizontal axis, while temperature is measured along the vertical axis.

Some sample pressure-class rating schedules are provided in the following three tables. These are the standards for valves, flanges, and fittings. For a given pressure class valve, the maximum working pressure is displayed for various operating temperatures. Tables are periodically updated; be certain you are using the most recent information.

The first schedule is for bronze valves. It is taken from MSS SP-80, 2013, Pressure Temperature Ratings. Updates to this schedule are made on occasion, for the most current and complete version of the standard please visit Manufacturers Standardization Society's website at http://mss-hq.org.

PRESSURE TEMPERATURE RATINGS IMPERIAL UNITS

	Pressure-PSI							
Pressure Class	125	150		200	300			350
End Connection	THD	THD	FLG	THD	THD	THD	FLG	THD
Temperature °F	Material							
	ASTM B-62				ASTM B-61			
-20 to 150	200	300	225	400	1000	600	500	1000
200	185	270	210	375	920	560	475	920
250	170	240	195	350	830	525	450	830
300	155	210	180	325	740	490	425	750
400	---	---	---	275	560	410	375	590
406	25	150	150	---	---	---	---	---
450	120	145	---	250	480	375	350	510
500	---	---	---	225	390	340	325	430
550	---	---	---	200	300	300	300	350

The second schedule is for cast-iron gate valves, flanged, and threaded ends. It is taken from MSS SP-70, 2011, Pressure Temperature Ratings, Non-shock psi. Updates to this schedule are made on occasion, for the most current and complete version of the standard please visit Manufacturers Standardization Society's website at http://mss-hq.org.

PRESSURE TEMPERATURE RATINGS - NON SHOCK - PSI

Class	125			250	
Temperature °F	NPS 2-12	NPS 14-24	NPS 30-48	NPS 2-12	NPS 14-24
-20 to 150	200	150	150	500	300
200	190	135	115	460	280
225	180	130	100	440	270
250	175	125	85	415	260
275	170	120	65	395	250
300	165	110	50	375	240
325	155	105		355	230
350	150	100		335	220
375	145			315	210
450	140			290	200
425	130			270	
450	125			250	

The third schedule presents a part of the schedule for steel valves. It is taken from ASME B 16.34, Valves - Flanged, Threaded and Welded End. The table does not include the higher temperatures that are included in the table in the standard. Steel valves can be used for the highest pressure and can withstand the highest temperature.

STEEL VALVES

A216-WCB Standard Class Valves				
	Working Pressure in PSI			
Temperature °F	150	300	600	900
20 to 100 200 300	285 260 230	740 675 655	1460 1350 1315	2220 2025 1970
400 500 600	200 170 140	635 600 550	1270 1200 1095	1900 1795 1640
650 700 750	125 110 95	535 535 505	1075 1065 1010	1610 1600 1510
800 850 900	80 65 50	410 270 170	825 535 345	1235 805 515
950 1000	35 20	105 50	205 105	319 155

Earlier Rating Systems

At one time, valve manufacturers classified valves by saturated steam ratings and used a secondary or cold rating that stood for water, oil, or gas (WOG). This is sometimes listed as CWP (cold working pressure). The term **OWG** was also used.

Under that earlier rating system, a 125-lb. threaded-end bronze valve had two psi ratings, one for saturated steam and the other for water, oil, or gas. For example, if a bronze valve, Class 125, had a saturated-steam rating of 125 psi (a temperature rating of 406°F), it also carried a secondary rating of 200 psi for oil, water, or gas at cold temperatures (-20°F to 150°F).

Today, MSS refers to that same bronze valve in MSS SP-80, 2013, the table for Bronze Gate, Globe, Angle, and Check Valves. This MSS Standard Practice establishes requirements for bronze gate, globe, angle, and check valves in Classes 125 (PN 20), 150, 200, 300 (PN 50) and 350 for threaded and solder ends and Classes 150 (PN 20) and 300 (PN 50) for flanged ends.

Pressures in this Standard Practice are gauge pressure in pounds per square inch (psi). Hereafter the pressure appears as psi.

MSS SP 80, CLASS 125 BRONZE, ASTM B-62

Temperature (°F)	Pressure (psi)
-20 to 150	200
200	185
250	170
300	155
350	140
400	—
406	125
450	120

Charts and Tables

Water and steam properties play especially important roles in steam power generation. For large-scale power generation, relatively small discrepancies in the calculation of key properties, such as the heat of vaporization, can translate into a difference of hundreds of thousands of dollars in the values calculated for the performance of boilers and turbines.

Such considerations make representations of the thermodynamic properties of water vital tools for process engineers. Characterizations of these properties are commonly known as "steam tables," though now they are more often in computerized form. Steam tables are vital tools for engineers, both for design and for evaluating equipment performance.

Steam tables are still used today. Steam is a constant because the properties of water are constant. The **STEAM TABLE EXAMPLE** is an excerpt from a steam table and it shows properties of saturated steam. Temperature and pressure of saturated steam are closely related. When one of them is given, the other is determined. Its source is *ASME Steam Tables Compact Edition, 2006*, p. 7.

Saturated steam is pure steam in direct contact with the liquid water from which it was generated and at a temperature of water at the existing pressure. For example, saturated steam at 120 psi has a temperature of 341.27°F. An example is provided in the **STEAM TABLE EXAMPLE** on the following page.

Latent heat, expressed in BTU per pound, is the amount of heat needed (absorbed) to convert a pound of boiling water to a pound of steam. The same amount of heat is liberated when a pound of steam condenses back to a pound of water. Latent heat varies with temperature.

STEAM TABLE EXAMPLE

Cage Pressure (PSI)	Saturated Steam Temperature
100	327.82
110	334.78
120	341.26
130	347.33
140	353.04
150	358.43
160	363.55
170	368.43
180	373.08
190	381.81

Be careful when using pressure-temperature ratings for valves. The charts and tables used here are for Class 125 Bronze valves with threaded ends; there are other limitations on Class 125 Bronze valves with solder joint or flanged ends. Remember to use the most current information.

We have just given you a few examples of how valves are classified by temperature and pressure ratings.

Common Problems and Solutions

Now, let's look at some valve problems and how to prevent them from occurring. Whenever your customers have a valve problem, try to help them, but if you become stymied, contact the manufacturer right away. While you or your company may not be able to answer all of your customer's questions, you can begin to find out as much information about the problem as possible.

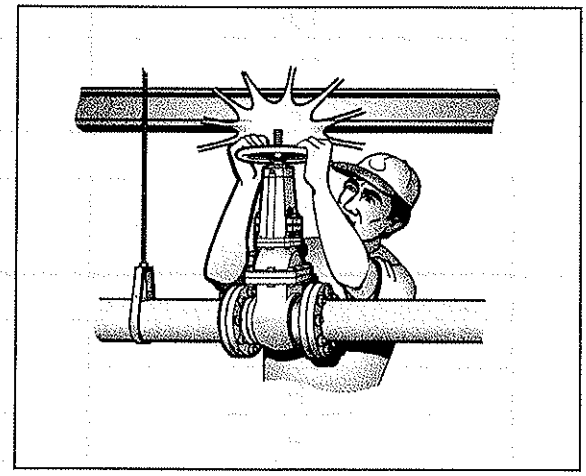
Common Problem: Overhead Limited

A common problem occurs when a rising stem valve is installed in a line where there is not enough overhead to open the valve (see illustration).

Plenty of clearance must be provided above the valve so that rising stem valves can be fully opened.

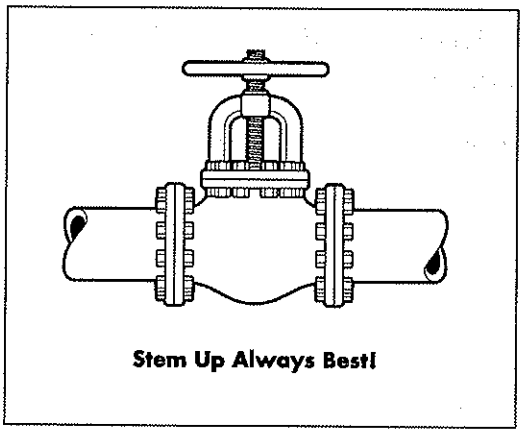
You can help prevent this problem from occurring by telling your customers the fully-open dimension of the rising stem valve.

ILLUSTRATION OF LIMITED OVERHEAD SPACE



IV 2.5.09

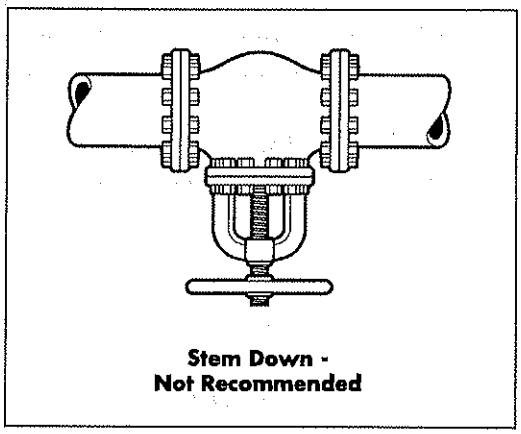
STEM UP - ALWAYS BEST!



Stem Up Always Best!

IV 2.5.12

STEM DOWN - NOT RECOMMENDED



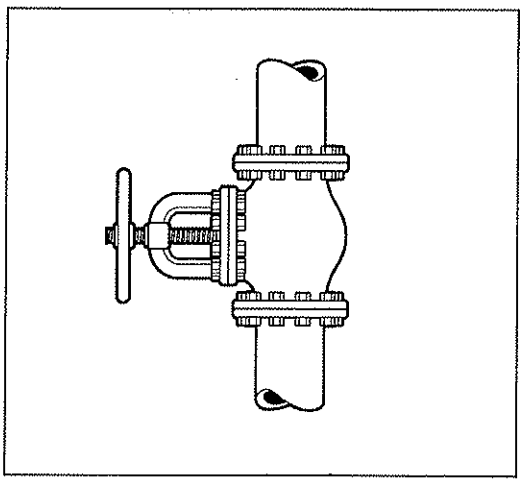
Stem Down - Not Recommended

IV 2.5.10

Valves work best when installed in an upright position with the stem pointing straight up. While some valves, such as the vertical check valve are specially designed for these installations, it is not good practice to install a valve with its stem down or in a horizontal position.

When multi-turn valves are installed with the stem pointing down, sediment in the flow media can collect in the bonnet, which may cause damage to the stem.

STEM HORIZONTAL - NOT PRACTICAL WITH SOME VALVES

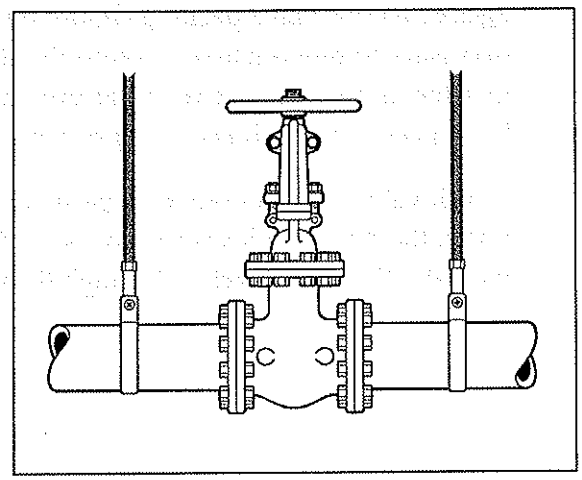


IV 2.5.11

Common Problem: Improper Pipe Support

Another problem occurs when pipe is not supported properly. The weight of a line can distort a valve, particularly bronze valves. As a result, a leak can occur at the valve-end connections. Even the valve body can be so distorted as to not seat properly and provide tight shutoff. It is good practice to use **PIPE HANGERS** on each side of the valve to support the line.

VALVE INSTALLED WITH PIPE HANGERS



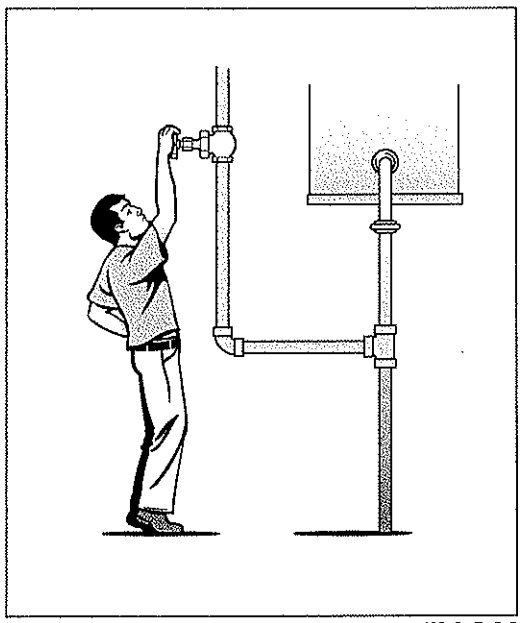
IV 2.5.13

Common Problem: Inaccessible Location

Another problem can occur when the valve is not installed in an accessible location for maintenance and repair (see illustration). Maintenance and valve repair can become very difficult if the valve is inaccessible.

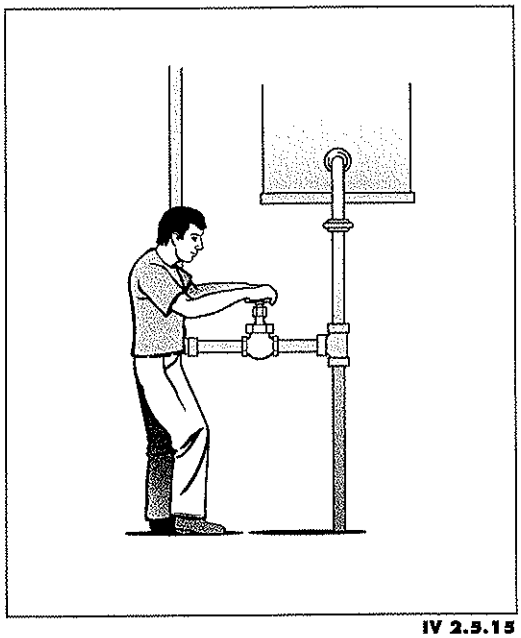
Valves should always be located where they can be easily reached (see illustration).

OVERHEAD VALVE NOT EASILY ACCESSIBLE



IV 2.5.14

VALVE AT WAIST LEVEL EASILY ACCESSIBLE



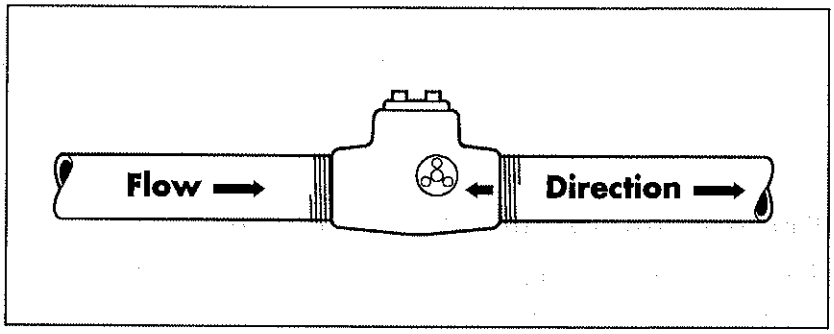
IV 2.5.15

Common Problem: Wear to Stem Area

Another problem involves leakage around the stem area as the packing material ages or wears. Valve packing should be checked periodically and adjusted as necessary to prevent leaks around the stem area. Most multi-turn valves and some quarter-turn valves use stem packing material. It is not recommend that the valve be re-packed while it is under pressure. If it is done, it is done at the user's risk.

Check valves will not work properly unless they are installed with the flow pressure under the disc. Check valves have a marking, generally an arrow on the body that indicates the flow direction through the valve in the open position (see illustration).

CHECK VALVE AND PIPE INDICATING FLOW DIRECTION



IV 2.5.16

REVIEW QUIZ – TEMPERATURE AND PRESSURE VALVES

Answers appear on page 226

DIRECTIONS: Carefully read each question and circle the correct answer. There is only one correct answer per question. When you have finished, check your answers.

1. The term "valve temperature pressure limits" is used to describe the
   a. lowest temperature at which a liquid can continue to flow.
   b. maximum pressure the flow media can exert across the valve.
   c. amount of pressure a valve can withstand.
   d. highest temperature at which a liquid can continue to flow.
2. The flow of liquid through a piping system is resisted by fluid particles rubbing against one another and the surface of the pipe. This resistance results in a loss of energy which is called
   a. pounds per square inch (psi).
   b. pressure.
   c. pressure drop.
   d. force.
3. The purpose of a pressure class rating schedule is to provide the
   a. pressure and temperature limits for a given valve.
   b. pressure limits for flanges and fittings.
   c. standards for bronze valves.
   d. flow velocity and pipe diameter required in a piping system.
4. What is the best way to help a customer to solve a valve problem?
   a. Check the valve for any obvious defects.
   b. Refer the customer to the most experienced person in your business.
   c. Get as much information as possible and report the problem to the manufacturer.
   d. Replace the valve with a valve that has no reported problems.

REVIEW QUIZ – TEMPERATURE AND PRESSURE VALVES

Answers appear on page 226

5. When overhead space is a problem, which of the following types of valve might be suitable?
   a. Non-rising stem
   b. Butterfly
   c. Ball
   d. Check

6. Which installation position is best recommended for multi-turn valves?
   a. Stem down
   b. Stem up
   c. Stem horizontal
   d. Stem slightly vertical

7. What problem might result from not providing adequate support for valve line installations?
   a. Not enough overhead room
   b. End flange joint leaks
   c. Leaking around the stem area
   d. Inaccessible valves

8. The standards charts for bronze, iron, and steel valve materials are measured in terms of which of the following?
   a. Temperature
   b. Pressure
   c. Temperature and pressure
   d. Temperature, pressure, and longevity

9. A check valve has a marking that indicates the
   a. flow direction through the valve in an open position.
   b. pressure measured in the amount of force exerted.
   c. temperature and pressure ratings.
   d. flow direction through the valve in a closed position.

REVIEW QUIZ – TEMPERATURE AND PRESSURE VALVES

Answers appear on page 226

10. How does pressure affect valve material?
    a. The more porous the material, the more pressure can be applied to the valve.
    b. The stronger the material, the more pressure can be applied to the valve.
    c. Pressure increases as the flow media temperature increases.
    d. Pressure makes valve material stronger as the pressure drops.

APPLYING WHAT YOU HAVE LEARNED:

By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.

A. Which parts of a ball valve is limit the valve applications due to material temperature limits? Why?

B. Look at the Pressure Temperature Ratings on page 213. For a Class 150 bronze valve, ASTM B-62, with an end connection of THD, what is the maximum pressure allowed at 350°F?

ANSWERS TO REVIEW QUIZ

CHAPTER 11

TEMPERATURE AND PRESSURE VALVES

Answers to Review Quiz: Review of Temperature and Pressure Valves

1. b. maximum pressure the flow material can exert across the valve.
2. c. Pressure drop
3. a. pressure and temperature limits for a given valve.
4. c. Get as much information as possible and report the problem to the manufacturer.
5. d. Check
6. b. Stem up
7. b. End flange joint leaks
8. c. Temperature and pressure
9. a. flow direction through the valve in an open position.
10. b. The stronger the material, the more pressure can be applied to the valve.

APPLYING WHAT YOU HAVE LEARNED:

A. The packing, seats, and gasket are affected because they are made of Teflon™, a temperature-sensitive material.

B. The maximum pressure allowed is 180 psi.

GLOSSARY OF TERMS

YNNOJN
TO
SNNT

Actuator: A device used to operate a valve semi-automatically or automatically.

All iron: Iron body, disc and seat of gray cast iron, stem of carbon steel.

Angle valve: A globe valve having an angular configuration that permits it to be fitted at bends pipework.

API: American Petroleum Institute. Establishes standards for the design and testing of various valve types for use in the petroleum (gas and oil production) and chemical industries.

ASME: American Society of Mechanical Engineers. Develops American national standards for valves and fittings. Develops standards for end connections, pipe threads, end-to-end dimensions and valve ratings and markings.

ASTM International: Establishes materials standards including the chemical and physical properties of all valve materials.

AWWA: American Water Works Association. Establishes standards for valves used in water supply systems.

Backflow: The flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable water supply from any source or sources other than the intended source.

Ball: A type of closure member found in valves by the same name and in some check valves.

Body: The principle pressure containing part of a valve in which the closure element and seats are located.

Bore: A hole or port through a ball closure member.

Butterfly valve: A type of valve, which can be used to replace a gate valve when cost and weight are important.

Buttweld: A weld end connection.

Check: Refers to the function of preventing backflow.

Closure member: The part of a valve which mates with the valve seat to provide clo- sure of the valve.

Conventional: Type of ball port, which may also be called "regular."

CPVC: Chlorinated polyvinyl chloride. A common type of thermoplastic used for valves.

Diaphragm: Type of valve or closure member often used in the chemical industry.

Disc: A common name for many of the closure members found in gate, globe, and lift check valves.

Downstream: Refers to the flow or pipe run after the valve in a line installation.

Ductile iron: Same as nodule iron and spheroidal iron.

End connection: The type of connection supplied on the ends of a valve which allows it to be connected to piping which may be weld end, flanged end, threaded, or socket weld.

External taper: A flanged valve facing that is machined to mate with the internal taper (female) end connection to provide assembly alignment and gasket containment.

Flat facing: Type of face machined on the flanged end of a valve.

Floating ball: A ball valve design in which the ball is not rigidly held on its rotational axis and so is free to float between the seat rings.

Fluid hammer: SEE water hammer.

Full port: Type of port opening, which provides for 100% flow through the valve. Describes a valve in which the bore (port) is nominally equal to the bore of the connecting pipe.

Gate valve: One of the first known types of valves, which uses a wedge disc. A straight through pattern valve in which closure element is a wedge situated between two fixed seating surfaces, with means to move it in or out of the flow stream in a direction perpendicular to the pipeline axis. Used as a block valve, or on/off valve.

Globe valve: A type of valve, which uses a composition, metal, or plug disc. A valve whose closure element is a flat disc or conical plug sealing on a seat, which is usually parallel to the flow axis. Can be used for throttling services.

Hand wheel: A wheel-shaped valve operating device intended to be grasped with one or both hands which allows turning the valve stem or operator shaft to which it is attached.

IBBM: A common term for valves with cast iron body and bonnet and bronze trim (seating surfaces, stem, bushings).

Internal taper: A flanged valve facing that is machined to mate with the external taper(male) end connection to provide assembly alignment and gasket containment.

Inverted tapered: A type of plug shape used in plug valves.

Lubricated plug valve: A type of plug valve, which used lubricate (sometimes called sealant) to seal mechanism against leaking.

MSS: Manufacturers Standardization Society of the Valve and Fitting Industry. Writes standards for a wide variety of valve details not covered by ASME and, also writes standards for valve ratings and markings, as does ASME.

Multi-turn valves: The category of valves, which require many turns of the handle or hand wheel in order to open or close the valve.

Nominal pipe size (NPS): A dimensionless number used to indicate sizes of pressure pipe and valves and used interchangeably with valve size in inches.

Nonrising stem: A gate valve having its stem threaded into the gate. As the stem turns the gate moves but the stem does not rise. Stem threads are exposed to the line fluid.

Outside screw & yoke (OS&Y): A valve design in which the stem threads are above the packing gland or outside the valve body and there is a yoke to support the top or outer end of the stem.

Packing: The deformable sealing material inserted into a valve stuffing box which when compressed by the gland provides a tight seal about the stem.

Plug: A type of closure member used in plug valves.

Port: An opening in the valve closure member, which permits flow through the valve.

PSI: Pounds per square inch; a pressure measurement.

PVC: Polyvinyl chloride. A common type of thermoplastic used for valves. Quarter-turn valve: A category of valves, which includes ball, butterfly, and plug.

Raised facing: Type of face machined on the flanged end of a valve.

Reduced port: A valve port opening that is smaller than the line size or the valve end connection size.

Rising stem (RS): A rotating valve stem, which moves towards or away from the valve seats.

Seat: The part of a valve, which mates with closure member to provide tight closure. Socket weld: A weld end connection that utilizes deep sockets at each valve end. Straight-through flow design: A model that permits flow straight through the valve.

Socket weld: A weld end connection that utilizes deep sockets at each valve end.

Stainless steel: High alloy steel.

Stem: The rod or shaft transmitting motion from an operator (hand wheel or gear operator) to the closure element of the valve.

TFE: Tetrafluoroethelyene. A plastic commonly used as seal material in quarter-turn valves.

Throttle: The mechanism by which the flow of a fluid is managed by constriction or obstruction.

Throttling: The intentional restriction of flow by partially closing or opening a valve.

Trunnion: The part of a ball valve, which holds the ball on a fixed vertical axis and about which the ball turns.

Valve pressure limit: The maximum pressure the flow media can exert.

Valve: A mechanical device used to control flow media.

Venturi port: A type of port design, which reduces the flow the most.

Water hammer: A pressure surge or wave caused by the kinetic energy of a fluid in motion when it is forced to stop or change direction suddenly.

Wedge disc: The moving part of a gate valve, positioned in the flow stream, which controls the flow through the valve.

Weir: A part of a diaphragm valve, which makes the valve more suitable for throttling purposes.

Weir-type diaphragm valve: A valve with a flexible linear motion closure member that is forced into the internal flow passageway of the body by the actuator.

Yoke: The part of gate or globe valve which acts as a bracket to support the top or outer end of the stem and stem bearing.

APPENDIX

NOTES

COMMONLY USED TABLES
MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTING INDUSTRY (MSS)

MSS SP-25	Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-55	Quality Standard for Steel Castings for Valves, Flanges, Fittings and Other Piping Components (Visual Method for Evaluation of Surface Irregularities
MSS SP-67	Butterfly Valves Valve design, manufacturing and testing requirements, including pressure and temperature ratings. Primary body materials: This standard allows many different body materials, from steel and nickel alloys, to bronze, to cast and ductile iron valves; consult standard for particulars
MSS SP-68	High Pressure Butterfly Valves with Offset Design Valve design, manufacturing and testing requirements, including pressure and temperature ratings. Primary body materials This standard leans directly on ASME B16.34, consult standard for particulars.
MSS SP-70	Cast Iron Gate Valves, Flanged and Threaded ends Valve design, manufacturing and testing requirements, including pressure and temperature ratings. Primary body materials: ASTM A126 Cl B (Cast iron) ASTM A536 (Ductile iron) ASTM A395 (Ductile iron)
MSS SP-71	Gray Iron Swing Check Valves, Flanged and Threaded Ends Valve design, manufacturing and testing requirements, including pressure and temperature ratings. Primary body material: ASTM A126 Cl B (Cast iron)
MSS SP-80	Bronze Gate, Globe, Angle and Check Valves Valve design, manufacturing and testing requirements, including pressure and temperature ratings. Primary body materials by pressure class: ASTM B61 (Pressure Class 125, 150) ASTM B62 (Pressure Classes 200 and higher)
MSS SP-85	Gray Iron Globe and Angle Valves, Flanged and Threaded Ends Valve design, manufacturing and testing requirements, including pressure and temperature ratings. Primary body material: ASTM A126 Cl B (Cast iron)
MSS SP-110	Ball Valves, Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends Valve design, manufacturing and testing requirements, including pressure and temperature ratings Primary body materials: This standard allows many different body materials, from steel and nickel alloys, to bronze, to cast and ductile iron valves; consult standard for particulars.

COMMONLY USED TABLES
AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings Design and material requirements and pressure and temperature ratings for pressure classes 25, 125 and 250. Primary Materials: ASTM Spec A126 Classes A or B (Pressure class dependent)
ASME 16.5	Pipe Flanges and Flanged Fittings Design and material requirements and pressure and temperature ratings for flanges and flanged fittings for classes 150 through 2500, inclusive. Primary Materials: Similar to ASME B16.34 above, specific materials are listed in the standard.
ASME 16.10	Face-to Face and End-to-End Dimensions of Valves Establishes the end to end length (or center to face dimensions of angled valves) of weld end and flanged valves
ASME 16.11	Forged fittings, Socket Weld and Threaded Establishes the design requirements for classes 2000, 3000 and 6000 for threaded fittings, and classes 3000, 6000 and 9000 for socket welding type fittings.
ASME B16.24	Cast Copper Alloy Pipe Flanges and Flanged Fittings Design and material requirements and pressure and temperature ratings for flanges and flanged fittings for classes 150 through 2500, inclusive. Primary Materials: ASTM B61 and B62, ASTM B148 Alloy C95200.
ASME B16.25	Buttwelding Ends Establishes the detail requirements for buttwelding ends for valves in various pressure classes end configurations.
ASME B16.33	Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 125 psi Valve design requirements for 1/2" through 2" for outdoor installation as primary shut off before the meter and regulator.
ASME B16.34	Valves - Flanged, Threaded and Welded End Valve design requirements, minimum wall thicknesses, allowable materials, and pressure and temperature ratings in standard and special class, all pressure classes from 150 to 4500. Primary Materials: This standard allows many different materials, from carbon steel through many nickel and other alloys, consult standard for particulars. Some of the included materials are shown below. ASTM A216-WCB ASTM A217-C12 ASTM A217-C5 ASTM A217-WC1 ASTM A217-WCC ASTM A351 CF8M

ASME B16.44	Manually Operated Metallic Gas Valves for Use in Aboveground Piping Systems up to 5 psi Valve design requirements for 1/4" through 4" for indoor installation as equipment shut off valves.
ASME B16.47	Large Diameter Steel Flanges Design and material requirements and pressure and temperature ratings for flanges and flanged fittings in sizes from 26 through 60 NPS, for various pressure classes.

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