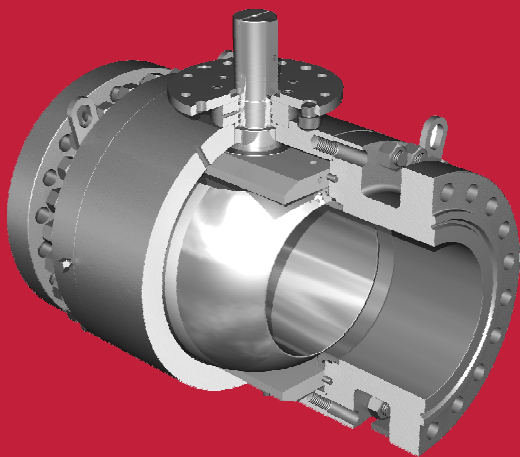


# GLOSSARY OF VALVE TERMS



# GLOSSARY OF VALVE TERMS

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## SECTION 1 VALVE TERMINOLOGY 1

### **AGA - American Gas Association**

A society comprising gas companies set up to achieve common goals.

### **AISI - American Iron & Steel Institute**

An association of steelmakers which sets standards for the chemical and physical properties of steel and iron in various shapes and forms - pipe, tubing, sheet, strip, wire.

### **ANSI - American National Standard Institute**

The principle organization in the US which oversees the creation, promulgation and use of standards for a wide variety of items, including the design, fabrication, and testing of pressure piping, systems, and components for various pipeline services.

### **API - American Petroleum Institute**

The principal US oil company trade association. It has some standards and specification writing functions, such as wellhead components and pipeline valves.

### **API SPEC 6FA**

The API specification dealing with the fire testing of pipeline valves. Once a particular size and pressure class valve is tested and passes the API fire test, all such valves can be identified with the above monogram. API-6FA supersedes API-RP-6F.

### **API SPEC 6D/ISO 14313**

An API specification dealing with pipeline valves. Most pipeline valves are manufactured to this specification and, if so, can be identified with the API 6D monogram.

### **ASME - American Society of Mechanical Engineers**

This professional society publishes technical books, papers, codes and standards. Of principal interest is the ASME Boiler and Pressure Vessel Code which is referenced for many aspects of valve making.

## 2 VALVE TERMINOLOGY

### **ASTM - American Society for Testing & Materials**

A professional society governing the detailed physical and chemical analysis of all basic metals and alloys used in construction. The valves of most manufacturers have components whose materials correspond to ASTM standards.

### **AWS - American Welding Society**

A society which sets guidelines and standards for all welds.

### **ACCUMULATOR**

A vessel in which a gas is trapped and compressed by the liquid in a hydraulic system, thus storing energy to supply liquid under pressure to the system when needed.

### **ACME THREAD**

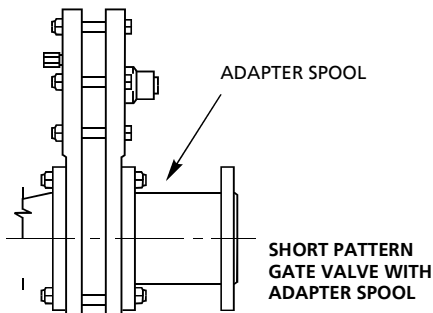
A flat-topped screw thread for power transmission. This thread has a 29° included angle between adjacent thread faces compared with the 60° angle of the US standard "V" thread.

### **ACTUATOR**

See "Operator".

### **ADAPTER SPOOL**

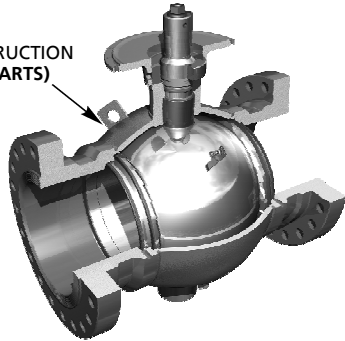
An extension which is added to a short face-to-face valve to conform to standard API 6D face-to-face dimensions.



### ALL WELDED CONSTRUCTION

Pertains to a valve construction in which the body is completely welded and cannot be disassembled and repaired in the field.

ALL WELDED CONSTRUCTION  
(NO BOLTED BODY PARTS)



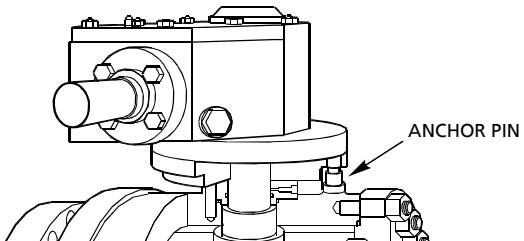
CAMERON® FULLY WELDED BALL VALVE

### AMBIENT TEMPERATURE

The prevailing temperature of the environment immediately surrounding an object.

### ANCHOR PIN

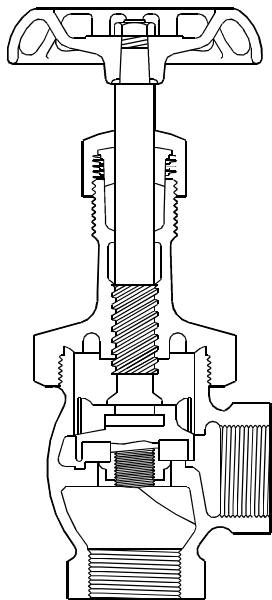
A pin welded to the body of a ball valve. This pin aligns the adapter plate and keeps the plate and gear operator from moving while the valve is being operated.



## 4 VALVE TERMINOLOGY

### ANGLE VALVE

A variation of the globe valve in which the end connections are at right angles to each other, rather than being in-line.



ANGLE VALVE

### ATMOSPHERIC PRESSURE

The external pressure exerted on a body by the atmosphere: 14.7 psi (absolute) at sea level.

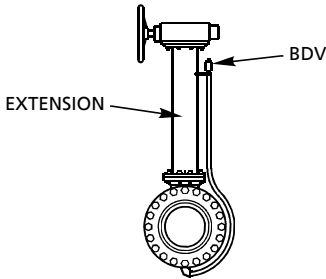
### BBL (bbl)

An abbreviation for "barrel". Used to express liquid volume. One barrel of oil is equal to 42 US gallons.

## BDV - Blow Down Valve

A small ball valve that is installed on the above-ground end of an extended drain line. This valve also serves to vent body cavity pressure in the "block-and-bleed" mode.

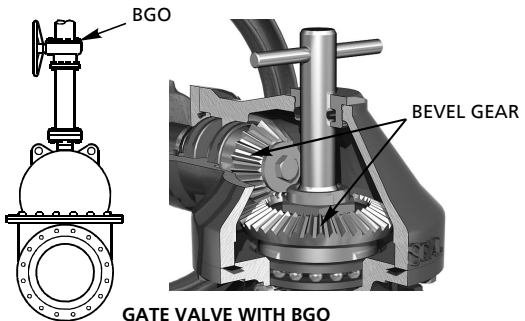
See "Block-and-Bleed", "Extended BDV".



**BALL VALVE WITH DRAIN LINE EXTENSION**

## BGO - Bevel Gear Operated (or Operator)

The actuation of a valve by means of a set of bevel gears having the axis of the pinion gear at right angles to that of the larger ring gear. The reduction ratio of this gear set determines the multiplication of torque achieved. Used on gate valves.

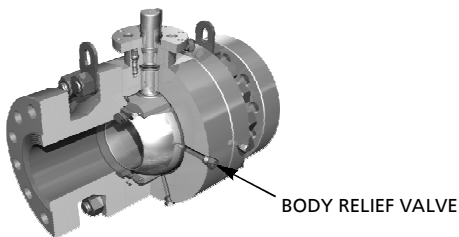


**GATE VALVE WITH BGO**

## 6 VALVE TERMINOLOGY

### **BRV - Body Relief Valve**

A relief valve (optional) installed on ball valves used in liquid service to provide for the relief of excess body pressure caused by thermal expansion.

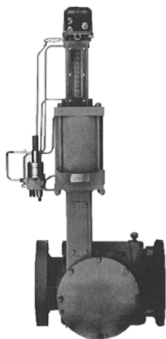


### **BS 6755**

The British Standard specification dealing with the fire testing of pipeline valves. Once a particular size and pressure class valve is tested and passes the BS 6755 fire test, all such valves can be identified with the BS 6755 standard.

### **BVR - Ball Valve Regulator**

An automatic throttling valve controlling flow or pressure in a pipeline comprising a package involving a ball valve, actuator, positioner, and controlling instrument.





### **BACK PRESSURE REGULATOR**

Regulator designed to control upstream pressure. See "Regulator".

### **BACK SEAT**

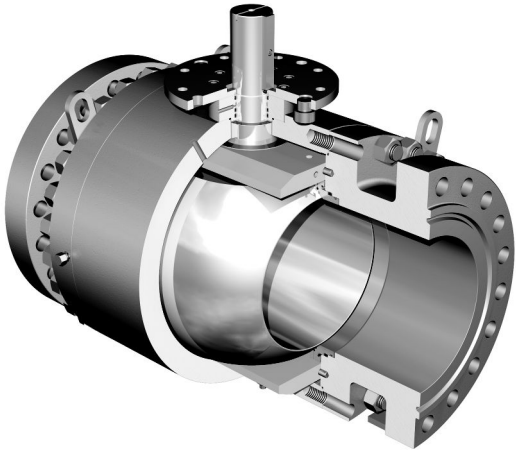
A shoulder on the stem of a valve which seals against a mating surface inside the bonnet to permit replacement, under pressure, of stem seals or packing.

### **BALL**

The spherical closure element of the ball valve.

### **BALL VALVE**

A valve using a spherical closure element (ball) which is rotated through 90° to open and close the valve.



**GROVE® B5 BALL VALVE**

## **8 VALVE TERMINOLOGY**

### **BAR**

A metric unit of pressure. One bar equals 14.5 psi.

### **BDV**

A BDV is also a valve or a system of valves which, when activated, initiate a blowdown of a pipeline, plant, process, or platform; like an ESDV that shuts in a line, except the BDV opens a line.

### **BELLEVILLE SPRING**

A spring resembling a dished washer, used in some ball valves to push the seats against the ball.

### **BENDING MOMENT**

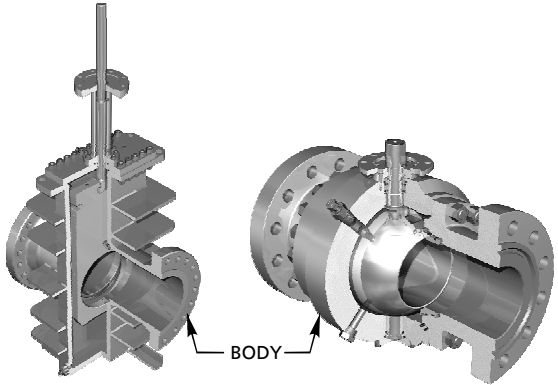
The mechanical bending load produced by a force applied to a part at a right angle to its surface or axis. The product of the force times the perpendicular distance to the point of restraint. Usually expressed in pound-feet.

### **BEVEL**

A chamfer. The angle between two adjacent surfaces (other than 90°). The word "bevel" is used in describing weld-end preparations. See "End Bevel".

### **BLOCK-AND-BLEED**

The capability of obtaining a seal across the upstream and downstream seat rings of a valve when the body pressure is bled off to the atmosphere through blow down valves or vent plugs. Useful in testing the integrity of seat seals and performing minor repairs under pressure.



GROVE® G4N GATE VALVE

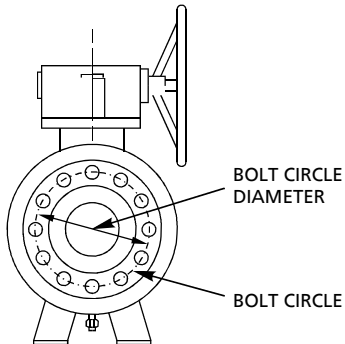
GROVE® B4 BALL VALVE

**BOLT**

A fastener which has a square or hex head and is threaded on the opposite end to receive a nut. Sometimes used to make up a flanged connection.

**BOLT CIRCLE**

The circle on which bolt holes are located.



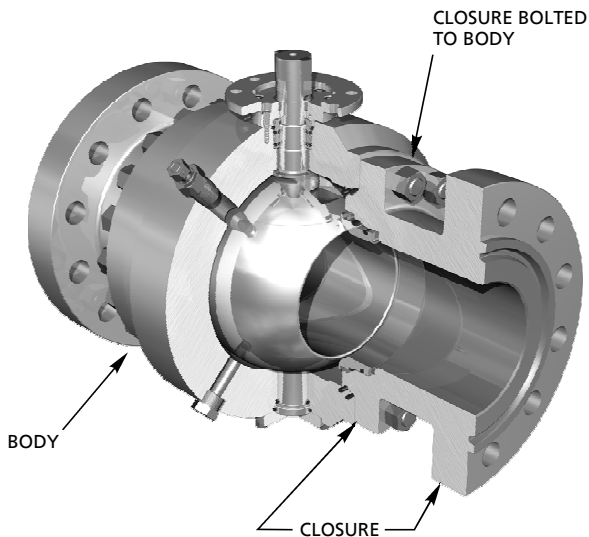
**BOLTED BONNET**

A bonnet which is connected to a valve body with bolts.

## 10 VALVE TERMINOLOGY

### BOLTED CONSTRUCTION

Describes a valve construction in which the pressure shell elements are bolted together, and thus can be taken apart and repaired in the field.



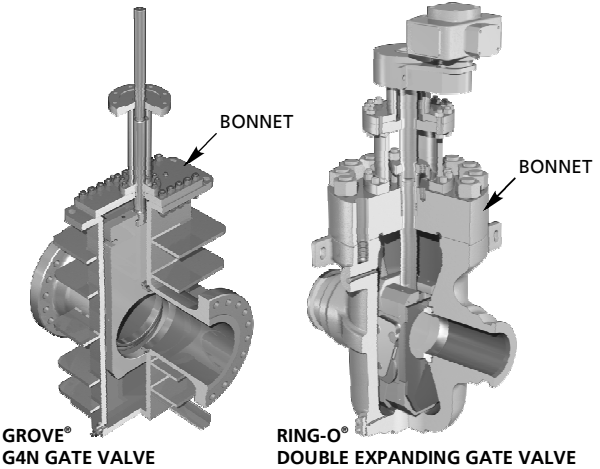
GROVE® B4 BALL VALVE

### BOLTING SETS

Bolts or studs and nuts sometimes supplied with flanged valves to install the valve between line flanges.

**BONNET**

The top part of a valve, attached to the body, which guides the stem and adapts to extensions or operators.



**BORE (or PORT)**

The inside diameter of the smallest opening through a valve. The diameter of the hole in the ball of a ball valve. The diameter of the hole in the gate of a gate valve. The inside diameter of seat rings.

**BRINELL HARDNESS NO.**

A number indicating metal hardness using the Brinell scale. Can be converted to Rockwell B & C hardness by reference to conversion tables.

See "Rockwell Hardness No".

**BUBBLE-TIGHT SHUTOFF**

A phrase used in describing the sealing ability of a valve. During air pressure testing of a new valve in the closed position, leakage past the seats is collected and bubbled through water. To qualify as "bubble-tight", no bubbles should be observed in a prescribed time span.

## 12 VALVE TERMINOLOGY

### **BURIED SERVICE**

An application in which valves are installed in lines which are buried below ground level.

### **BURST PRESSURE**

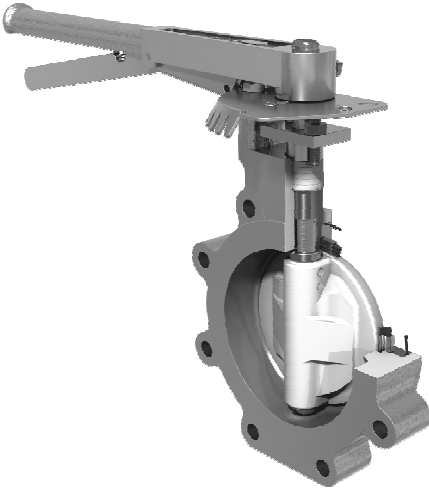
That pressure (psi) at which rupture of a stressed element or pressure-containing vessel takes place. See "Ultimate Strength".

### **BUTT WELD ENDS**

The end connections of a valve, suitably prepared for butt welding to connecting piping. See "WE", "End Bevel".

### **BUTTERFLY VALVE**

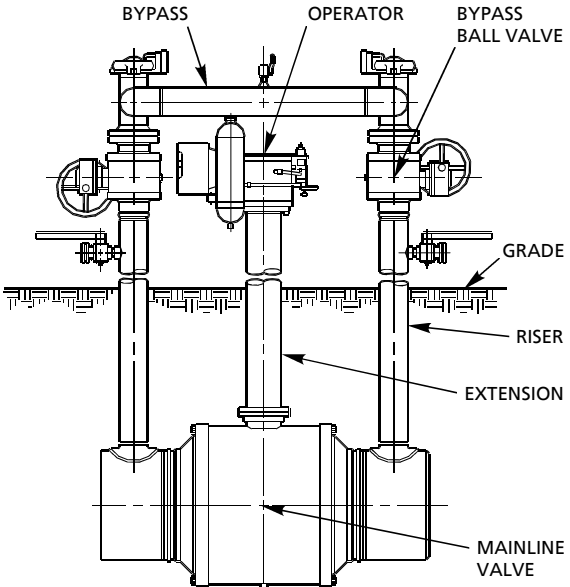
A short face-to-face valve which has a movable vane, in the center of the flow stream, which rotates 90° as the butterfly valve opens and closes.



**WKM® DYNACENTRIC® HIGH PERFORMANCE BUTTERFLY VALVE**

**BYPASS**

A system of pipes and valves permitting the diversion of flow or pressure around a line valve.



**BURIED VALVE SETTING**

**C-PACK**

A special stem packing designed by GROVE® to give maximum lifetime sealing in gate, ball and check valve stems.

**C.I.F. - Cost Insurance & Freight**

Shipper pays all freight and insurance charges. Same as FOB Destination.

## 14 VALVE TERMINOLOGY

### $C_v$

The capacity factor of a valve, also called the valve coefficient; specifically, the number of gallons of water per minute that will flow through a valve with a pressure drop of 1 psi.

### **CWP - Cold Working Pressure**

See "MWP".

### **CAPACITY FACTOR**

See "C".

### **CAPSCREW**

A fastener with a head whose shank is normally threaded throughout its entire length. It is not used with a nut, but rather engagement is made with a female thread in the piece to be joined.

### **CAST**

The form of a particular part of a valve, where the basic shape is formed by molding rather than fabricating.

### **CASTING**

A part which has been formed by pouring molten metal into a mold.

### **CAVITATION**

The rapid formation and collapse of vapor pockets in a flowing liquid in localized regions of very low pressure - often a cause of erosive damage to pumps, throttling type valves and the piping itself. Can be the cause of excessive noise.

### **CERTIFYING (or CERTIFICATION) AUTHORITY (CA)**

An independent body appointed by the purchaser to carry out a survey of the equipment and/or materials that they are buying. It is the responsibility of the supplier to provide the CA with information, documents, access to works and personnel to enable the survey to be carried out.

### **CHAIN WHEEL OPERATED VALVE**

An overhead valve operated by a chain drive wheel instead of a handwheel.

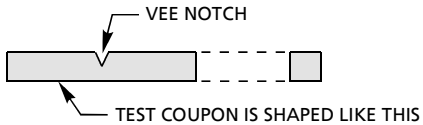


**CHARACTERIZED GATE OR BALL**

A ball or gate, the shape of whose port has been specially altered to provide a specific throttling capability.

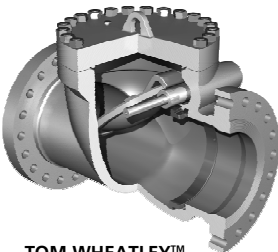
**CHARPY TEST**

A mechanical test conducted on a precisely machined coupon of the steel to be tested. The coupon is clamped in a special machine and subjected to a lateral hammer blow. This test provides a relative measure of the toughness of the steel or its resistance to shock or impact loads. Often required for low temperature applications where testing is done at the expected minimum service temperature. (Refer to Table 3.8 of API 6D.)

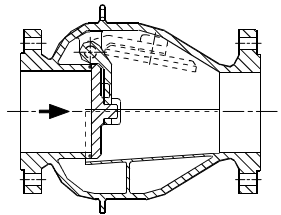


**CHECK VALVE**

A one-directional valve which is opened by the fluid flow in one direction and which closes automatically when the flow stops or reverses direction. See "Clapper".



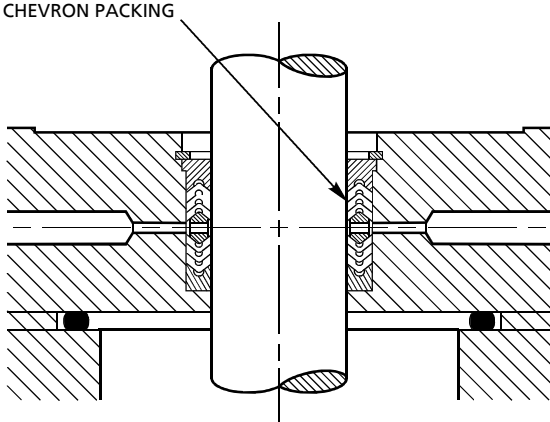
**TOM WHEATLEY™  
SWING CHECK VALVE**



## 16 VALVE TERMINOLOGY

### CHEVRON PACKING

A type of packing used in packing boxes consisting of a nest of "V" cross-section rings.



### CITY GATE (or CITY GATE STATION)

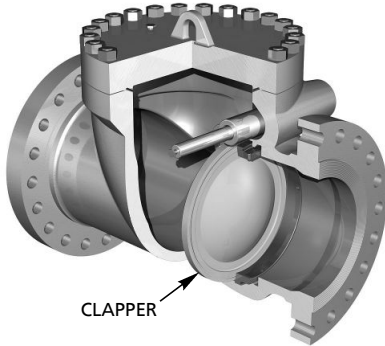
The metering and pressure-reducing station where gas is transferred from a high pressure cross-country transmission line to a low pressure distribution piping system within a city.

### CLADDING

A method of coating metals by which the coating becomes an integral part of the material. This can be done by casting or hot working. It is generally done on valves where special trims are required for difficult applications.

**CLAPPER**

The hinged closure element of a swing-disc check valve.



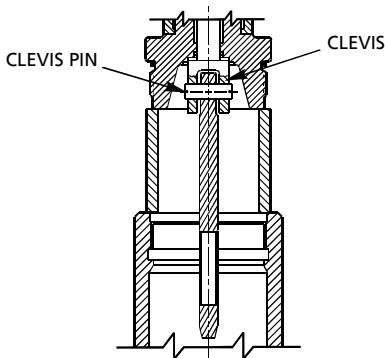
TOM WHEATLEY™ SWING CHECK VALVE

**CLASS**

A designation of pressure capability.  
See "ASME", "MWP".

**CLEVIS**

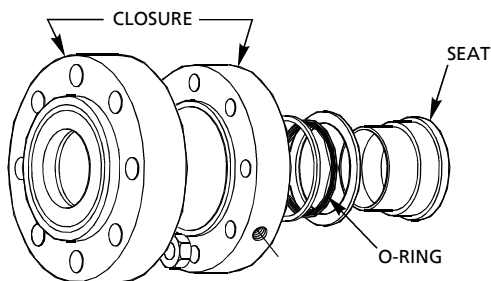
A "U" shaped connecting yoke at the end of a stem or rod, between the ends of which a gate or other part may be pinned or bolted.



## 18 VALVE TERMINOLOGY

### CLOSURE

The end of a ball valve bolted to the body, which often contains the seat rings. Often referred to as part of the body.



### CLOSURE ELEMENTS

The moving part of a valve, positioned in the flow stream, which controls flow through the valve. Ball, Gate, Plug, Clapper, Disc, etc., are specific names for closure elements.

### COAL GASIFICATION

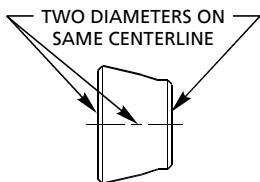
The process of manufacturing natural gas from coal.

### COMPRESSOR

A device which converts mechanical energy into gas pressure.

### CONCENTRIC

Having the same centers.



CONCENTRIC REDUCER

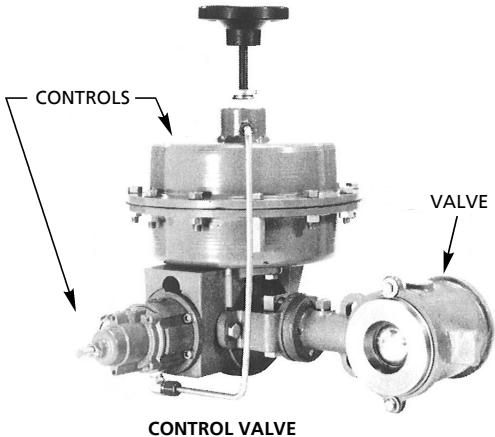
### **CONTAMINANT**

A particle or material which is foreign to the fluid media.

### **CONTROL VALVE**

A valve that controls a process variable, such as pressure, flow or temperature, by modulating its opening in response to a signal from a controller.

See "Controller".



### **CONTROLLER**

A device that measures a controlled variable, compares it with a predetermined setting and signals the actuator to re-adjust the opening of the valve in order to re-establish the original control setting.

### **CORROSION**

The deterioration of a material due to chemical action.

### **COULISSE**

Of or using runners or slides as a guiding mechanism, as in a "Coulisse" style gate valve.

### **CRUDE OIL**

Unrefined oil. Oil as it comes directly from the well.

## 20 VALVE TERMINOLOGY

### CRYOGENIC TEMPERATURE

Any temperature below about  $-240^{\circ}\text{F}$  ( $-151^{\circ}\text{C}$ ).

### CRYOGENIC VALVE

A valve capable of functioning at cryogenic temperatures.

### CYCLE

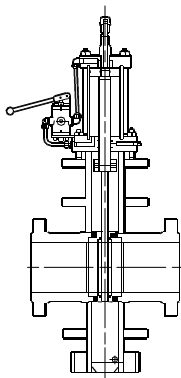
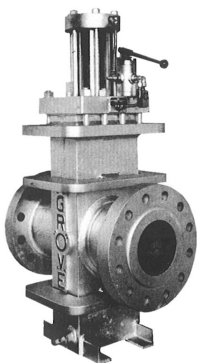
A single complete operation or process returning to the starting point. A valve, stroked from full open to full closed and back to full open, has undergone one cycle.

### CYCLE TEST

A procedure whereby a product is put through an interval of time during which a test process is completed. This can be a set number of events or it can be a continuous operation until something in the product fails.

### CYLINDER OPERATOR

A power-piston valve operator using either hydraulic or pneumatic pressure. A sealed piston converts applied pressure into a linear piston rod (stem) motion. See "Power Operator".



**POWER-PISTON VALVE**

**DPD - DOUBLE-POLE DOUBLE-THROW**

Related to electrical switches.  
See "SPDT".

**DPST - DOUBLE POLE SINGLE-THROW**

Related to electrical switches.  
See "SPST".

**DELTA ( $\Delta P$ )**

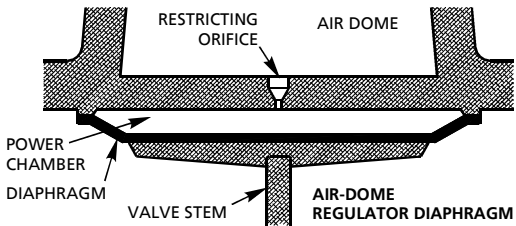
See "Differential Pressure", "Pressure Drop".

**DESIGN APPRAISAL**

A procedure by which a certifying authority, appointed by the purchaser, appraises the design parameters of the equipment and/or materials they are buying. The supplier shall submit drawings, calculations and documents as required to the CA, in conjunction with those normally required for review and acceptance by the purchaser.

**DIAPHRAGM**

A round, thin, flexible sealing device secured and sealed around its outer edge - and sometimes around a central hole in the diaphragm - with its unsupported area free to move by flexing.



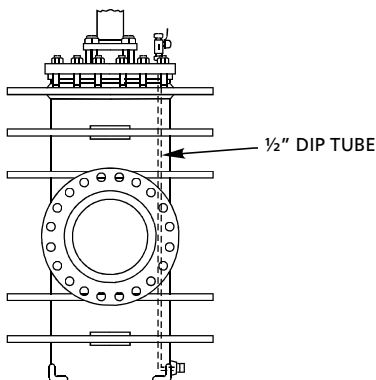
**DIFFERENTIAL PRESSURE**

The difference in pressure across a valve in a pressurized line. The difference in pressure between any two points in a pressurized system under flowing conditions.

## 22 VALVE TERMINOLOGY

### DIP TUBE

Extending the blow down valve on large gate valves requires a tube which is located inside of the valve. This tube is called the "dip tube" and extends through the bonnet to the bottom of the body cavity.



### DISC

The closure element of a globe angle or small regulator valve. The disc (sometimes referred to as a "valve", "poppet", or "plug") moves to and from the seat in a direction perpendicular to the seat face. Depends on stem force for tight shutoff.

### DISTRIBUTION LINE

Pipeline which distributes gas to the service lines of individual consumers. Usually it is small in diameter (6" and under) and low pressure (under 150 psi).

### DOT REGULATIONS - Department of Transportation

A code of federal regulations setting forth minimum safety requirements for the transportation of hazardous gases or liquids by pipeline.



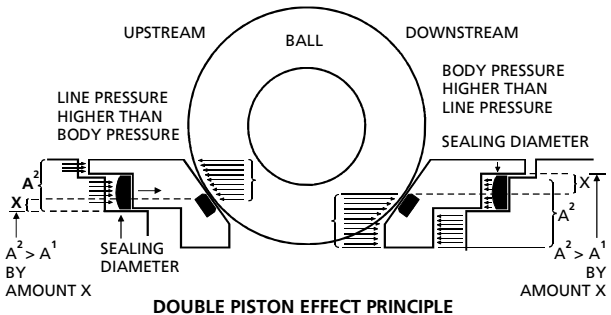
**DOUBLE-BLOCK-AND-BLEED**

A valving arrangement which ensures no flow in a line, even though the valve may leak. It consists of two block valves in the main line with a small bleeder valve draining the line between the block valves.

See "Block-and-Bleed".

**"DOUBLE" PISTON EFFECT PRINCIPLE (DPE)**

The sealing principle of GROVE® ball valves whereby line pressure is used on both upstream and downstream floating seats to effect a dead-tight seal simultaneously on both sides of the ball. With the DPE seat configuration, when the upstream seat leaks, the pressure entering into the body cavity acts on the downstream seat, which, being of the DPE design, is then pushed against the ball, and the valve seals in both directions.



**DRAIN PLUG**

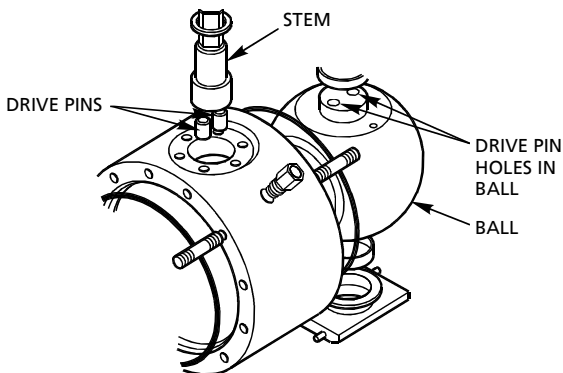
A fitting at the bottom of a valve, the removal of which permits draining and flushing of the body cavity. The vent plug assembly on some ball and gate valves also serves as a drain valve.

See "Vent Plug".

## 24 VALVE TERMINOLOGY

### DRIVE PINS

The two pins which fit into the bottom of a ball valve stem and engage corresponding holes in the ball. As the operator turns the stem, the drive pins turn the ball.



### DROOP

A drop in set (outlet) pressure of a regulator or control valve due to the travel of its valve or poppet as the required flow increases from low to maximum. A slight change in the control spring length due to the valve travel will result in spring force variations, translating into a change of set (outlet) pressure.

### DRY LUBE

Dry-film moly disulphide applied as a coating to sliding or rotating parts to reduce frictional drag. After application, the film is baked in an oven at high temperature.

### "DU" BEARING

A bearing consisting of bronze impregnated with TFE (Teflon) resin which is lead powder-bonded to a low carbon steel backing. A Garlock Company product.

### **DUROMETER**

An instrument for determining the hardness of synthetic rubber or elastomeric materials, usually on the Shore A scale. Also the unit of hardness: i.e., "90 Durometer Shore A".

### **DYE PENETRANT INSPECTION**

See "Liquid Penetrant Inspection".

### **EMO - Electric Motor Operated**

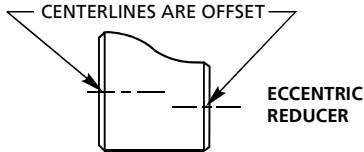
The actuation of a valve by electric motor.  
See "Power Operator".

### **ESDV - Emergency Shutdown Valve**

A valve or a system of valves which, when activated, initiate a shutdown of the plant, process, or platform they are tied to.

### **ECCENTRIC**

Not having the same center.



### **ELASTOMER**

A natural or synthetic material. Used in synthetic rubber parts such as O-rings.

### **ELBOW**

A female-threaded or socket fitting used for changing direction in a run of pipe or tubing.  
See "Ell", "Street Ell".



90° ELBOW



45° ELBOW

## 26 VALVE TERMINOLOGY

### ELECTROLESS NICKEL PLATING

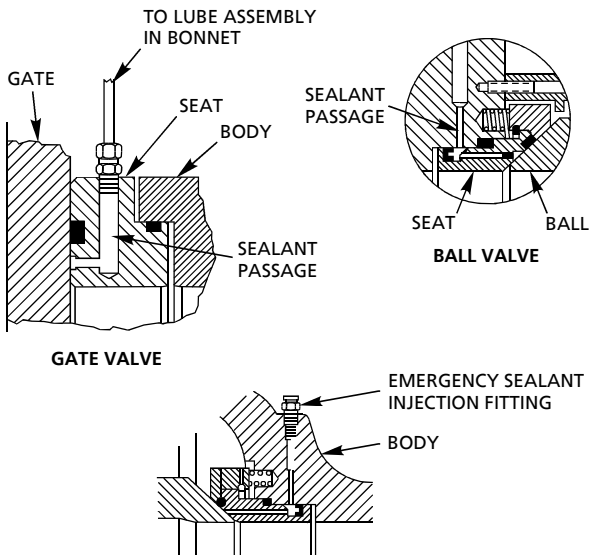
A plating process which requires no external electrical power and is the result of a chemical reaction between the part and the plating solution. A uniform consistent deposit and plating rate can be produced by controlling and adjusting the chemistry of the plating bath.

### ELL

A pipe or tubing fitting that has the shape of an "L". See "Elbow".

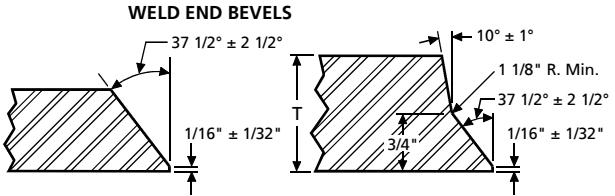
### EMERGENCY SEAT SEAL

To obtain tight shutoff in an emergency situation, a sealant can be injected into a specially designed groove in the seat rings. Available for most ball valves and gate valves.



**END BEVEL**

Weld end preparations for butt welding. Governed by ASME B31.4 and B16.25.



**END CONNECTION**

The type of connection supplied on the end of a valve which allows it to be installed in a pipeline. Weld end, flanged end, screwed end.

**EROSION**

The mechanical wearing away of a metal surface or part due to fluid impingement. The presence of entrained solid particles accelerates this process.

**EXPANDING GATE VALVE**

A gate valve comprised of a separate gate and segment that, as the valve operates that gate and segment, move without touching the seats, permitting the valve to be opened and closed without wear. In the closed position, the gate and segment are forced against the seats. Continued downward movement of the gate causes the gate and segment to expand against the seats. When the valve reaches its full open position, the gate and segment seal off against the seats while the flow is isolated from the valve body.

**EXPLOSION PROOF**

The prevention of explosion triggered by electrical components through containment in special housings. A requirement for electrical devices, such as solenoids and switches, when exposed to a potentially explosive environment.

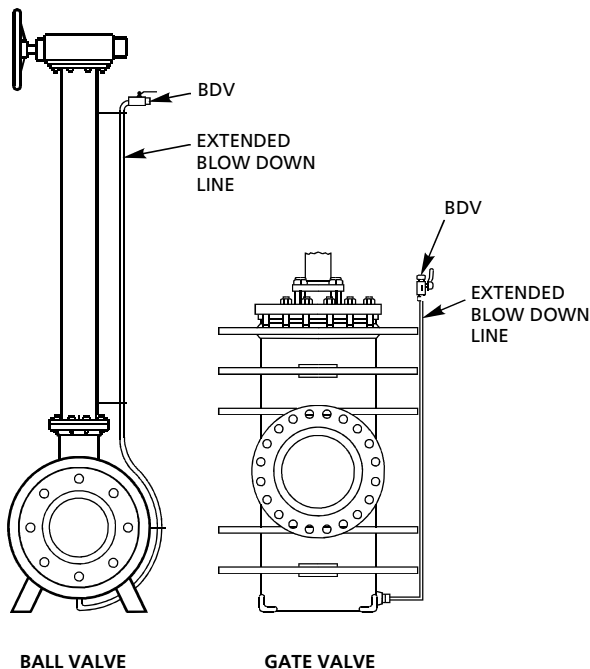
## 28 VALVE TERMINOLOGY

### EXPORT PACKING

Special packing and crating that is required for export shipping. Includes sealing against a salt atmosphere (sea air).

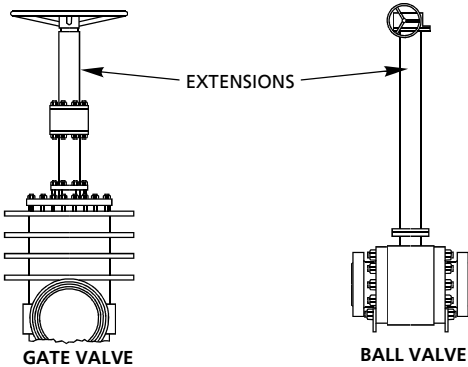
### EXTENDED BDV - Blow Down Valve

Used on buried valves where the drain plug is inaccessible. Instead, a line is piped above grade, terminating in a small valve. Line pressure is used to blow out condensates and other material which settles out in the bottom of the body cavity. See "BDV".



### EXTENSION STEM

The equipment applied to buried valves to provide above-grade accessibility to operating gear, blow down, and seat lubrication systems.



### EXTERNAL COATING

Coating applied to protect valves against various environments - sea air, salt water, earth burial, and normal air exposure.

### FAS - Free Along Side

Term used for ocean shipment. Vendor pays transportation only to shipping dock alongside vessel.

### FE - Flanged End

See "RF", "RTJ".

### FEA - Finite Element Analysis

State-of-the-art method of analyzing complex shapes by organizing the shapes into a series of smaller elements which can be more accurately analyzed to determine whether or not components are suitable for their intended purpose.

### FERC - Federal Energy Regulatory Commission

A United States government agency which has the final approval of new pipelines, right of ways, etc.

## 30 VALVE TERMINOLOGY

### FOB - Free On Board

Transportation charges are absorbed by vendor to the FOB point. Usually a shipment is FOB Factory, in which case, title, and transportation charges pass to the customer when it leaves the factory.

### FPC - Federal Power Commission

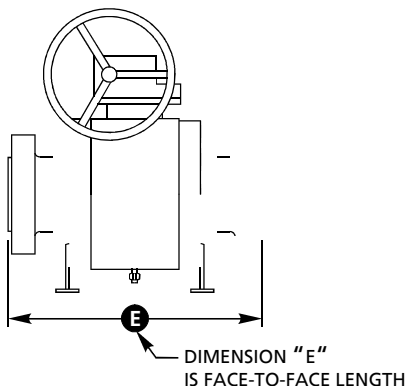
The United States government agency which governs and regulates the natural gas and pipeline industry, as well as other energy industries.

### FABRICATED VALVE

One in which the body and hub parts are not cast, but rather are formed from plate or pipe and then welded or bolted together.

### FACE-TO-FACE

The overall dimension from the inlet face of a valve to the outlet face of the valve (one end to the other). This dimension is governed by ASME B16.10 and API 6D to ensure that such valves are mutually interchangeable, regardless of the manufacturer.



### FACING

The finish of the contact surface of flanged fittings.



### **FAIL SAFE VALVE**

A valve designed to operate to a preferred position (open or closed) in order to avoid an undesirable consequence in a piping system. Refer to ESDV and BDV.

### **FATIGUE ASSESSMENT**

Fatigue resistance verification of a component subjected to a number of operating cycles.

### **FEMALE THREAD**

An internal screw thread designed to mate with a component having male (external) threads of the same size and type.

### **FIELD SERVICEABLE**

A statement indicating that normal repair of the valve or replacement of operating parts can be accomplished in the field without returning the valve or part to the manufacturer.

### **FIRE GATE**

A gate or ball valve which is positioned in a pipeline at the entrance to a compressor station. This valve is closed in case of fire in the compressor station. Closing the valve prevents the gas in the pipeline from feeding the fire.

### **FIRE SAFE**

A statement associated with a valve design which is capable of passing certain specified leakage and operational tests after exposure to fire. Must be referenced to a particular specification. See API Spec 6FA and BS Spec 6755.

### **FITTING**

Any device used for connecting elements in fluid lines, i.e., elbows, tees, nipples, unions, flanges, etc.

## 32 VALVE TERMINOLOGY

### FLANGE

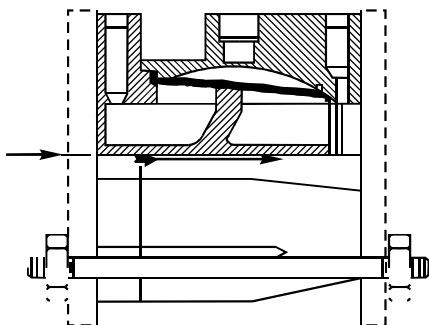
A cast or formed pipe fitting consisting of a projecting radial collar with bolt holes to provide a means of attachment to piping components having a similar fitting. The end piece of flanged-end valves.

### FLEXFLO®

The registered trademark of a flexible tube valve manufactured by CAMERON.

### FLEXIBLE TUBE VALVE

A special valve using a flexible sleeve or tube which acts as the closure element. Pressure applied to the jacket space surrounding the outside of the tube that controls the opening and closing of the valve.



FLEXIBLE TUBE VALVE

### FLOATING BALL

A ball valve having a non-trunnion mounted ball. The ball is free to float between the seat rings and thus causes higher torques.

### FLOW

A fluid in motion in a conducting line.

### FLOW COEFFICIENT

The number of gallons of water per minute that will flow through a valve with a pressure drop of 1 psi. Also referred to as the  $C_v$  of the valve.

### **FLOW, LAMINAR**

The flow of a viscous fluid in which the fluid moves in parallel layers with a fixed velocity gradient from the centerline to the containing walls of the conduit. Sometimes referred to as "streamline" flow.

### **FLOW METER**

An instrument used to measure flow rate or total flow or both.

### **FLOW RATE**

The volume or weight of a fluid passing through a pipeline or conductor per unit of time, i.e., 3000 barrels of oil per day; 4 MMCF of gas per hour.

### **FLOW, TURBULENT**

The random flow of a fluid in which the velocity at a certain point in the fluid varies irregularly.

### **FLUID**

Any non-solid substance that can be made to flow. Both liquids and gases are fluids.

### **FORCE**

The intensity of an influence tending to produce motion, distortions or change of shape. The product of unit force (psi) and the area over which it acts. Usually expressed in pounds.

### **FORGING**

A part that is formed by heating and hammering to a specific shape.

### **FRICTION**

The resistance to motion between two contacting surfaces or substances. Friction is also developed between a flowing fluid and the inner wall of the conducting pipe - resulting in a drop in pressure.

### **FULL BORE**

See "Full Opening".

## 34 VALVE TERMINOLOGY

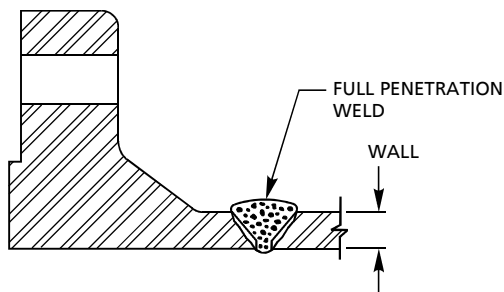
### FULL OPENING

Describes a valve whose bore (port) is nominally equal to the bore of the connecting pipe.

See "Venturi Valve".

### FULL PENETRATION WELD

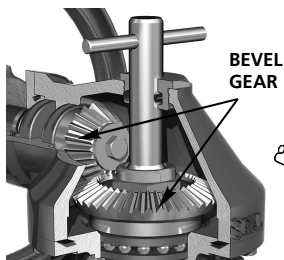
Describes the type of weld wherein the weld metal extends across the entire wall thickness of the joint.



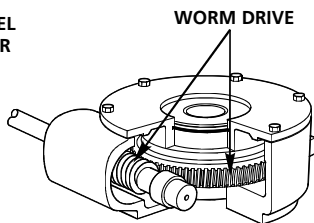
### GO - Gear Operated

The actuation of a valve through a gear set which multiplies the torque applied to the valve stem.

See "BGO - Bevel Gear Operator", "MGO - Manual Gear Operator".



BEVEL GEAR OPERATOR



WORM GEAR OPERATOR

### **GALLING**

The tearing of metal when two elements rub against each other. Usually caused by lack of lubrication or extreme contact pressure.

### **GAS**

A compressible fluid such as air, hydrogen, nitrogen, etc.

### **GASKET**

A seal or packing placed between mechanical joints (such as flanges) to prevent the escape of the flowing medium.

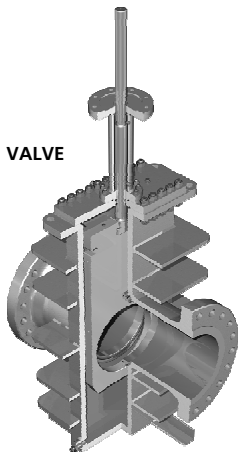
### **GATE**

The closure element of a gate valve.

### **GATE VALVE**

A straight-through pattern valve whose closure element is a wedge or parallel-sided slab, 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.

**GROVE® G4 GATE VALVE**



## 36 VALVE TERMINOLOGY

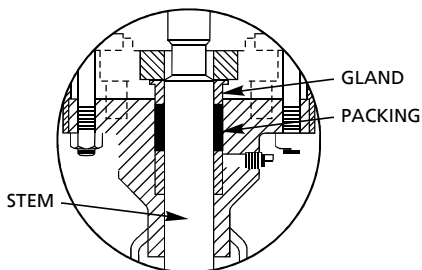
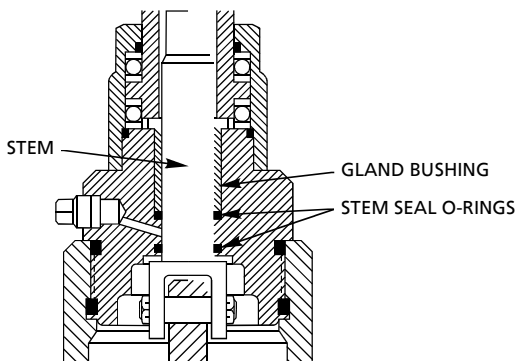
### GAUGE, PRESSURE

An instrument, usually with a threaded connection, for measuring and indicating the pressure in a piping system at the point at which it is connected.

### GLAND (or GLAND BUSHING)

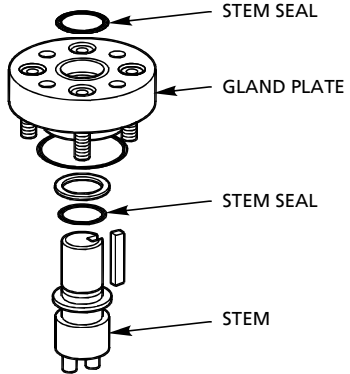
That part of a valve which retains or compresses the stem packing in a stuffing box (where used) or retains a stem O-ring, lip seal, or stem O-ring bushing. Sometimes manually adjustable.

See "Packing", "Stuffing Box".



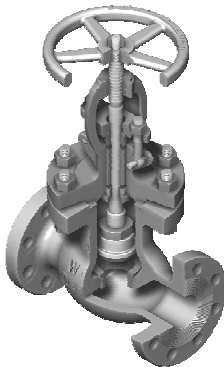
### GLAND PLATE

The plate in a valve which retains the gland, gland bushing, or stem seals, and sometimes guides the stem.



### GLOBE VALVE

A valve whose closure element is a flat disc or conical plug sealing on a seat which is usually parallel to the flow axis. The tortuous flow path produces a relatively high pressure loss.



NAVCO® GLOBE VALVE

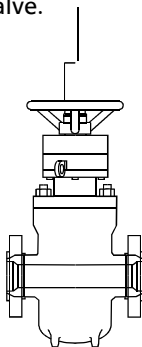
## 38 VALVE TERMINOLOGY

### GREASE FITTING

A fitting through which lubricant or sealant is injected.

### HWO - Handwheel Operated

A valve on which the handwheel drives the stem directly to operate the valve.



### HARD FACING

A surface preparation, such as detonation gun or high velocity oxygen flow (HVOF), in which an alloy is deposited on a metal surface, usually by weld overlay, to increase abrasion and/or corrosion resistance.

### HEAD

The height of an open column of liquid above a given datum, expressed in linear units; i.e., feet of water, inches of mercury, etc. It is another way of expressing pressure.

### HEADER

See "Manifold".

### HEAT ANALYSIS

A chemical analysis, conducted by the foundry immediately prior to pouring, which measures the exact chemical composition of a particular batch of molten metal. Does not include analysis of physical properties. See "Mill Test".



## HEAT TREATMENT

Describes any process or procedure by which the internal structure of steel is altered by heating to produce desired physical characteristics. This is usually accomplished by furnace heating followed by controlled cooling.

## HEAT TREATMENT CHARTS

Furnace charts providing a temperature vs. time record of the heating and cooling cycle, required by a specific heat treatment process for a particular furnace load of steel or steel parts.

## HOLIDAY

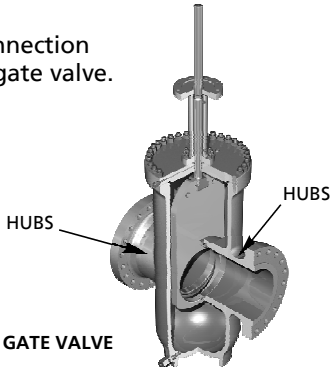
An imperfection or "bare spot" in a coating or plating.

## HOT TAPPING

The process by which a pipeline, under pressure, is cut into to provide a side outlet. A flanged fitting is saddle-welded to the pipeline and a full port valve bolted to the flange. The hot tapping machine, bolted to the outboard valve flange, is operated through the open valve. After cutting out a circular piece from the pipe wall, the tapping machine is removed and the valve closed.

## HUBS

The end connection tubes on a gate valve.



GROVE® GATE VALVE

## **40 VALVE TERMINOLOGY**

### **HYDRAULIC**

Pertaining to, or using, water, oil, or other liquids.

### **HYDRAULIC MOTOR ACTUATOR ( or OPERATOR)**

A device by which rotation of an hydraulically powered motor is converted into mechanical motion.

### **HYDRAULIC SEATS**

The movement of the seats in a valve that are controlled by using water, oil, or other liquids under pressure.

### **HYDROSTATIC TEST (or SHELL TEST)**

A test in which a valve is completely filled with water and pressure tested. Used for conducting proof pressure testing. See "Proof Pressure".

### **ID - Inside Diameter**

The measurement of the inner diameter of a circular part.

### **IDS - Instrument Data Sheet**

A table summarizing data such as service, valve size, supply pressure, etc., necessary in prescribed pressure steps.

### **ISO - International Standards Organization**

An organization which sets minimum international standards for a wide variety of items manufactured and used in pipeline services.

### **INCREMENTAL SEAT TEST**

The leakage testing of valve seats in an assembled valve by increasing the applied pressure in prescribed pressure steps.

### **INERTIA**

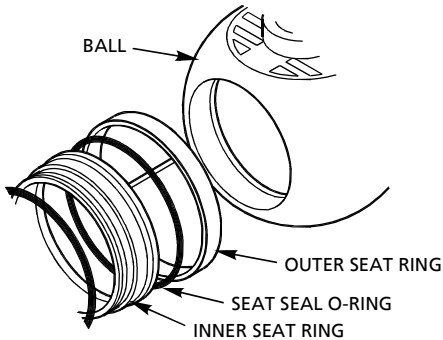
The property of a body or mass which resists a change in velocity.

### **INLET PORT**

That end of a valve which is connected to the upstream pressure zone of a fluid system.

### INNER SEAT RING

The inner part of a two-piece valve seat assembly.



### INSIDE-OUT AIR SEAT TEST

A pressure test that can be performed only on independent seating, trunnion mounted ball valves. By closing the valves and pressurizing the body cavity, all of the seals in an independent seating ball valve can then be pressure tested.

### "IN SITU" MAINTENANCE

To maintain or repair a product "in its original place", such as a top entry ball valve or regulator.

### INTERNAL PRESSURE RELIEF

A self-relieving feature in non-independent seating valves that automatically relieves excessive internal body pressure caused by sudden changes in line pressures. By means of the piston effect principle the excessive body pressure will move the seat away from its seating surface and relieve it to the lower pressure side.

## 42 VALVE TERMINOLOGY

### KEY STOP

A method of restricting the travel of a ball valve from fully open to fully closed. The stem key bears against the ends of an arc machined in the adapter plate.

### LNG - Liquefied Natural Gas

Natural gas in the liquid state. For the gas to remain liquified, the temperature must be maintained in the cryogenic region. The liquid occupies far less volume than an equivalent volume of gas and it can be readily transported by ship and stored ashore in insulated tanks to await re-gasification.

### LPG - Liquid Petroleum Gas

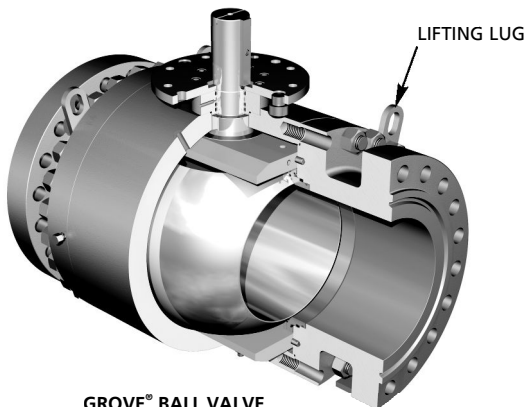
Gases such as butane or propane in the liquid state. LPG, under relatively low pressure, remains a liquid at normal ambient temperature.

### LANTERN RING

See "Chevron Packing".

### LIFTING LUGS

Lugs provided on larger ball, gate and check valves, for lifting and positioning valves. Also called lifting eyes.



GROVE® BALL VALVE

**LIMIT SWITCH**

An electrical device providing a signal to a remote observation station indicating when the valve is in the fully open or fully closed position. Usually a component of a valve operator.

**LINE**

A pipe, tube or hose for conducting fluids.

**LIP SEAL**

A circular seal ring of "U" shaped cross section encompassing an elastomeric O-ring which provides resiliency and ensures a seal at the inner and outer lips of the "U".

**LIQUID PENETRANT INSPECTION**

An NDE method of detecting the presence of surface cracks and surface imperfections in welds or castings through use of a special red dye.

**LOCK UP PRESSURE**

The differential pressure required to produce tight shutoff in a regulator. It is usually a few psi.

**LOCKING DEVICE**

A mechanism provided on valve operators to prevent unauthorized operation or tampering.

**LUBE SEATS**

Seats which are equipped with a lubricant injecting system. See "Emergency Seat Seal".

**MAOP - Maximum Allowable Operating Pressure.**

Determined in accordance with piping codes, DOT regulations, etc.

## 44 VALVE TERMINOLOGY

### **MDS - Material Data Sheets**

The material data sheets define the minimum requirements for the required materials, i.e., chemical requirements, manufacturing, qualification of supplier, mechanical testing and properties, non-destructive examination, repair, marking, and certification.

### **MGO - Manual Gear Operator**

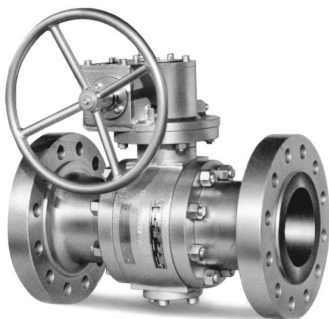
A gear operator that is operated manually (with a handwheel).

### **MMCF**

An abbreviation for "million cubic feet" used to designate gas volume and gas flow rates in pipelines (MMCF per hour or day).

### **MO - Motor Operated**

See "Power Operator", "EMO".



**MANUAL GEAR OPERATOR  
MOUNTED ON BALL VALVE**

### **MSS - Manufacturers Standardization Society of the Valve and Fitting Industry**

A technical association of valve, fitting and actuator manufacturers that writes standards and practices for the valve and fitting industry. Recommendations of this society are advisory only.

**MWP - Maximum Working Pressure (or CWP - Cold Working Pressure)**

The maximum working pressure (pounds per square inch) at which a valve can be operated. The maximum working pressure for various pressure classes, per Table 2.1 of API 6D, within temperature limits of -20°F and +100°F (-29°C and +38°C) are as follows:

Class	MWP (CWP)
150	275
300	720
400	960
600	1440
900	2160
1500	3600
2500	6000

**MAGNETIC PARTICLE INSPECTION**

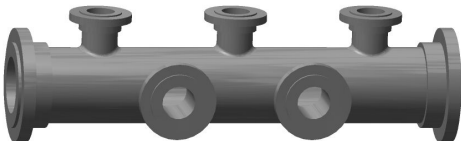
An inspection procedure for detecting surface cracks in welded areas through the use of fine iron particles in an electrical field.

**MALE THREAD**

The external thread on pipe, fittings or valves used in making a connection with mating female (internal) threaded parts.

**MANIFOLD (or HEADER)**

A common pipe or chamber having several lateral outlets.



MANIFOLD

## **46 VALVE TERMINOLOGY**

### **MASS SPECTROMETER**

An instrument used for sorting streams of electrified particles in accordance with their different masses by means of deflecting fields. The instrument can produce a photographic or graphic record of each compound and the percentage of the compound. Most commonly used in analyzing petroleum and steel products.

### **MECHANICAL SEAL**

In a valve, a shutoff that is accomplished by a mechanical means rather than with fluid or line pressure. The wedging action of a gate against the seats or the seat springs pushing the seat against the ball or gate are examples of mechanical seals in a valve.

### **METAL-TO-METAL SEAL**

The seal produced by metal-to-metal contact between the sealing face of the seat ring and the closure elements, without benefit of a synthetic seal.

### **METER PROVER**

A system used to check or "prove" a flow meter. A close fitting sphere is launched into a pipe of known inside diameter. The flow medium pushes the sphere through a measured length of pipe between two sphere detection devices. Knowing the transit time and the exact volume between the stations, a flow rate is calculated and compared with the meter reading.

### **METER RUN**

A section of pipeline in which a meter is installed to measure the volume of fluid passing through the line.



**MILL CERTIFICATES**

Certificates, provided by the steel mill, indicating the chemical analysis and physical properties of a specific batch of steel. "Mill Certs" are usually required only for pressure-containing parts. The customer's need for such "Mill Certs" must be made known when the order is first placed, otherwise is it not possible to trace a valve part back to the mill.

See "Heat Analysis".

**MILL TEST**

All tests required by the material specification. Usually includes both the heat analysis (chemical) and the physical properties. Sometimes also impact tests.

**MILL TEST REPORTS**

See "Mill Certificates".

**MODULUS (or COEFFICIENT) OF ELASTICITY**

The ratio between a force per unit area (stress) which acts to deform a body and the corresponding fractional deformation (strain) produced by the stress.

**MOLD**

A hollow cavity (frequently in packed sand) for giving a desired shape to a material in a molten or plastic state. Used in making metal castings.

**MONITORING (or MONITOR SERVICE)**

A field procedure whereby two valves - usually regulators - are installed in series and adjusted in such a manner that, should the primary regulator fail, the standby regulator will automatically take over at a slightly higher pressure setting.

**NACE - National Association of Corrosion Engineers**

The technical association publishes papers, articles and standards on all aspects of corrosion and has written the definitive standard for valve materials for sour gas service.

## 48 VALVE TERMINOLOGY

### **NDE - Non-Destructive Examination**

See "Non-Destructive Tests".

### **NEMA - National Electrical Manufacturers Association**

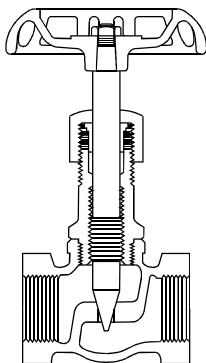
An association which has set up guidelines for the manufacture of electrical equipment. Generally applicable to specifications for switches, etc., for electric operators.

### **NPT - National Pipe Tapered**

A uniform standard governing the dimensions of tapered pipe threads.

### **NEEDLE VALVE**

A type of small valve, used for flow metering, having a tapered needlepoint plug or closure element and a seat having a small orifice.



**NEEDLE VALVE**

### **NIPPLE**

A short length of small size pipe, threaded on both ends. Used on end connections of screwed-end valves and in small size piping systems.



**NIPPLE WITH  
THREADED ENDS**

**NITROGEN/HELIUM TEST**

A pressure test conducted using nitrogen or helium (inert gases) instead of air, water, or other gases to prevent any danger of fires or explosions. Generally specified by the purchaser when buying a valve or regulator product.

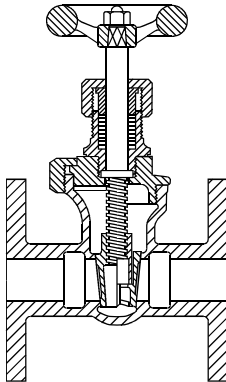
**NON-DESTRUCTIVE TESTS**

Those inspection tests which are not destructive to the valve structure or function.

See "Radiographic Inspection", "Liquid Penetrant Inspection", "Magnetic Particle Inspection", and "Ultrasonic Inspection".

**NON-RISING 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 line fluids.



**WEDGE GATE VALVE  
WITH NON-RISING STEM**

**NORMALLY CLOSED SOLENOID VALVE**

An electrically operated valve whose inlet orifice is closed when the solenoid coil is not energized. Energize to open. See "Solenoid Valve".

## 50 VALVE TERMINOLOGY

### **NORMALLY OPEN SOLENOID VALVE**

An electrically operated valve whose inlet orifice is open when the solenoid coil is not energized.

Energize to close.

See "Solenoid Valve".

### **OCMA - Oil Companies Materials Association**

An association of British oil companies which has written a standard for "fire safe" testing of soft seated valves.

See "Fire Safe".

### **OD - Outer Diameter**

The measurement of the outermost diameter of a circular part.

### **OLDHAM COUPLING**

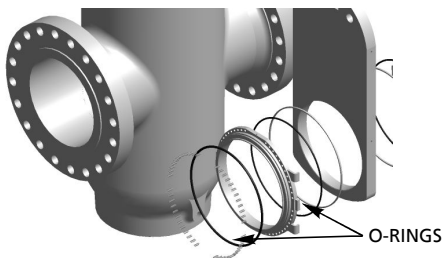
A double slider connection used to connect shafts



OLDHAM COUPLING

### **O-RING**

An elastomeric or synthetic seal ring of circular cross-section.



## **OPERATING TIME**

The time required for a power operator to stroke the valve from a full open to full closed position or vice versa.

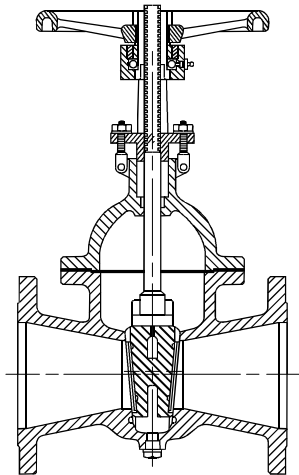
## **OPERATOR**

A device which converts manual, hydraulic, pneumatic or electrical energy into mechanical motion to open and close a valve.

See "Power Operator", "EMO", "GO", "HWO", "MGO", "MO".

## **OS&Y - Outside Screw and Yoke**

A valve in which the fluid does not come in contact with the stem threads. The stem sealing element is between the valve body and the stem threads.



**WEDGE GATE VALVE WITH OS&Y**

## **OUTER SEAT RING**

The outer metal piece of a two-piece seat ring unit. See "Inner Seat Ring".

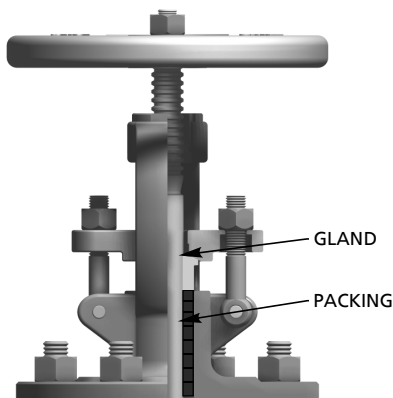
## 52 VALVE TERMINOLOGY

### PSI (psi)

An abbreviation for "pounds per square inch". The force per unit area exerted against a resisting body.

### PACKING

The deformable sealing material inserted into a valve stem stuffing box, which, when compressed by a gland, provides a tight seal about the stem. See "Gland", "Stuffing Box".



### PACKING GLAND

See "Gland".

### PATTERN

A duplicate or copy, usually wooden, of a part to be cast. Used to form the mold into which molten metal is poured.

### PEAK SHAVING

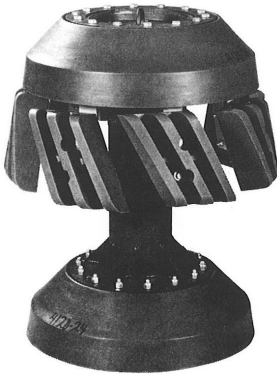
When daily usage of natural gas is charted on graphs, it will show high peaks (of usage) during the winter months. These peaks can be "shaved" (averaged out) when the daily consumption is augmented with standby supplies of synthetic natural gas, propane, or methane.

**PHENOLIC COATING**

A thermo-setting resin applied to valve interiors and/or exteriors to inhibit corrosion. A plastic material.

**PIG**

A device, closely conforming to the pipe bore, which is forced through a pipeline to clean the pipe of all foreign material and debris. The valves in a pipeline that will be pigged must be through-conduit, full port; otherwise the pig will not pass through them.



**24" PIG WITH URETHANE BLADES**

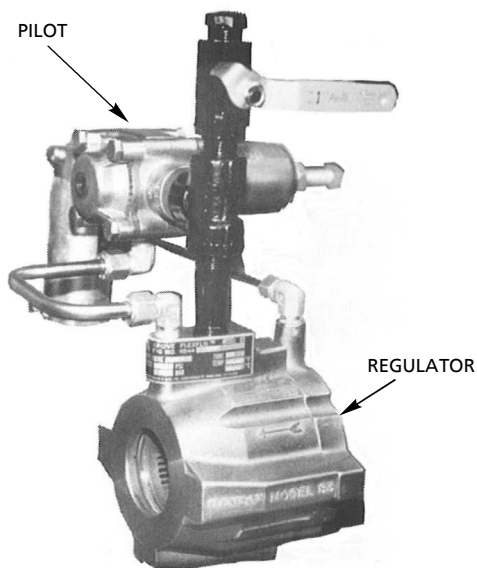
**PILOT**

A spring-loaded pressure regulator used to control the pressure and flow of other larger pressure regulators or instruments.

## 54 VALVE TERMINOLOGY

### PILOT-OPERATED REGULATOR

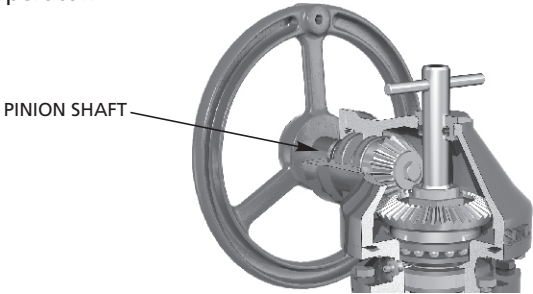
A regulator which is controlled by a second small volume, high accuracy regulator or pilot. This arrangement has the advantages of improving performance by minimizing the effects of unbalanced pressure and droop. The number of possible applications are also increased since a wide range of pilot configurations are feasible.





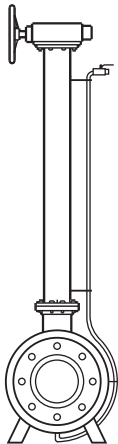
**PINION SHAFT**

The external input shaft of certain gear operators which drives the internal reduction gearing. The pinion shaft can accept a handwheel or power operator.



**PINION SHAFT EXTENSION**

On a buried valve, the gear operator pinion shaft must be extended above grade to permit the valve to be operated.



## 56 VALVE TERMINOLOGY

### PISTON EFFECT

The sealing principle involved in utilizing line pressure to effect a seal across the floating seats of some valves.

### PITCH AND LEAD

Pertaining to screw threads, the pitch refers to the measurement between adjacent threads. The lead refers to the distance the screw advances in one complete revolution. Worm gears of gear operators are also identified by pitch and lead. Speed of operation and torque required are related to pitch and lead .

### PLASTICS

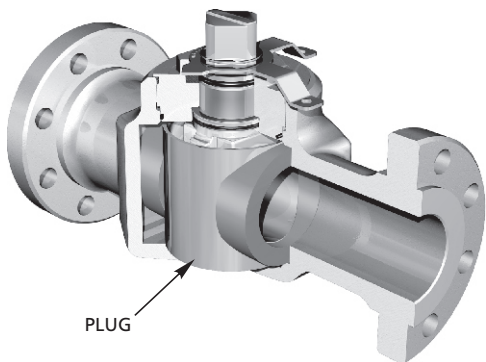
A broad classification covering a variety of non-metallic, synthetic or organic materials capable of being molded or formed into desired shapes. Also used as a protective coating for valves.

### PLUG

The rotating closure element of a plug valve. Also a threaded fitting used to close off and seal an opening into a pressure-containing chamber, e.g., pipe plug.

### PLUG VALVE

A quarter-turn valve whose closure element is usually a tapered plug having a rectangular port.



**PNEUMATIC**

Pertaining to, or using, air or gas.

**POLY PAK STEM SEAL**

**(A Parker Seal Company Product)**

An O-ring energized lip seal which replaces the O-ring stem seal in certain gate valves. Also used for stem seals in some ball valves.

See "Lip Seal".

**PORT**

See "Bore".

**POSITION INDICATOR**

Any external device which visually indicates the open and closed position of a valve.

See "Stem Indicators".

**POWER OPERATOR**

Powered valve operators are of the following general types: Electric Motor, Pneumatic or Hydraulic Motor, Pneumatic or Hydraulic Cylinder. Operators can either be adapted directly to the valve stem or side mounted on existing gear or scotch yoke operators.

**PRESSURE**

See "PSI".

**PRESSURE DIFFERENTIAL**

See "Differential Pressure".

**PRESSURE DROP**

Decrease in pressure along the direction of flow in a piping system caused by fluid friction, restrictions, and change-of-direction fittings. Pressure drop is related to velocity, specific gravity, viscosity and the size and roughness of the pipe interior.

See "Differential Pressure".

**PRESSURE REDUCING REGULATOR**

Regulator designed to control downstream pressure.

See "Regulator".

## 58 VALVE TERMINOLOGY

### **PRESSURE SWITCH**

A switch (usually electric) activated by a rise or drop in pressure. A transducer.

### **PRESSURE TEST**

A test using specified pressures of liquid or gases, which can be used to check the sealing, integrity, design standards, etc., of a particular product.

### **PRODUCT ANALYSIS**

A verification conducted by the valve manufacturer to assure that the chemical composition of received material coincides with the heat analysis and with requirements of the applicable specification.

### **PRODUCT STANDARDIZATION**

The process by which purchasers ensure consistency of a product's quality by the approval of the vendors' standardized documentation. This is normally used as the basis for blanket purchase agreements .

### **PROOF PRESSURE**

A hydrostatic test pressure, usually 1 1/2 times the rated working pressure, applied to an assembled valve to verify the structural integrity of the pressure-containing parts. Synonymous with hydrostatic shell test. (Table 5.1, API 6D).

### **PROTECTIVE SLEEVES**

A circular "pipe-like" sleeve inserted in place of the ball and seats of a top entry ball valve. This protective sleeve remains in place inside the valve during valve installation and ultimate pigging of a pipeline to clear debris from the line before placing the pipeline into service. Once the pipeline has been purged of all debris, the protective sleeve is removed entirely from the ball valve cavity, and operating trim (i.e., ball and seats) is then installed for normal service conditions.

**PULSATION**

Rhythmical throbbing or vibrating. In pipelines, a flow or pressure oscillation which is identically repeated in every fixed time interval. Pulsation is an inherent characteristic of reciprocating gas compressors and reciprocating liquid pumps. Pressure and flow pulsations interact with piping systems to cause vibration, metering errors and potential equipment damage.

**PUMP**

A rotary or reciprocating device using mechanical energy to propel liquids through pipelines or to draw liquids from tanks or sumps by suction.

**PUMP CONTROL VALVE**

A ball valve that is not meant for on-off service, but whose specific function is to control flow and prevent cavitations in pumps on liquid pipelines.

**PUPS**

See "Transition Piece".

**QUALIFICATION TEST**

An investigation, independent of a purchasing function, that is performed on a product to determine whether or not the product conforms to all of the requirements of a particular specification. This is generally done by a third independent party to qualify a product for a specific application.

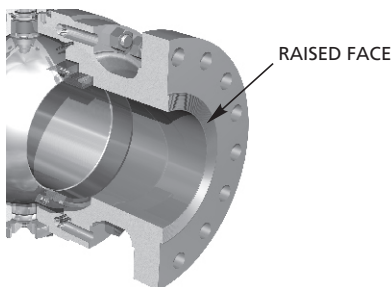
**QUALITY ASSURANCE**

Planned regular and/or preventive actions which are used to ensure that materials, products, or services will meet specified requirements .

## 60 VALVE TERMINOLOGY

### RF - Raised Face

The raised area of a flange face which affords a seal with a mating flange face by means of a flat gasket of the same diameter as the raised face.

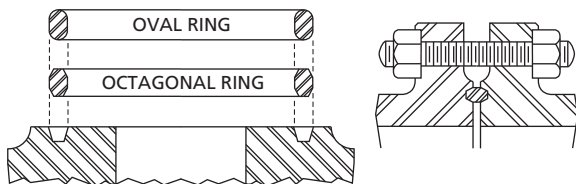


### RPM - Revolutions Per Minute

Rotational speed, turns per minute. For example, the RPM delivered by a power operator to the pinion shaft of a gear operator.

### RTJ or R.T.J. - Ring Type Joint

A flange connection using a specially shaped soft metal ring as a gasket. Generally used on high pressure valves and not widely used in the pipeline industry.



### RADIOGRAPHIC INSPECTION

An X-ray NDE procedure for locating flaws in welds, casting, and fabricated parts.

## RATCHET DRIVE

A shaft or valve that is operated by means of a ratchet mechanism. The ratchet delivers an intermittent stepped rotation through a gear in one direction only.

## REDUCED PORT (or REDUCED BORE)

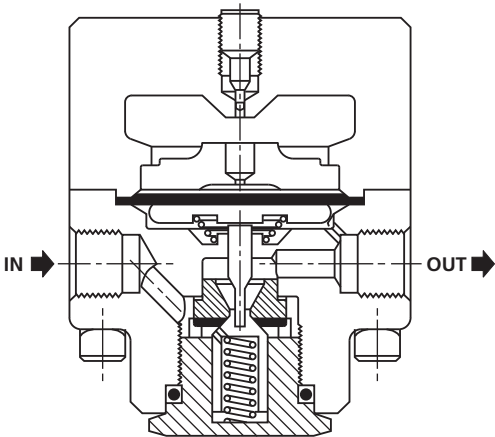
See "Venturi" Valve®.

## REGULAR PORT VALVE

A term usually applied to plug valves. The "regular" port of such a valve is customarily about 40% of the line pipe area. Hence, it corresponds to a Venturi or reduced bore valve of the same nominal pipe size. Venturi ball valves are often a logical alternative to plug valves with advantages in price torque and low maintenance.

## REGULATOR

A throttling valve which exercises automatic control over some variable (usually pressure). Not an on-off valve.



GROVE® MITY-MITE PRESSURE-REDUCING REGULATOR

## 62 VALVE TERMINOLOGY

### RELIEF VALVE

A quick acting, spring-loaded valve that opens (relieves) when the pressure exceeds the spring setting. Often installed on the body cavity of ball and gate valves to relieve thermal overpressure in liquid services. See "B.R.V" and Section 2.

### REMOTE CONTROL

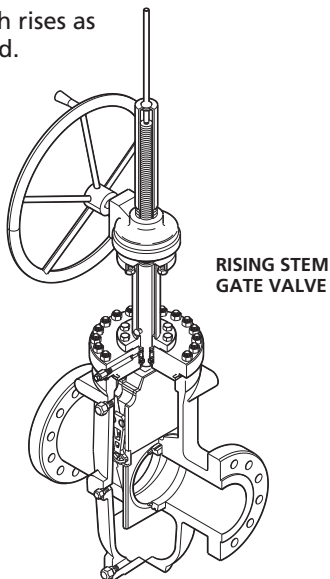
The operation of a valve or other flow control device from a point at a distance from the device being controlled. Can be accomplished by electrical, pneumatic or hydraulic means.

### RESILIENT SEAT

A valve seat containing a soft seal, such as an O-ring, to assure tight shutoff.

### RISING STEM

A valve stem which rises as the valve is opened.

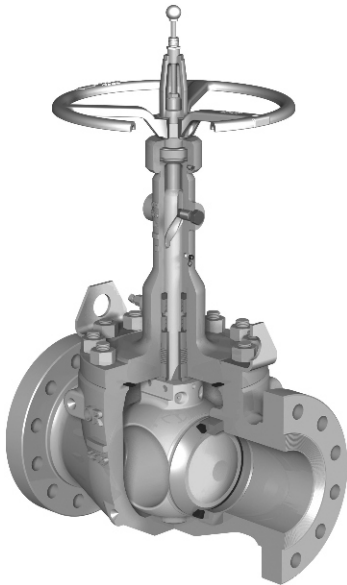




**RISING STEM BALL VALVE**

A single-seated ball valve that is designed to seal by using the valve's stem to mechanically wedge the valve's ball into a stationary seat, effecting a bubble-tight seal. The valve's stem operates through a guide sleeve assembly that guides the stem through a quarter turn of rotation as the stem is raised or lowered by a handwheel (or actuator).

The mechanical action of the stem moves the ball away from the seat prior to the 90° rotation of the ball. The design provides lower operating torques and longer seat life while assuring bubble-tight shutoff.

**ORBIT® RISING STEM BALL VALVE**

## 64 VALVE TERMINOLOGY

### **ROAD BOX**

A concrete or metal box with a removable cover, enclosing and providing access to valves installed in buried lines alongside roads or streets. The valves are operated by removing the box cover and inserting a long-handled "T" wrench which engages a 2" square nut attached to the valve stem or to the pinion shaft of geared valves.

### **ROCKWELL HARDNESS NO.**

A numerical expression of the hardness of a metal as determined with a Rockwell Hardness Tester. There are several hardness scales. The most commonly used are the Rockwell B scale for soft metals and the Rockwell C scale for hard materials.

### **RUPTURE DISC (or BLOW-OUT DISC)**

An emergency over pressure relief device, a relatively thin diaphragm designed to burst at a specified pressure. It cannot be reset, but must be replaced after rupture event.

### **SNG - Synthetic Natural Gas**

A substitute natural gas made from the by-products of chemical plants and refineries. See "Coal Gasification".

### **SPDT - Single-Pole, Double-Throw**

See "SPST".

### **SPST - Single-Pole, Double-Throw**

Refers to the function of an electrical switch often used in the control system of electric valve operators.

### **SSIV - Subsea Isolation Valve**

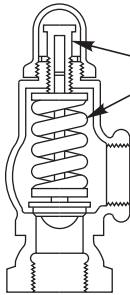
A valve used underwater, generally in a manifold that will close and isolate a particular pipeline or process in an emergency.

### **SY - Scotch Yoke**

See "Scotch Yoke Operator".

**SAFETY VALVE**

A quick opening, pop action valve used for fast relief of excessive pressure.



THE PRESSURE AT WHICH VALVE RELIEVES IS SET BY ADJUSTING SPRING FORCE

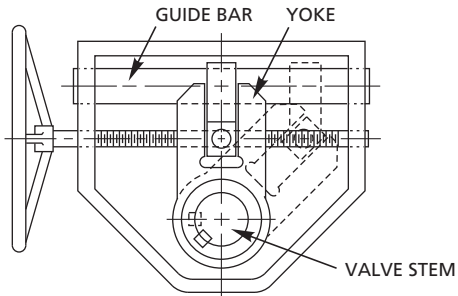
SPRING-LOADED SAFETY VALVE

**SCHEDULE**

A system for indicating the wall thickness of pipe. The higher the schedule number, the thicker the wall for a certain pipe size.

**SCOTCH YOKE OPERATOR**

A quarter-turn operator for use on quarter-turn valves using a scotch yoke mechanism rather than gears. The scotch yoke has a torque output at the beginning and ending of its stroke that is generally twice the magnitude of the torque output in the center of its stroke.



SCOTCH YOKE OPERATOR

## 66 VALVE TERMINOLOGY

### SCREWED ENDS

Internally threaded end connections supplied on some valves. Usually tapered pipe threads.

See "NPT".

### SEAL, DYNAMIC

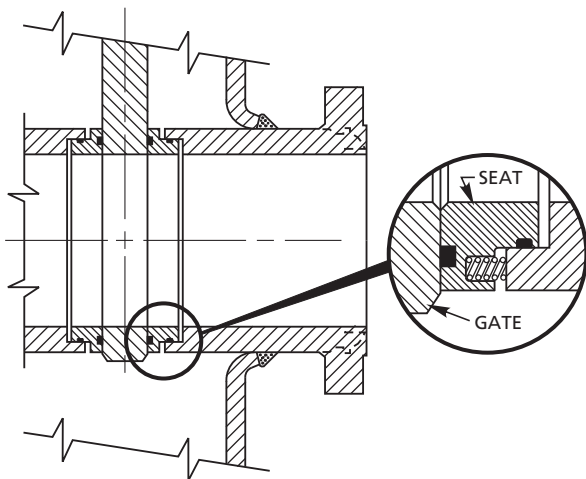
A sealing element used between parts that have relative motion, i.e., stem seals, seat seal O-rings, etc.

### SEAL, STATIC

A sealing element used as a gasket between two non-moving parts, i.e., valve bonnet O-rings, ball valve body O-rings, flange gaskets, etc.

### SEAT

That part of a valve against which the closure element (gate, ball) effects a tight shutoff. In many ball valves and gate valves, it is a floating member containing a soft seating element (usually



SLAB GATE POSITIONED BETWEEN SEAT RINGS

### **SELF RELIEVING**

The process whereby excessive internal body pressure, in some valves, is automatically relieved into either the upstream or downstream line by forcing the seats away from the closure elements .

### **SEPARATOR**

A special tank used to separate gas from oil in some crude oil gathering systems.

### **SHORT GATE**

A gate valve whose seat rings contact the gate only in the closed position. Such valves are not through conduit, as the gate is completely withdrawn from the flow area in the open position.

### **SHORT PATTERN VALVE**

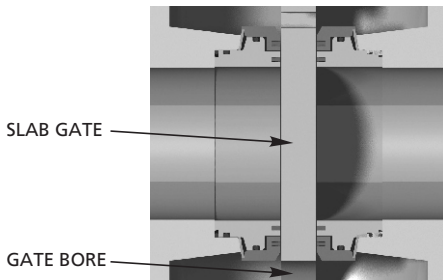
A valve whose face-to-face dimension is less than the API 6D standard.

### **SHUTOFF VALVE**

A valve designed only for on/off service. Not a throttling valve. Sometimes referred to as a "block valve".

### **SLAB GATE**

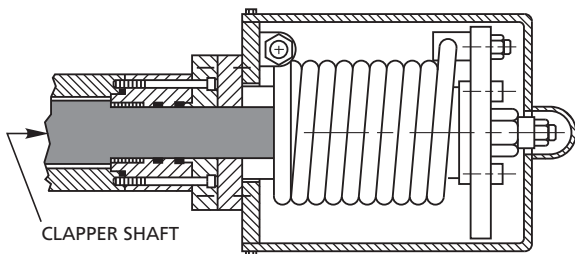
A gate having flat, finely finished, parallel faces as opposed to a wedge gate. Such a closure element slides across the seats and does not depend on stem force to achieve tight shutoff.



## 68 VALVE TERMINOLOGY

### SLAM RETARDER

A device to prevent the clapper of a check valve from slamming as it closes upon flow reversal. Hydraulic damping cylinders, rotary vanes and torsional springs are all used for this purpose.



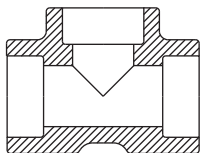
TORSIONAL SPRING SLAM RETARDER

### SLURRY SERVICE

An application involving a flow medium consisting of small solid particles suspended in a liquid. Coal slurry, consisting of about equal parts of coal and water, is transported by pipeline from coal mines to Dower plants where the coal is de-watered and burned. A specially modified GROVE® B5 ball valve is offered for this service.

### SOCKET END

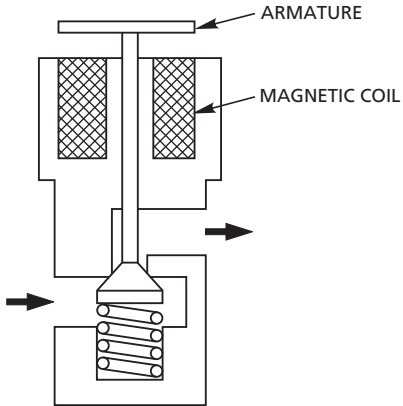
An end connection in which a pipe or tube is inserted into a counterbored hole and then brazed or fillet-welded.



TEE WITH SOCKET ENDS

**SOLENOID VALVE**

A small electrically operated valve used in the control piping of powered hydraulic or pneumatic cylinder operators.



NORMALLY CLOSED - ENERGIZED TO OPEN

**SOUR GAS**

Natural gas containing significant amounts of hydrogen sulfide ( $H_2S$ ). Requires special trim.

**SPECIFIC GRAVITY**

The ratio of the weight of a given volume of fluid to the weight of an equal volume of water (if the fluid is a liquid) or to the weight of an equal volume of air (if the fluid is a gas).

**SPHERE-LOK (a GROVE® trade name)**

A ball valve having a blind pocket in the ball rather than a through hole. The valve will catch and hold a metal sphere and then launch it down the pipe . Used in meter prover systems to accurately measure flow rates and calibrate flow meters.

See "Two-Way Sphere-Lok", "Meter Prover".

## 70 VALVE TERMINOLOGY

### SPOOL PIECE

See "Adapter Spool".

### SPUR GEAR

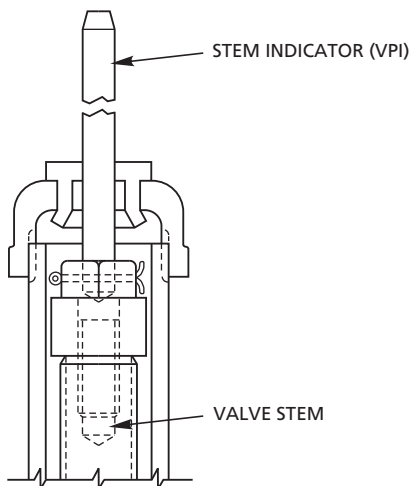
The simplest of gears. In a gear set, the pinion and ring gear are aligned on parallel shafts.

### STEM

A rod or shaft transmitting motion from an operator to the closure element of a valve.

### STEM INDICATOR (or VPI - Visible Position Indicator)

A position-indicating rod supplied with gate valves. It extends from the top of the valve stem and serves to indicate the relative position of the gate.



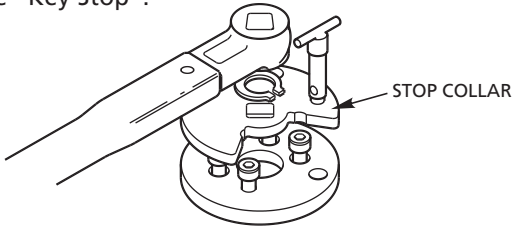
### STEM NUT

A one or two-piece nut which engages the stem threads of a valve and transmits torque from an operator to the valve stem.



**STOP COLLAR**

The collar on a ball valve which restricts the ball to 90° of rotation from the fully closed position. See "Key Stop".



**STOPPLE (or STOP OFF)**

A procedure used in the repair of a pipeline to isolate a section of line in the absence of a shutoff valve. After welding a flanged saddle to the pipe, the line is "hot tapped" and an expanding resilient plug is inserted into the pipe bore. When the repair is completed, the plug is withdrawn and a valve, installed on the saddle flange, is closed.

**STRAIN GAUGE**

An instrument used to measure small or minute distortions caused by stress forces in mechanical components.

**STREET ELL**

A 90° pipe fitting with male and female threaded ends .



90° STREET ELL

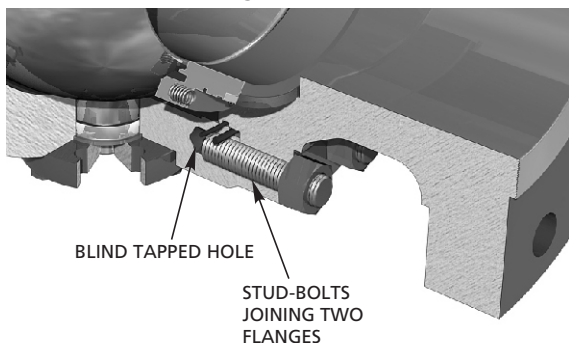
**STRESS**

An engineering parameter used in the design of valves. The value of unit force (psi) produced within a material as the result of an applied force or load. Developed stress must be held well below the yield strength of the material.

## 72 VALVE TERMINOLOGY

### STUD

A bolt, threaded on both ends, often used in bolting together two members, one of which has blind tapped bolt holes. Comprises the bolting sets of GROVE® G5D and G9 gate valves.



### STUFFING BOX

The annular chamber provided around a valve stem in a sealing system into which deformable packing is introduced.

See "Packing", "Gland".

### SUBMERSIBLE SERVICE

Underwater or subsea installation. Valves require special treatment to protect against corrosion and external seawater pressure.

### SURGE

To rise suddenly to an excessive or abnormal value; a transient sudden rise of pressure in a pipeline. Pipeline surges can be positive or negative and are caused most frequently by the sudden closure of a block valve or emergency shutdown of a pump. Surge pressure in excess of the rated capacity of a pipeline can cause ruptures of the piping system. See Section 2.

### **SURGE RELIEVER**

A valve designed to relieve pressure surges in liquid pipelines, thus preventing line rupture due to transient pressures exceeding design limits of the pipe. A special flexible tube valve can function as a fast-acting surge reliever.

See Section 2.

### **SWAGE**

A tool for bending or forming cold metal to a required shape.

### **SWEET GAS**

Natural gas having no significant hydrogen sulfide content.

### **SWING CHECK VALVE**

A check valve in which the closure element is a hinged clapper which swings or rotates about a supporting shaft.

See "Clapper", "Check Valve".

### **SYSTEM ENGINEERING**

That engineering approach which deals with the design and integration of multiple components and controls into an assembled piping complex to accomplish a specified function or functions. The skid-mounted Arcron Surge Reliever is an example of system engineering.

See Section 2.

### **TEE**

A pipe or tubing fitting with a side outlet at right angles.



TEE

## **74 VALVE TERMINOLOGY**

### **TENSILE STRENGTH**

The highest tensile stress that a material can withstand before failure or rupture occurs with force being applied in a direction tending to elongate the material .

### **TENSILE TEST**

A test performed on specially machined specimens taken from material in its delivered condition, to determine physical properties, i.e., yield strength, ultimate strength and percent elongation .

### **TENSION TEST**

Same as "Tensile Test".

### **TEST CERTIFICATES**

Documents provided by a manufacturer certifying that required tests were performed.

### **THROTTLING**

The intentional restriction of flow by partially closing or opening a valve. A wide range of throttling is accomplished automatically in regulators and control valves.

### **THROUGH CONDUIT**

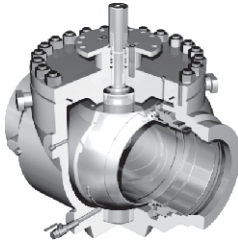
An expression characterizing valves when in the open position, wherein the bore presents a smooth uninterrupted interior surface across seat rings and through the valve port, thus affording minimum pressure drop. There are no cavities or large gaps in the bore between seat rings and body closures or between seat rings and ball/gate. Consequently, there are no areas that can accumulate debris to impede pipeline cleaning equipment or restrict the valve's motion.

### **THRUST**

Force applied to a part in a particular direction - e.g., thrust on a valve stem.

### TOP ENTRY

The design of a particular valve or regulator where the unit can be serviced or repaired by leaving its body in the line and accessing its internals by removing a top portion of the unit.



TOP ENTRY  
BALL VALVE

### TORQUE

The turning effort required to operate a valve. Usually expressed in "pound-feet" and in reference to the stem nut, handwheel or operator pinion shaft .

### TORQUE SWITCH

An electrical device on a motor operator which cuts off power to the operator when allowable torque is exceeded, thus preventing damage to the valve and/or the operator.

### TORSIONAL SPRING

A coiled spring which exerts a force by twisting about its axis rather than by compression or elongation. The torsional spring in a check valve slam retarder is restrained at one end and fastened to the clapper shaft on the other end. As the clapper opens, the spring resists the motion, creating a closing force. During a rapid decrease in flow rate, the clapper is urged toward the closed position and is virtually closed just prior to the instant of actual flow reversal - thus slamming is avoided.

See "Slam Retarder".

## 76 VALVE TERMINOLOGY

### TRANSITION PIECE

A length of pipe that is welded to a valve hub or closure. Generally provided by the customer, it serves as a transition from the customer's piping to the valve to compensate for differences in material or size.

### TRANSMISSION LINE

A main pipeline transporting oil or gas from wells or storage fields to refineries, loading docks or distribution companies. Generally, the pipeline is bigger than 6" and the pressure greater than 150 psi.

### TRIM

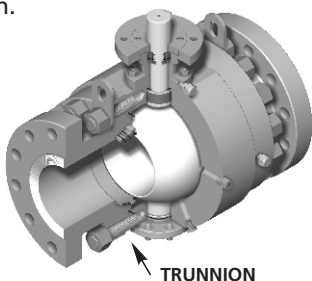
Commonly refers to the valve's working parts and to their materials.

### TRIPLE ECCENTRIC (or BUTTERFLY VALVE)

A particular design of a butterfly valve where the stem is located behind the disc and below the centerline of the disc, and its cone axis is offset from the centerline of the disc. This particular design is capable of a very tight shutoff at temperatures well above 1000°F (538°C).

### TRUNNION

That part of a ball valve which holds the ball on a fixed vertical axis and about which the ball turns. The torque requirements of a trunnion mounted ball valve are significantly less than for a floating ball design.



**TURNS TO OPERATE**

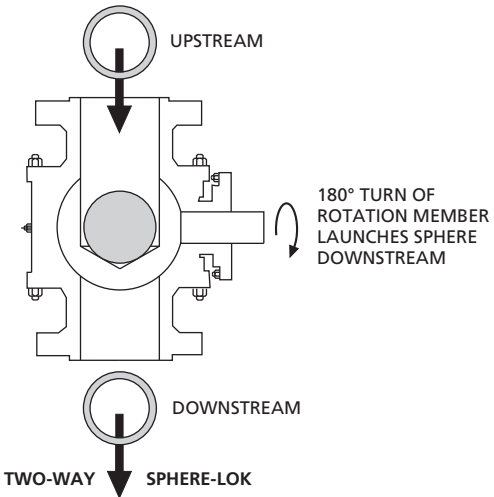
The number of complete revolutions of a handwheel or the pinion shaft of a gear operator required to stroke a valve from full open to fully closed or vice versa.

**TWO-INCH SQUARE OPERATING NUT**

A nut attached to the valve stem or to the pinion shaft of a gear operator. Valves so equipped are usually situated below grade in road boxes and are operated by long-handled "T" wrenches.

**TWO-WAY SPHERE-LOK**

A Sphere-Lok with two ports.  
See "Sphere-Lok".



**U-CUP (RING PACKING)**

A "U" cross-section ring located in the tail end of certain ball valve seats to retain the grease in an emergency seat seal system.

## 78 VALVE TERMINOLOGY

### **UL - Underwriters Laboratory**

An impartial testing laboratory concerned with the safety of electrical components. Products surviving the tests are included on a certified listing of products by manufacturer. This does not imply UL approval.

### **ULTIMATE STRENGTH**

That stress at which a material will fail.  
See "Tensile Test", "Burst Pressure".

### **ULTRASONIC INSPECTION**

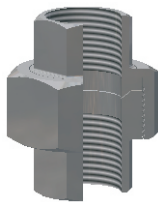
An inspection procedure using high frequency sound waves to detect voids and imperfections throughout the thickness of metal parts.

### **UNDERGROUND STORAGE**

The storage of natural gas or other fluids underground.

### **UNION CONNECTION**

A small three-piece fitting used to join two lengths of pipe. A female piece is installed on each of the two pipe ends and the connection is mechanically sealed by an external nut.



UNION CONNECTION

### **VDS - Valve Data Sheet**

A data sheet defining the minimum level of a valve design, including the materials, testing, inspection and certification requirements.

### **VPI - Visible Position Indicator**

See "Stem Indicator".

### **VACUUM**

A space from which air or gas been exhausted until its pressure is less than atmospheric pressure, i.e., any pressure below 14.7 psi absolute.



**VALVE**

A device which controls the flow of a liquid or gas in a conduit or pipeline.

**VARIABLE ORIFICE**

A small variable profile valve put in a flow line and used with a pilot to restrict the flow into the pilot and make the pilot more or less sensitive to changing conditions.

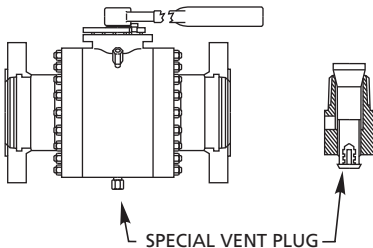
**VELOCITY**

The speed at which a fluid flows through a line in a specified direction. Usually expressed in "feet per second".

**VENT PLUG (or VENT PLUG ASSEMBLY or SAFETY VENT PLUG)**

A special pipe plug having a small allen wrench-operated vent valve. These special plugs are located at the bottom of most ball valves. With the line valve closed (and under pressure) the body cavity pressure can be vented through this small valve to check the tightness of seat seals or to make minor repairs. Having vented the body pressure, the vent plug may be removed to blow out debris and foreign material or to flush the body cavity. On some gate valves, the vent plug is installed on the bonnet for the sole purpose of venting the body. Such valves have separate drain valves.

See "Block-and-Bleed", "Drain Plug".



## 80 VALVE TERMINOLOGY

### VENTURI VALVE

A reduced bore valve. A valve having a bore smaller in diameter than the inlet or outlet. For example, an 8" x 6" x 8" ball valve has 8" inlet and outlet connections, while the ball and seats are 6". The flow through a Venturi valve will be reduced because of the smaller port. Venturi valves can often be economically substituted for plug valves .

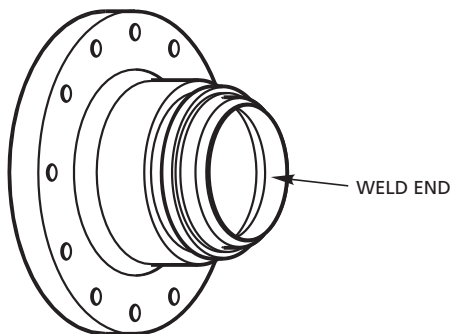
### VISCOSITY

A measure of the internal friction of a fluid or the resistance of a flow. Two fluids of identical specific gravity may have quite different viscosities.

### WE (or W.E.) - Weld End

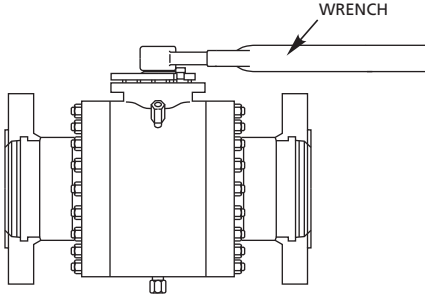
The end connection of a valve which is to be installed by welding into the line. To prepare the end bevel, it is necessary to know the wall thickness and specified minimum yield strength of the connecting pipe.

See "End Bevel".



## **WO - Wrench Operated**

The operation of a valve by means of a handle or lever. Used on smaller size and lower pressure class valves.



## **WOG - Water-Oil-Gas**

Used in connection with a pressure rating. Thus: 100 WOG indicates the rated pressure is 100 psi in water, oil, or gas service at normal ambient temperatures.

## **WP - Working Pressure**

The maximum anticipated sustained operating pressure applicable to a pipe.

## **WALL THICKNESS**

The thickness of the wall of a pressure vessel or the thickness of the wall of a pipe.

## **WATER HAMMER**

The physical effect, often accompanied by loud banging, produced by pressure waves generated within the piping by a rapid change of velocity in a liquid system.

## **WEAR TEST**

Verification of a component's resistance under specific wear conditions .

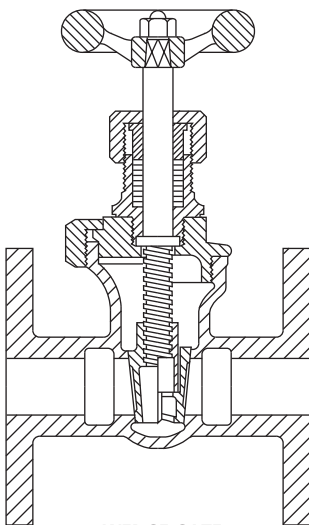
## 82 VALVE TERMINOLOGY

### WEATHERPROOF

Describes a valve operator or other device that is protected against intrusion of water, sand, dust, or other atmospheric contamination.

### WEDGE GATE

A gate whose seating surfaces are inclined to the direction of closing thrust so that mechanical force on the stem produces tight contact with the inclined seat rings.

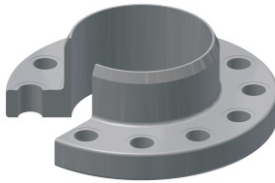


### WELD END

See "WE", "End Bevel".

**WELD NECK FLANGE**

A flanged piping element with a weld neck used in pipeline construction to provide a companion for installation of flanged valves. Also used to convert weld end valves to flanged valves or vice versa.



WELD NECK FLANGE

**WELD REDUCER**

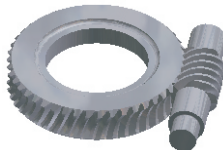
A reducing fitting used on weld end piping components to adapt from a large sized pipe to a smaller diameter pipe or vice versa .



WELD REDUCER

**WORM GEARS**

Gears used to transmit motion or power between right angle shafts when a high-ratio reduction is necessary. The worm is the smaller gear which drives the larger ring gear. Worm threads resemble screw threads and are available in various leads and pitches.



WORM GEAR

## 84 VALVE TERMINOLOGY

### X-RAY

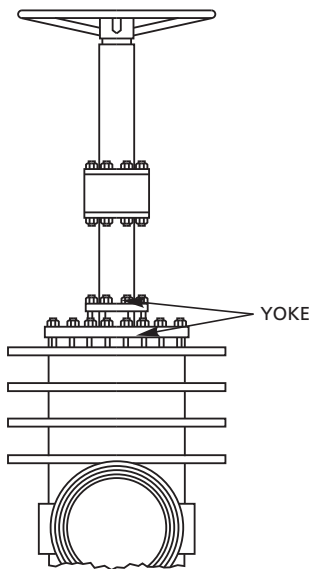
See "Radiographic Inspection".

### YIELD STRENGTH

The limiting stress (psi) beyond which a material will sustain permanent deformation. Up to the yield strength, the material will spring back to its original dimension when the pressure is removed. Often in valves specs, the yield strength will be designated; this allows proper material selection .

### YOKE

The part of a gate valve which serves as a spacer between the bonnet and the operator or actuator.



**ENGINEERED SURGE RELIEF SYSTEMS****CONTROL OF PRESSURE SURGES IN LIQUID PIPELINES**

Pressure surges in liquid pipelines occur as the result of rapid changes in flow rate as might be caused by sudden valve closure or pump stoppage. Surge pressure can be either positive or negative, each kind presenting its own set of problems to the pipeline designer.

Positive pressure surges, or spikes, can reach dangerous levels within fractions of a second of the triggering event. Peak pressures can easily exceed pipeline ratings and can occur at points in the line quite remote from the triggering event.

Surge relief valves placed at critical locations along the pipeline can be made to open and discharge liquid into holding tanks as surges start to build and thus maintain pipeline pressures at safe levels.

A flexible tube (Flexflo<sup>®</sup>) surge reliever is ideally suited for this service. This type of reliever is the ultimate in simplicity and reliability, featuring a synthetic rubber tube which functions as both pressure sensing means and the valve element.

The tube, the valve's only moving part, opens smoothly and automatically within milliseconds to relieve a surge and then seals off drop-tight as the pressure subsides.

The mathematical treatment of surges in liquid pipelines is a complex study usually involving extensive computer analysis.

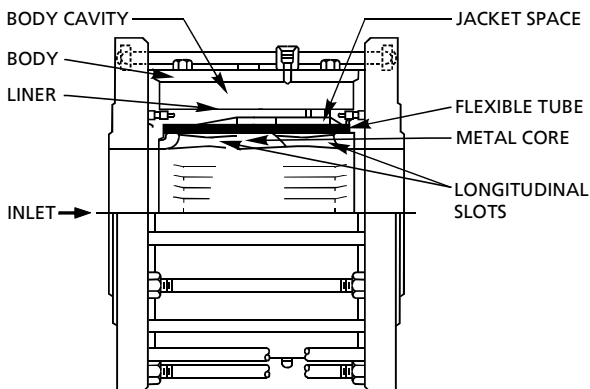
There are firms which specialize in pipeline surge analysis and are able to include mathematical models of the Flexflo reliever in their calculations.

## 86 ENGINEERED SURGE RELIEF SYSTEMS

The Flexflo surge reliever is designed to have an opening time in the low millisecond range when line pressure increases over set pressure. The body cavity/jacket space is gas loaded (usually nitrogen) to a predetermined pressure. Rapid actuation is achieved by high speed transfer of the gas from the jacket space into the larger body cavity as the tube expands. The surge is relieved by the increase of the annular volume under the flexible tube as it expands and by discharge of line liquid when the Flexflo opens.

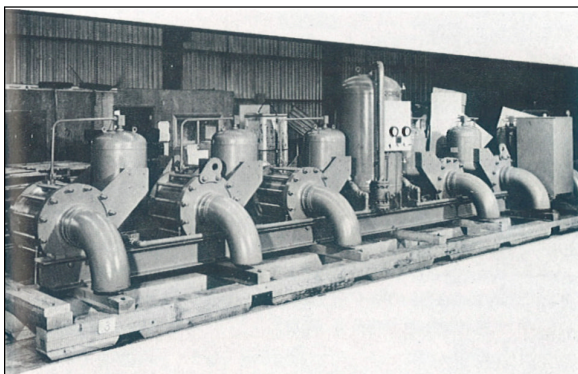
Minor pipeline surges are relieved without discharging liquid through the Flexflo. A minor surge over set pressure causes the tube to expand on the inlet end, increasing the annular volume, but does not cause the Flexflo to open.

The body cavity/jacket space may be pressurized to a desired set pressure and locked in, or a pressure regulator may be used to maintain pressure on top of the tube. If significant changes in ambient temperature are expected, a loading regulator is recommended to hold the jacket pressure constant.



**FLEXIBLE TUBE SURGE RELIEVER (Flexflo® Surge Reliever)**





**SURGE RELIEF SYSTEM USING FLEXFLO® RELIEVERS**

An engineered system for the control of pressure surge in a large liquid pipeline. This system consists of a number of Flexflo surge relievers in parallel responding to the same control signal.

## CONVERSION TABLES AND EQUIVALENTS

TO CONVERT	MULTIPLY BY	TO OBTAIN
<b><u>A</u></b>		
acres	43,560	sq. ft.
acres	4,047	sq. meters
acres	0.001562	sq. miles
acres	4,840	sq. yards
atmospheres	76.0	cm. of mercury (at 0°C)
atmospheres	29.92	in. of mercury (at 0°C)
atmospheres	1.0332	kg./sq. cm.
atmospheres	10,330	kg./sq. meter
atmospheres	14.7	pounds/sq. in.

<b><u>B</u></b>		
barrels (U.S. liquid)	31.5	gallons
barrels (oil)	42.0	gallons (oil)
barrels/day (oil)	0.02917	gallons/min. (oil)
barrels/hr. (oil)	0.7	gallons/min. (oil)
bars	0.9869	atmospheres
bars	$1.020 \times 10^4$	kg./sq. meter
bars	2,089	pounds/sq. ft.
bars	14.5	pounds/sq. in.
barye	1.0	dynes/sq. cm.
btu	10.41	liter-atmospheres
btu	$1.055 \times 10^{10}$	ergs
btu	778.2	foot-pounds
btu	252.0	gram-calories
btu	$3.927 \times 10^{-4}$	horsepower-hours
btu	1,055	joules
btu	0.252	kilogram-calories
btu	107.6	kilogram-meters
btu	$2.928 \times 10^{-4}$	kilowatt-hours
btu/hr.	0.2162	ft.-pounds/sec.

## CONVERSION TABLES AND EQUIVALENTS 89

TO CONVERT	MULTIPLY BY	TO OBTAIN
<b><u>B</u></b>		
btu/hr.	0.07	gram-cal./sec.
btu/hr.	$3.929 \times 10^{-4}$	horsepower
btu/hr.	0.2931	watts
btu/min.	12.96	ft.-pounds/sec.
btu/min.	0.02356	horsepower
btu/min.	0.01757	kilowatts
btu/min.	17.57	watts
btu/sq. ft./min.	0.122	watts/sq. in.
<b><u>C</u></b>		
candlepower	12.5664	lumens
centares	1.0	sq. meters
centigrade (degrees)	$(^{\circ}\text{C} \times 9/5) + 32$	fahrenheit (degrees)
centigrade (degrees)	$^{\circ}\text{C} + 273.18$	kelvin (degrees)
centigrams	0.01	grams
centiliters	0.3382	ounce (fluid) U.S.
centiliters	0.6103	cubic in.
centiliters	2.705	drams
centiliters	0.01	liters
centimeters	0.03281	feet
centimeters	0.3937	inches
centimeters	0.01	meters
centimeters	10.0	millimeters
centimeters	10,000	microns
centimeter-dynes	0.00102	cm.-grams
centimeter-dynes	$1.020 \times 10^{-8}$	meter-kg.
centimeter-dynes	$7.376 \times 10^{-8}$	pound-ft.
centimeter-grams	980.7	cm.-dynes
centimeter-grams	$1.0 \times 10^{-5}$	meter-kg.
centimeter-grams	$7.233 \times 10^{-5}$	pound-ft.
centimeters of mercury	0.01316	atmospheres
centimeters of mercury	0.4461	ft. of water

## 90 CONVERSION TABLES AND EQUIVALENTS

TO CONVERT	MULTIPLY BY	TO OBTAIN
	<u>C</u>	
centimeters of mercury	136.0	kg./sq. meter
centimeters of mercury	0.1934	pounds/sq. in.
centimeters/sec.	1.969	feet/min.
centimeters/sec.	0.0328	feet/sec.
centimeters/sec.	0.036	kilometers/hr.
centimeters/sec.	0.0194	knots
centimeters/sec.	0.6	meters/min.
centimeters/sec.	0.02237	miles/hr.
centimeters/sec.	$3.728 \times 10^{-4}$	miles/min.
centimeters/sec./sec.	0.0328	ft./sec./sec.
centimeters/sec./sec.	0.036	km./hr./sec.
centimeters/sec./sec.	0.01	meters/sec./sec.
centimeters/sec./sec.	0.0224	miles/hr./sec.
centipoise	0.01	gr./cm.-sec.
centipoise	$6.72 \times 10^{-4}$	pound/ft.-sec.
circumference	6.283	radians
cubic centimeters	$3.531 \times 10^{-5}$	cubic ft.
cubic centimeters	0.06102	cubic in.
cubic centimeters	$1.308 \times 10^{-6}$	cubic yards
cubic centimeters	0.001	liters
cubic centimeters	0.001057	quarts (U.S. liquid)
cubic feet	0.178	barrels (oil)
cubic feet	28,320	cu. cm.
cubic feet	1,728	cu. inches
cubic feet	0.02832	cu. meters
cubic feet	0.03704	cu. yards
cubic feet	7.48052	gallons (U.S. liquid)
cubic feet	28.32	liters
cubic feet/min.	62.4	pounds water/min.
cubic feet/sec.	448.8	gallons/min.
cubic inches	16.39	cu. cm.

## CONVERSION TABLES AND EQUIVALENTS 91

TO CONVERT	MULTIPLY BY	TO OBTAIN
<u>C</u>		
cubic inches	$5.787 \times 10^{-4}$	cu. ft.
cubic inches	$1.639 \times 10^{-5}$	cu. meters
cubic inches	$2.143 \times 10^{-5}$	cu. yards
cubic inches	0.01639	liters
cubic meters	6.28	barrels (oil)
cubic meters	8.38	barrels (U.S. liquid)
cubic meters	1,000,000	cu. cm.
cubic meters	35.31	cu. ft.
cubic meters	61,023.	cu. inches
cubic meters	1.308	cu. yards
cubic meters	264.2	gallons
cubic meters/hr.	151.0	barrels/day (oil)
cubic meters/hr.	4.403	gallons/min.
cubic yards	27.0	cu. ft.
cubic yards	46,656.	cu. inches
cubic yards	0.7646	cu. meters
<u>D</u>		
deciliters	0.1	liters
decimeters	0.1	meters
degress (angle)	0.01745	radians
dekagrams	10.0	grams
dekaliters	10.0	liters
dekameters	10.0	meters
drams	1.7718	grams
drams	27.344	grains
drams	0.0625	ounces
dynes/sq. cm.	0.01	ergs/sq. millimeter
dynes/sq. cm.	$9.869 \times 10^{-7}$	atmospheres
dynes/sq. cm.	$2.953 \times 10^{-5}$	in. of mercury (at 0°C)
dynes/sq. cm.	$4.015 \times 10^{-4}$	in. of water (at 4°C)

## 92 CONVERSION TABLES AND EQUIVALENTS

TO CONVERT	MULTIPLY BY	TO OBTAIN
<b><u>D</u></b>		
dynes	0.00102	grams
dynes	$1.0 \times 10^{-7}$	joules/cm.
dynes	$1.0 \times 10^{-5}$	joules/meter (newtons)
dynes	$1.020 \times 10^{-6}$	kilograms
dynes	$7.233 \times 10^{-5}$	poundals
dynes	$2.248 \times 10^{-6}$	pounds
dynes/sq. cm.	$1.0 \times 10^{-6}$	bars
<b><u>E</u></b>		
erg/sec.	1.	dyne-cm./sec.
ergs	$9.486 \times 10^{-11}$	btu
ergs	1.	dyne-centimeters
ergs	$7.376 \times 10^{-8}$	foot-pounds
ergs	$2.389 \times 10^{-8}$	gram-calories
ergs	0.00102	gram-cm.
ergs	$3.7250 \times 10^{-14}$	horsepower hr.
ergs	$1.0 \times 10^{-7}$	joules
ergs	$2.389 \times 10^{-11}$	kg.-calories
ergs	$1.020 \times 10^{-5}$	kg. meters
ergs	$2.773 \times 10^{-14}$	kilowatt-hr.
ergs	$2.773 \times 10^{-11}$	watt-hr.
erg/sec.	$5.668 \times 10^{-9}$	btu/min.
erg/sec.	$4.426 \times 10^{-6}$	ft.-lb./min.
erg/sec.	$7.3756 \times 10^{-8}$	ft.-lb./sec.
erg/sec.	$1.341 \times 10^{-10}$	horsepower
erg/sec.	$1.433 \times 10^{-9}$	kg.calories/min.
erg/sec.	$1.0 \times 10^{-10}$	kilowatts
exajoules	$1.0 \times 10^{18}$	joules

## CONVERSION TABLES AND EQUIVALENTS 93

TO CONVERT	MULTIPLY BY	TO OBTAIN
	<u>F</u>	
fathoms	1.8288	meters
fathoms	6.0	feet
feet	30.48	centimeters
feet	0.3048	meters
feet	$1.894 \times 10^{-4}$	miles (stat.)
feet of water	0.8826	in. of mercury
feet of water	0.03048	kg./sq. cm.
feet of water	0.4335	pounds/sq. cm.
feet/min.	0.01667	feet/sec.
feet/min.	0.01136	miles/hr.
feet/sec.	0.6818	miles/hr.
feet/sec./sec.	0.3048	meters/sec./sec.
foot-pounds	0.001286	btu
foot-pounds	0.1383	kg.-meters
foot-pounds/min.	0.001286	btu/min.
foot-pounds/min.	$3.030 \times 10^{-5}$	horsepower
foot-pounds/min.	$2.260 \times 10^{-5}$	kilowatts
foot-pounds/sec.	0.001818	horsepower
foot-pounds/sec.	0.001356	kilowatts
	<u>G</u>	
gallons	3,785.	cu. cm.
gallons	0.1337	cu. feet
gallons	231.0	cu. inches
gallons	0.003785	cu. meters
gallons	3.785	liters
gallons of water	8.331	pounds of water
gallons/min.	34.28	barrels/day (oil)
gallons/min.	0.002228	cu. feet/sec.
gallons/min.	0.06308	liters/sec.
gills (U.S.)	0.25	pints (liquid)
grams	980.7	dynes

## 94 CONVERSION TABLES AND EQUIVALENTS

TO CONVERT	MULTIPLY BY	TO OBTAIN
<u>G</u>		
grams	15.43	grains (troy)
grams	0.001	kilograms
grams	0.03527	ounces (avoir.)
grams	0.002205	pounds
grams/cm.	0.0056	pounds/in.
grams/cu. cm.	62.43	pounds/cu. ft.
grams/cu. cm.	0.03613	pounds/cu. in.
grams/liter	0.06247	pounds/cu. ft.
grams/sq. cm.	2.0481	pounds/sq. ft.
gram-calories	0.003968	btu
gram-calories	$4.184 \times 10^7$	ergs
gram-calories	3.086	foot-pounds
gram-calories	$1.5596 \times 10^{-6}$	horsepower-hr.
gram-calories	$1.162 \times 10^{-6}$	kilowatts-hr.
gram-calories	0.001162	watt-hr.
gram-calories/sec.	14.286	btu/hr.
gram-centimeters	$9.297 \times 10^{-8}$	btu
gram-centimeters	980.7	ergs
gram-centimeters	$9.807 \times 10^{-5}$	joules
gram-centimeters	$2.343 \times 10^{-8}$	kg.-calories
gram-centimeters	$1.0 \times 10^{-5}$	kg.-meters
<u>H</u>		
hectares	2.471	acres
hectares	107,600.	sq. feet
hectograms	100.0	grams
hectoliters	100.0	liters
horsepower	42.44	btu/min.
horsepower	33,000.	foot-lbs./min.
horsepower	550.0	foot-lbs./sec.
horsepower	10.7	kg.-calories/min.



## CONVERSION TABLES AND EQUIVALENTS 95

TO CONVERT	MULTIPLY BY	TO OBTAIN
<u>H</u>		
horsepower	745.7	watts
horsepower-hours	2,547	btu
horsepower-hours	$1.98 \times 10^6$	foot-lb.
horsepower-hours	$2.737 \times 10^5$	kg.-meters
horsepower-hours	0.7457	kilowatt-hr.
<u>I</u>		
inches	2.54	centimeters
inches	0.0254	meters
inches	25.4	millimeters
inches of mercury	0.03342	atmospheres
inches of mercury	1.133	feet of water
inches of mercury	0.03453	kg./sq cm.
inches of mercury	0.4912	pounds/sq. in.
inches of water	0.002458	atmospheres
inches of water	0.07355	inches of mercury
inches of water	0.00254	kg./sq. cm.
inches of water	0.03613	pounds/sq. in.
<u>J</u>		
joules	$9.486 \times 10^{-4}$	btu
joules	$1.0 \times 10^7$	ergs
joules	$1.0 \times 10^{-18}$	exajoules
joules	0.7376	foot-pounds
joules	$2.389 \times 10^{-4}$	kg.-calories
joules	0.102	kg.-meters
joules	$2.778 \times 10^{-4}$	watt-hr.
joules/cm.	$1.020 \times 10^4$	grams
joules/cm.	$1.0 \times 10^7$	dynes
joules/cm.	100.0	joules/meter (newtons)
joules/cm.	723.3	poundals
joules/cm.	22.48	pounds

## 96 CONVERSION TABLES AND EQUIVALENTS

TO CONVERT	MULTIPLY BY	TO OBTAIN
	<u>K</u>	
K Pascal (KPa)	0.145	pounds/sq. in.
kilograms	980,665	dynes
kilograms	1,000	grams
kilograms	2.2046	pounds
kilograms	0.001102	tons (short)
kilograms/cu. meter	0.06243	pounds/cu. ft.
kilograms/cu. meter	$3.613 \times 10^{-5}$	pounds/cu. in.
kilograms/meter	0.672	pounds/ft.
kilograms/sq. cm.	$9.807 \times 10^5$	dynes/sq. cm.
kilograms/sq. cm.	0.9678	atmospheres
kilograms/sq. cm.	32.8	feet of water
kilograms/sq. cm.	28.96	inches of mercury
kilograms/sq. cm.	14.22	pounds/sq. in.
kilograms/sq. meter	$9.678 \times 10^{-5}$	atmospheres
kilograms/sq. meter	$9.807 \times 10^{-5}$	bars
kilograms/sq. meter	0.003281	feet of water
kilograms/sq. meter	0.002896	inches of mercury
kilograms/sq. meter	0.001422	pounds/sq. in.
kilograms/sq. meter	98.067	dynes/sq. cm.
kilogram-calories	3.968	btu
kilogram-calories	3,086	foot-pounds
kilogram-calories	0.001163	kilowatt-hr.
kilogram-calories/min.	51.43	ft.-lb./sec.
kilogram-calories/min.	0.09351	horsepower
kilogram-calories/min.	0.06972	kilowatts
kilogram-meters	0.009296	btu
kilogram-meters	7.233	foot-pounds
kiloliters	1,000	liters
kiloliters	35.316	cubic feet
kiloliters	264.18	gallons (U.S. liquid)
kilometers	$1.0 \times 10^5$	centimeters

## CONVERSION TABLES AND EQUIVALENTS 97

TO CONVERT	MULTIPLY BY	TO OBTAIN
	<u>K</u>	
kilometers	3,281	feet
kilometers	1,000	meters
kilometers	0.6214	miles (statute)
kilometers/hr.	27.78	cm./sec.
kilometers/hr.	54.68	feet/min.
kilometers/hr.	0.9113	feet/sec.
kilometers/hr.	16.67	meters/min.
kilometers/hr.	0.6214	miles/hr.
kilowatts	56.92	btu/min.
kilowatts	44,260	foot-lb./min.
kilowatts	737.6	foot-lb./sec.
kilowatts	1.341	horsepower
kilowatts	14.34	kg.-calories/min.
kilowatts	1,000	watts
kilowatt-hr.	3,413	btu
kilowatt-hr.	$2.655 \times 10^6$	foot-lb.
kilowatt-hr.	1.341	horsepower-hours
kilowatt-hr.	860.0	kg.-calories
kilowatt-hr.	$3.671 \times 10^5$	kg.-meters
knots	1.8532	kilometers/hr.
knots	1.151	statute miles/hr.
	<u>L</u>	
league	3.0	miles (approx)
light year	$5.9 \times 10^{12}$	miles
liters	1,000	cu. cm.
liters	0.03531	cu. ft.
liters	61.03	cu. inches
liters	0.001	cu. meters
liters	0.001308	cu. yards
liters	0.2642	gallons (liquid)
liters	2.113	pints (liquid)
liters	1.057	quarts (liquid)

## 98 CONVERSION TABLES AND EQUIVALENTS

TO CONVERT	MULTIPLY BY	TO OBTAIN
<u>L</u>		
liters/min.	$5.886 \times 10^{-4}$	cu. ft./sec.
liters/min.	0.004403	gallons/sec.
liters/min.	0.2642	gallons/min.
liters/sec.	15.852	gallons/min.
lumen	0.07958	spherical candle power
lumen/sq. ft.	1.	foot-candles
<u>M</u>		
meters	100.0	centimeters
meters	3.281	feet
meters	39.37	inches
meters	0.001	kilometers
meters	$6.214 \times 10^{-4}$	miles (statute)
meters	1,000	millimeters
meters	1.094	yards
meters of water	1.421	pounds/sq. in.
meters/min.	1.667	cm./sec.
meters/min.	3.281	feet/min.
meters/min.	0.05468	feet/sec.
meters/min.	0.06	km./hr.
meters/min.	0.03728	miles/hr.
meters/sec.	196.8	feet/min.
meters/sec.	3.281	feet/sec.
meters/sec.	3.6	kilometers/hr.
meters/sec.	0.06	kilometers/min.
meters/sec.	2.237	miles/hr.
meter-kilogram	7.233	pound-feet
microns	$1.0 \times 10^{-6}$	meters
miles (statute)	$1.609 \times 10^5$	centimeters
miles (statute)	5,280	feet
miles (statute)	1.609	kilometers
miles (statute)	1,760	yards

## CONVERSION TABLES AND EQUIVALENTS 99

TO CONVERT	MULTIPLY BY	TO OBTAIN
	<u>M</u>	
miles/hr.	44.7	cm./sec.
miles/hr.	88.0	ft./min.
miles/hr.	1.467	ft./sec.
miles/hr.	1.6093	km./hr.
miles/hr.	0.8684	knots
miles/hr.	26.82	meters/min.
miles/hr.	0.01667	miles/min.
miles/min.	2,682	cm./sec.
miles/min.	88.0	feet/sec.
miles/min.	1.6093	km./min.
miles/min.	60.0	miles/hr.
milliers	1,000	kilograms
milligrams	0.001	grams
milligrams/liter	1.0	parts/million
milliliters	0.001	liters
millimeters	0.1	centimeters
millimeters	0.03937	inches
millimeters	0.001	meters
million gal./day	1.5472	cu.ft./sec.
mils	0.00254	centimeters
mils	0.001	inches
miner's inches	1.5	cu.ft./min.
minutes (angles)	0.01667	degrees
minutes (angles)	$2.909 \times 10^{-4}$	radians
myriagrams	10.0	kilograms
myriameters	10.0	kilometers
myriawatts	10.0	kilowatts
	<u>N</u>	
nails	2.25	inches
newtons	$1.0 \times 10^5$	dynes
newtons	0.2248	pounds
newton/meters	0.7376	ft./lb.
newton/meters	8.851	in./lb.

## 100 CONVERSION TABLES AND EQUIVALENTS

TO CONVERT	MULTIPLY BY	TO OBTAIN
	<u>O</u>	
ounces (avoir)	16.0	drams
ounces (avoir)	437.5	grains
ounces (avoir)	28.349	grams
ounces (avoir)	0.0625	pounds
ounces (avoir)	0.9115	ounces (troy)
ounces (fluid)	1.805	cu. inches
ounces (fluid)	0.02957	liters
ounces (troy)	480.0	grains
ounces (troy)	31.103	grams
ounces (troy)	1.097	ounces (avoir)
ounces (troy)	20.0	pennyweights (troy)
ounces (troy)	0.08333	pounds (troy)
ounces/sq. in.	0.0625	pounds/sq. in.

	<u>P</u>	
pace	30.0	inches
parsec	$1.9 \times 10^{13}$	miles
parsec	$3.084 \times 10^{13}$	kilometers
parts/million	0.0584	grains/U.S. gal.
parts/million	0.07016	grains/imp. gal.
parts/million	8.345	pounds/million gal.
pascal	$1.45 \times 10^{-4}$	pounds/sq. in.
pascal	1.0	newtons/sq. meter
pecks (U.S.)	0.25	bushels
pecks (U.S.)	537.6	cubic inches
pecks (U.S.)	8.8096	liters (dry)
pecks (U.S.)	8.0	quarts (dry)
pints (dry)	33.6	cubic inches
pints (dry)	0.50	quarts (dry)
pints (dry)	0.5506	liters
pints (liquid)	473.2	cubic cm.

# CONVERSION TABLES AND EQUIVALENTS 101

TO CONVERT	MULTIPLY BY	TO OBTAIN
	<u>P</u>	
pints (liquid)	0.01671	cubic ft.
pints (liquid)	28.87	cubic inches
pints (liquid)	0.125	gallons (liquid)
pints (liquid)	0.4732	liters
poise	1.0	gram/cm.-sec.
poundals	$1.3826 \times 10^4$	dynes
poundals	0.0141	kilograms
poundals	0.03108	pounds
pounds (avoir)	256.0	drams (avoir)
pounds (avoir)	7,000	grains
pounds (avoir)	453.6	grams
pounds (avoir)	0.4536	kilograms
pounds (avoir)	16.0	ounces (avoir)
pounds (avoir)	14.58	ounces (troy)
pounds (avoir)	1.2153	pounds (troy)
pounds (avoir)	$5.0 \times 10^{-4}$	tons (short)
pounds (troy)	5,760	grains
pounds (troy)	373.24	grams
pounds (troy)	13.166	ounces (avoir)
pounds (troy)	12.0	ounces (troy)
pounds (troy)	240.0	pennyweights (troy)
pounds (troy)	0.8229	pounds (avoir)
pounds (troy)	$3.6735 \times 10^{-4}$	tons (long)
pounds (troy)	$3.7324 \times 10^{-4}$	tons (metric)
pounds (troy)	$4.1143 \times 10^{-4}$	tons (short)
pounds of air	13.1	std. cubic feet
pounds of water	0.01602	cu. ft.
pounds of water	27.68	cu. inches
pounds of water	0.1198	gallons
pounds of water/hr.	0.002	gallons/min.
pounds of water/min.	$2.670 \times 10^{-4}$	cu. ft./sec.
pounds-feet	0.1383	meter-kg.
pounds/cu. ft.	0.01602	grams/cu. cm.

## 102 CONVERSION TABLES AND EQUIVALENTS

TO CONVERT	MULTIPLY BY	TO OBTAIN
	<u>P</u>	
pounds/cu. ft.	16.02	kg./cu. meter
pounds/cu. ft.	$5.787 \times 10^{-4}$	pounds/cu. in.
pounds/cu. in.	27.68	gram/cu. cm.
pounds/cu. in.	$2.768 \times 10^{-4}$	kg./cu. meter
pounds/cu. in.	1,728	pounds/cu. ft.
pounds/ft.	1.488	kg./meter
pounds/in.	178.6	grams/cm.
pounds/sq. ft.	0.01602	feet of water
pounds/sq. ft.	0.01414	inches of mercury
pounds/sq. ft.	4.882	kg./sq. meter
pounds/sq. ft.	0.006944	lb./sq. in.
pounds/sq. in.	0.06804	atmospheres
pounds/sq. in.	2.307	ft. of water
pounds/sq. in.	2.036	inches of mercury
pounds/sq. in.	703.1	kg./sq. meter

### Q

quadrants (angle)	5,400	minutes
quadrants (angle)	1.571	radians
quarts (dry)	67.2	cu. in.
quarts (liquid)	946.4	cu. cm.
quarts (liquid)	0.03342	cu. ft.
quarts (liquid)	57.75	cu. in.
quarts (liquid)	0.9463	liters

### R

radians	57.3	degrees
radians	3,438	minutes
radians	0.6366	quadrants
radians/sec.	57.3	degrees/sec.
radians/sec.	9.549	revolutions/min.
radians/sec.	0.1592	revolutions/sec.
radians/sec./sec.	0.1592	rev./sec./sec.
reams	500.0	sheets



## CONVERSION TABLES AND EQUIVALENTS 103

TO CONVERT	MULTIPLY BY	TO OBTAIN
<u>R</u>		
revolutions	360.0	degrees
revolutions	4.0	quadrants
revolutions	6.283	radians
revolutions/min.	6.0	degrees/sec.
revolutions/min.	0.1047	radians/sec.
revolutions/min.	0.01667	rev./sec.
rev./min./min.	0.001745	radians/sec./sec.
rev./min./min.	$2.778 \times 10^{-4}$	rev./sec./sec.
revolutions/sec.	360.0	degrees/sec.
revolutions/sec.	6.283	radians/sec.
revolutions/sec.	60.0	rev./min.
rev./sec./sec.	6.283	radians/sec./sec.
rev./sec./sec.	3,600	rev./min./min.
rods	5.029	meters
rods	5.5	yards
rods	16.5	feet
<u>S</u>		
seconds (angle)	0.01667	minutes
seconds (angle)	$4.848 \times 10^{-6}$	radians
slugs	14.59	kilograms
slugs	32.17	pounds
sphere (solid angle)	12.57	steradians
square centimeters	0.001076	sq. ft.
square centimeters	0.1550	sq. in.
square centimeters	$1.0 \times 10^{-4}$	sq. meters
square centimeters	100.0	sq. millimeters
square feet	$2.296 \times 10^{-5}$	acres
square feet	929.0	sq. cm.
square feet	144.0	sq. in.
square feet	0.0929	sq. meters
square feet	0.1111	sq. yards
square inches	6.452	sq. cm.

## 104 CONVERSION TABLES AND EQUIVALENTS

TO CONVERT	MULTIPLY BY <u>S</u>	TO OBTAIN
square inches	0.006944	sq. ft.
square inches	645.2	sq. millimeters
square inches	$7.716 \times 10^{-4}$	sq. yards
square kilometers	247.1	acres
square kilometers	$1.076 \times 10^7$	sq. ft.
square kilometers	$1.0 \times 10^6$	sq. meters
square kilometers	0.3861	sq. miles
square kilometers	$1.196 \times 10^6$	sq. yards
square meters	$2.471 \times 10^{-4}$	acres
square meters	10.76	sq. ft.
square meters	$3.861 \times 10^{-7}$	sq. miles
square meters	1.196	sq. yards
square miles	640.0	acres
square miles	$2.788 \times 10^7$	sq. ft.
square miles	2.590	sq. km.
square miles	$2.590 \times 10^6$	sq. meters
square miles	$3.098 \times 10^6$	sq. yards
square millimeters	0.01	sq. cm.
square millimeters	$1.076 \times 10^{-5}$	sq. ft.
square millimeters	0.00155	sq. in.
square yards	$2.066 \times 10^{-4}$	acres
square yards	8,361	sq. cm.
square yards	9.0	sq. ft.
square yards	1,296	sq. in.
square yards	0.8361	sq. meters
square yards	$3.228 \times 10^{-7}$	sq. miles
steradians	0.07958	spheres
steradians	0.1592	hemispheres
steres	1,000	liters
steres	1.0	cu. meters

## CONVERSION TABLES AND EQUIVALENTS 105

TO CONVERT	MULTIPLY BY	TO OBTAIN
<u>I</u>		
temperature (°C + 273)	1.0	abs. temp (°kelvin)
temperature (°C + 17.78)	1.8	temperature (°F)
temperature (°F + 460)	1.0	abs. temp (°rankine)
temperature (°F - 32)	0.5555	temperature (°C)
tons (long)	1,016	kilograms
tons (long)	2,240	pounds
tons (metric)	1,000	kilograms
tons (metric)	2,205	pounds
tons (short)	907.2	kilograms
tons (short)	2,000	pounds
tons (short)/sq. ft.	9,765	kg./sq. meter
tons (short)/sq. ft.	13.89	pounds/sq. in.
tons of water/24 hr.	0.1664	gallons/min.
tons of water/24 hr.	1.3349	cu. ft./hr.
<u>W</u>		
watts	3.4129	btu/hr.
watts	0.0569	btu/min.
watts	$1.0 \times 10^7$	ergs/sec.
watts	44.27	ft.-lb./min.
watts	0.7378	ft.-lb./sec.
watts	0.00134	horsepower
watts	0.00136	horsepower (metric)
watts	0.01433	kg.-calories/min.
watts	0.001	kilowatts
watts (abs.)	1.0	joules/sec.
watt-hours	3.413	btu
watt-hours	$3.6 \times 10^{10}$	ergs
watt-hours	2,656	foot-lb.
watt-hours	860.5	gram-calories
watt-hours	0.00134	horsepower-hours
watt-hours	0.8605	kilograms-calories

## 106 CONVERSION TABLES AND EQUIVALENTS

TO CONVERT	MULTIPLY BY	TO OBTAIN
	<u>W</u>	
watt-hours	367.2	kilogram-meters
watt-hours	0.001	kilowatt-hours
watt (international)	1.000165	watt (absolute)
weeks	168.0	hours
weeks	10,080	minutes
	<u>Y</u>	
yards	91.44	centimeters
yards	$9.144 \times 10^{-4}$	kilometers
yards	0.9144	meters
yards	$5.682 \times 10^{-4}$	miles (statute)
yards	914.4	millimeters
years	365.26	days (mean solar)

## SECTION 4 GENERAL INFORMATION 107

### STEEL PIPE FLANGES\* (Dimensions)

#### CLASS 150

Nom. Pipe Size	O.D. of Flange	Thick. of Flange	Bolt Circle Diam.	Bolt Hole Diam.	No. of Bolts	Diam. of Bolts
2	6.00	0.75	4.75	0.75	4	5/8
2 1/2	7.00	0.88	5.50	0.75	4	5/8
3	7.50	0.94	6.00	0.75	4	5/8
4	9.00	0.94	7.50	0.75	8	5/8
6	11.00	1.00	9.50	0.88	8	3/4
8	13.50	1.12	11.75	0.88	8	3/4
10	16.00	1.19	14.25	1.00	12	7/8
12	19.00	1.25	17.00	1.00	12	7/8
14	21.00	1.38	18.75	1.12	12	1
16	23.50	1.44	21.25	1.12	16	1
18	25.00	1.56	22.75	1.25	16	1 1/8
20	27.50	1.69	25.00	1.25	20	1 1/8
22	29.50	1.81	27.25	1.38	20	1 1/4
24	32.00	1.88	29.50	1.38	20	1 1/4
26	34.25	2.69	31.75	1.38	24	1 1/4
28	36.50	2.81	34.00	1.38	28	1 1/4
30	38.75	2.94	36.00	1.38	28	1 1/4
32	41.75	3.18	38.50	1.62	28	1 1/2
34	43.75	3.25	40.50	1.62	32	1 1/2
36	46.00	3.56	42.75	1.62	32	1 1/2
38	48.75	3.44	45.25	1.62	32	1 1/2
40	50.75	3.56	47.25	1.62	36	1 1/2
42	53.00	3.81	49.50	1.62	36	1 1/2
44	55.25	4.00	51.75	1.62	40	1 1/2
46	57.25	4.06	53.75	1.62	40	1 1/2
48	59.50	4.25	56.00	1.62	44	1 1/2
50	61.75	4.38	58.25	1.88	44	1 3/4
52	64.00	4.56	60.50	1.88	44	1 3/4
54	66.25	4.75	62.75	1.88	44	1 3/4
56	68.75	4.88	65.00	1.88	48	1 3/4
58	71.00	5.06	67.25	1.88	48	1 3/4
60	73.00	5.19	69.25	1.88	52	1 3/4

\* Size 2" thru 24" (except 22") are in accordance with ASME B16.5. Size 22" and sizes 26" and larger are per MSS SP-44.

## 108 GENERAL INFORMATION

### STEEL PIPE FLANGES\* (Dimensions)

#### CLASS 300

Nom. Pipe Size	O.D. of Flange	Thick. of Flange	Bolt Circle Diam.	Bolt Hole Diam.	No. of Bolts	Diam. of Bolts
2	6.50	0.88	5.00	0.75	8	5/8
2 1/2	7.50	1.00	5.88	0.88	8	3/4
3	8.25	1.12	6.62	0.88	8	3/4
4	10.00	1.25	7.88	0.88	8	3/4
6	12.50	1.44	10.62	0.88	12	3/4
8	15.00	1.62	13.00	1.00	12	7/8
10	17.50	1.88	15.25	1.12	16	1
12	20.50	2.00	17.75	1.25	16	1 1/8
14	23.00	2.12	20.25	1.25	20	1 1/8
16	25.50	2.25	22.50	1.38	20	1 1/4
18	28.00	2.38	24.75	1.38	24	1 1/4
20	30.50	2.50	27.00	1.38	24	1 1/4
22	33.00	2.62	29.25	1.62	24	1 1/2
24	36.00	2.75	32.00	1.62	24	1 1/2
26	38.25	3.12	34.50	1.75	28	1 5/8
28	40.75	3.38	37.00	1.75	28	1 5/8
30	43.00	3.62	39.25	1.88	28	1 3/4
32	45.25	3.88	41.50	2.00	28	1 7/8
34	47.50	4.00	43.50	2.00	28	1 7/8
36	50.00	4.12	46.00	2.12	32	2
38	46.00	4.25	43.00	1.62	32	1 1/2
40	48.75	4.50	45.50	1.75	32	1 5/8
42	50.75	4.69	47.50	1.75	32	1 5/8
44	53.25	4.88	49.75	1.88	32	1 3/4
46	55.75	5.06	52.00	2.00	28	1 7/8
48	57.75	5.25	54.00	2.00	32	1 7/8
50	60.25	5.50	56.25	2.12	32	2
52	62.25	5.69	58.25	2.12	32	2
54	65.25	6.00	61.00	2.38	28	2 1/4
56	67.25	6.06	63.00	2.38	28	2 1/4
58	69.25	6.25	65.00	2.38	32	2 1/4
60	71.25	6.44	67.00	2.38	32	2 1/4

\* Size 2" thru 24" (except 22") are in accordance with ASME B16.5. Size 22" and sizes 26" and larger are per MSS SP-44.

### STEEL PIPE FLANGES\* (Dimensions)

#### CLASS 400

Nom. Pipe Size	O.D. of Flange	Thick. of Flange	Bolt Circle Diam.	Bolt Hole Diam.	No. of Bolts	Diam. of Bolts
2						
2 1/2	Use Class 600 dimensions in these sizes.					
3						
4	10.00	1.38	7.88	1.00	8	7/8
6	12.50	1.62	10.62	1.00	12	7/8
8	15.00	1.88	13.00	1.12	12	1
10	17.50	2.12	15.25	1.25	16	1 1/8
12	20.50	2.25	17.25	1.38	16	1 1/4
14	23.00	2.38	20.25	1.38	20	1 1/4
16	25.50	2.50	22.50	1.50	20	1 3/8
18	28.00	2.62	24.75	1.50	24	1 3/8
20	30.50	2.75	27.00	1.62	24	1 1/2
22	33.00	2.88	29.25	1.75	24	1 5/8
24	36.00	3.00	32.00	1.88	24	1 3/4
26	38.25	3.50	34.50	1.88	28	1 3/4
28	40.75	3.75	37.00	2.00	28	1 7/8
30	43.00	4.00	39.25	2.12	28	2
32	45.25	4.25	41.50	2.12	28	2
34	47.50	4.38	43.50	2.12	28	2
36	50.00	4.50	46.00	2.12	32	2
38	47.50	4.88	44.00	1.88	32	1 3/4
40	50.00	5.12	46.25	2.00	32	1 7/8
42	52.00	5.25	48.25	2.00	32	1 7/8
44	54.50	5.50	50.50	2.12	32	2
46	56.75	5.75	52.75	2.12	36	2
48	59.50	6.00	55.25	2.38	28	2 1/4
50	61.75	6.19	57.50	2.38	32	2 1/4
52	63.75	6.38	59.50	2.38	32	2 1/4
54	67.00	6.69	62.25	2.62	28	2 1/2
56	69.00	6.88	64.25	2.62	32	2 1/2
58	71.00	7.00	66.25	2.62	32	2 1/2
60	74.25	7.31	69.00	2.88	32	2 3/4

\* Size 2" thru 24" (except 22") are in accordance with ASME B16.5. Size 22" and sizes 26" and larger are per MSS SP-44.

## 110 GENERAL INFORMATION

### STEEL PIPE FLANGES\* (Dimensions)

#### CLASS 600

Nom. Pipe Size	O.D. of Flange	Thick. of Flange	Bolt Circle Diam.	Bolt Hole Diam.	No. of Bolts	Diam. of Bolts
2	6.50	1.00	5.00	0.75	8	5/8
2 1/2	7.50	1.12	5.88	0.88	8	3/4
3	8.25	1.25	6.62	0.88	8	3/4
4	10.75	1.50	8.50	1.00	8	7/8
6	14.00	1.88	11.50	1.12	12	1
8	16.50	2.19	13.75	1.25	12	1 1/8
10	20.00	2.50	17.00	1.38	16	1 1/4
12	22.00	2.62	19.25	1.38	20	1 1/4
14	23.75	2.75	20.75	1.50	20	1 3/8
16	27.00	3.00	23.75	1.62	20	1 1/2
18	29.25	3.25	25.75	1.75	20	1 5/8
20	32.00	3.50	28.50	1.75	24	1 5/8
22	34.25	3.75	30.62	1.88	24	1 3/4
24	37.00	4.00	33.00	2.00	24	1 7/8
26	40.00	4.25	36.00	2.00	28	1 7/8
28	42.25	4.38	38.00	2.12	28	2
30	44.50	4.50	40.25	2.12	28	2
32	47.00	4.62	42.50	2.38	28	2 1/4
34	49.00	4.75	44.50	2.38	28	2 1/4
36	51.75	4.88	47.00	2.62	28	2 1/2
38	50.00	6.00	45.75	2.38	28	2 1/4
40	52.00	6.25	47.75	2.38	32	2 1/4
42	55.25	6.62	50.50	2.62	28	2 1/2
44	57.25	6.81	52.50	2.62	32	2 1/2
46	59.50	7.06	54.75	2.62	32	2 1/2
48	62.75	7.44	57.50	2.88	32	2 3/4
50	65.75	7.75	60.00	3.12	28	3
52	67.75	8.00	62.00	3.12	32	3
54	70.00	8.25	64.25	3.12	32	3
56	73.00	8.56	66.75	3.38	32	3 1/4
58	75.00	8.75	68.75	3.38	32	3 1/4
60	78.50	9.19	71.15	3.62	28	3 1/2

\* Size 2" thru 24" (except 22") are in accordance with ASME B16.5. Size 22" and sizes 26" and larger are per MSS SP-44.



**STEEL PIPE FLANGES\***  
(Dimensions)

**CLASS 900**

Nom. Pipe Size	O.D. of Flange	Thick. of Flange	Bolt Circle Diam.	Bolt Hole Diam.	No. of Bolts	Diam. of Bolts
2	Use Class 1500 dimensions in these sizes.					
2 1/2						
3	9.50	1.50	7.50	1.00	8	7/8
4	11.50	1.75	9.25	1.25	8	1 1/8
6	15.00	2.19	12.50	1.25	12	1 1/8
8	18.50	2.50	15.50	1.50	12	1 3/8
10	21.50	2.75	18.50	1.50	16	1 3/8
12	24.00	3.12	21.00	1.50	20	1 3/8
14	25.25	3.38	22.00	1.62	20	1 1/2
16	27.75	3.50	24.25	1.75	20	1 5/8
18	31.00	4.00	27.00	2.00	20	1 7/8
20	33.75	4.25	29.50	2.12	20	2
24	41.00	5.50	35.50	2.62	20	2 1/2
26	42.75	5.50	37.50	2.88	20	2 3/4
28	46.00	5.62	40.25	3.12	20	3
30	48.50	5.88	42.75	3.12	20	3
32	51.75	6.25	45.50	3.38	20	3 1/4
34	55.00	6.50	48.25	3.62	20	3 1/2
36	57.50	6.75	50.75	3.62	20	3 1/2
38	57.50	7.50	50.75	3.62	20	3 1/2
40	59.50	7.75	52.75	3.62	24	3 1/2
42	61.50	8.12	54.75	3.62	24	3 1/2
44	64.88	8.44	57.62	3.88	24	3 3/4
46	68.25	8.88	60.50	4.12	24	4
48	70.25	9.19	62.50	4.12	24	4

\* Size 2" thru 24" (except 22") are in accordance with ASME B16.5. Size 22" and sizes 26" and larger are per MSS SP-44.

## 112 GENERAL INFORMATION

### STEEL PIPE FLANGES\* (Dimensions)

#### CLASS 1500

Nom. Pipe Size	O.D. of Flange	Thick. of Flange	Bolt Circle Diam.	Bolt Hole Diam.	No. of Bolts	Diam. of Bolts
1/2	4.75	0.88	3.25	0.88	4	3/4
3/4	5.12	1.00	3.50	0.88	4	3/4
1	5.88	1.12	4.00	1.00	4	7/8
1 1/4	6.25	1.12	4.38	1.00	4	7/8
1 1/2	7.00	1.25	4.88	1.12	4	1
2	8.50	1.50	6.50	1.00	8	7/8
2 1/2	9.62	1.62	7.50	1.12	8	1
3	10.50	1.88	8.00	1.25	8	1 1/8
4	12.25	2.12	9.50	1.38	8	1 1/4
6	15.50	3.25	12.50	1.50	12	1 3/8
8	19.00	3.62	15.50	1.75	12	1 5/8
10	23.00	4.25	19.00	2.00	12	1 7/8
12	26.50	4.88	22.50	2.12	16	2
14	29.50	5.25	25.00	2.38	16	2 1/4
16	32.50	5.75	27.75	2.62	16	2 1/2
18	36.00	6.38	30.50	2.88	16	2 3/4
20	38.75	7.00	32.75	3.12	16	3
24	46.00	8.00	39.00	3.62	16	3 1/2

\* Dimensions are in accordance with ASME B16.5.

**STEEL PIPE FLANGES\***  
(Dimensions)

**CLASS 2500**

Nom. Pipe Size	O.D. of Flange	Thick. of Flange	Bolt Circle Diam.	Bolt Hole Diam.	No. of Bolts	Diam. of Bolts
1/2	5.25	1.19	3.50	0.88	4	3/4
3/4	5.50	1.25	3.75	0.88	4	3/4
1	6.25	1.38	4.25	1.00	4	7/8
1 1/4	7.25	1.50	5.12	1.12	4	1
1 1/2	8.00	1.75	5.75	1.25	4	1 1/8
2	9.25	2.00	6.75	1.12	8	1
2 1/2	10.50	2.25	7.75	1.25	8	1 1/8
3	12.00	2.62	9.00	1.38	8	1 1/4
4	14.00	3.00	10.75	1.62	8	1 1/2
6	19.00	4.25	14.50	2.12	8	2
8	21.75	5.00	17.25	2.12	12	2
10	26.50	6.50	21.25	2.62	12	2 1/2
12	30.00	7.25	24.38	2.88	12	2 3/4

\* Dimensions are in accordance with ASME B16.5.

## 114 GENERAL INFORMATION

### SPECIFIC GRAVITY OF GASES RELATIVE TO AIR

<u>Name of Gas</u>	<u>Chemical Formula</u>	<u>Specific Gravity Relative To Air</u>
Acetylene	$C_2H_2$	0.9107
Air		1.0000
Ammonia	$NH_3$	0.5961
Anthracite Producer Gas		0.85
Argon	A	1.377
Benzene	$C_6H_6$	2.6920
Bituminous Producer Gas		0.86
Blast Furnace Gas		1.00
Blue Water Gas		0.53
Butane	$C_4H_{10}$	2.06654
Butylene	$C_4H_8$	1.9936
Carbon Dioxide	$CO_2$	1.5282
Carbon Monoxide	CO	0.9672
Carburated Water Gas		0.65
Coke Oven Gas		0.42
Ethane	$C_2H_6$	1.04882
Ethylene	$C_2H_4$	0.974
Helium	He	0.138
Hydrochloric Acid	HCL	1.256
Hydrogen	$H_2$	0.06959
Methane	$CH_4$	0.5543
Methyl Chloride	$CH_3CL$	1.738
Natural Gas, Cleveland		0.65
Natural Gas, Oil City, Pa.		0.71
Nitrogen	$N_2$	0.9718
Nitric Oxide	NO	1.034
Nitrous Oxide	$N_2O$	1.518
Oxygen	$O_2$	1.1053
Pentane	$C_5H_{12}$	2.4872
Propane	$C_3H_8$	1.5617
Propylene	$C_3H_6$	1.4504
Sulphur Dioxide	$SO_2$	2.264
Toluene	$C_7H_8$	3.1760
Xylene	$C_8H_{10}$	3.6618

## SPECIFIC GRAVITY OF LIQUIDS

<u>Liquid</u>	<u>Specific Gravity at 60°F Referred to Water at 60°F</u>
Acetone	0.792
Alcohol, Ethyl (100%)	0.789
Alcohol, Methyl (100%)	0.796
Acid, Muriatic (40%)	1.20
Nitric (91%)	1.50
Sulfuric (87%)	1.80
Bunkers C Fuel Max.	1.014
Distillate	0.850
Fuel 3 Max.	0.898
Fuel 5 Min.	0.966
Fuel 5 Max.	0.993
Fuel 6 Min.	0.993
Gasoline	0.751
Gasoline, Natural	0.680
Kerosene	0.815
M.C. Residuum	0.935
Mercury	13.570
Olive Oil	0.919
Pentane	0.624
SAE 10 Lube *	0.876
SAE 30 Lube *	0.898
SAE 70 Lube *	0.916
Salt Creek Crude	0.843
Sea Water	1.025
32.6° API Crude	0.862
35.6° API Crude	0.847
40° API Crude	0.825
48° API Crude	0.788
Water	1.000

\* 100 Viscosity Index.

## 116 GENERAL INFORMATION

### OTHER USEFUL INFORMATION

#### GAS CONSTANTS (R)

R = 0.0821	(atm.) (liter)/(g.-mole) (°K)
R = 1.987	g.-cal./(g.-mole) (°K)
R = 1.987	btu./(lb.-mole) (°R)
R = 1.987	c.h.u./(lb.-mole) (°K)
R = 8.314	joules/(gm.-mole) (°K)
R = 1,546	(ft.) (lb. force)/(lb.-mole) (°R)
R = 10.73	(lb.-force/sq. in.) (cu. ft.)/(lb.-mole) (°R)
R = 18,510	(lb.-force/sq. in.) (cu. in.)/(lb.-mole) (°R)
R = 0.7302	(atm.) (cu. ft.)/(lb./mole) (°R)
R = $8.48 \times 10^5$	(Kg./m <sup>2</sup> ) (cu. cm.)/(lb.-mole) (°K)

#### ACCELERATION OF GRAVITY (STANDARD)

$$g = 31.17 \text{ ft./sec.}^2 = 980.6 \text{ cm./sec.}^2$$

#### VELOCITY OF SOUND IN DRY AIR @ 32°F (0°C) and 1 atm.

$$33,136 \text{ cm./sec.} = 1,089 \text{ ft./sec.}$$

Pounds/hr. of gas x 13.3/spec.grav. = standard cu. ft./hr.

$$\text{Velocity (ft./sec.)} = .408 \times Q/d^2$$

Where Q = flow rate in cu. ft./sec.

and d = inside pipe diam. in feet

#### VISCOSITY CONVERSION

$$\text{C.S.} = \frac{\text{C.P.}}{\text{S.G.}}$$

$$\text{C.P.} = \text{S.G.} \times \text{C.S.}$$

#### WHERE

C.S. = Centistoke

C.P. = Centipoise

S.G. = Specific Gravity





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