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Control Valves

Category of Valves

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Valves

- **Manual valves**

- **Automated valves**

These valves are operated automatically.

  - **On-Off valves**

On-Off valves just put the flow “on” or “off” . On the other word, let the flow medium run or stop. There types of valves are mainly used for sequential control or rough control like air conditioning.

  - **Modulating valves**

Modulating valves are moreover categorized into 2 types.

    - **Self Operated valves**

Self-operated valves operate receiving energy from fluid pressure of fluid temperature. It has high responsibility but generally is not good at accuracy.

    - **Control valves**

Control valves operate receiving energy from compressed air, electric power, etc. used with controllers and sensors. Control valves and related equipment realizes most accurate control.

What Is A Control Valve?

The control valve manipulates a flowing fluid, such as gas, steam, water, or chemical compounds, to compensate for the load disturbance and keep the regulated process variable as close as possible to the desired set point.

The control valve assembly typically consists of the:

* Valve body
* The internal trim parts
* An actuator to provide the motive power to operate the valve
* A variety of additional valve accessories, which can include positioners, transducers, supply pressure regulators, manual operators, snubbers, or limit switches.

Roles of control valves

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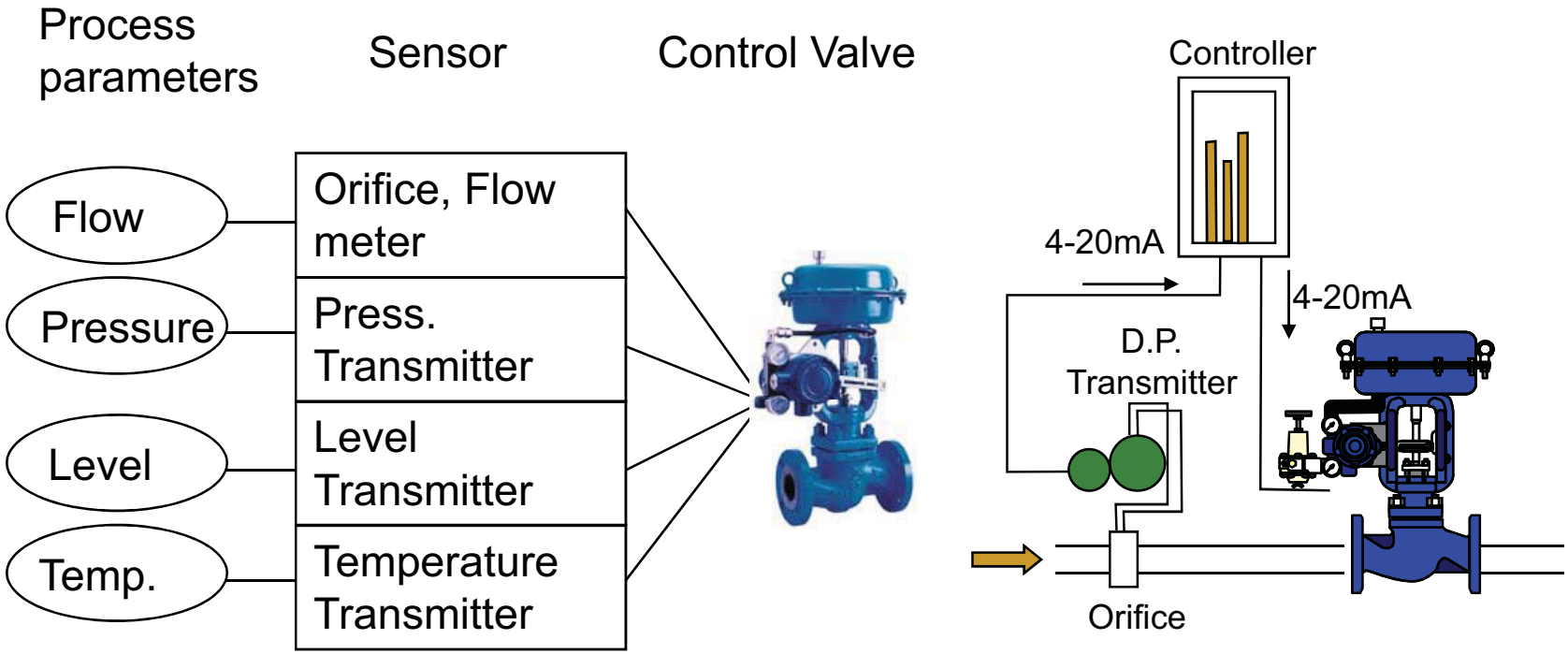

Example of process control

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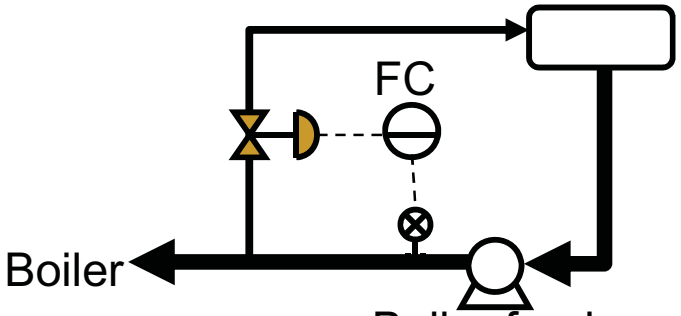
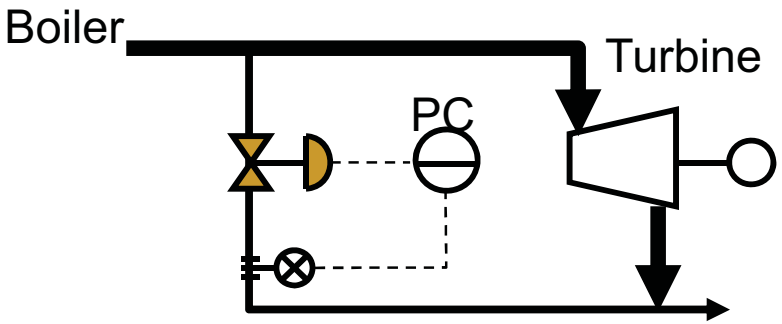
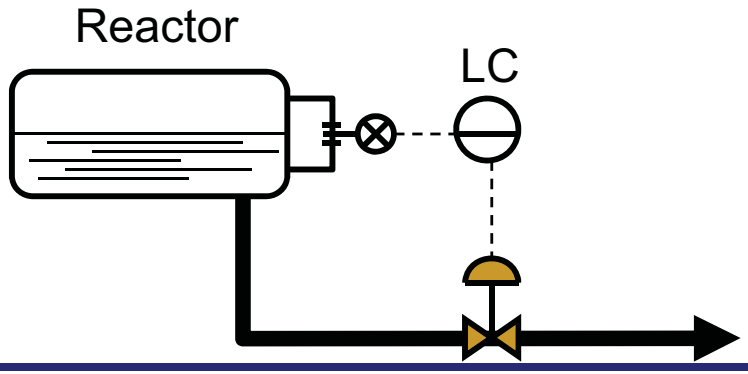
Flow control



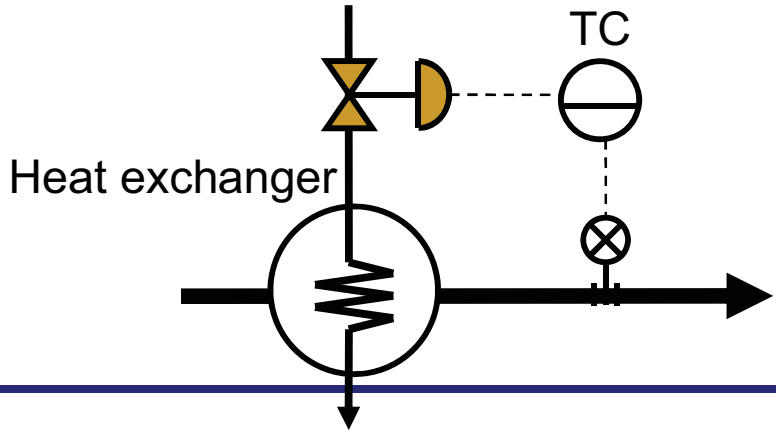
Pressure control



Level control



Temperature control



Introduction

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Typical Valve Assembly

Component parts

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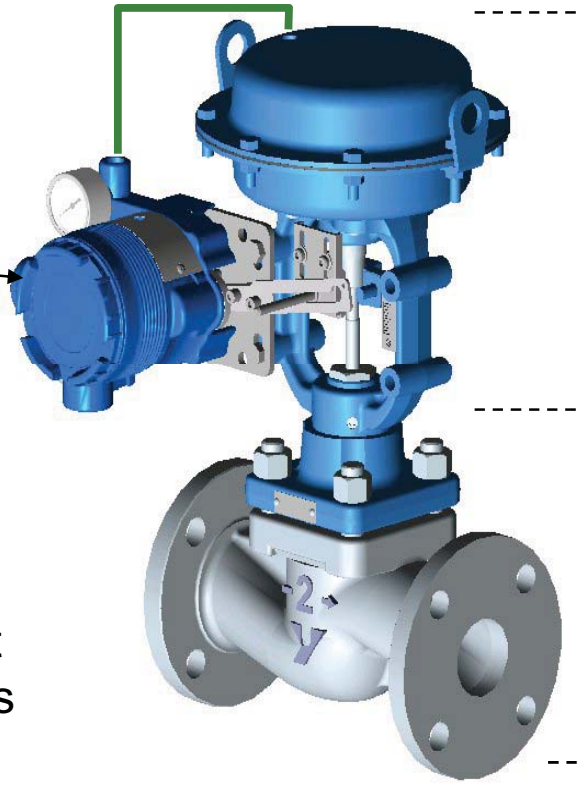
Positioner

Convert electrical signal to pneumatic signal so that valve can operate using pneumatic energy.

Control valve travel so that correct amount of fluid runs inside valve.



Actuator

Body

Yamatake Standard
Single Seated Valve

Structure of actuator and valve body

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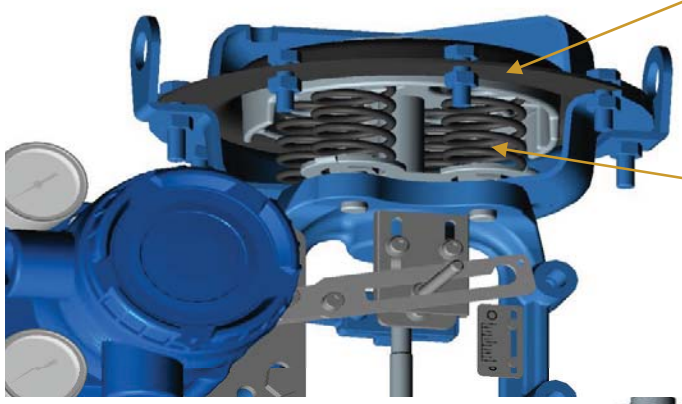
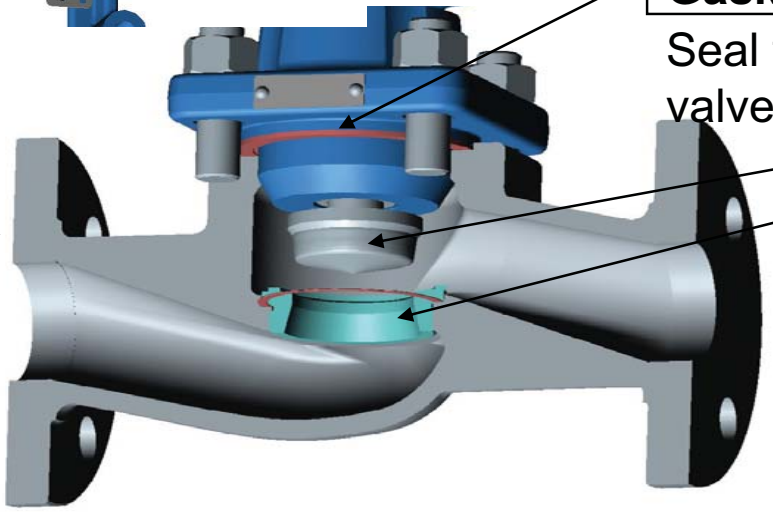


Diaphragm

Convert pneumatic energy to force

Spring

Convert force to displacement



Gasket

Seal the space between valve body and bonnet

Valve Body

Valve Plug

Seat Ring

Trim modulates flow passage to control flow rate.

Introduction

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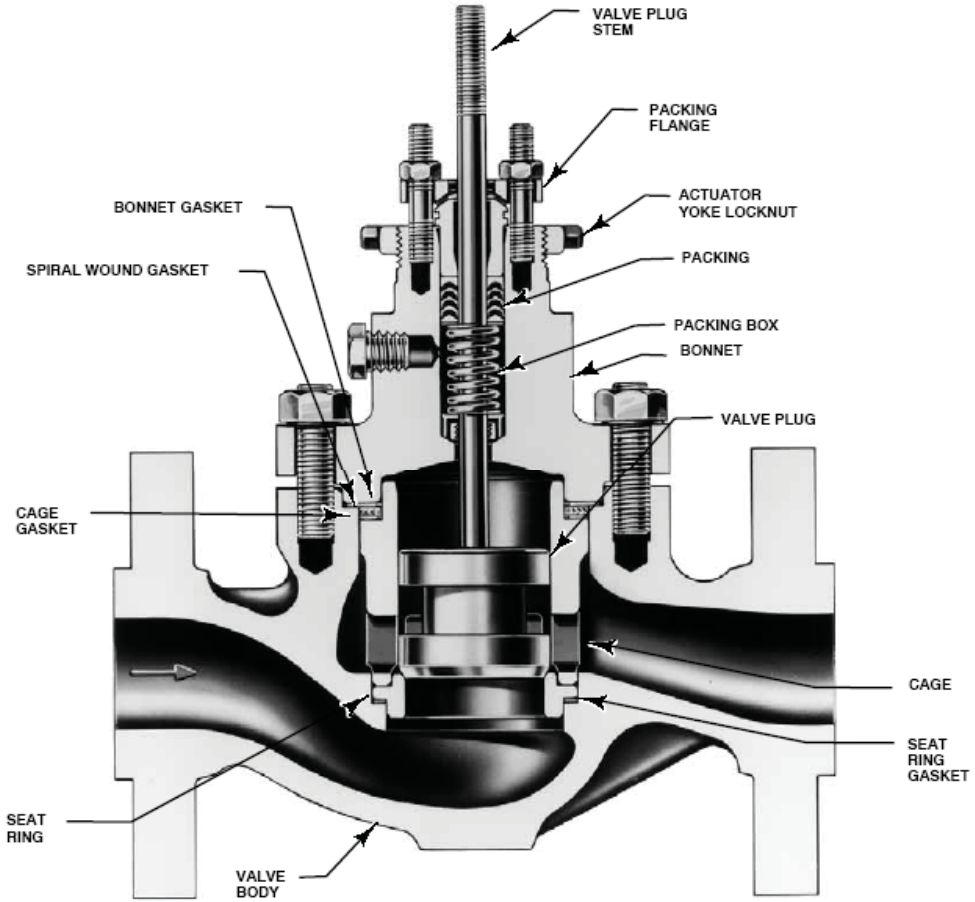

Major Component of Typical Control Valve Body

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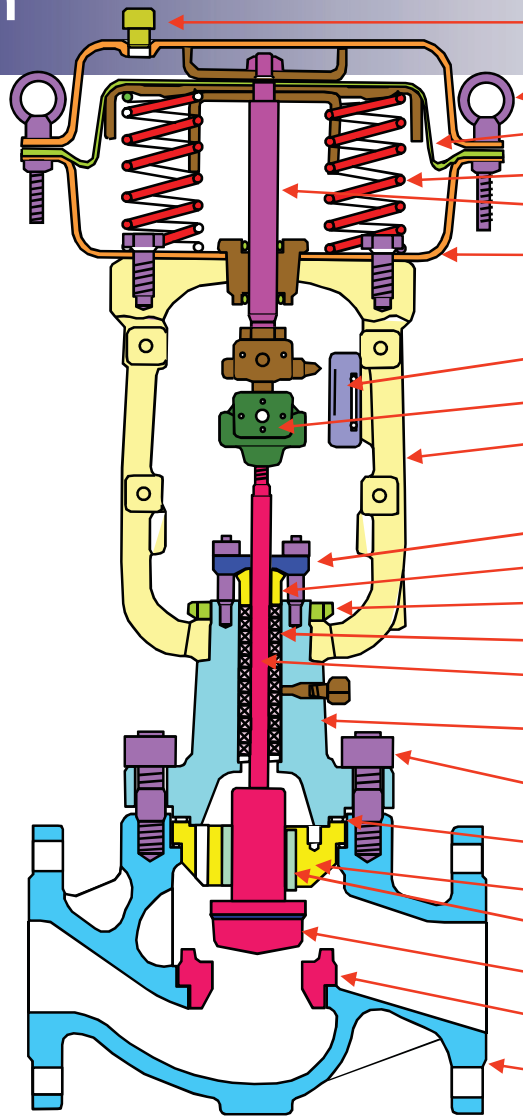

Actuator

Body

Rain cap
Eye bolt
Diaphragm
Spring
Actuator stem
Diaphragm case
Scale plate
Stem connector
Yoke
Packing flange
Packing follower
Yoke claming nut
Gland packing
Valve stem
Bonnet
Stud bolt and nut
Gasket
Guide ring
Guide bushing
Valve plug
Seat ring
Valve body

Trim

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Combination of body and actuator

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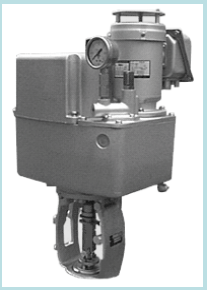
Control valves

Actuator

Pneumatic

Motorized

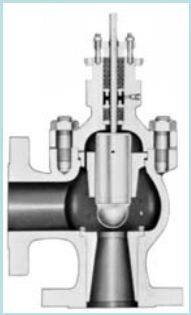


Hydraulic

+

Body

Glove



Angle

Butterfly

Features of each actuator types

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	Pneumatic type	Hydraulic type	Motorized type
Response time	Dead time is rather long. Action speed is fast.	Dead time is short. Action speed is fast	No dead time. Action speed is slow
Maintaining safety position at supply fail time	Possible by using integrated spring or connecting volume tank easily and certainly.	Difficult to maintain	Can stop and maintain only the position at an emergency time.
Output power	Middle for spring diaphragm type. Big for piston cylinder type.	Small for oil integrated type. Big for oil separated installation type	Bigger than pneumatic type and oil pressure type
Structure	Simple	Complicated	Complicated
Weather proof and Exprosion proof	Not necessary	Should be considered	Should be considered
Air piping or electric wiring	Simple	Simple for oil integrated type. Complicated for oil separated installation	Simple
Maintenance work	Easy	Complicated	Complicated
Cost	Reasonable	Expensive	Expensive

Features of each body types

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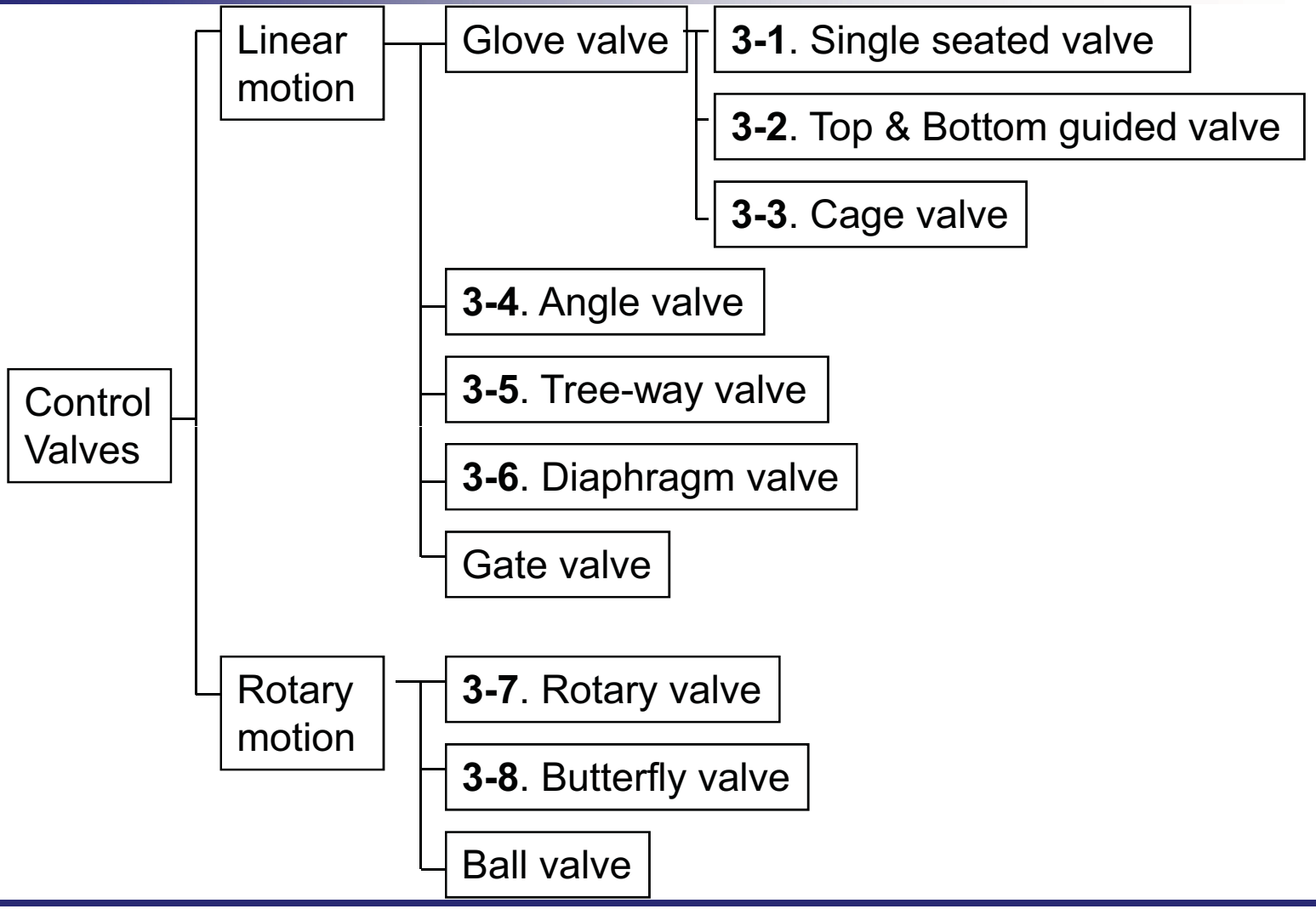

Cv calculation

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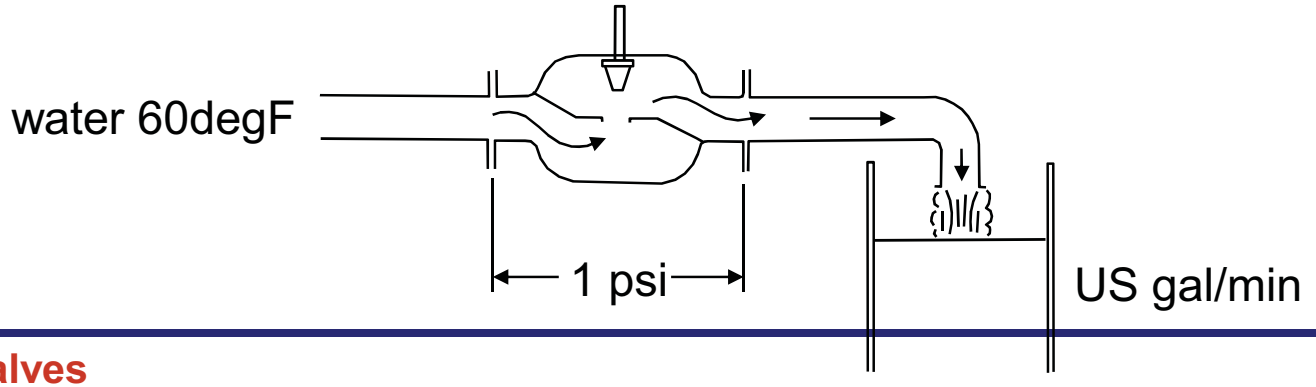
When you decide port size of control valve, you need to calculate required Cv value with fluid condition given on control valve data sheet. Then, you can specify appropriate Rated Cv value and port size.
At this chapter, most popular Cv calculation formula that is established by FCI (Fluid Controls Institute, Inc.) is introduced.

What is Cv value ?

One of the popular coefficients that express flow capacity. Cv value us defined as follows.
Flow rate of 60 degF (15.6 degC) clean water with the unit of US gal/min at differential pressure of 1 psi and specific travel of valve.
-Rated Cv value: Cv value at a valve is fully opened.
-Required Cv value: Cv value calculated with fluid condition



Flow Control Characteristics

As the actuator moves the valve plug through its travel range, the unobstructed flow area changes in size and shape depending on the contour of the valve plug.

When a constant pressure differential is maintained across the valve, the changing relationship between percentage of maximum flow capacity and percentage of total travel range can be portrayed , and is designated as the inherent flow characteristic of the valve.

Commonly specified inherent flow characteristics include:

* Linear Flow Characteristic
* Equal-Percentage Flow Characteristics
* Quick-Opening Flow Characteristic

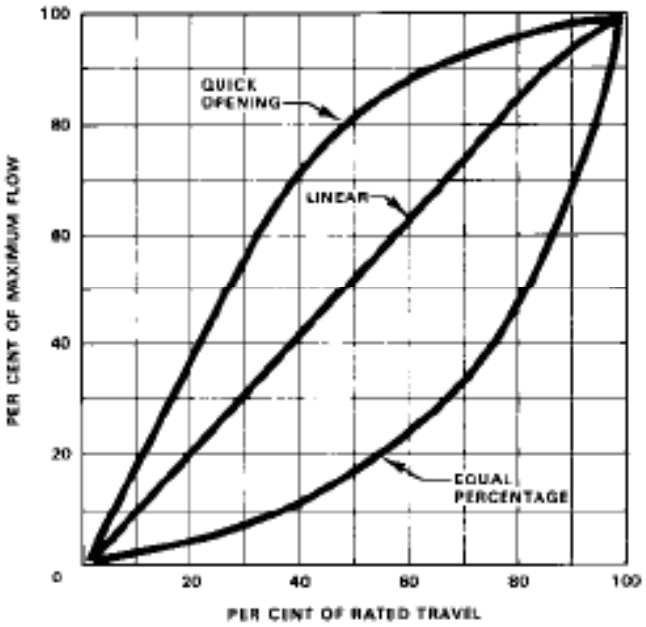
Linear Flow Characteristic

$Cv = K \cdot L$

(K: Constant, L: Valve plug travel)

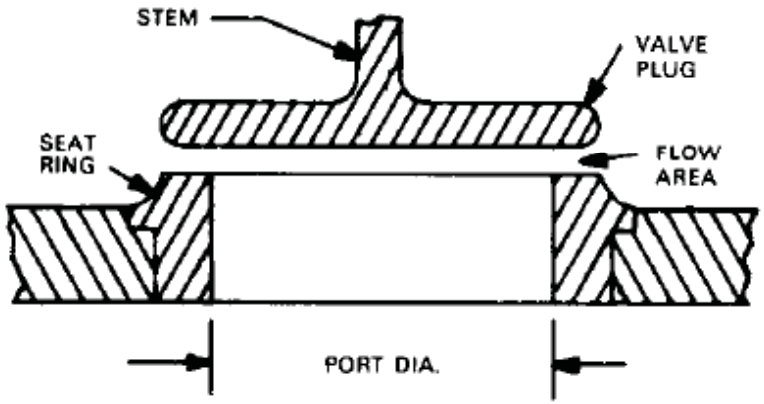
Equal-Percentage Flow Characteristics

$$\frac{dCv}{dL} = K \cdot Cv$$



Inherent Flow Characteristics Curves

Quick-Opening Flow Characteristic



Typical Construction to Provide Quick-Opening Flow Characteristic

Selection of Flow Characteristic

Control Valve Pressure Drop	Best Inherent Characteristic
Constant ΔP	Linear
Decreasing ΔP with Increasing Load, ΔP at Maximum Load > 20% of Minimum Load ΔP	Linear
Decreasing ΔP with Increasing Load, ΔP at Maximum Load < 20% of Minimum Load ΔP	Equal Percentage
Increasing ΔP with Increasing Load, ΔP at Maximum Load < 200% of Minimum Load ΔP	Linear
Increasing ΔP with Increasing Load, ΔP at Maximum Load > 200% of Minimum Load ΔP	Quick Opening

Liquid Level Systems

Rangeability

"Rangeability" denotes the ratio between the maximum flow rate and the minimum flow rate which can be controlled by a control valve.

$$\text{Inherent rangeability} = \frac{Cv - \max imum}{Cv - \min imum}$$

Valve and Actuator Types

Control Valves

The control valve regulates the rate of fluid flow as the position of the valve plug or disk is changed by force from the actuator. To do this, the valve must:

* Contain the fluid without external leakage;
* Have adequate capacity for the intended service;
* Be capable of withstanding the erosive, corrosive, and temperature influences of the process; and
* Incorporate appropriate end connections to mate with adjacent pipelines and actuator attachment means to permit transmission of actuator thrust to the valve plug stem or rotary shaft.

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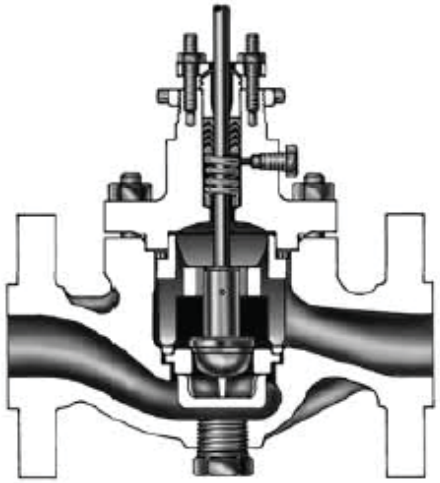
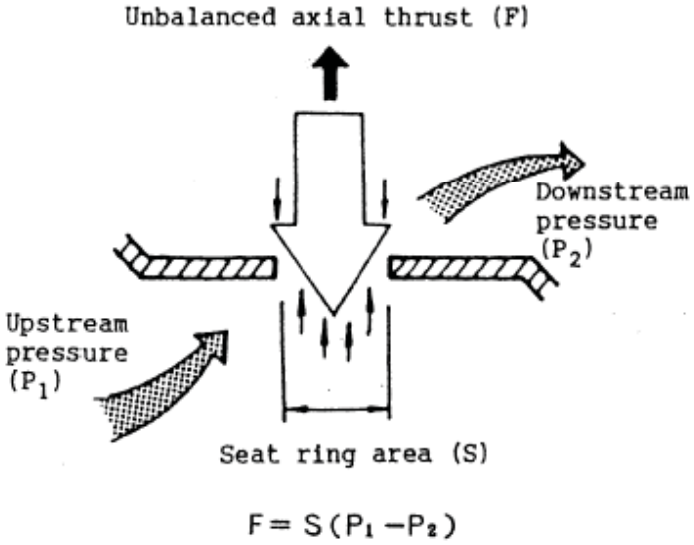
Globe Valves

Single-Port Valve Bodies



Single-Ported Globe-Style
Valve Body



Valve Bodies

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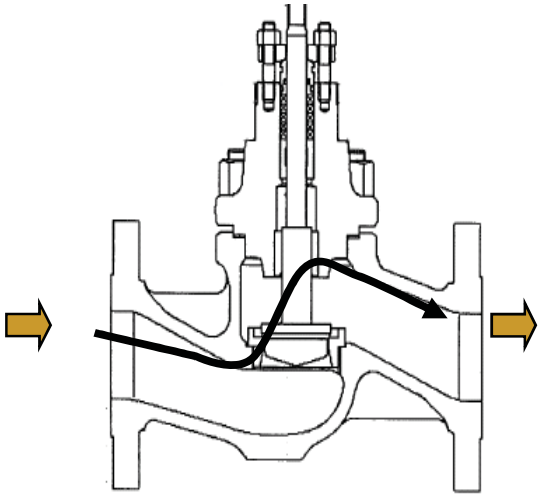

Most Popular type•
Valve plug has only one seat to shut-of fluid•
Seat leakage is low even though it has metal • seat
Unbalancing fluid force is higher than • pressure balancing type
When required valve size is lower than 2 inch,• This type is most advantageous because small sized actuator can be mounted.
That means price is reasonable.•
When required size is larger than 2 inch, • generally, price is not reasonable because the larger the valve size is, the bigger the actuators size is comparing single seated type to pressure balancing type.

Valve Bodies

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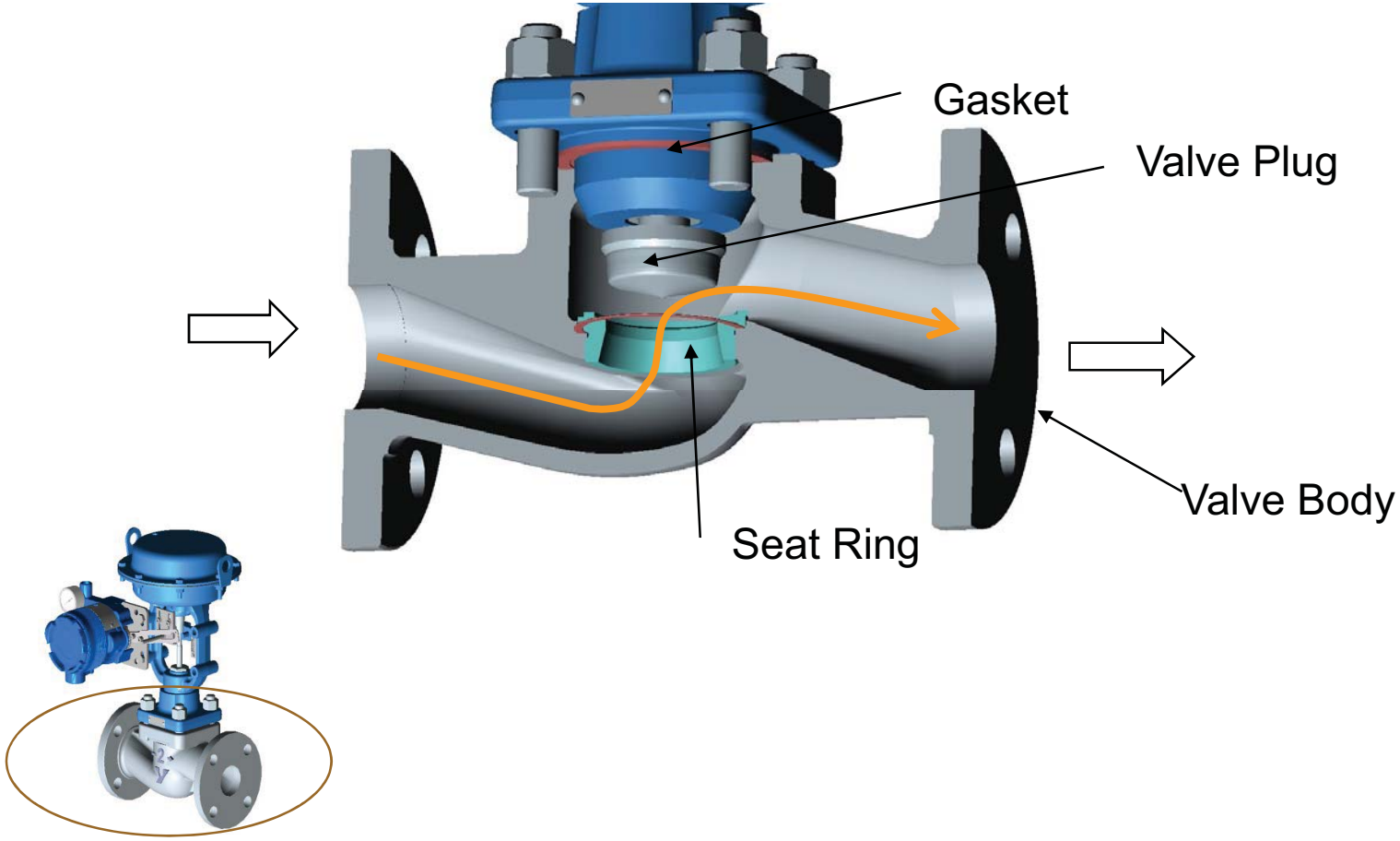

Top and Bottom Guided valve

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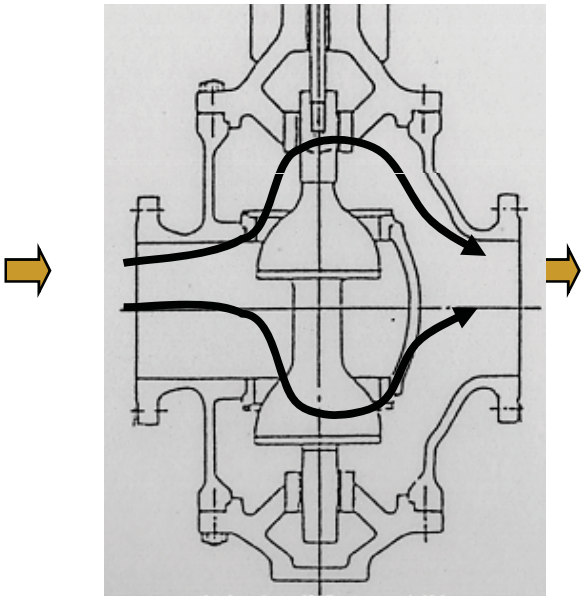

- The valve plug is guided at top and bottom.
- Pressure balanced type.
- This type is used mainly for oil refinery industry.
- Generally, seat leakage is larger than single seated valves.

Cage valve

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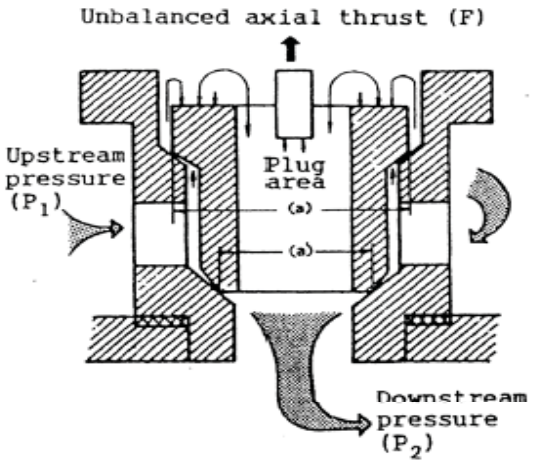

Seat ring

Valve plug

- This type comes after single seated type in market.
- Valve plug is guided by cage (shaped like pipe and set in valve body. It has window that consists of flow characteristics.)
- Pressure balanced type is more popular than unbalanced type.
- For pressure balanced cage type, actuator size is smaller than single seated type when body size is same. Therefore price is more competitive than single seated type when valve size larger than 3 inch or used with high-pressure rating.
- This type can reduce cavitation erosion and aerodynamic noise that are typical control valve claim.
- Generally, seat leakage is larger than single seated valve.

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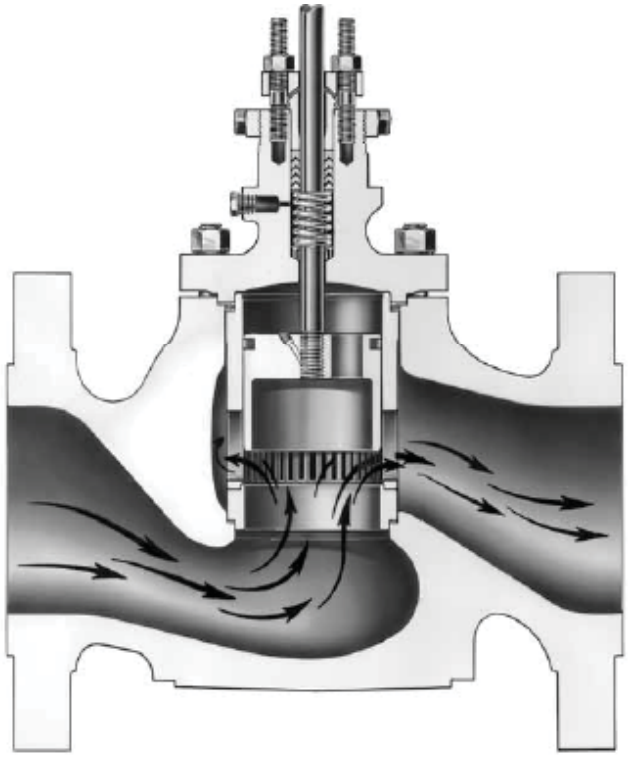
High Capacity, Cage-Guided Valve Bodies



High Capacity Valve Body with Cage-Style Noise Abatement Trim

Angle valve

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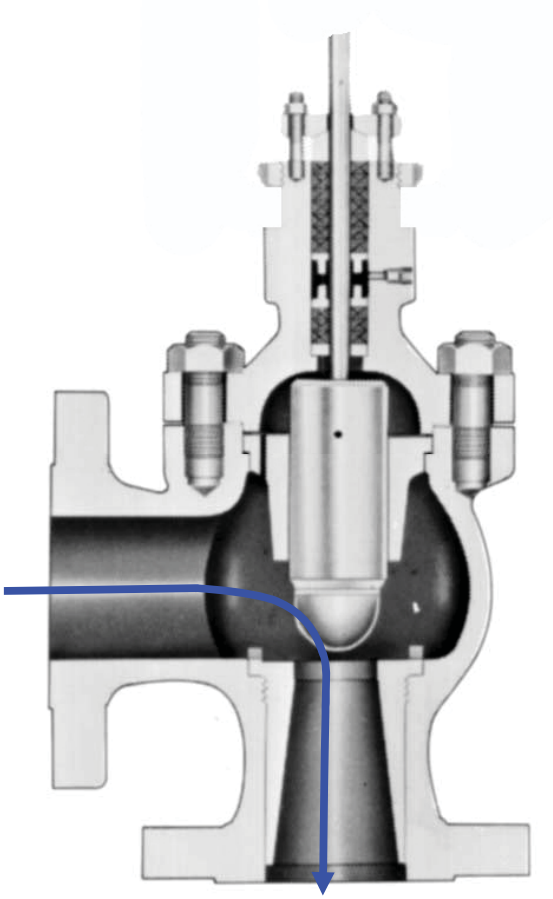

- Center of inlet and outlet of valves are right angle.
- This type is advantageous for erosive or abrasive fluid.
- Also used because of piping design advantage.
- Wetted parts design is simpler than general 2 way valves. So this type is also advantageous for viscous fluid.

Erosion: Destruction of valve bodies or trims due to high fluid velocity

Abrasion: Erosion due to slurry that contains solids or particles.

Tree-way valve

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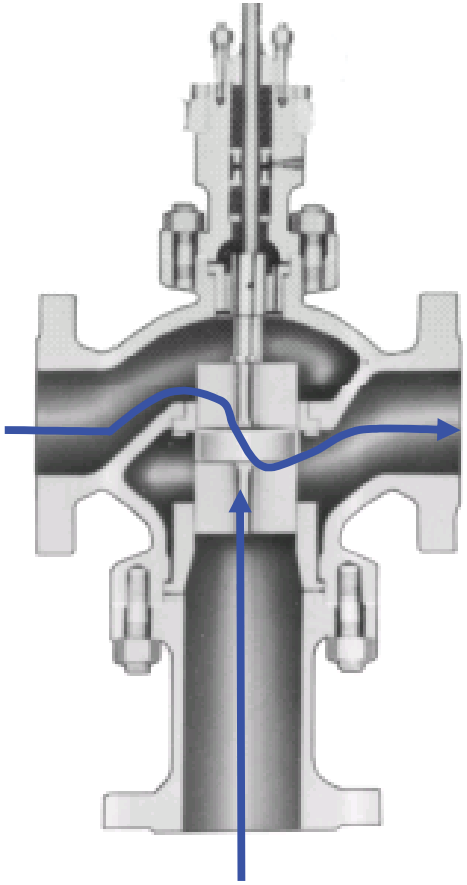
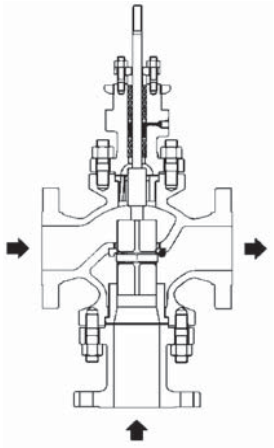
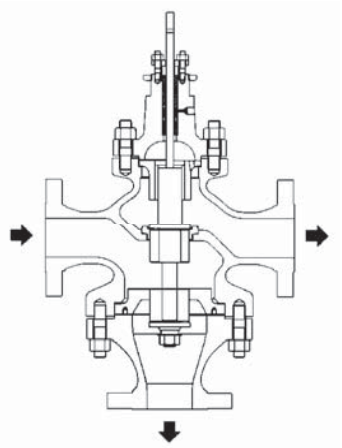
Three-Way Valve Bodies



Diverting type is used to separate flow to 2 way.•
Mixing type is used to mix 2 flow.•
Mainly used for temperature control.•



Mixing type



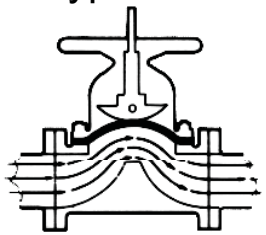
Diverting type

Diaphragm Valve

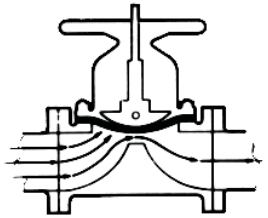
•Elastic diaphragm made with rubber and PTFE modulate the flow passage.

•Wetted parts can be lined with several materials (PTFE, Glass, and rubbers). So this type is advantageous for slurry or corrosive fluid.

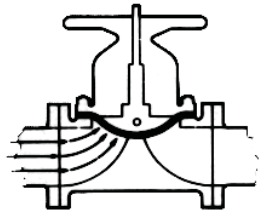
•This type is cost effective.



Full open



Control



Full close

Valve Bodies

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Rotary Valves

Butterfly Valve Bodies

High-Performance
Butterfly Control Valve

- A disk that is almost same diameter as pipe size rotate so as to modulates flow.
- Valve capacity is highest for all types of valves.
- Generally, this type is used at pressure rating 300# or lower. For higher-pressure rating, this type cannot be applied.

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V-Notch Ball Control Valve Bodies

Rotary-Shaft Control
Valve with V-Notch Ball

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Eccentric-Disk Control Valve Bodies

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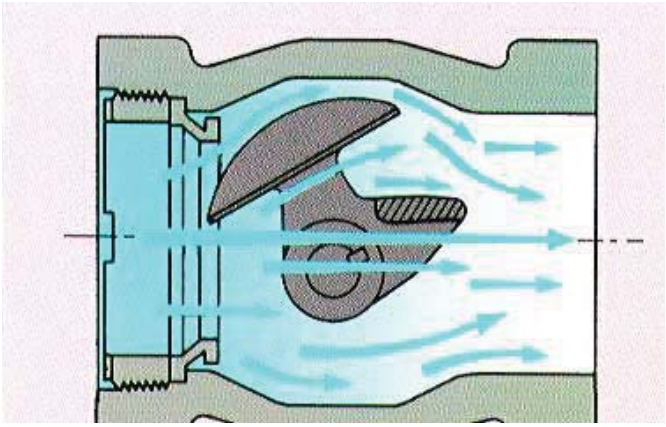
Center of the plug rotating point is eccentric from the center of valve body.

CV capacity is bigger than that of other globe valves.

Fluid can be passed easily because of straight trough construction.

Eccentric-Disk
Rotary-Shaft Control Valve



PTFE Valve

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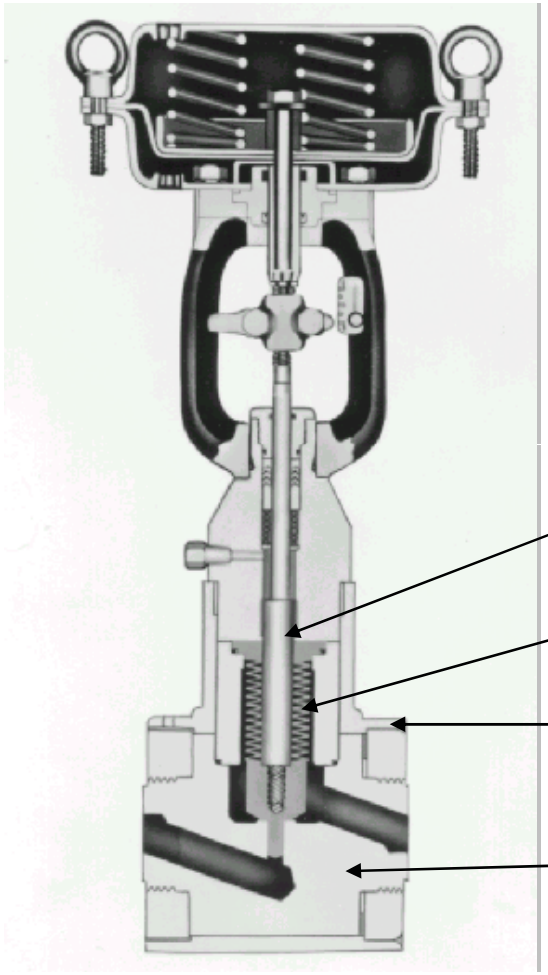

Plug: PTFE with 304ss core

Bellows: PTFE

Casing: SUS304

Body: PTFE

- A branch of single seated control valve.
- Especially used for corrosive fluid.
- All wetted parts are made with PTFE, which resist most of acids and alkalis.
- Body has rigid stainless casing to avoid warp with piping stress.
- Applicable pressure and temperature is limited.

- Max Operating Temperature: 140 deg C

PVC / Polypropylene Valve

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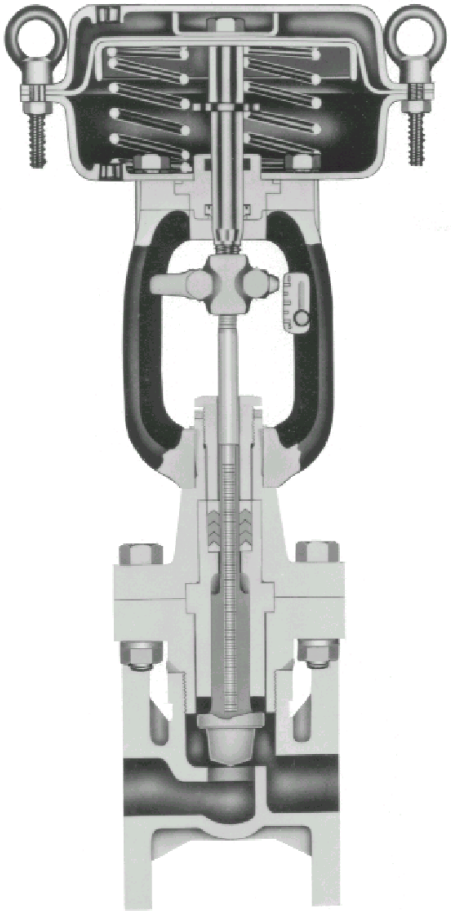

Model VNP

A branch of single seated control valve.
Especially used for corrosive fluid.
All wetted parts are made with PVC or Polypropylene, which resist most of acids and alkalis
Applicable pressure and temperature is limited.
Cheaper than PTFE valve

Max Operating Temperature:
PVC: 50 deg C,
Polypropylene: 80 deg C

Ceramic Valve

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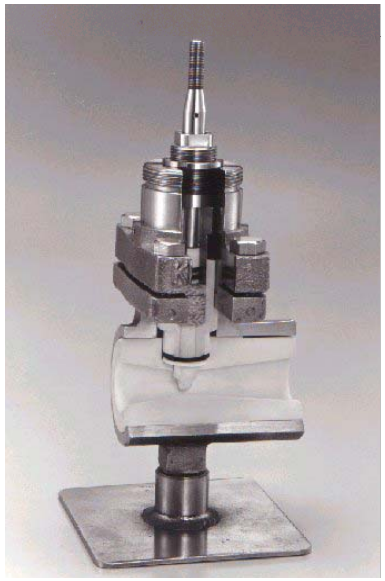
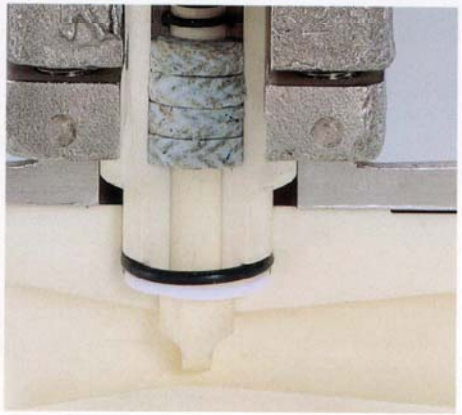
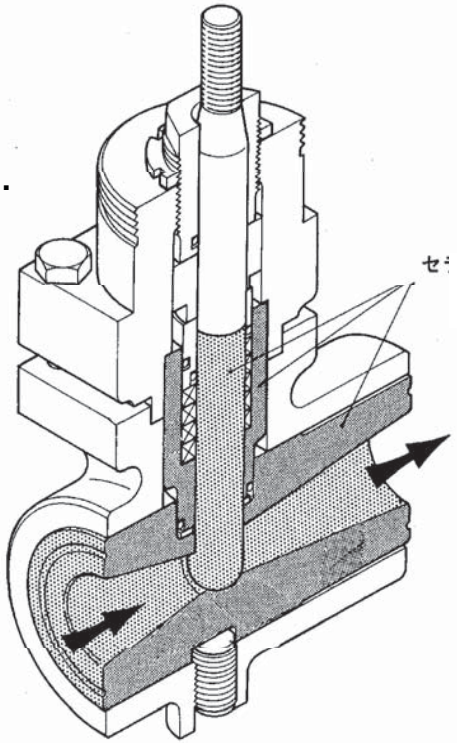
- Wetted part materials are all ceramics
- All wetted parts are made with ceramics that resists most of acids and alkalis.
- 3.Highest abrasion resistance.
- 4. There are application limitations for temperature, pressure and seat leakage class.





Model HMC CV ≤ 4.0

Model HIC 13≤CV≤120



Ceramic

99% aluminum ceramic or Silicon carbide ceramic

Aluminum ceramic: 70 deg C

Valve Plugs

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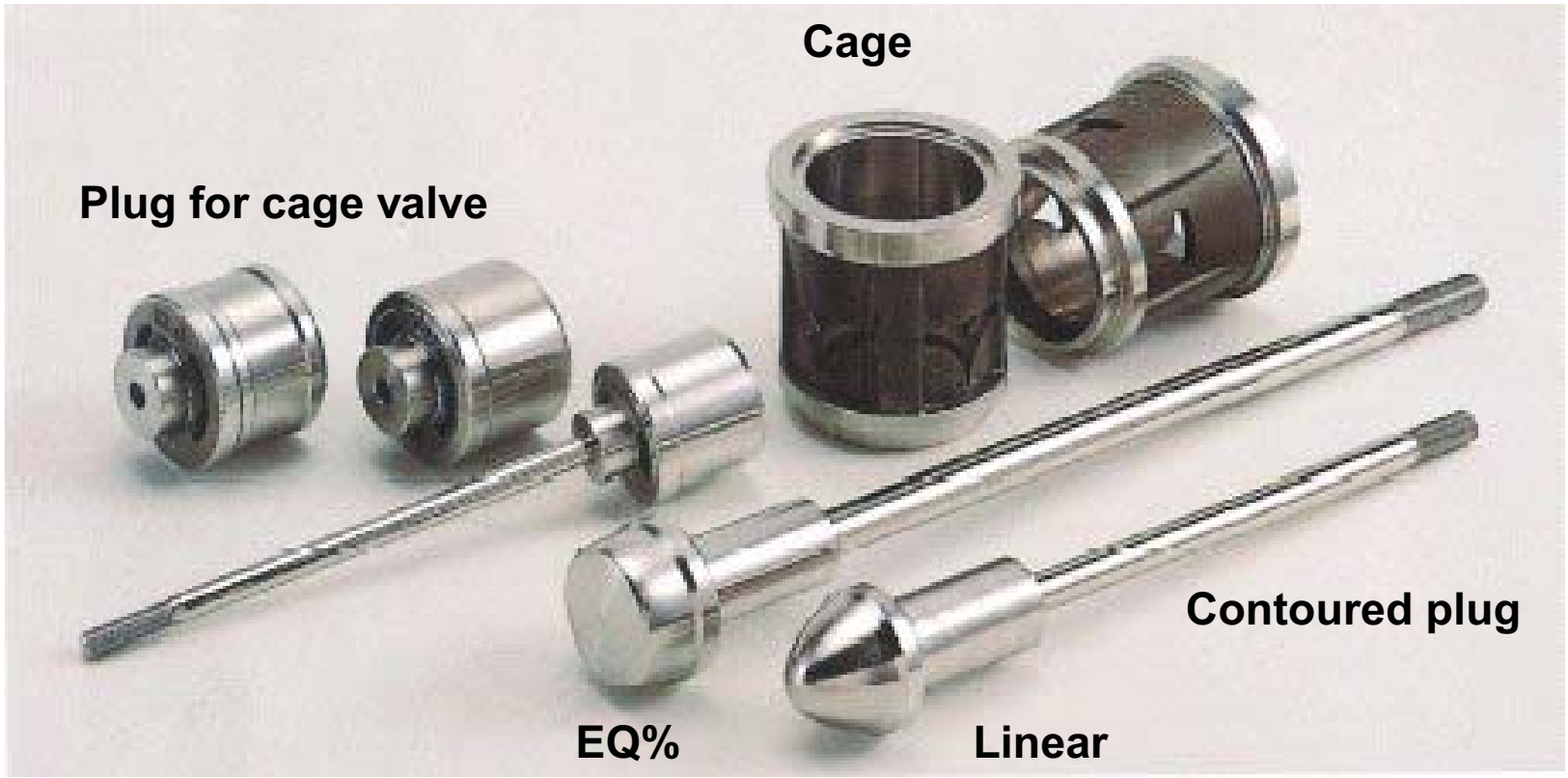
Types of Valve Plugs



Valve Plugs

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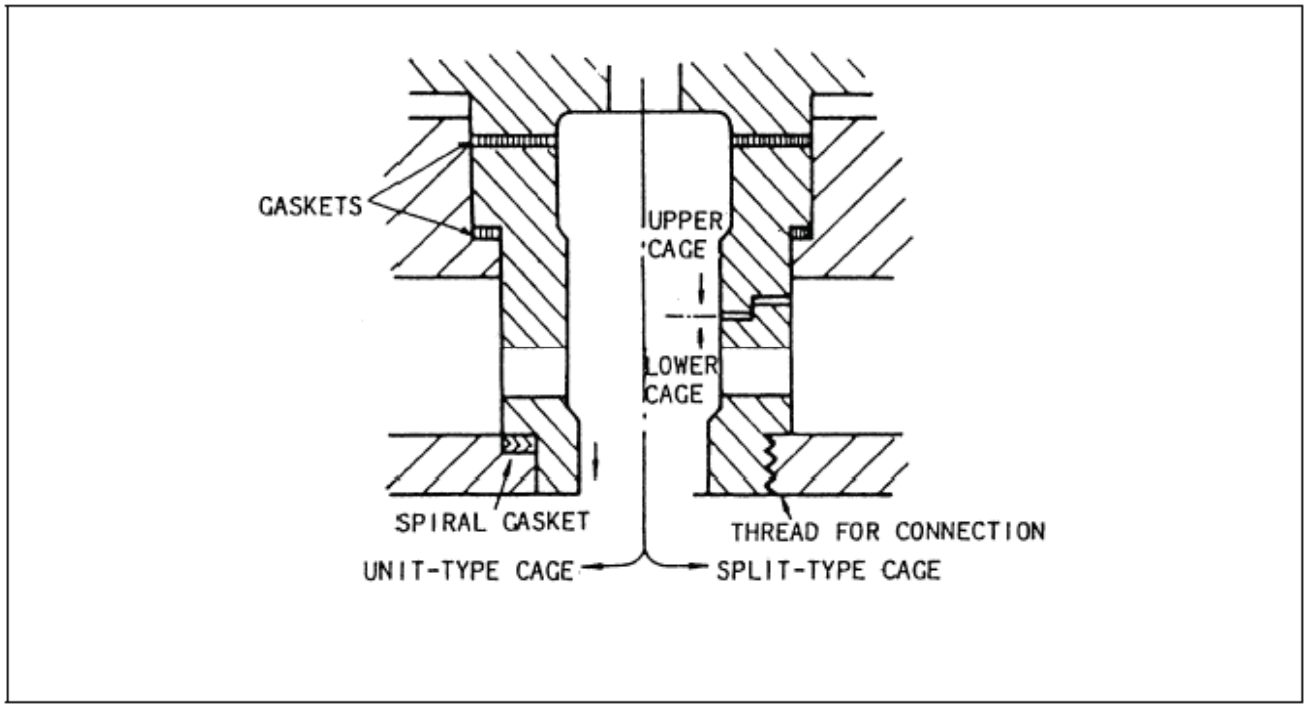

Characterization of Cage-Guided Valve Bodies

Characterized Cages for Globe-Style Valve Bodies

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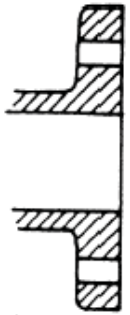
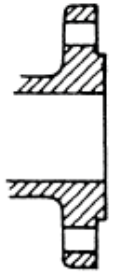
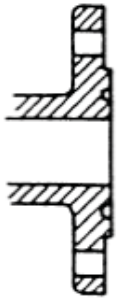
Control Valve End Connections

 Primarily for connections of small valves - 1 in. (25mm) or less 1) Thread type (S)	 For cast iron valves for low pressure service 2) Flat face type (FF)
 Most popular type for ANSI 600#, (JIS 40K) or lower 3) Raised face type (RF)	 For high-temperature high-pressure service 4) Ring joint type (RJ)

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End Connections

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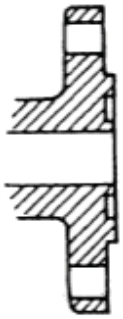
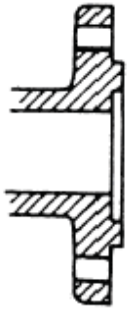
 To prevent leakage, for gas or vacuum service. (Normally, the valve flange is female) 5) Groove type	 For the same purpose as those of the groove type 6) Fit-in type
 For high-temperature high-pressure service of ANSI 900# or higher. For poisonous fluids or precious fluids. Normally, for valves of 2 in. (50mm) or smaller. 7) Socket welded type (SW)	 For the same purposes as those of the socket welded type. Normally, for valves of 2½ in. (80 mm) or larger 8) Butt welded type (BW)

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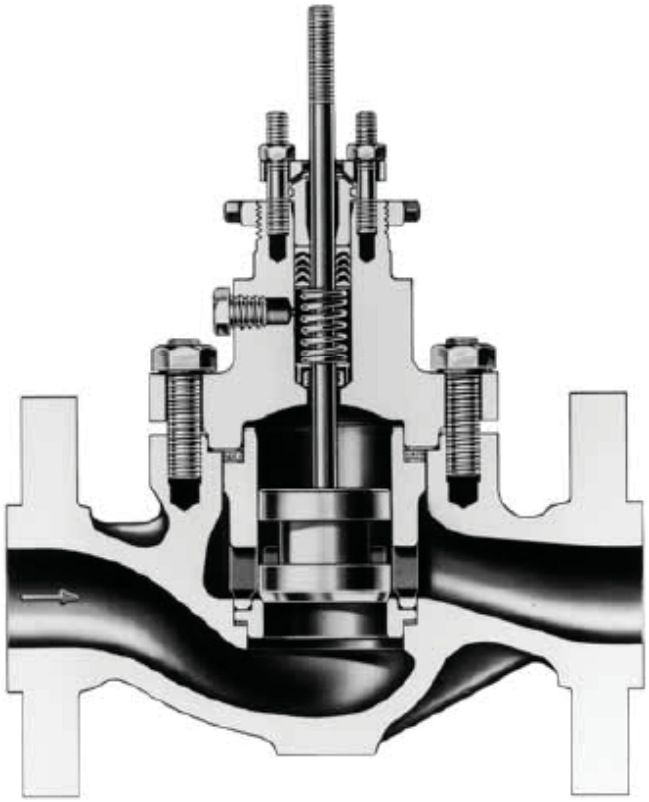
Valve Body Bonnets

The bonnet of a control valve is that part of the body assembly through which the valve plug stem or rotary shaft moves.



Typical Bonnet, Flange, and Stud Bolts

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Extension Bonnets

Extension Bonnet

Valve Body with
Fabricated Extension Bonnet

Packing

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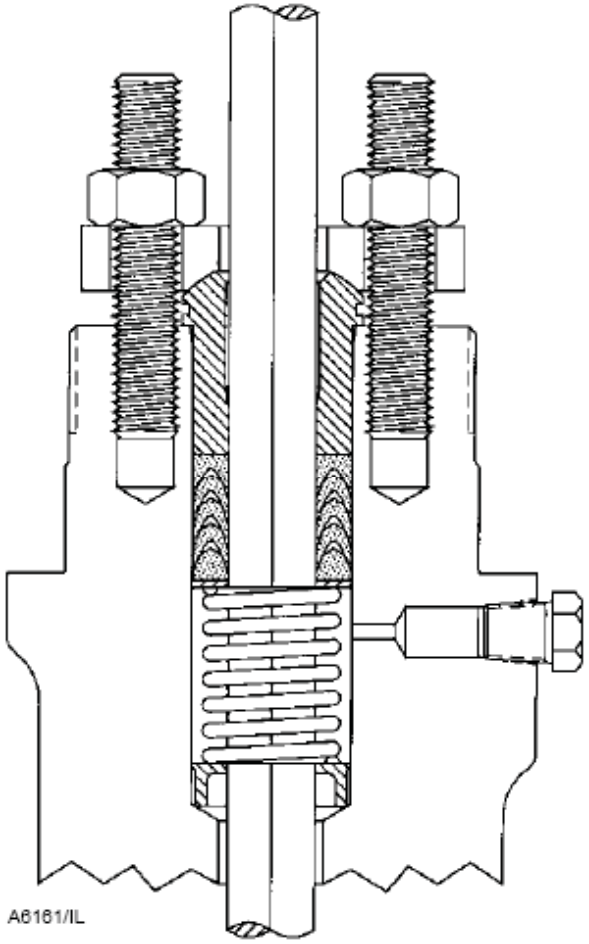
Control Valve Packing



Single PTFE V-Ring Packing

Packing

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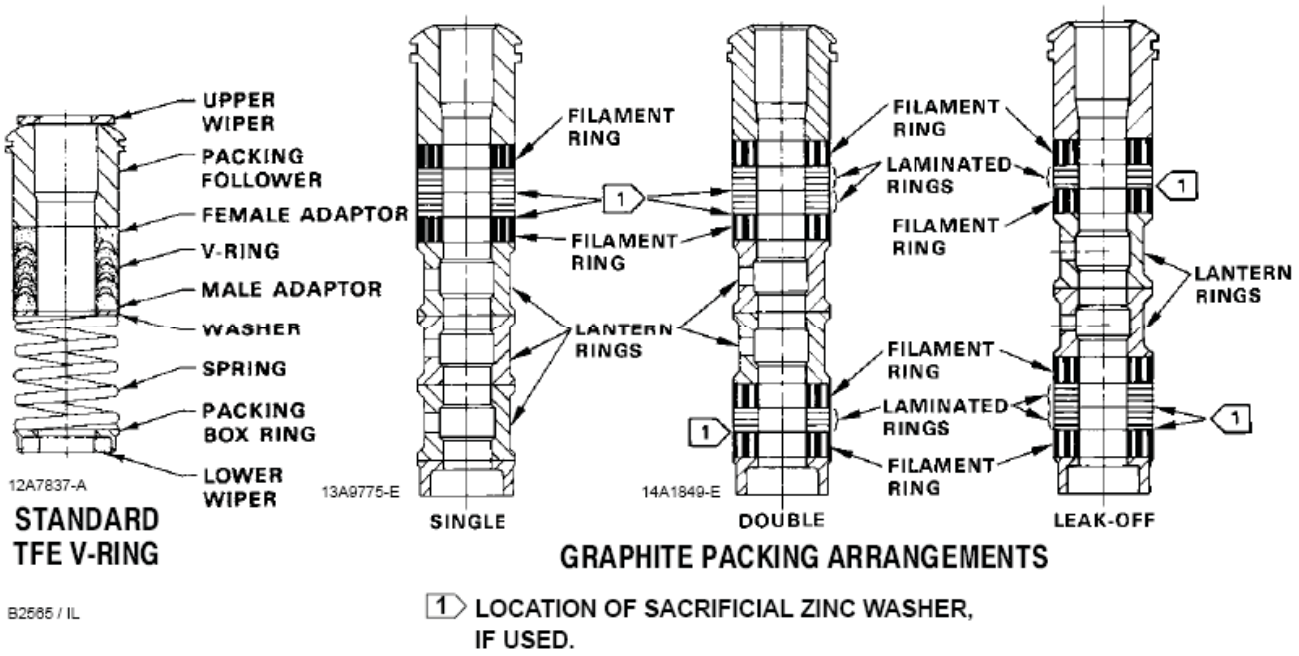

Comprehensive Packing Material Arrangements
for Globe-Style Valve Bodies

Packing

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Typical Valve
Stem Packing Assemblies

Packing

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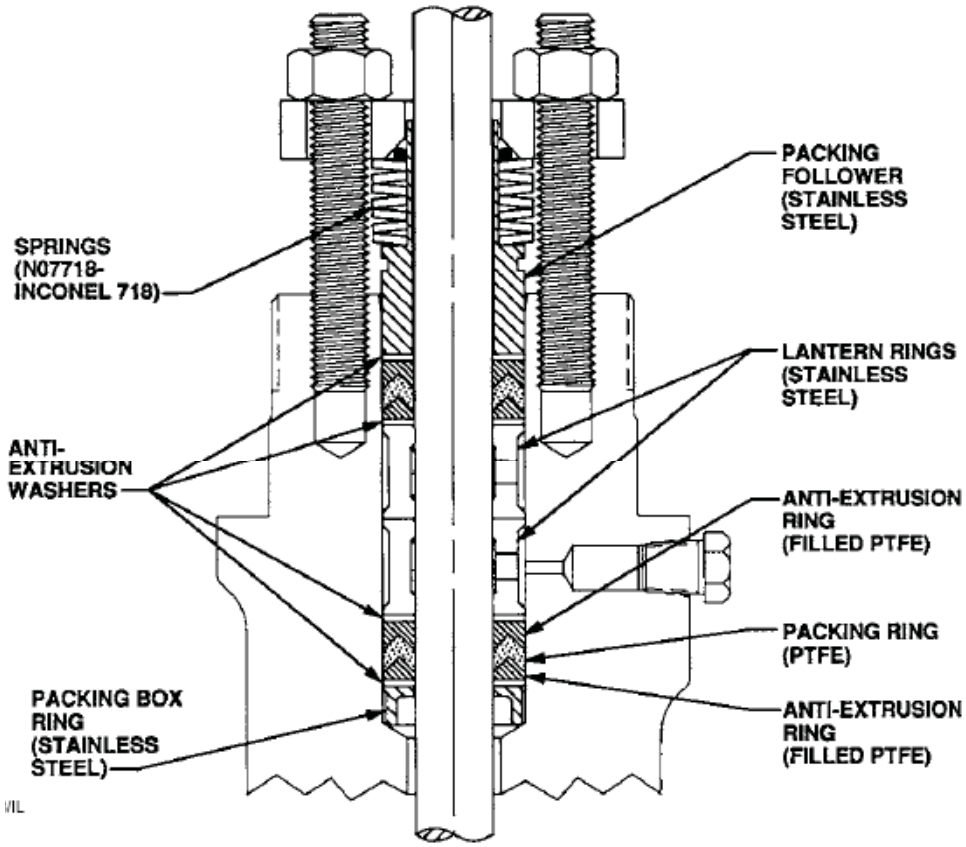
PTFE V-Ring

Laminated and Filament Graphite

Single PTFE V-Ring Packing

ENVIRO-SEAL_ PTFE Packing



ENVIRO-SEAL PTFE Packing System

Packing

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V-PTFE

V7132Y

#4519 yarn

Graphite (T2200)

SM636

TK2006

Graphite Ribbon for Rotary Valves

Sliding-Stem Environmental Packing Selection

Packing System	Maximum Pressure & Temperature Limits for 500 PPM Service(1)		Seal Performance Index	Service Life Index	Packing Friction
	Customary US	Metric			
Single PTFE V-Ring	300 psi 0 to 200°F	20.7 bar -18 to 93°C	Better	Long	Very Low
ENVIRO-SEAL PTFE	See Fig. 3-25 -50 to 450°F	See Fig. 3-25 -46 to 232°C	Superior	Very Long	Low
ENVIRO-SEAL Duplex	750 psi -50 to 450°F	51.7 bar -46 to 232°C	Superior	Very Long	Low
ENVIRO-SEAL Graphite ULF	1500 psi 20 to 600°F	103 bar -7 to 315°C	Superior	Very Long	Moderate

(1) The values shown are only guidelines. These guidelines can be exceeded, but shortened packing life or increased leakage might result. The temperature ratings apply to the actual packing temperature, not to the process temperature.

Packing

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Rotary Environmental Packing Selection

Packing System	Maximum Pressure & Temperature Limits for 500 PPM Service(1)		Seal Performance Index	Service Life Index	Packing Friction
	Customary US	Metric			
ENVIRO-SEAL PTFE	1500 psig -50 to 450°F	103 bar -46 to 232°C	Superior	Very Long	Low
ENVIRO-SEAL Graphite	1500 psig 20 to 600°F	103 bar -18 to 315°C	Superior	Very Long	Moderate

(1) The values shown are only guidelines. These guidelines can be exceeded, but shortened packing life or increased leakage might result. The temperature ratings apply to the actual packing temperature, not to the process temperature.

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Gaskets

Type	Type No. of gasket	Operable temperature range (°C)	Operable maximum pressure	Composition	Use
Flat type 	V562	-196 to + 260	150 kgf/cm^2	Copper Monel Aluminium	Oil-inhibited
	V564 (Monel)	-5 to + 566	ANSI 2500		
	V567	-196 to + 400	150 kgf/cm^2		service Oil-inhibited coper inhibited service
Sawtooth Type 	V540	0 to +200	20 kgf/cm^2	S15C	Material of valve body: FC20
	V 542	-196 to + 260	150 kgf/cm^2	Copper	Oil-inhibited service
	V 543 (SUS316L)	-196 to + 566	ANSI2500	SUS316	General Service
	V544	-196 to 450	ANSI2500	SUS316L	
	V544 (Monel)	-196 to + 566	ANSI 2500	Monel	
	V547	-196 to 400	150 kgf/cm^2	Aluminium	Oil-inhibited copper-inhibited service
Spiral shaped external pressure type 	V590	-100 to +500	ANSI 600	SUS316+ asbestos	For seat of unit-structure cage
	V590 (SUS 316L)	-100 to +450	ANSI 600	SUS 316L+ asbestos or teflon	
	V 7590	-196 to +100	20 Kgf/cm^2	SUS316L+ teflon	Oil inhibited service

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Gaskets

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Type	Type No. of gasket	Operable temperature range (°C)	Operable maximum pressure	Composition	Use
Others (special uses)	V1500 V1501	0 to 100	20 kgf/cm^2	Asbestos	For HLS, HTS (when specified by customer)
	V1500AC V1501AC	+100 to +260	10 kgf/cm^2		
	V7010	-196 to +260	ANSI 300	Teflon	For HLS, HTS (when specified by customer)
	V7020	-196 to + 260	ANSI 300	Teflon+ ceramics fillers	
	V 563 Teflon Coating	-196 to + 260	ANSI 300	SUS316+ teflon	Oil-inhibited with special material spur-water service
	V 543 Teflon Coating	-196 to + 260	ANSI 300	SUS 316+ teflon	
	V6590	-196 to + 566	ANSI 2500	SUS 316+ graphite	When heat cycles are severe For nuclear energy service

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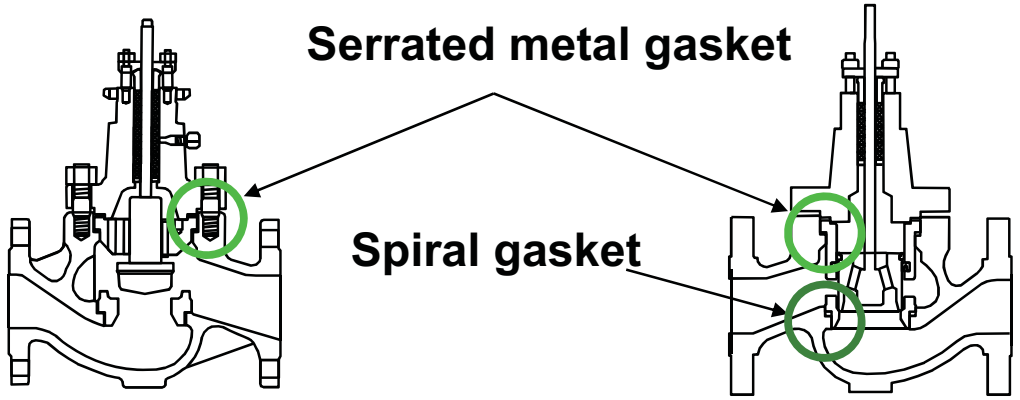
Examples on Uses of Gaskets



V543

V543 PTFE coated

V8590

Serrated metal gasket

Spiral gasket

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Gaskets

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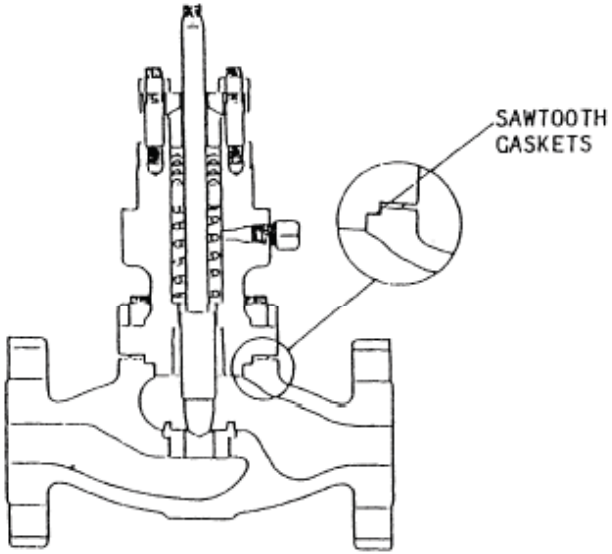
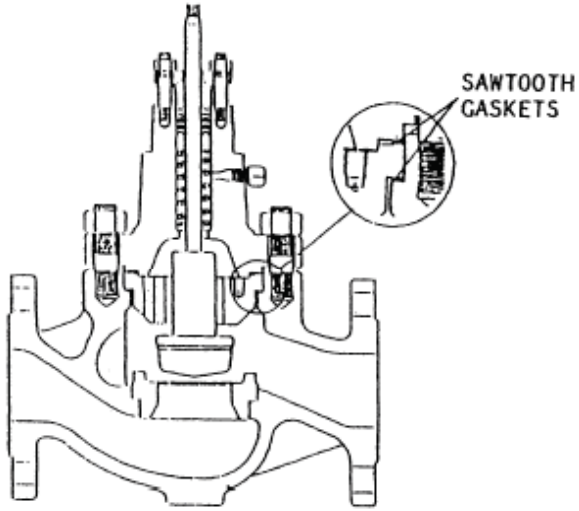


Structure of Single-seat Valve (HLS)



Structure of Single-seat Valve (HTS)

Grease

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Lubricator

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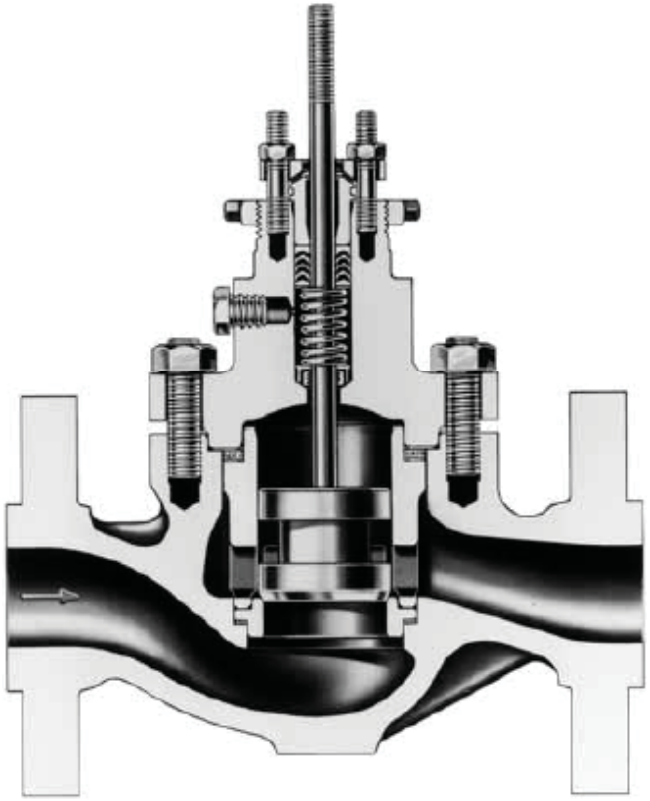
Valve Plug Guiding

1. Cage Guiding



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Valve Plug Guiding

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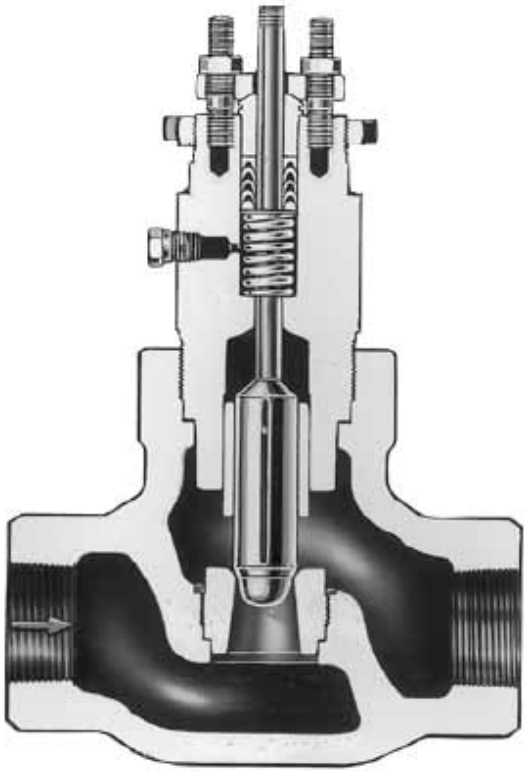
2. Top Guiding



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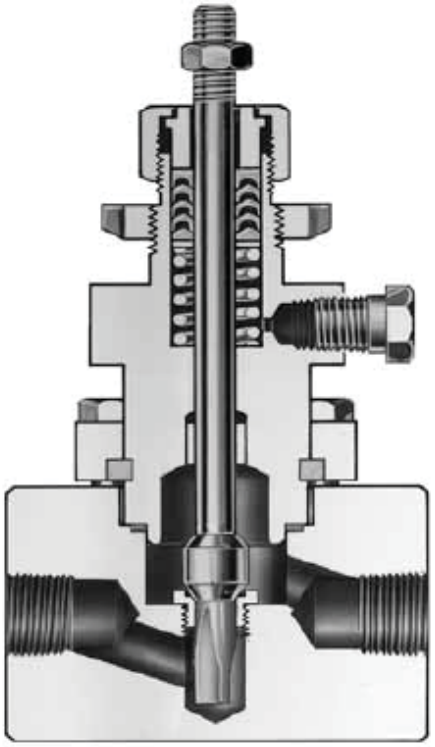
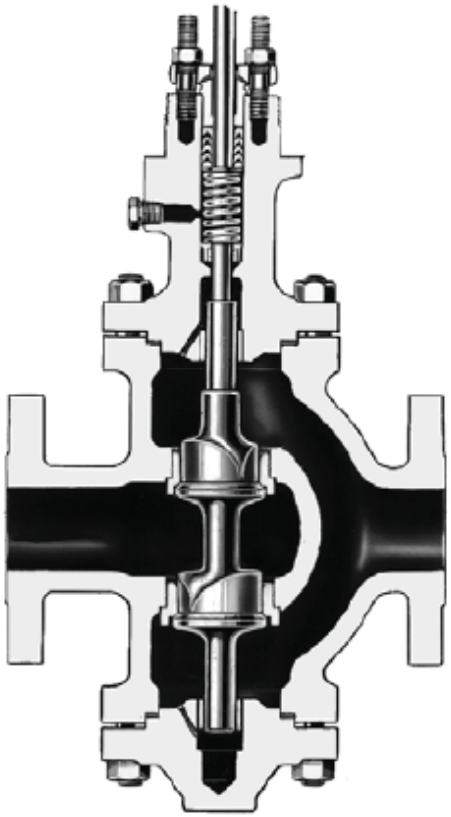
3. Stem Guiding



Left view

4. Top-and-Bottom Guiding



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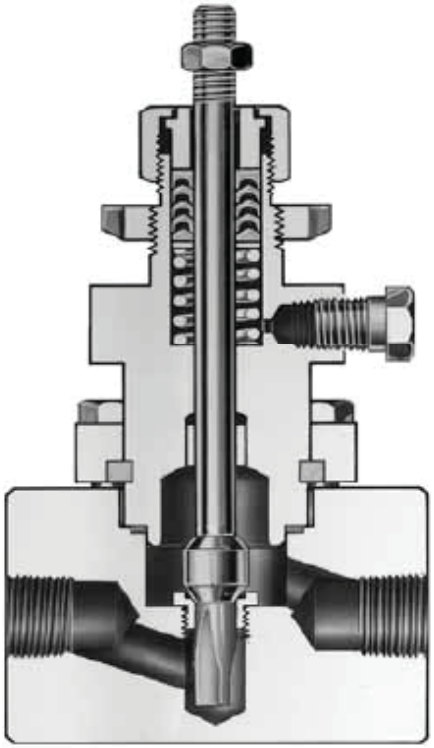
5. Port Guiding



Right view

Valve Plug Guiding

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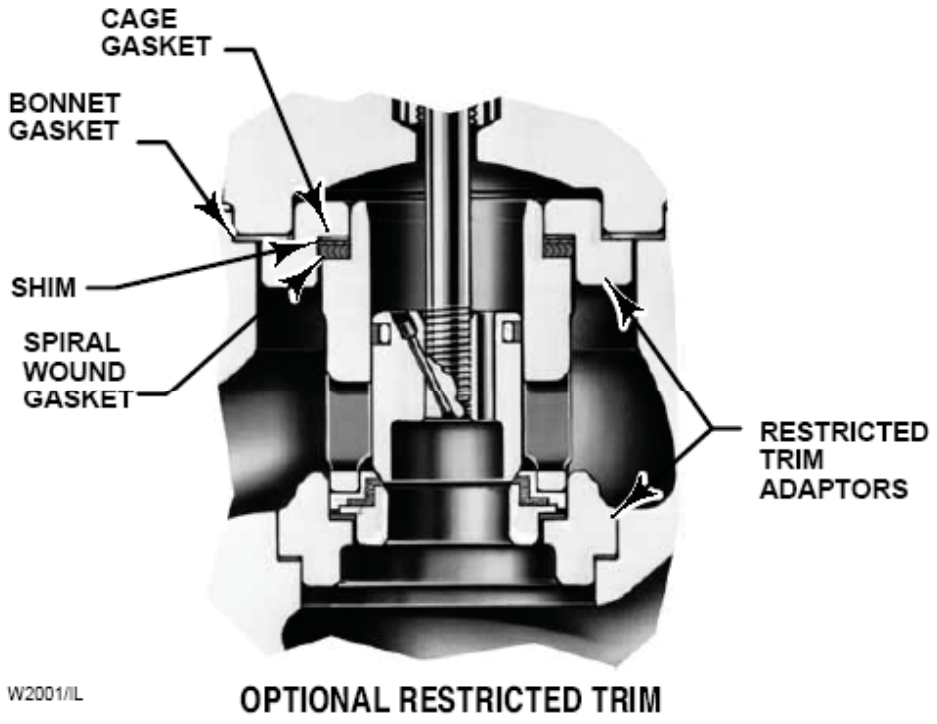
Restricted-Capacity

Control Valve Trim



Adapter Method for Providing Reduced Flow Capacity

Actuators

Pneumatically operated control valve actuators are the most popular type in use, but electric, hydraulic, and manual actuators are also widely used.

The spring-and-diaphragm pneumatic actuator is most commonly specified due to its dependability and simplicity of design. Pneumatically operated piston actuators provide high stem force output for demanding service conditions.

Actuators

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1. Diaphragm Actuators

3/IL

DIRECT-ACTING

W0364/IL

REVERSE-ACTING

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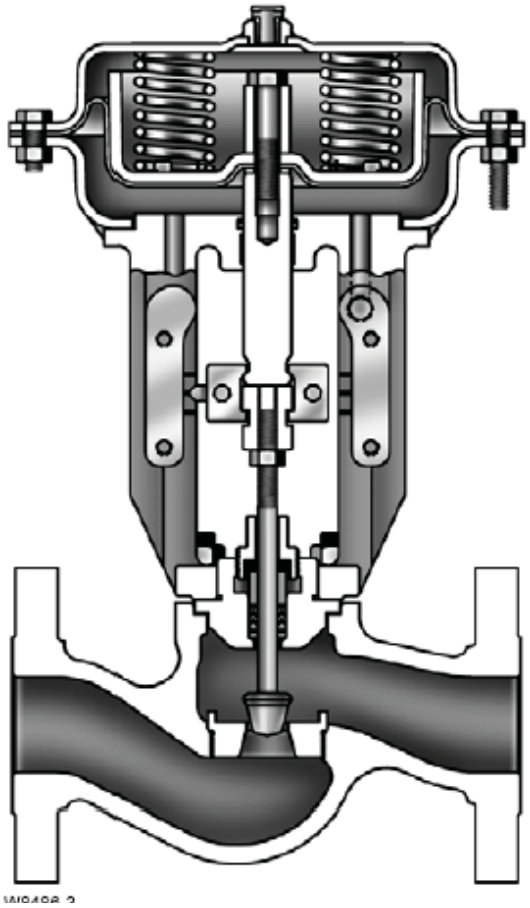

Field-Reversible Multi-Spring Actuator

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Actuators

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Diaphragm Actuator for Rotary Shaft Valves

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2. Piston Actuators

Control Valve with
Double-Acting Piston Actuator

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3. Electrohydraulic Actuators

Control Valve with Double-Acting Electrohydraulic Actuator and Handwheel

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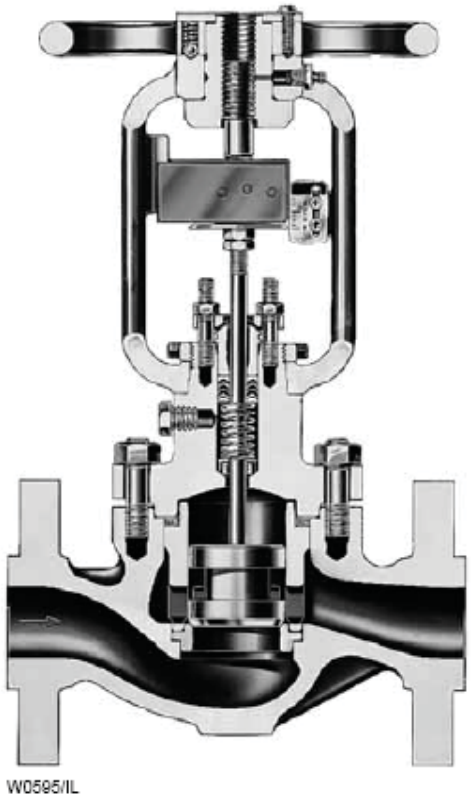
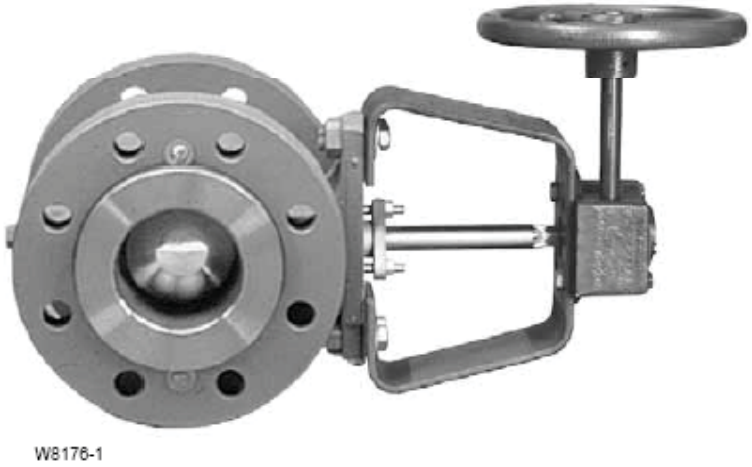
4. Manual Actuators



FOR SLIDING-STEM VALVES



FOR ROTARY-SHAFT VALVES

Typical Manual Actuators

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5. Rack and Pinion Actuators

Typical Rack and Pinion Actuator

6. Electric Actuators

Traditional electric actuator designs use an electric motor and some form of gear reduction to move the valve. Through adaptation, these mechanisms have been used for continuous control with varying degrees of success.

7. Types (Directions) of Valve and Actuator Actions

Types of valve and actuator actions should be correctly selected for fail-safe plant operation when the driving power (air supply) has failed. The type (direct and reverse) are defined as follows:

(a) Direct action: Valve opens when driving power has failed.
(b) Reverse action: Valve closes when driving power has failed.

Actuators

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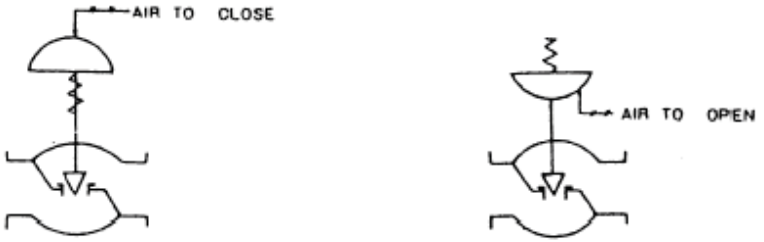
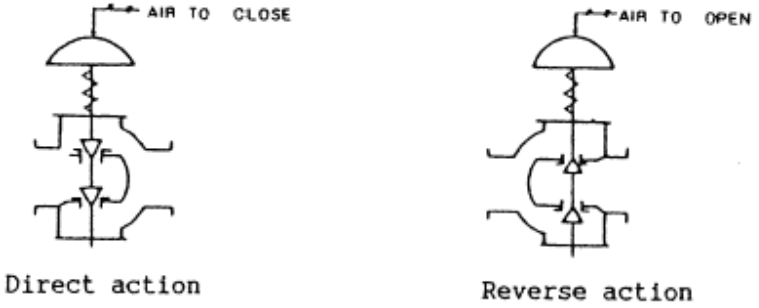
1. When valve action cannot be reversed (Top-guided single-seat valves, cage valves, angle valves, ceramics valves, and Saunders valves) Valve: Direct action → Actuator: Direct action Valve: Reverse action → Actuator: Reverse action	
2. When valve action can be reversed (Top-and-bottom guided single-seat or double-seat valves) Valve: Direct action → Valve body: normal Actuator: Direct action Valve: Reverse action → Valve body: Inverted Actuator: Direct action	

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Actuators

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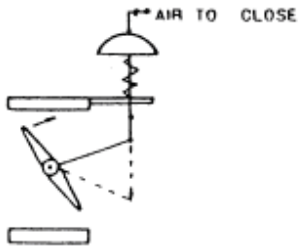
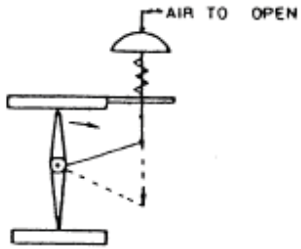
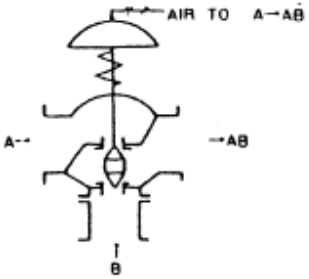
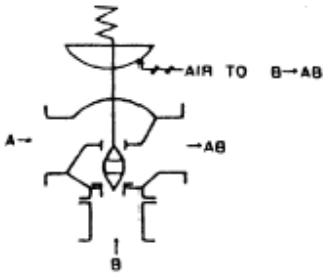
3. When driving the valve via a lever mechanism (Butterfly valves, FloWing valves) Valve: Direct action → Vane: Normal position Actuator: Direct action Valve: Reverse action → Vane: Reverse position Actuator: Direct action	 Direct action  Reverse action
4. To change flow direction (3-way valves) (1) Converging 3-way valves Valve: Bottom port open when air failure → Actuator: Direct action Valve: Bottom port closed when air failure → Actuator: Reverse action	 Bottom port open when air failure  Bottom port closed when air failure

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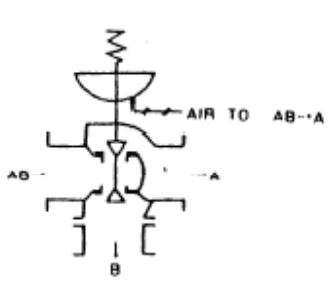
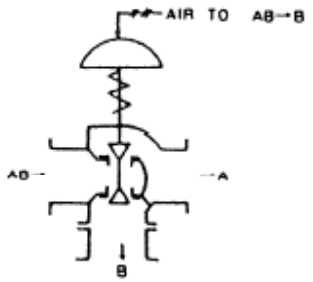
(2) Diverting 3-way valves
Valve: Bottom port open
when air failure →
Actuator: Reverse action
Valve: Bottom port closed
when air failure →
Actuator: Direct action



Bottom port open
when air failure



Bottom port closed
when air failure

Control Valve Accessories

Positioners

Pneumatically operated valves depend on a positioner to take an input signal from a process controller and convert it to valve travel. These instruments are available in three configurations:

1. Pneumatic Positioners
2. Analog I/P Positioner
3. Digital Controller

Positioners

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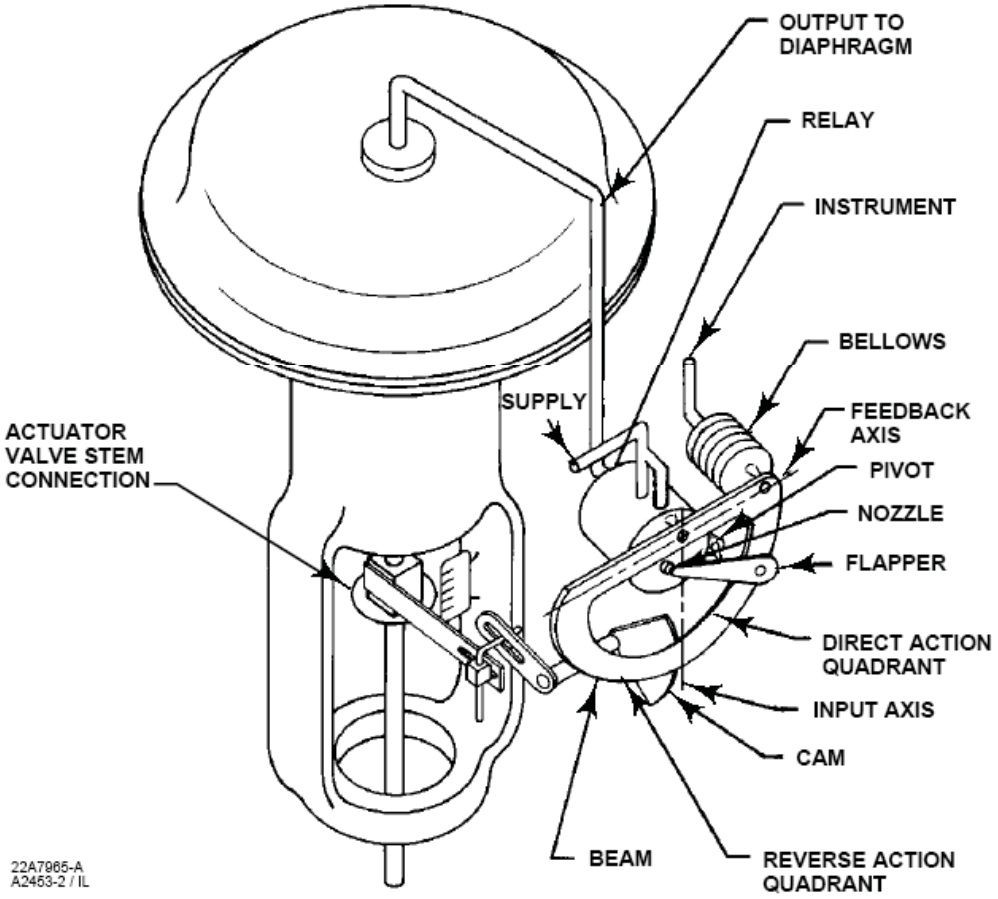
1. Pneumatic Positioners: A pneumatic signal (usually 3-15 psig) is supplied to the positioner.



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2. Analog I/P Positioner

This positioner performs the same function as the one above, but uses electrical current(usually 4-20 mA) instead of air as the input signal.

3. Digital Controller

Although this instrument functions very much as the Analog I/P described above, it differs in that the electronic signal conversion is digital rather than analog. The digital products cover three categories.

* Digital Non-Communicating
* HART
* Fieldbus

Positioners

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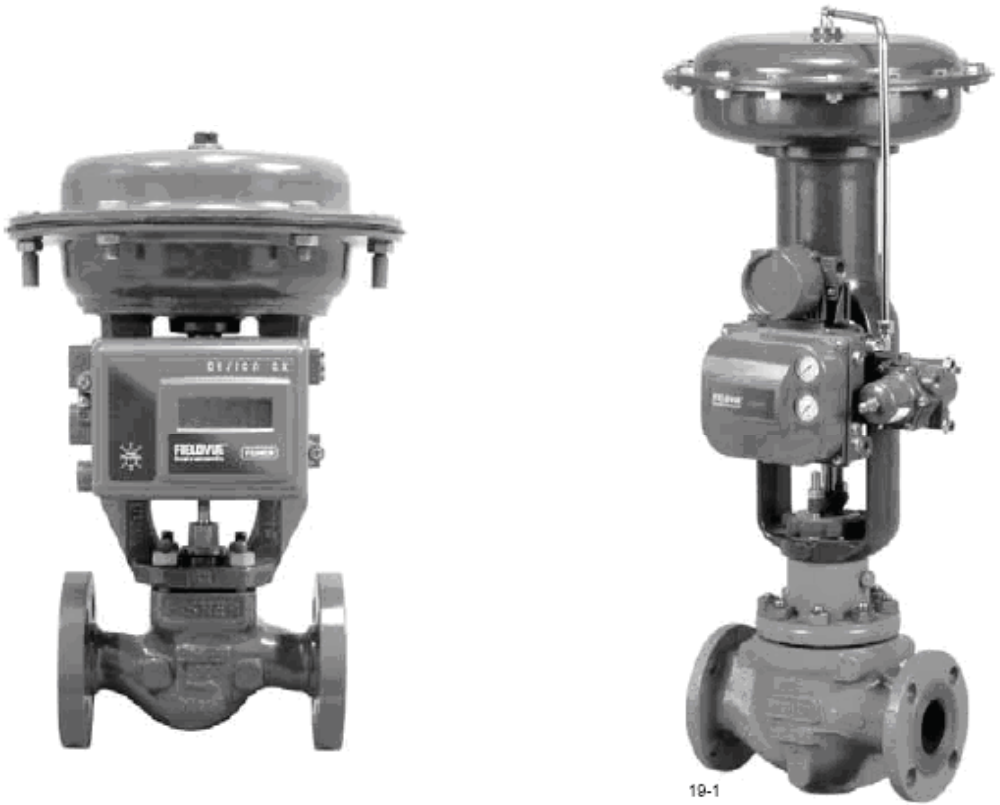

Modern Control Valves
Utilizing Digital Valve Controllers

Positioners

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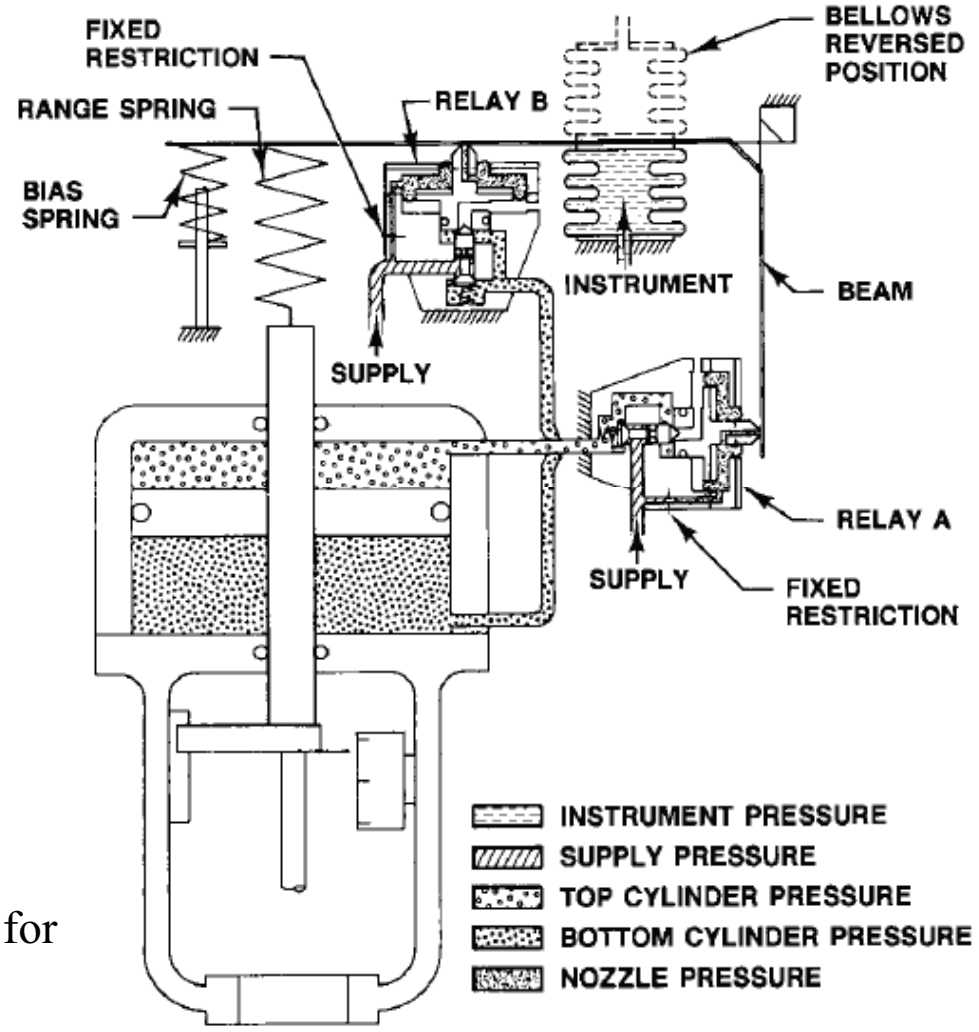

Positioner Schematic for Piston Actuator

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Volume Booster

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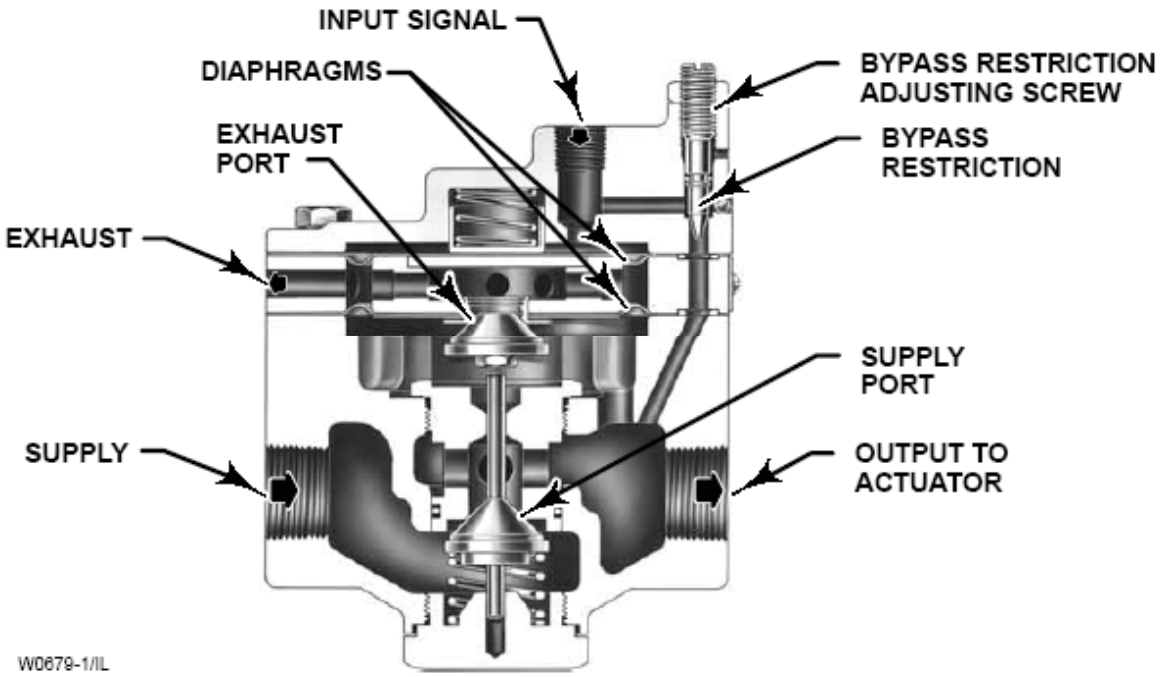

Volume Booster

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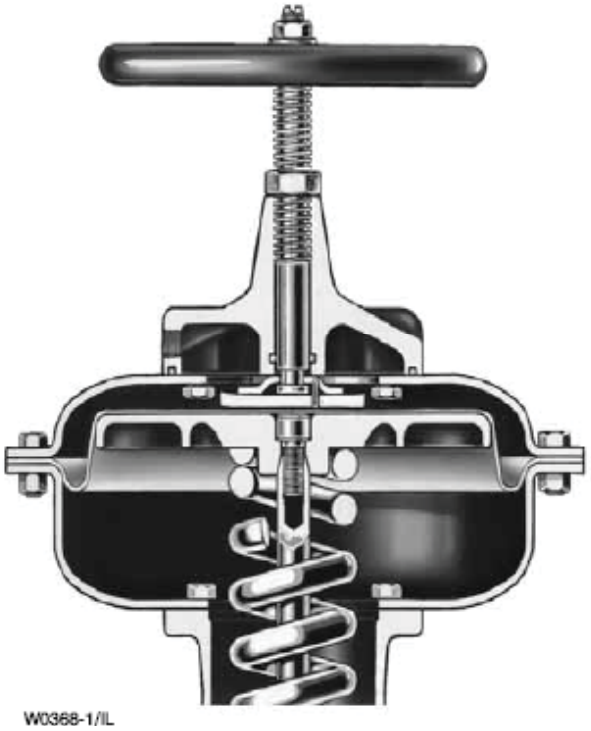
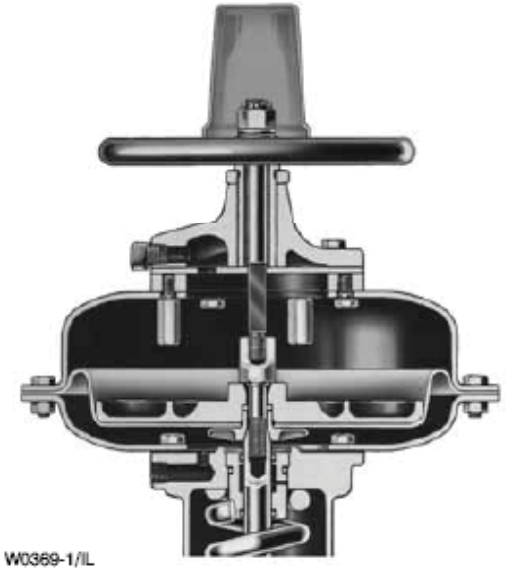
Other Control Valve Accessories



Top-Mounted Handwheel
for Direct-Acting Diaphragm Actuator



Top-Mounted Handwheel
for Reverse-Acting Diaphragm Actuator

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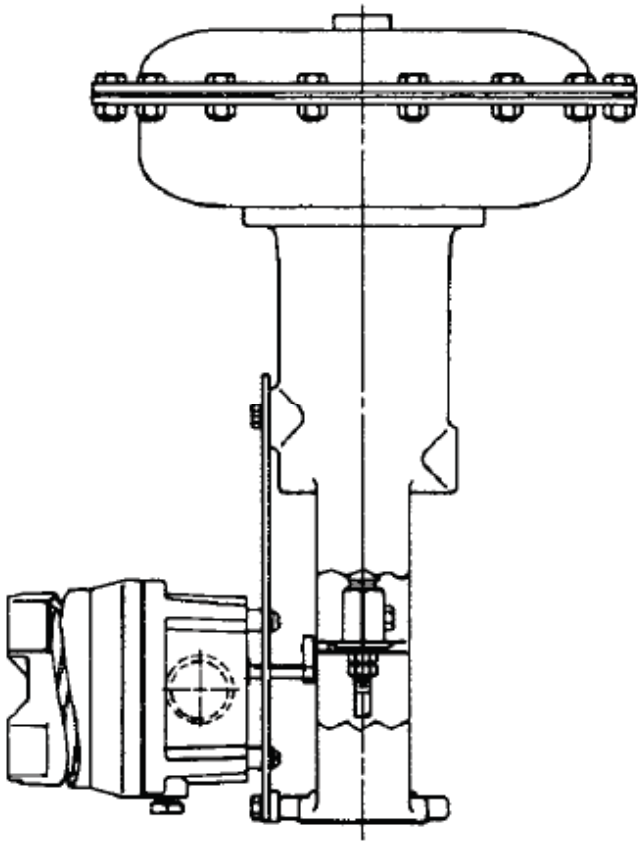
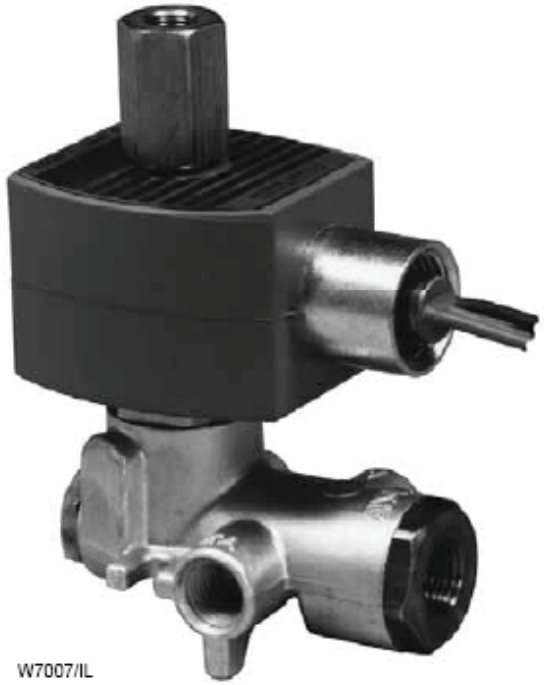
Limit Switches



Cam-Operated Limit Switches

Solenoid Valve Manifold



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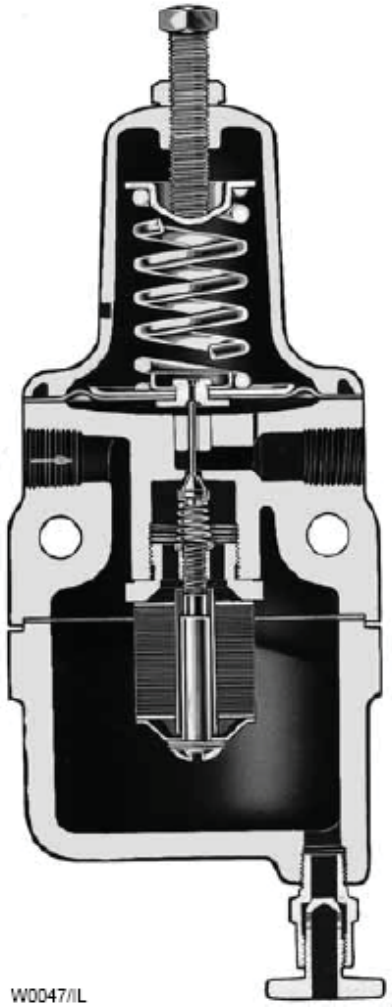
Supply Pressure Regulator



Supply Pressure Regulator
with Filter and Moisture Trap

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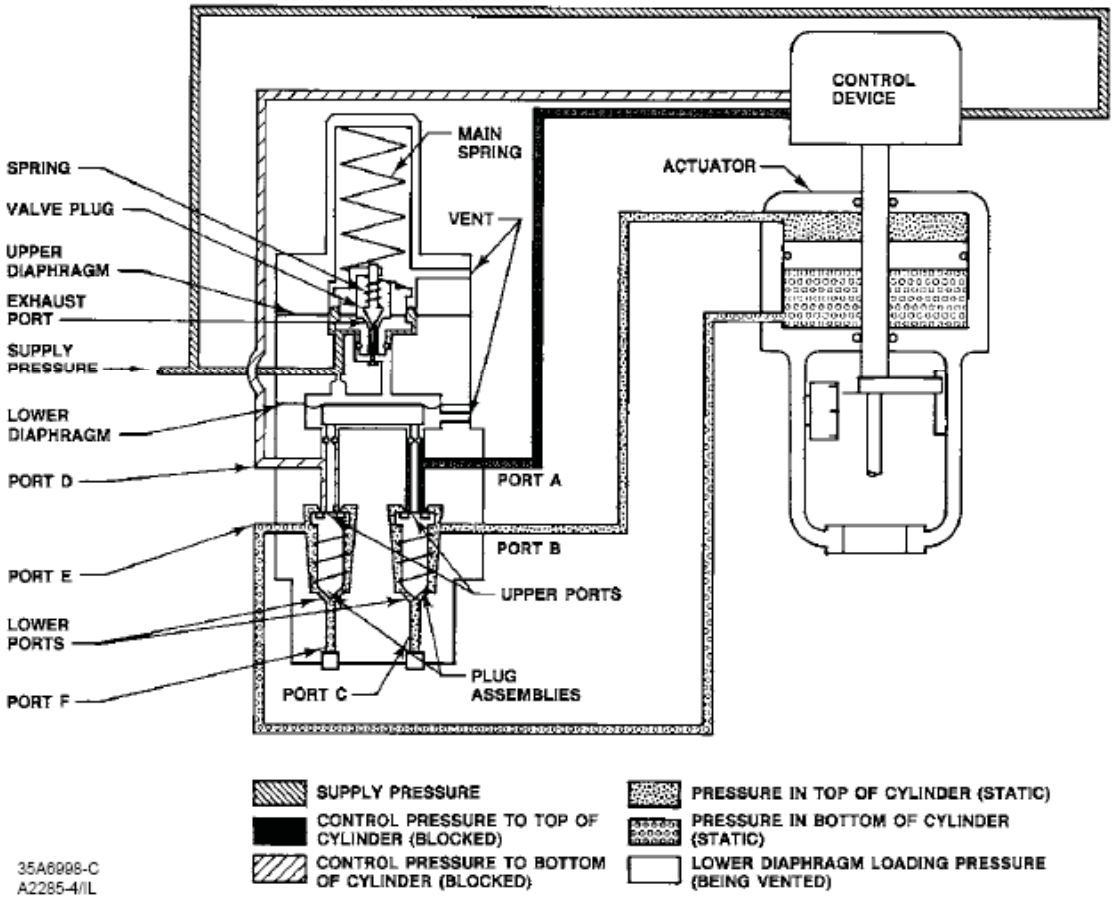
Pneumatic Lock-Up Systems



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Other Accessories

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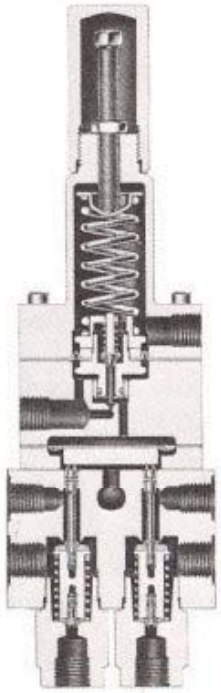

Trip Valve

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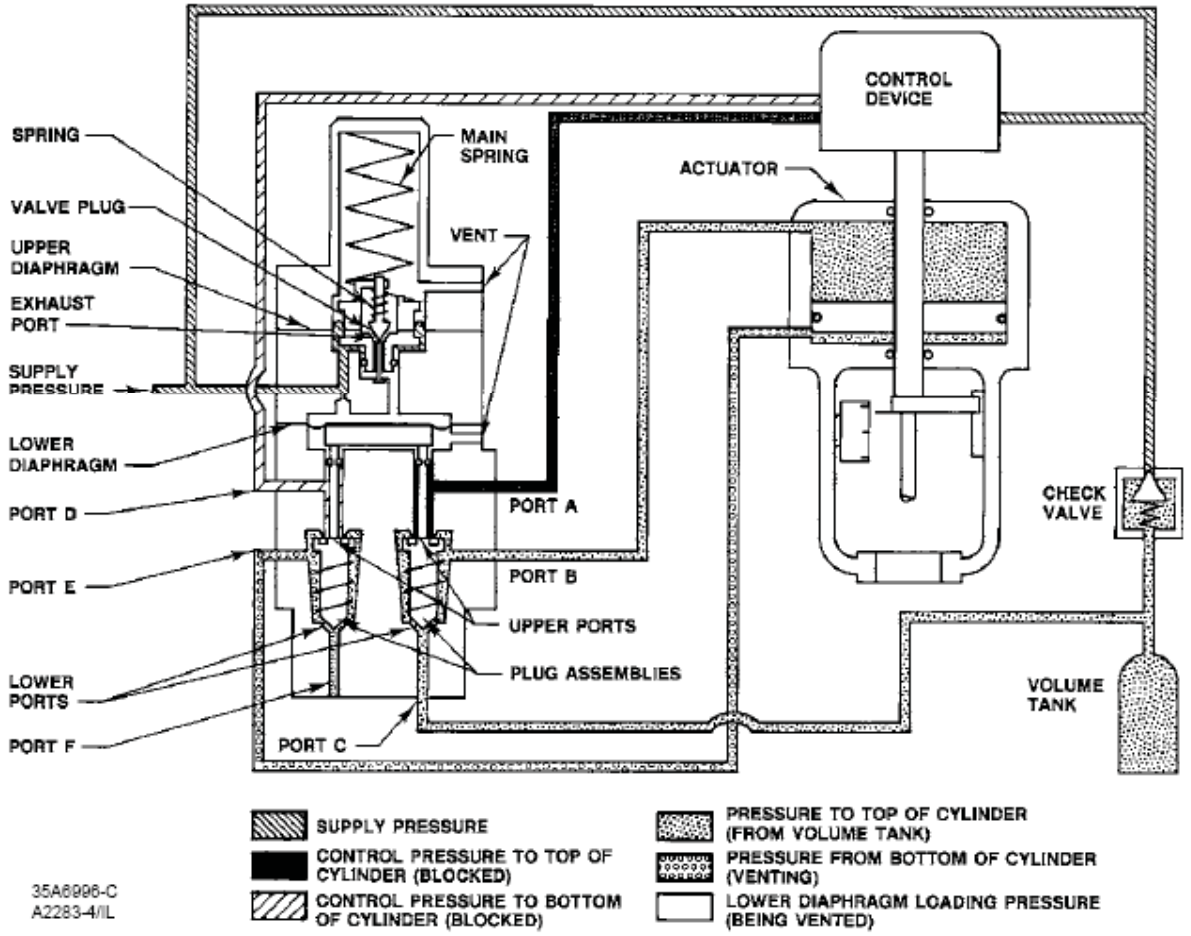
Fail-Safe Systems for Piston Actuators



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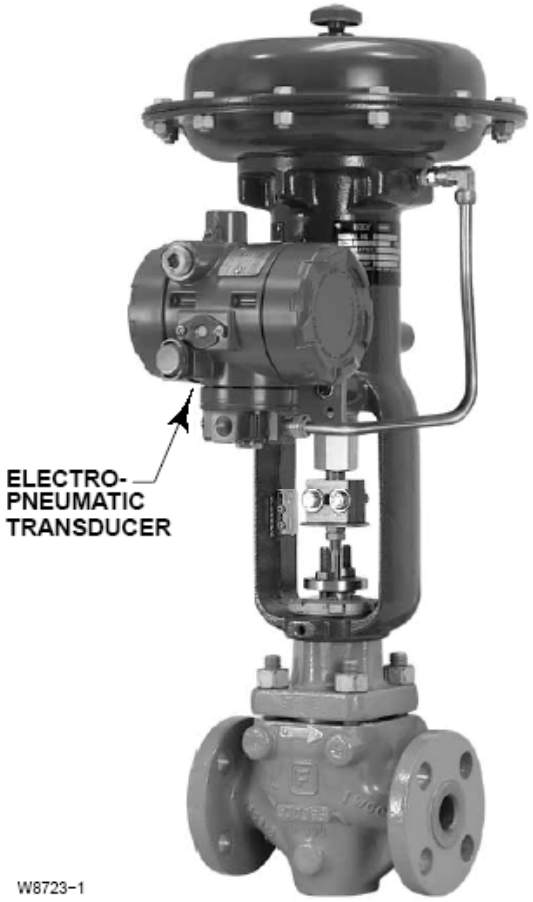
Electro-Pneumatic Transducers



Electro-Pneumatic Transducer Mounted on a Diaphragm-Actuated Control Valve

Other Accessories

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Electro-Pneumatic Valve Positioners

W4930/IL

Diagnostics

Digital valve controllers incorporate predefined instrument and valve diagnostics within firmware to provide alerts if there are problems with instrument mounting, electronics, hardware or valve performance.

Seat Leakage Classifications

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Standards and Approvals

Control Valve Seat Leakage Classifications

(In accordance with ANSI/FCI 70−2 and IEC 60534-4)

Leakage Class Designation	Maximum Leakage Allowable	Test Medium	Test Pressures	Testing Procedures Required for Establishing Rating
I	- - -	- - -	- - -	No test required provided user and supplier so agree.
II	0.5% of rated capacity	Air or water at 10−52°C (50−125°F)	3-4 bar (45−60 psig) or max. operating differential, whichever is lower.	Pressure applied to valve inlet, with outlet open to atmosphere or connected to a low head loss measuring device, full normal closing thrust provided by actuator.

Seat Leakage Classifications

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III	0.1% of rated capacity	As above	As above	As above.
IV	0.01% of rated capacity	As above	As above	As above.
V	0.0005ml per minute of water per inch of orifice diameter per psi differential ($5 \times 10^{-12} m^3$ per second of water per mm of orifice diameter per bar differential).	Water at 10–52°C (50–125°F)	Max. service pressure drop across valve plug, not to exceed ANSI body rating, or lesser pressure by agreement.	Pressure applied to valve inlet after filling entire body cavity and connected piping with water and stroking valve plug closed. Use net specified max. actuator thrust, but no more, even if available during test. Allow time for leakage flow to stabilize.

Seat Leakage Classifications

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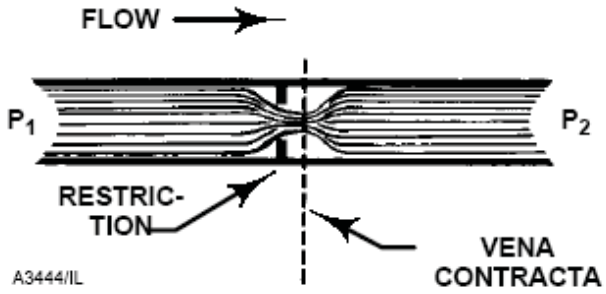
VI	Not to exceed amounts shown in following table based on port diameter.	Air or nitrogen at 10–52°C (50–125°F)	3.5 bar (50 psig) or max. rated differential pressure across valve plug, whichever is lower.	Pressure applied to valve inlet. Actuator should be adjusted to operating conditions specified with full normal closing thrust applied to valve plug seat. Allow time for leakage flow to stabilize and use suitable measuring device.

Cavitation and Flashing

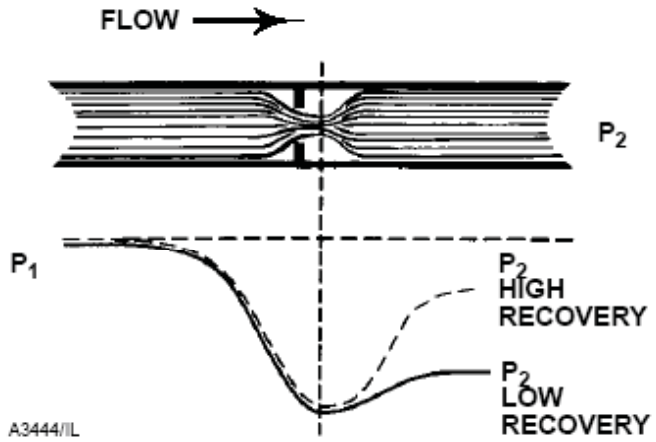
Choked Flow Causes Flashing and Cavitation

The IEC liquid sizing standard calculates an allowable sizing pressure drop, ΔPmax. If the actual pressure drop across the valve, as defined by the system conditions of P1 and P2, is greater than ΔPmax then either flashing or cavitation may occur.

The change is from the liquid state to the vapor state and results from the increase in fluid velocity at or just downstream of the greatest flow restriction, normally the valve port.



Vena Contracta Illustration



Comparison of Pressure
Profiles for High and Low Recovery Valves

Cavitation and Flashing

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Typical Appearance of
Flashing Damage

Typical Appearance of
Cavitation Damage

Noise Prediction

1. Aerodynamic

The method defines five basic steps to a noise prediction:

1. Calculate the total stream power in the process at the vena contracta.
2. Determine the fraction of total power that is acoustic power
3. Convert acoustic power to sound pressure.
4. Account for the transmission loss of the pipewall and restate the sound pressure at the outside surface of the pipe
5. Account for distance and calculate the sound pressure level at the observer's location

2. Hydrodynamic

Noise Control

Valve Trim Design for Reducing Aerodynamic Noise

Noise Prediction

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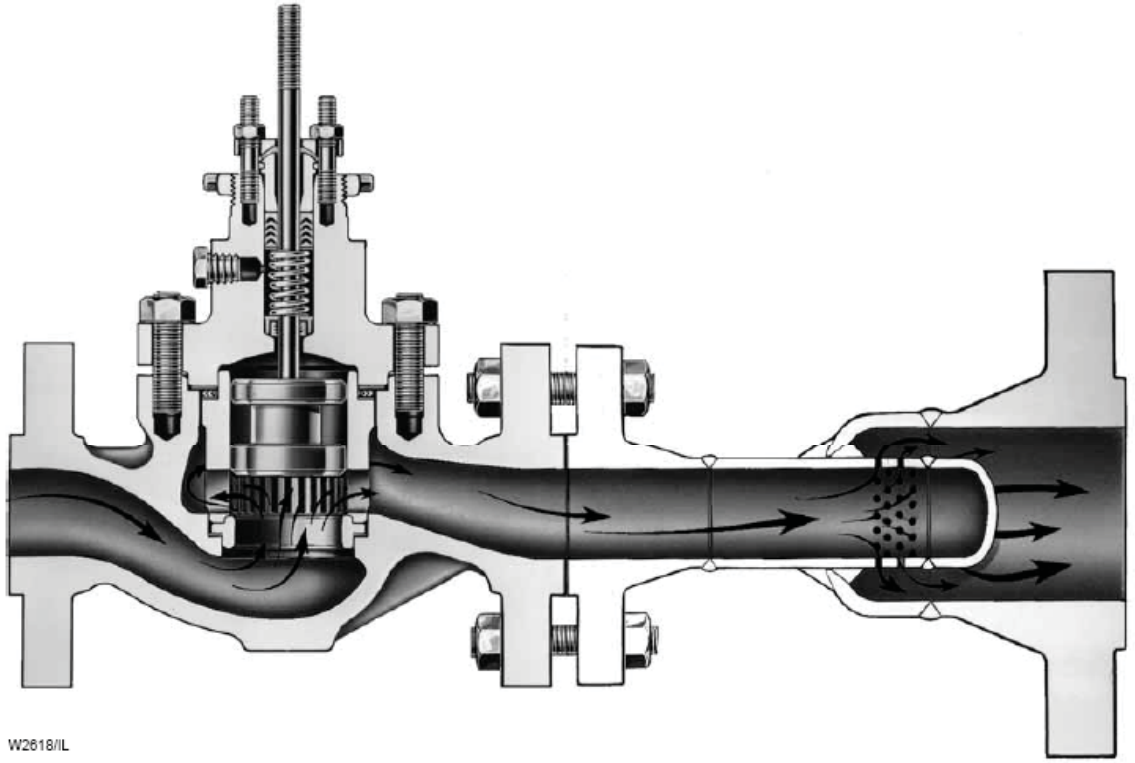
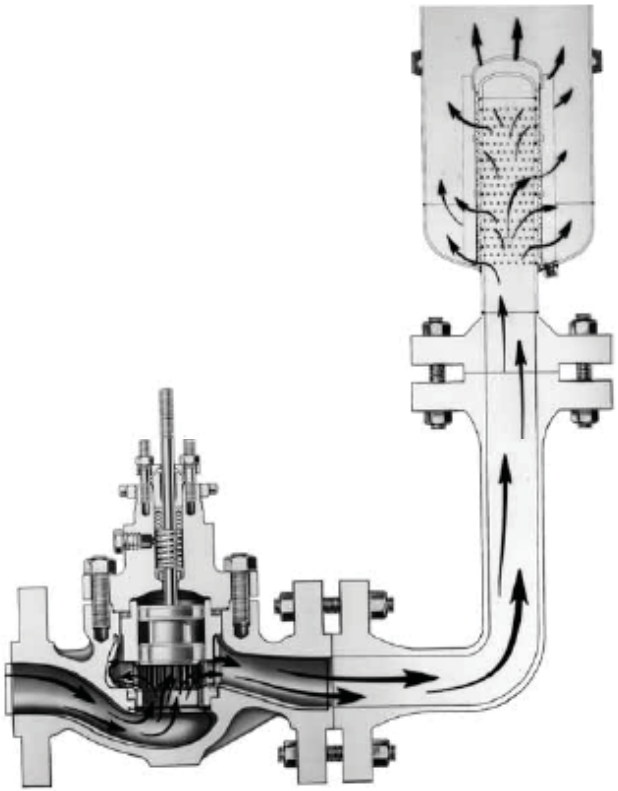
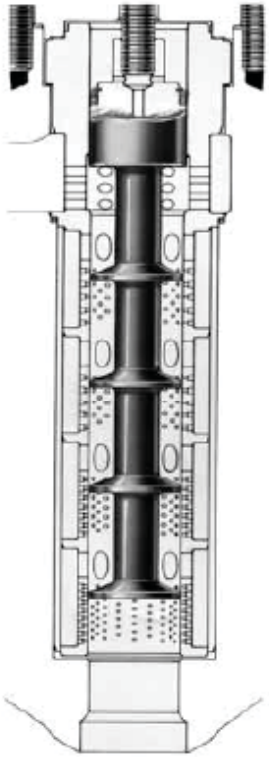


Valve and Inline Diffuser Combination



Valve and Vent
Diffuser Combination



Special Valve
Design to Eliminate Cavitation

Typical In-Line Silencer

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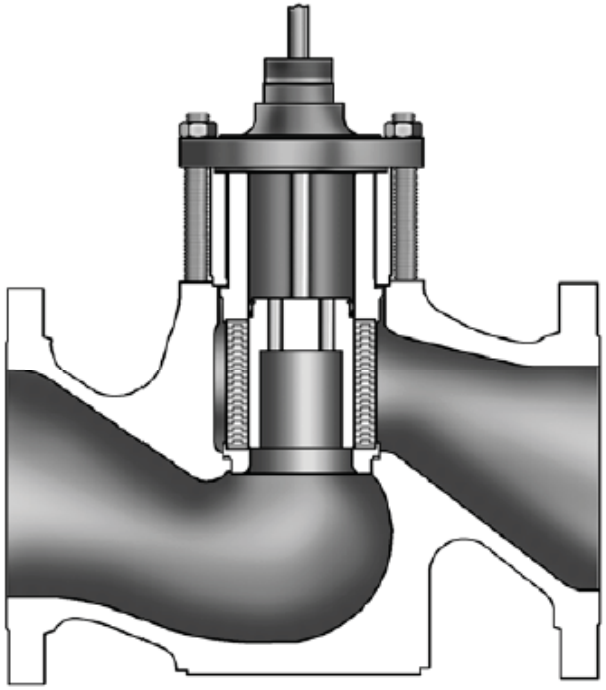
Noise Summary



Globe Style Valve
with Noise Abatement Cage for Aerodynamic Flow

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Noise Prediction

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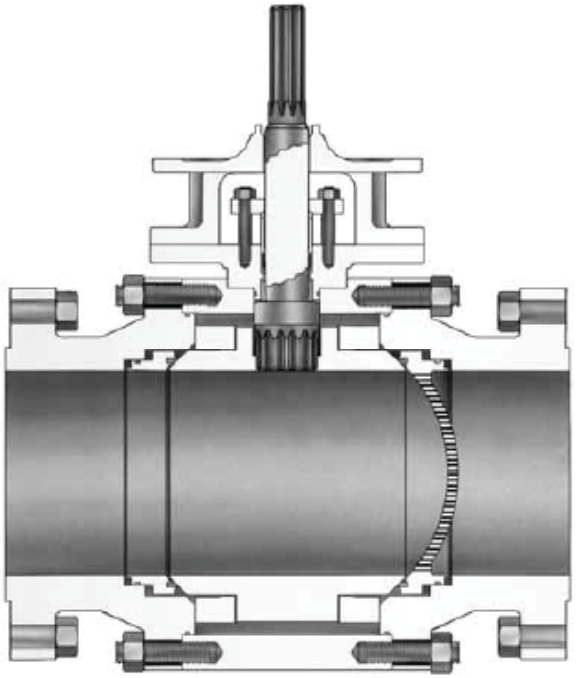

Ball Style Valve with Attenuator to Reduce Hydrodynamic Noise