CONTROL VALVES

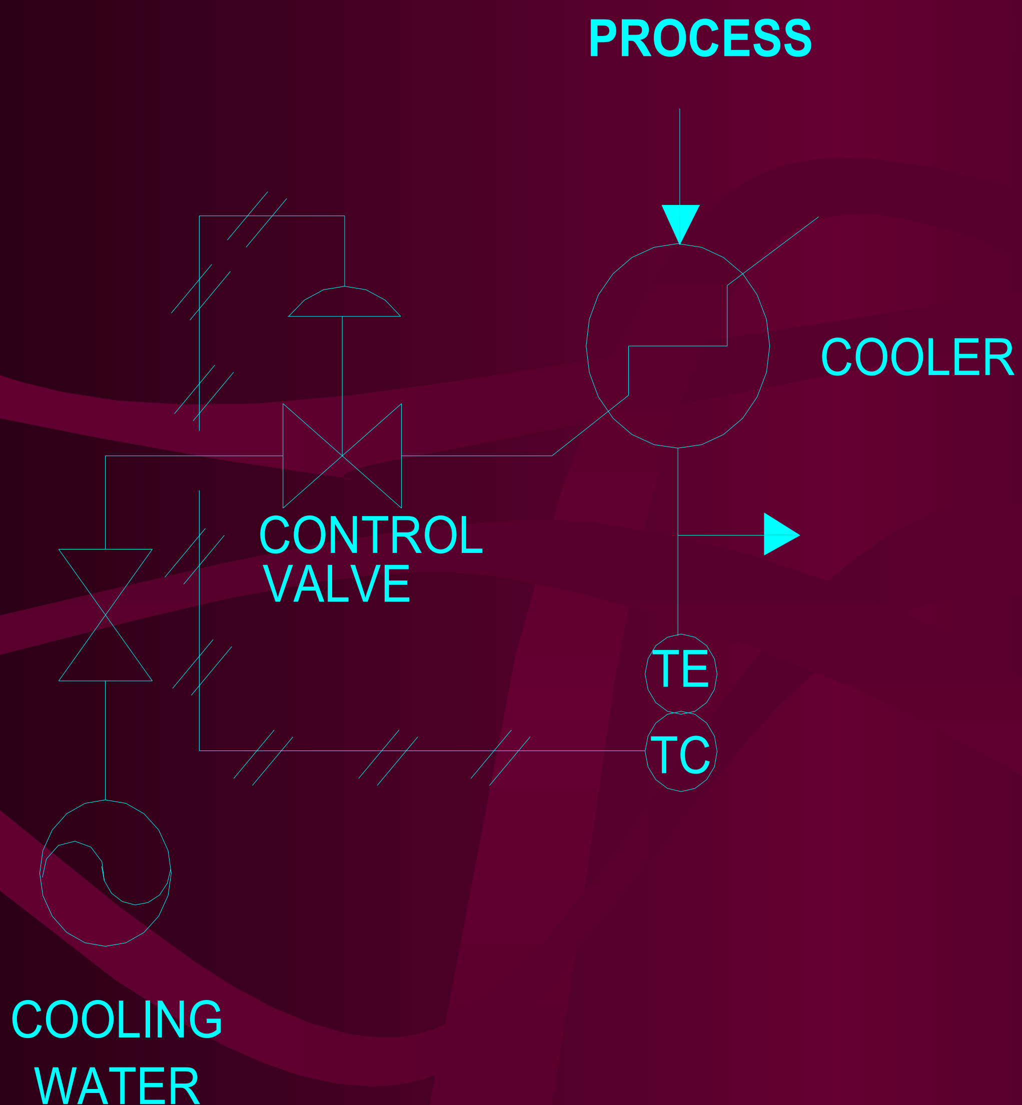
CONTROL VALVES

DEFENITION

THE CONTROL VALE IS THE EARLIEST KNOWN FINALCONTROL ELEMENT WHICH DOES EITHER OF THE FOLLOWING THREE FUNCTIONS:

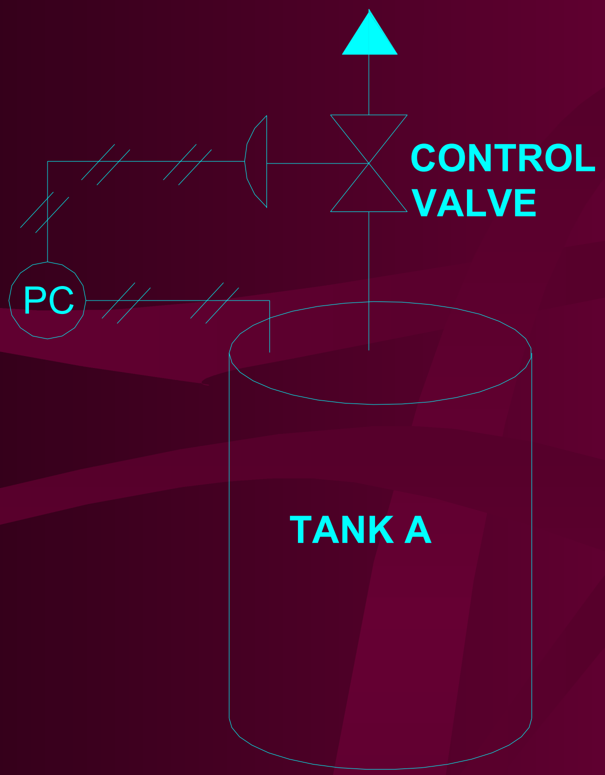
1. DISPENSING APPLICATION (REGULATE FLOW)
2. DISSIPATING APPLICATION (PRESSURE LET DOWN)
3. DISTRIBUTING APPLICATION (DIVIDE PROCESS FLOW)

DISPENSING APPLICATION



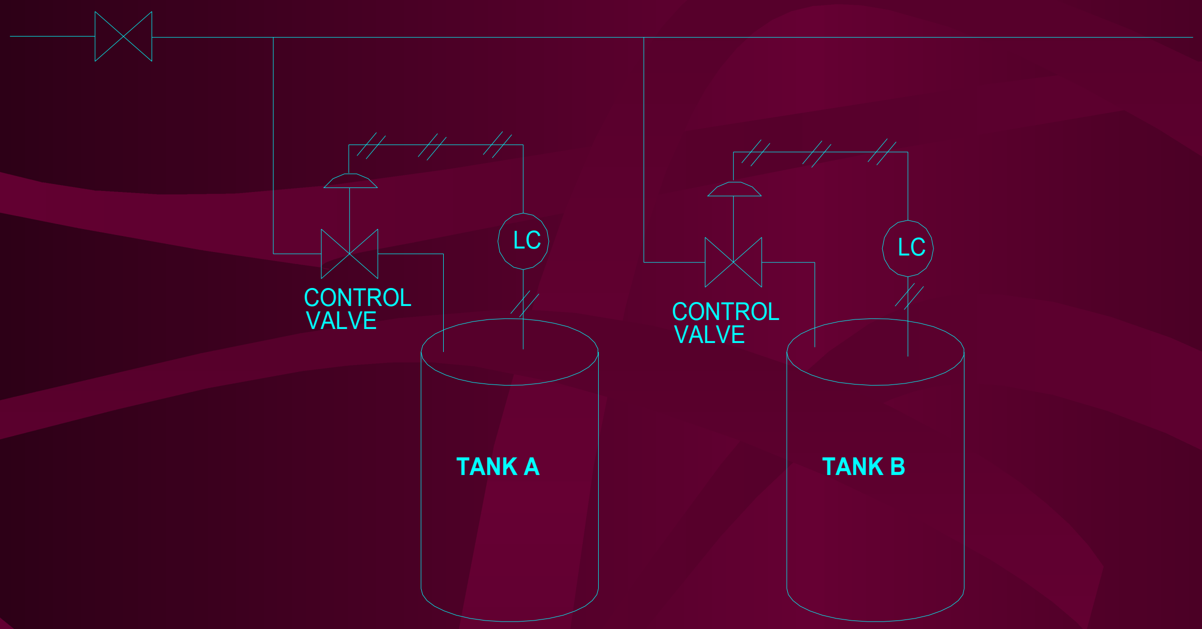
SIMILLAR TO SH/RH SPRAY APPLICATION WHERE THE FLOW IS DISPENSED AS PER PROCESS REQUIREMENT TO MAINTAIN A SET TEMPERATURE AT DESUPERHEATER

Dissipating application



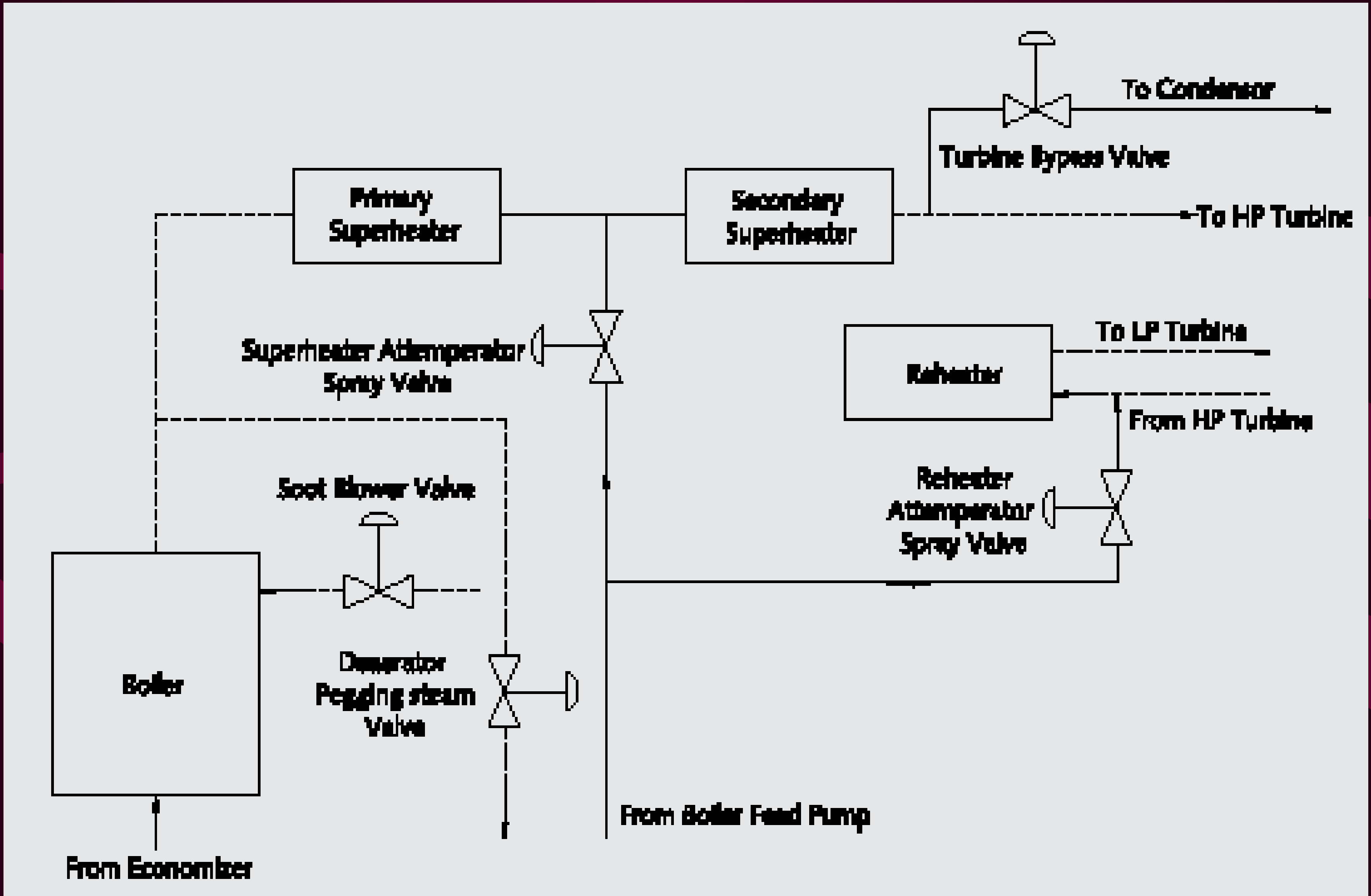
SIMILLAR TO SBPRV WHERE PRESSURE UPSTREAM IS REDUCED TO 30kg/Sq.cm FOR SOOT BLOWER APPLICATION

Distributing application

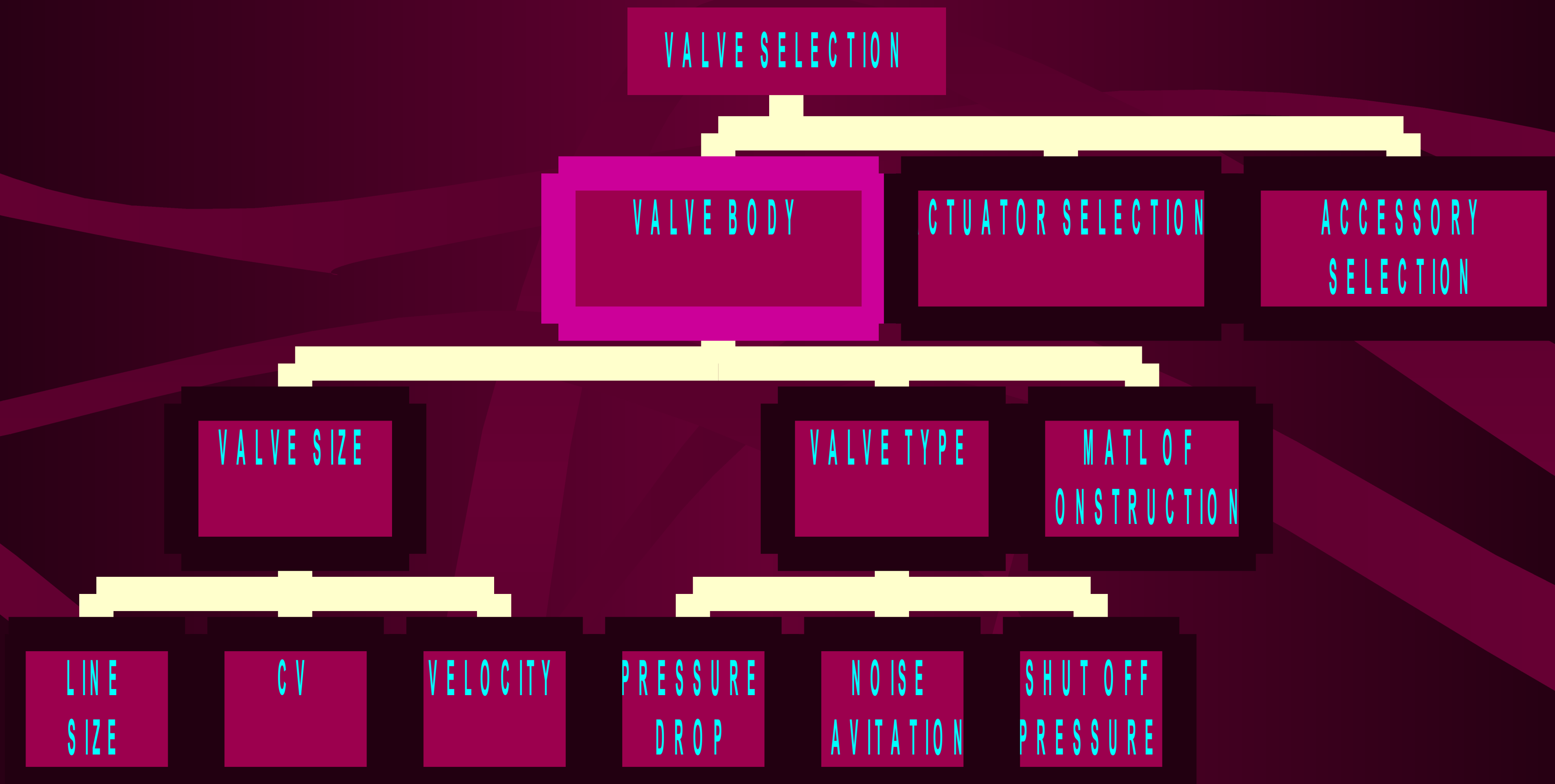


SIMILLAR TO DEAERATOR LEVEL CONTROL VALVES

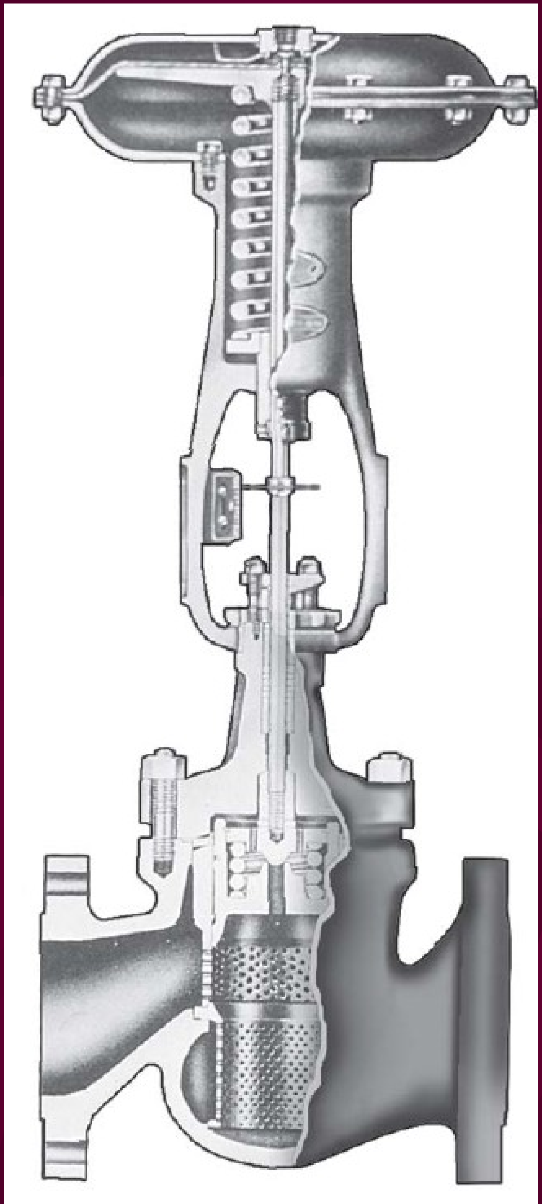
Control Valves in Boiler Mountings



BASIC TERMS IN VALVE SIZING



A TYPICAL CONTROL VALVE



CONTROL VALVE FLOW COEFF.(Cv)

DEFENITION

Cv IS THE NUMBER OF US GALLONS PER MIN OF WATER WHICH WILL PASS THROUGH A GIVEN FLOW RESTRICTION WITH A PRESSURE DROP OF 1 Psi

Eg: A CONTROL VALVE WHICH HAS A Cv OF 12 HAS AN EFFECTIVE PORT AREA IN THE FULL OPEN POSITION SUCH THAT IT PASSES 12gpm OF WATER WITH 1pSI PRESSURE DROP

Equation For Cv

Incompressible Fluid

$$Cv = \frac{1.16Q\sqrt{Gf}}{\sqrt{Dp}}$$

Q increases,

Cv increases

Dp increases,

Cv reduces

Cavitation

Cavitation is a two stage process consisting of formation of vapour bubbles when the pressure of the liquid falls below vapour pressure and the collapsing of the bubbles (Cavities) when the pressure recovers above the vapour pressure.

In valves it may occur in the vena- contracta portion if outlet pressure is close to Vapour Pressure of the fluid.

Two Options to Get rid of Cavitation

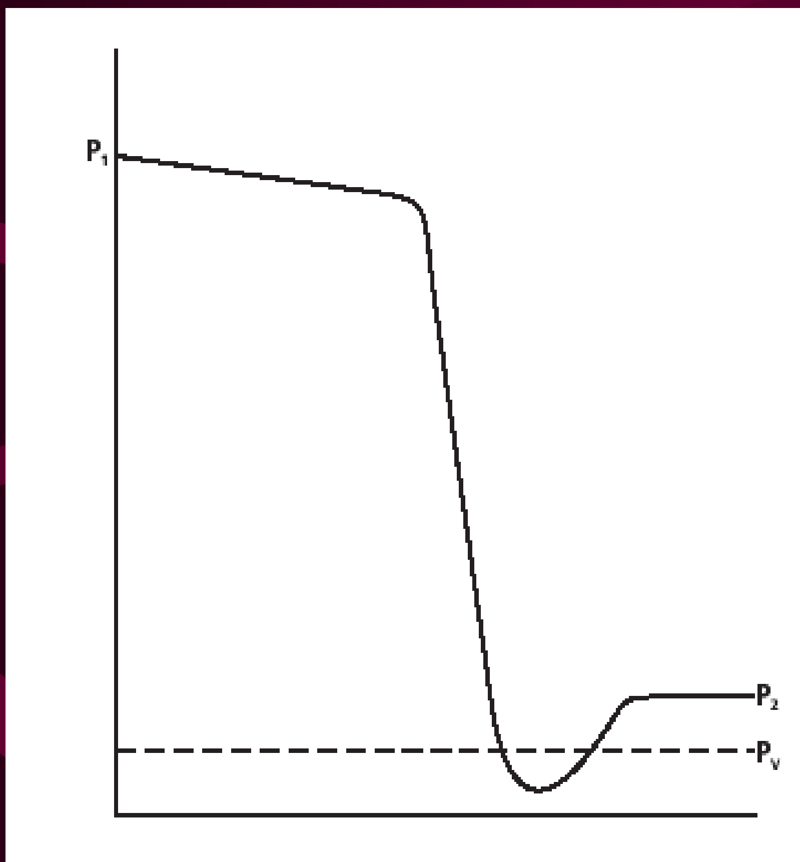
1. Prevention of Cavitation
2. Cavitation Control

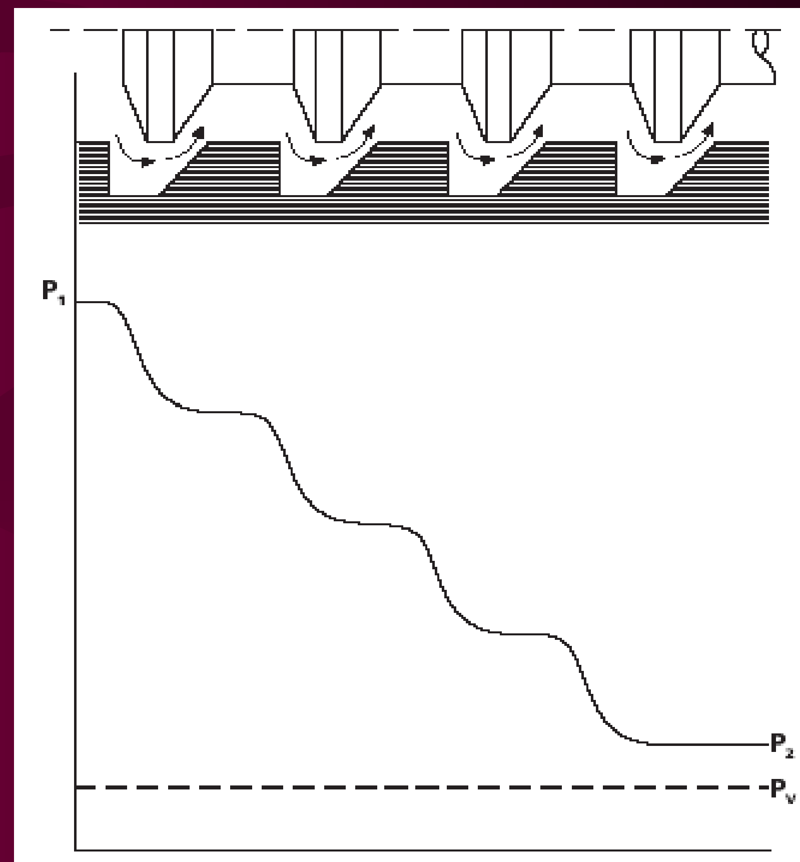
Cavitation Contd….

Prevention done by providing tortuous flow path, Pressure dropping stages and Expanding flow area

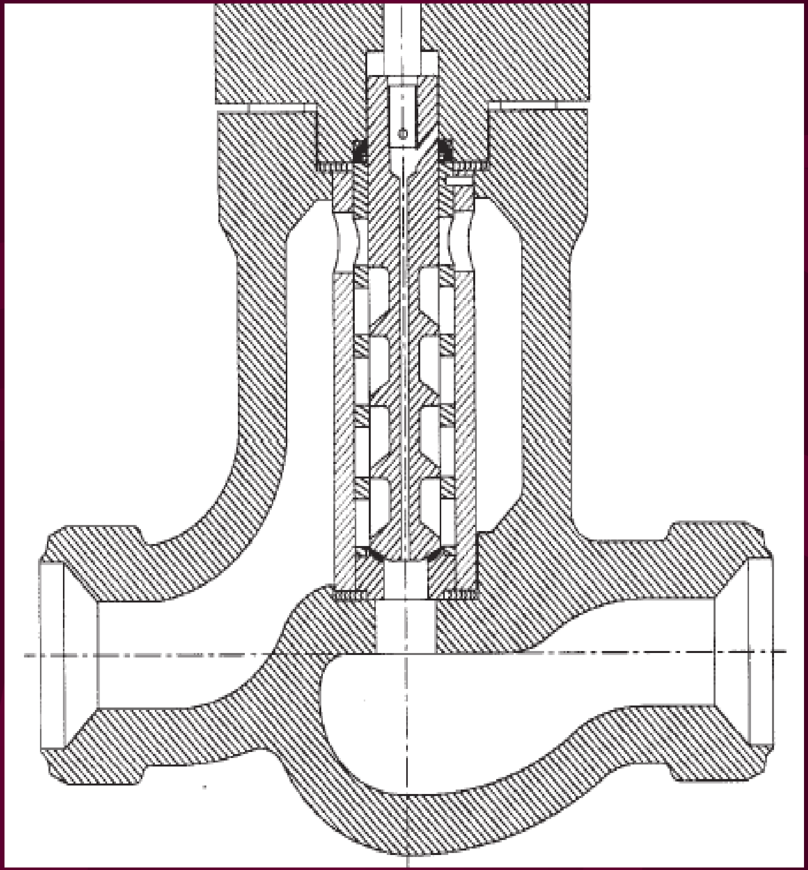
Controlling of Cavitation done by providing harder trim materials and special multi hole anti Cavitation trims (Here Cavitation occurs and the construction is such that the bubbles collapse at the centre of the cage thereby safe guarding the trim and body)

Cavitation prevention

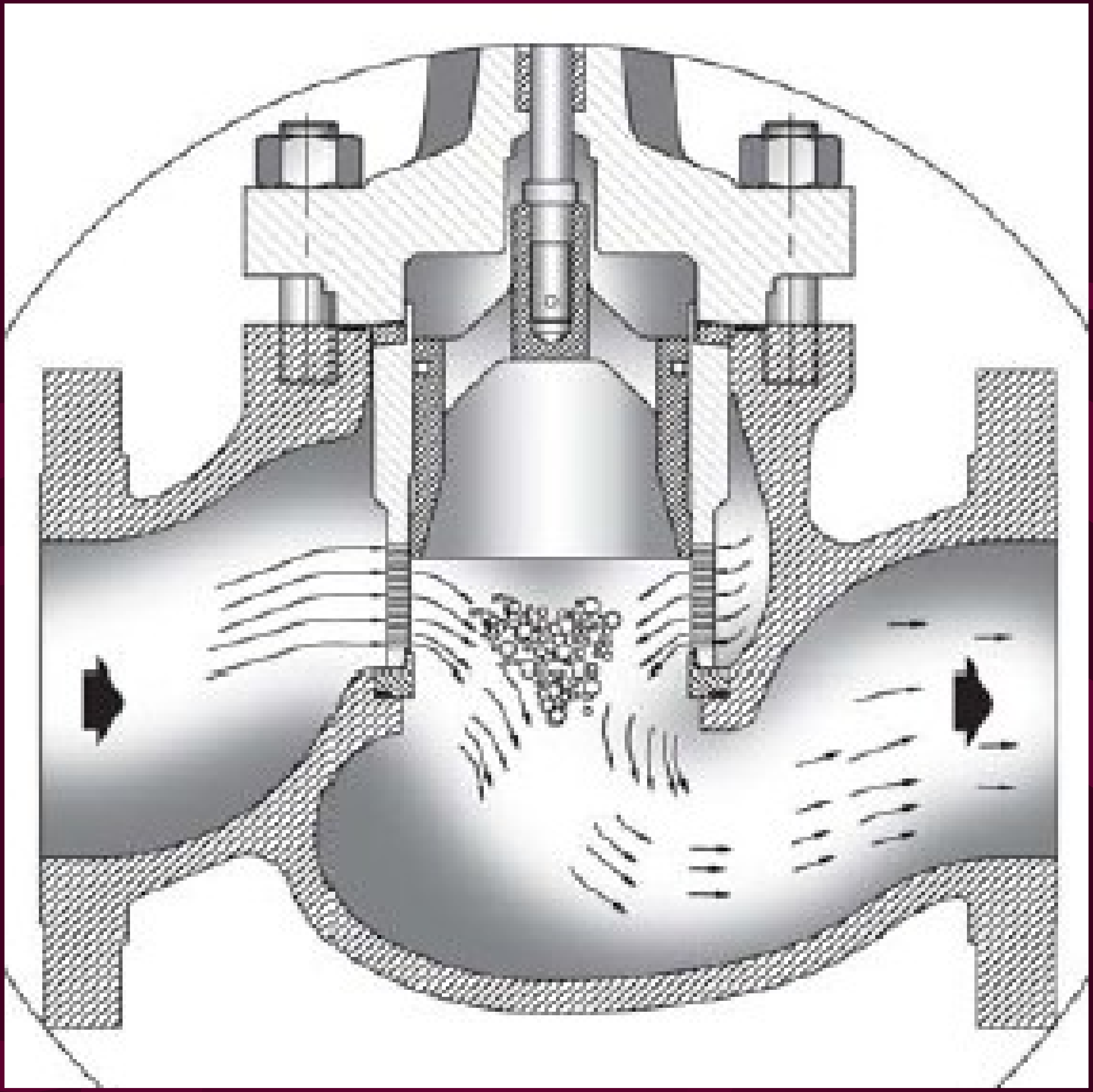




Multiple flow Trim



Cavitation Control



Pressure Recovery/ Critical flow factor (Cf)

Flow through a control valve can be considered as a flow through an orifice. Hence the vena-contracta (Min. Pressure & Max velocity in downstream flow) effect will be there in control valves.Gradually the pressure recovers with fluid deceleration further down stream.

CRITICAL FLOW FACTOR IS EFFECTIVELY AN INDEX OF PRESSURE RECOVERY IN A CONTROL VALVE

Cf Contd…

$$Cf = \sqrt{\frac{(P1 - P2)}{(P1 - Pvc)}}$$

P1 & P2 – Inlet & Outlet Pr.

Pvc – Vena Contracta Pressure

<u>Typical Cf values</u>

Globe Valves – 0.8

Single seated control Valves – 0.9

Multi stage Valves – 0.98

“ Cf ” a Comparison

P1	70	70	70	70	70	70
P2	30	30	30	30	30	30
Cf	0.8	0.85	0.9	0.95	0.99	1
PVc	7.5	14.64	20.62	25.68	29.19	30

Higher the Cf, Lower the pressure recovery OR
Higher the Cf

Better the resistance to Cavitation.

Cf varied by Body contour variations

Flashing

Flashing is a process in which the pressure of the liquid falls below the vapour pressure thus leading to the formation of vapour bubbles. The subsequent flow will be two phase consisting partly of liquid and partly of vapour.

Flashing leads to high flow velocities which can damage both trims and the body.

It is difficult to avoid flashing due to process requirements hence flashing damage is taken care by suitable angle body design (outlet of flow connected to Tank)

Fluid Velocity

Fluid velocity is a very important factor to be considered while selecting a control valve because erosion damage, ie., the higher the velocity, the more extensive the damage. It also relates to noise level, vibration and other un desirable phenomenon.

Acceptable velocity limits

Liquid Service < 8m/s (BHEL)

SH Steam Service < 0.33Mach

Flow Direction

The direction of flow through a control valve should be considered as it will influence the degree of pressure recovery, Flow characteristics, Leakage rate,amount of noise produced by the valve and even the amount of damage by erosive fluids

1. Flow to open the valve (Most common and advisable) Here flow is under the plug, ie., the highest fluid pressure tends to open the valve.
2. Flow to close the valve (Used for Anti-Cavitation valves)

Sizing

Delta P (ΔP) Sizing

ΔP sizing is the pressure drop across the valve which corresponds to the system's normal operating flow rate.Other conditions like max flow rate through the valve shall also be reviewed for selection process.

Delta P (ΔP) Shutoff

Unless otherwise specified ΔP shutoff is equal to maximum inlet pressure with the valve in closed position

Valve Noise

1.Mechanical Vibration

Due to response of internal components within a valve to turbulent flow through the valve.

Turbulent flow inside the valve may induce vibration against neighboring surfaces.

2.Aerodynamic Noise

Aerodynamic noise is a direct result of the conversion of the mechanical energy of the flow into acoustic energy as the fluid passes through the flow restriction.

Valve Noise Contd…….

3.Hydrodynamic Noise

Liquid flow noise, Cavitation noise and flashing noise can be generated by the flow of a liquid through a valve and piping system.These constitutes the hydrodynamic noise.

Noise due to Cavitation is the most serious one because it can be a sign that damage is occurring at some point in the valve or piping.

Valve Ratings

Pressure and ratings for the pressure containment parts have been established for the more common materials by American National Standards Institute

Since most materials have a reduction in allowable working stress at elevated temperatures, the pressure temperature rating must be considered in the choice of materials

Seat Leakage

Any untoward passing through the seat when the valve is in full close position is called the seat leakage.

Control valve users specify leakage based on an international standard ANSI/FCI 70.2.

The leakage class specified is as follows:

Class I – Understanding between supplier & purchaser

Class II – 0.5% of rated valve flow coefficient

Class III – 0.1% of rated valve flow coefficient

Class IV – 0.01% of rated valve flow coefficient

Class V – 5 x 10^{-4} ml/min of water/psi of shut off pressure / inch of orifice diameter.

Flow Characteristics

Control valve flow characteristics are determined principally by the design of the valve trim.

Three fundamental characteristics are available:

1. Quick Opening
2. Linear
3. Equal Percentage

A modified characteristics Modified Equal Percentage generally falling between linear and equal percentage is also available

Flow Characteristics Contd……..

Quick Opening: This type of characteristics provides a large opening as the plug is first lifted from the seat, with lesser flow increase as the valve opens further. The most common application occurs when the valve is required to be in either an open or closed position with no throttling of flow required.

Linear: Linear trim provides equal increases in flow rate for equal increases in plug lift. Thus the flow rate is linear with plug position throughout its travel. This type of trim is specified if the control valve is to absorb most of the system pressure drop.

Flow Characteristics Contd……..

Equal Percentage: Equal percentage trim provides equal percentage increase in rate of flow for equal increments of plug lift. In this case small flow passes corresponds to large changes in lift as the plug first leaves the seat and vice-versa towards the full open position. This type of trim is specified if the control valve is to absorb a small portion of the total system pressure drop.

Eg: SBPRV – Linear Chara

SH/RH spray Block Valves – ON/OFF

SH Control valve – Equal Percentage

RH Control Valve – Mod Eq. Percentage

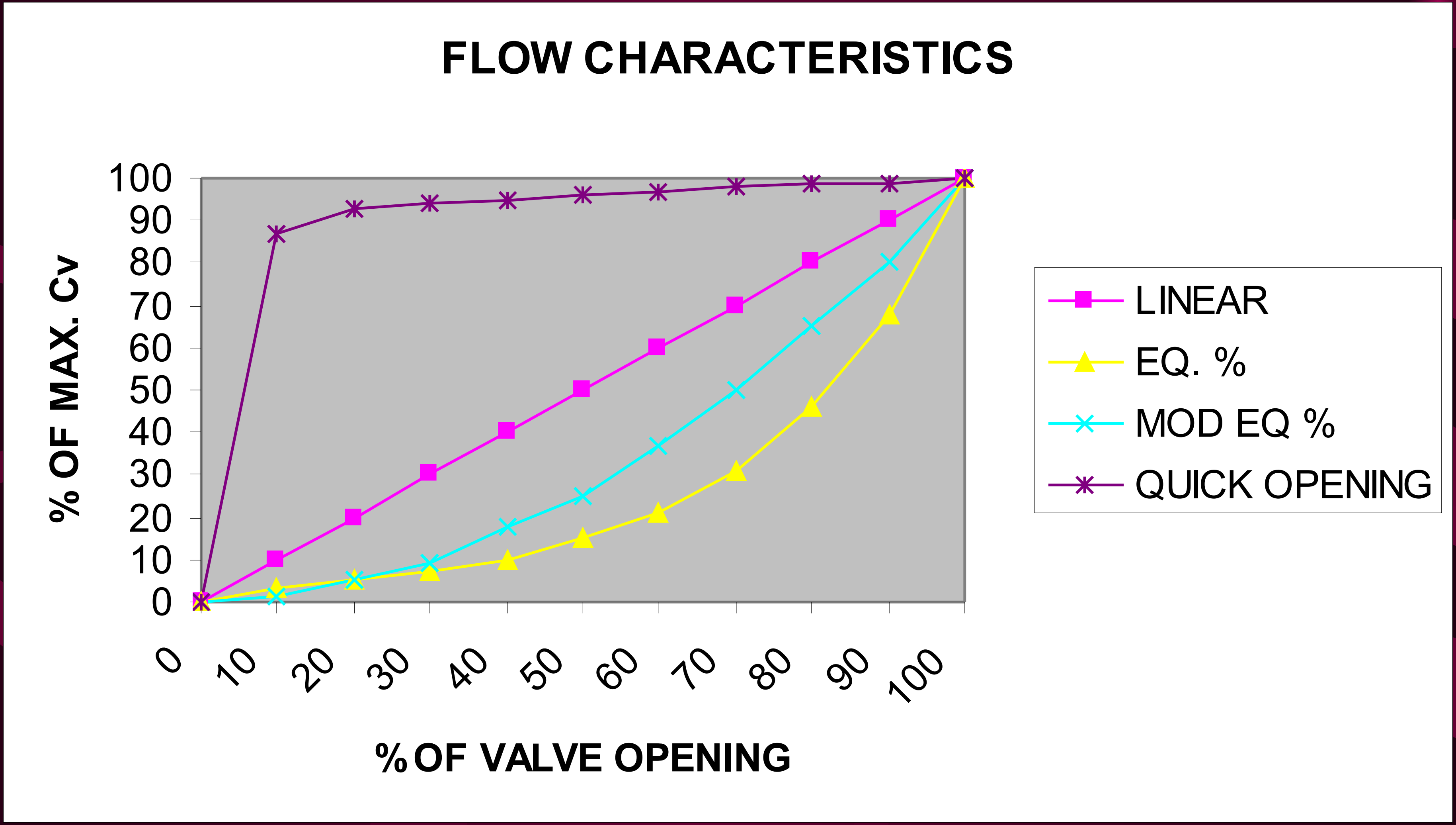
TRIM FORMS

EQUAL %

LINEAR

LINEAR WITH LO-DB TRIM

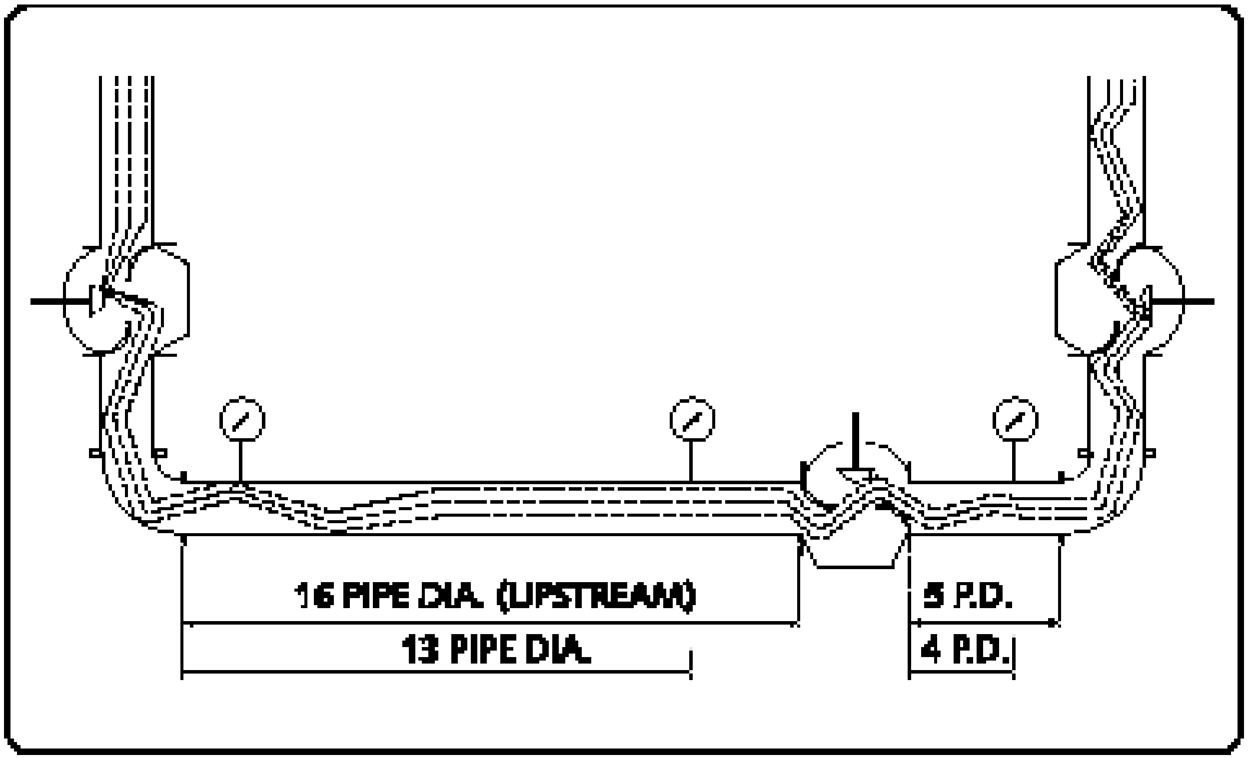
TYPICAL VALVE CHARACTERISTICS



Typical Trim Materials

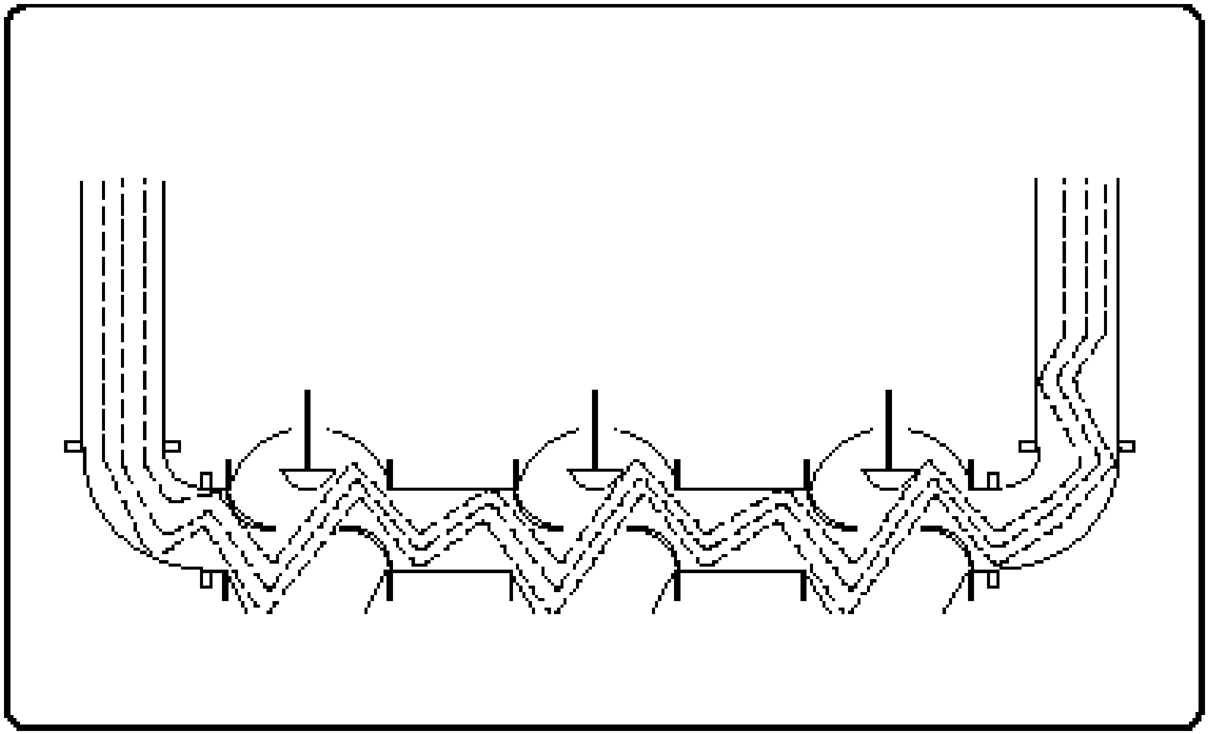
PART NAME	MAX. TEMP	STANDARD MATERIAL
Valve Plug Stem	<343°C	17.4 PH (ASTM A 564 Gr 630, H 1075)
	>343°C	SUPER ALLOY (ASTM A 638 Gr 660)
Valve Plug	<343°C	17.4 PH (H 1075)
	>343°C	ASTM A 743 Gr CA6NM, Nitrided
Cage		ASTM A 743 Gr CA6NM, Chrome plated or Nitrided
Seat Ring		SS 316+ Stellite No. 6
Gland Packing	<180°C	PTFE
	>180°C	GRAPHITE

Location of Control Valves



TYPICAL SATISFACTORY ARRANGEMENT OF UPSTREAM AND DOWNSTREAM PIPING

Contd…….



LESS SATISFACTORY ARRANGEMENT OF UPSTREAM AND DOWNSTREAM PIPING

Control Valve Selection

1. Decide Flow Direction and characteristics
2. Calculate Cv
3. Select Higher Cv from available
4. Select Valve size, trim size for available range
5. End Conn. and rating selection
6. Leakage class selection
7. Material Selection
8. Actuator selection
9. Packing and bonnet type selection
10. Accessories selection

ACTUATORS

1.PNEUMATIC TYPE
(11",13",15",18",24")

2.ELECTRICAL TYPE

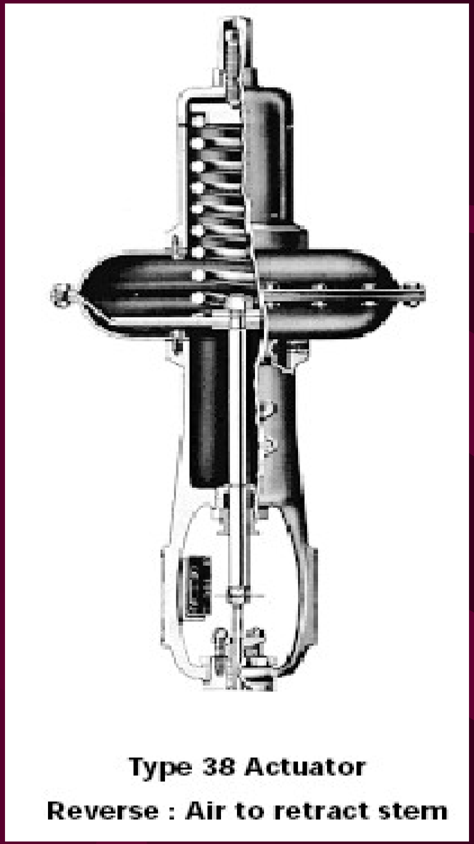
ACTUATORS ARE PRIME MOVERS FOR THE VALVE WHICH OPENS AND CLOSES THE VALVES.

ACTUATOR SELECTION IS BASED ON THE EFFECTIVE UNBALANCED FORCE ACTING ON THE DIAPHRAGM/PISTON

ELECTRICAL MOTORS ARE ALSO USED AS ACTUATORS WHICH UTILISES A MOTOR WITH HIGH STARTING TORQUE .

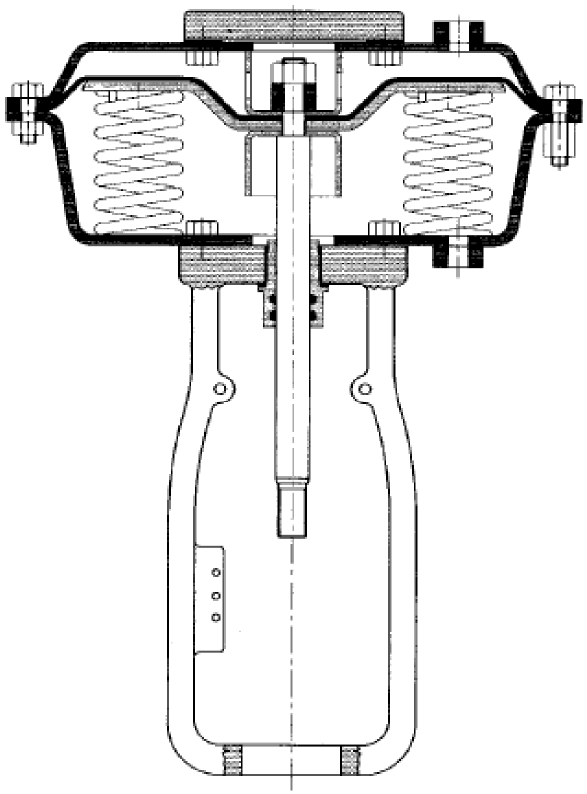
PNEUMATIC ACTUATORS

AIR TO CLOSE

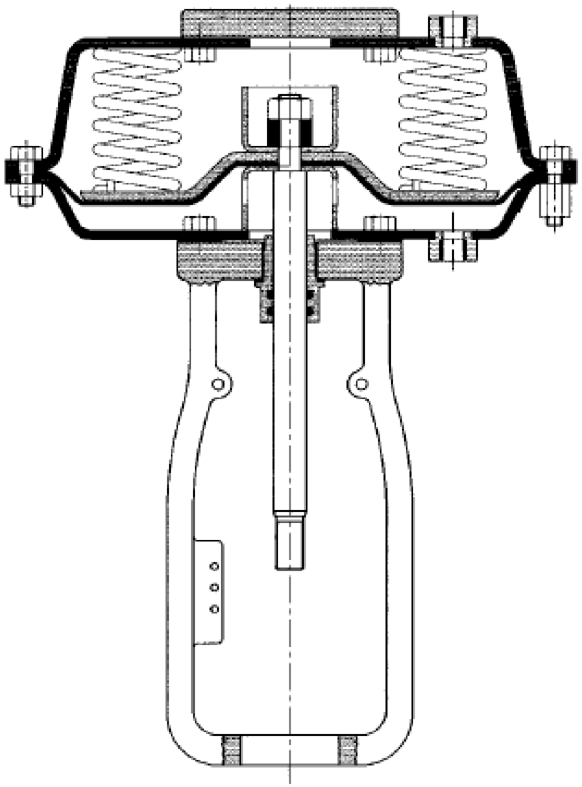


AIR TO OPEN

MULTI SPRING ACTUATORS



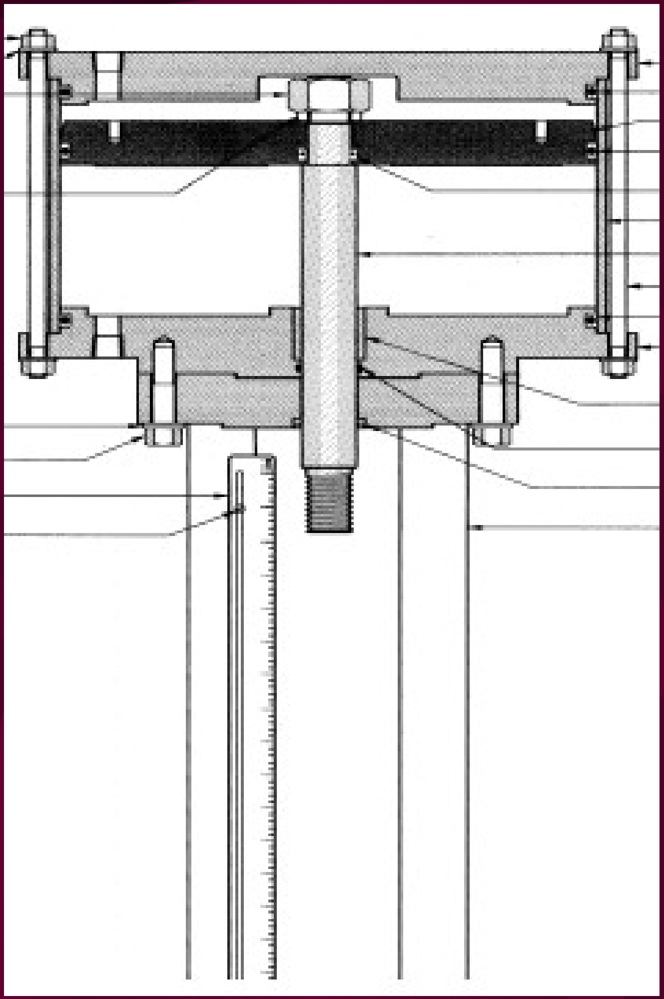
TYPE 57
MULTI-SPRING ACTUATOR (DIRECT)



TYPE 58
MULTI-SPRING ACTUATOR (REVERSE)

DIFFERENT SPRING RANGES ACHIEVED BY VARYING THE QUANTITY AND COMPRESSION

PISTON CYLINDER TYPE



HIGH THRUST OBTAINED WITH COMPACT DESIGN

Accessories

1. Valve Positioner (Pneum.,Electro Pneum., SMART)
2. Position Transmitter
3. Position Controller
4. Solenoid Valve
5. Volume Booster
6. Air Set
7. Lock up valve
8. Limit Switch
9. Travel Stop
10. Hand wheels

Typical arrangement of control valve

VENDOR TO INDICATE TUBING & FITTING SIZES FOR 1,2,3 & 4

NOMENCLATURE :-

LS – LIMIT SWITCH

PS – POSITIONER (REFER DATA SHEET FOR FEATURES)

AS – AIR SET

AL – AIR LOCK

MVV – MANUAL VENT VALVE

TB – TERMINAL BOX (36 WAY)

PT – POSITION TRANSMITTER

ACT – ACTUATOR

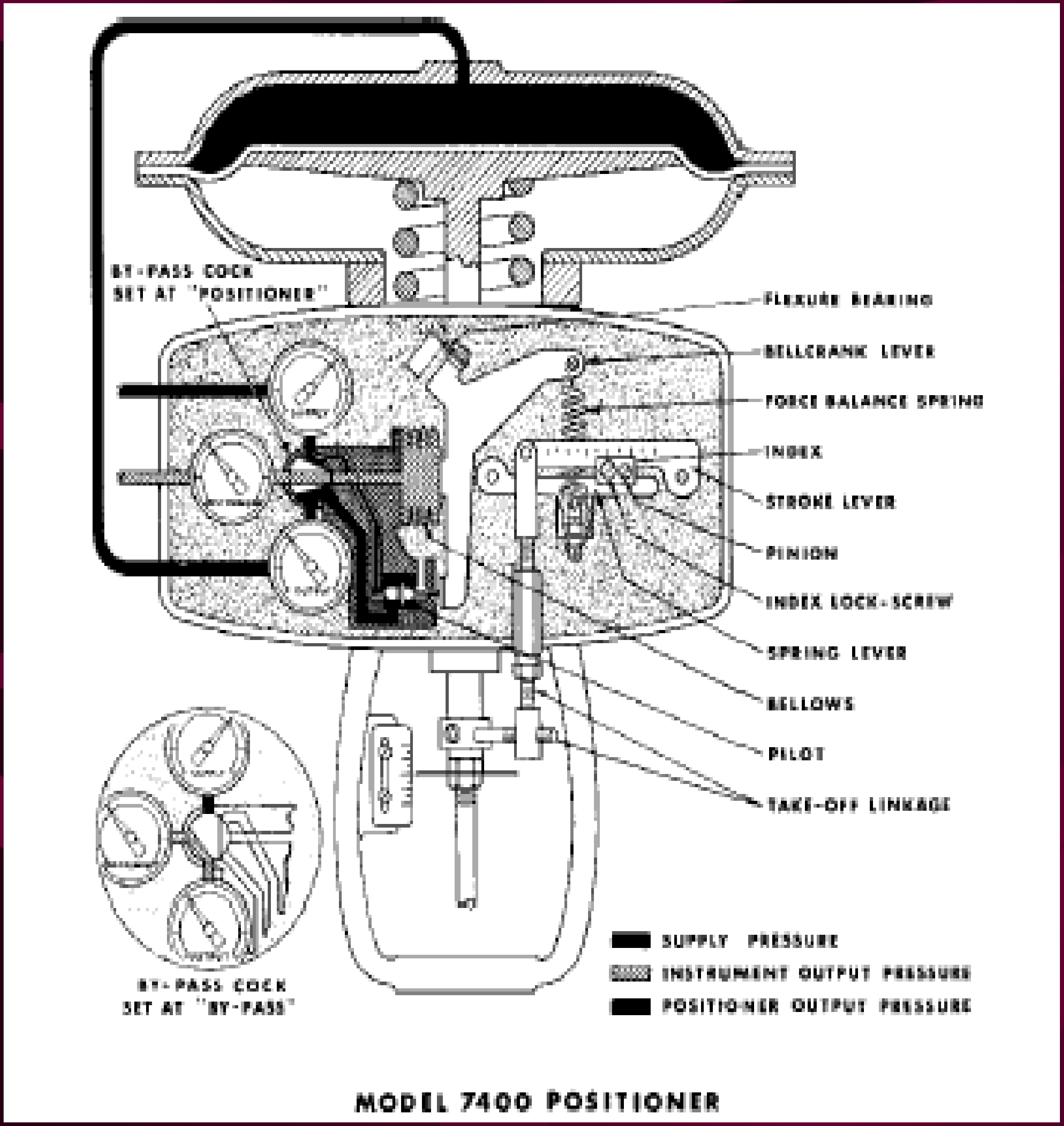
DV – DUMP VALVE

VB – VOLUME BOOSTER

(DV & VB may be provided if required)

SV – SOLENOID VALVE (3 WAY,SINGLE COIL,UNIVERSAL
DENERGISED CONDITION – A&C OPEN, ENERGISED CONDITION – A&B OPEN)

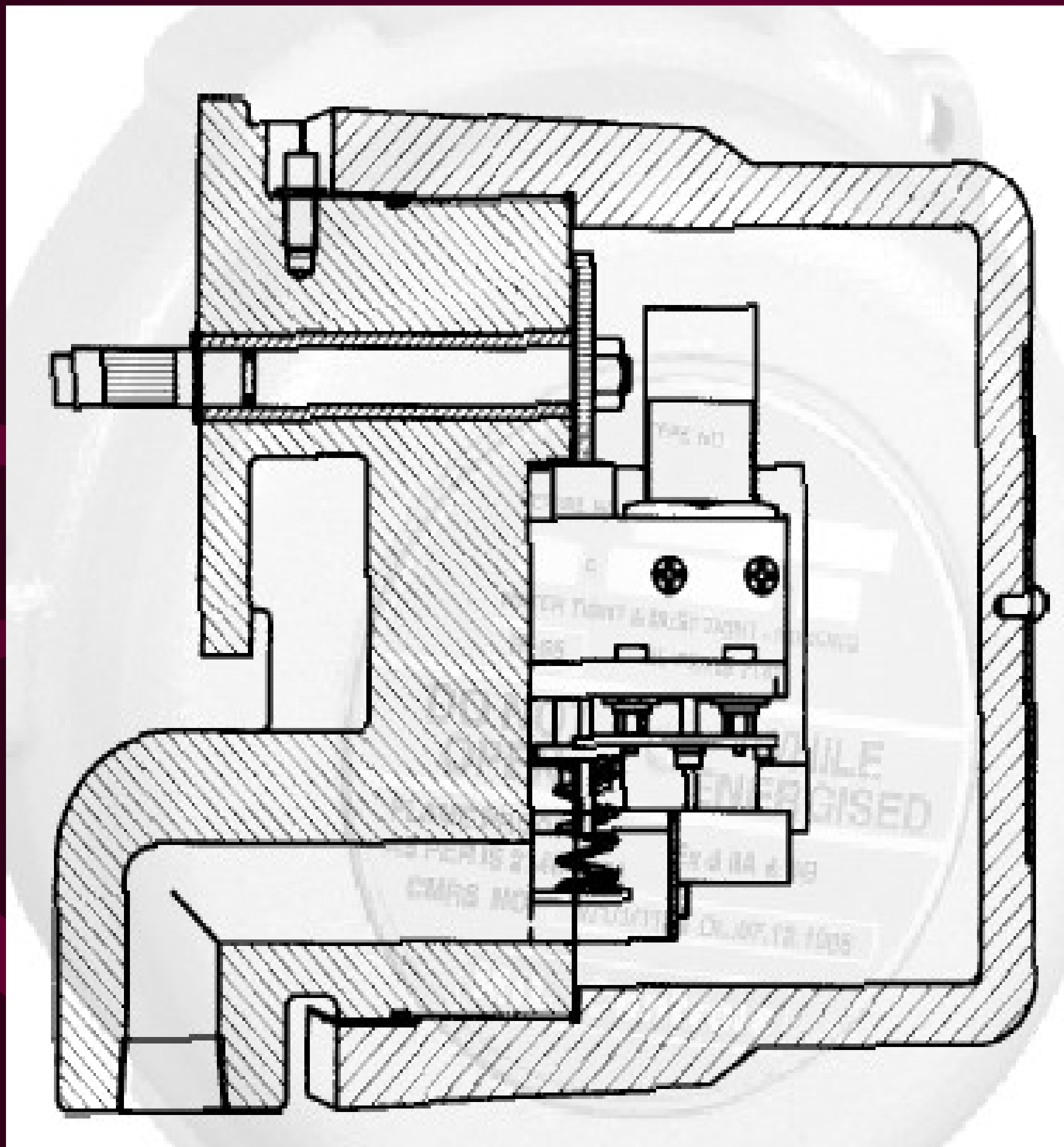
Pneumatic Positioner



3-15 psi to diaphragm

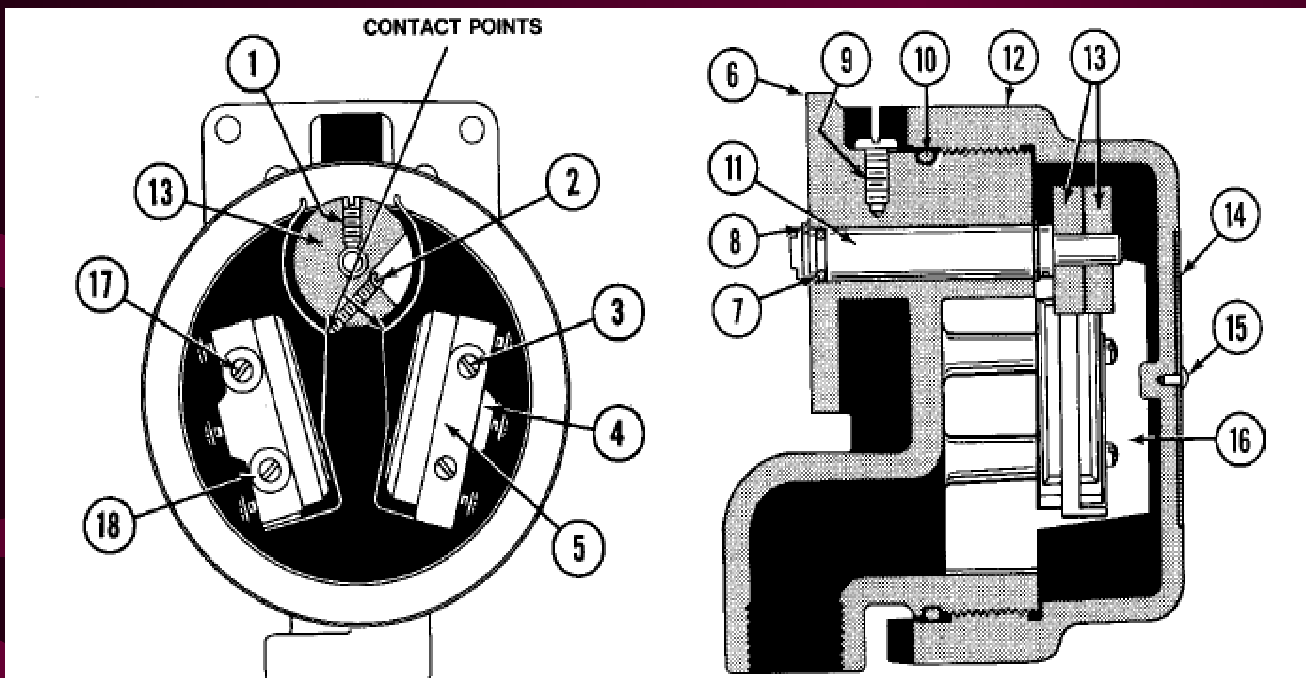
Electro Pneumatic Positioner

Position transmitter

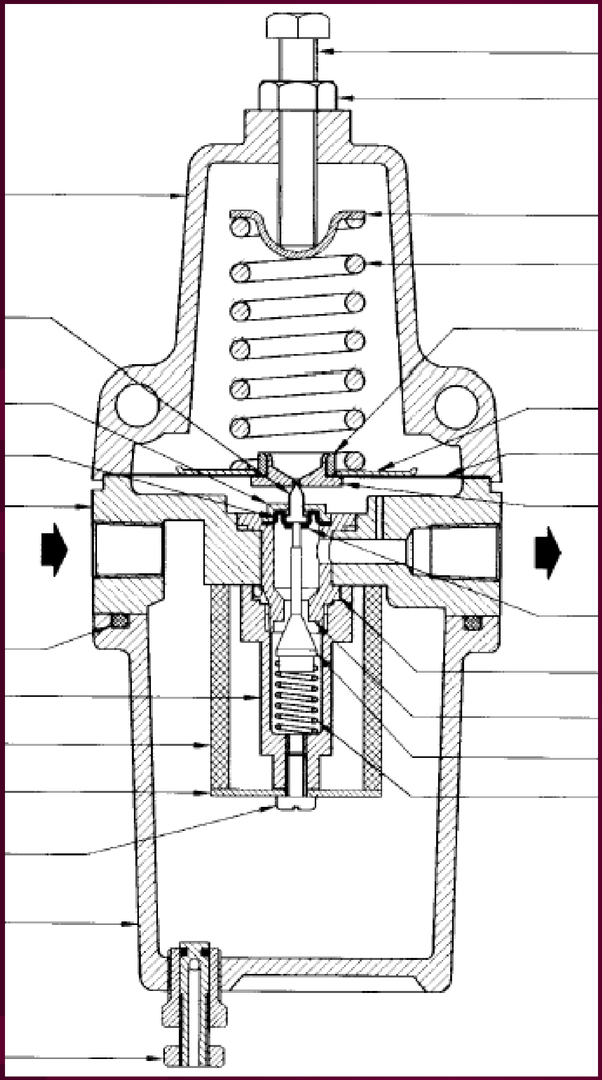


4-20 mA signal output, based on the actuator stem position

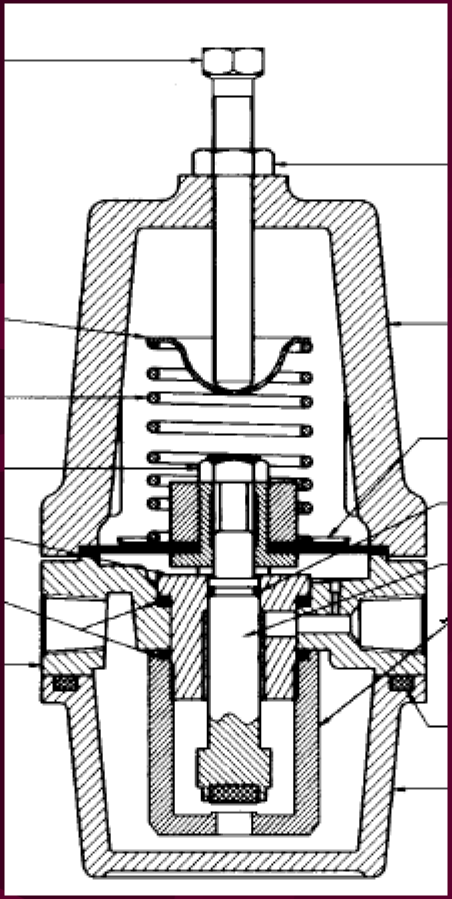
Rotary Switch



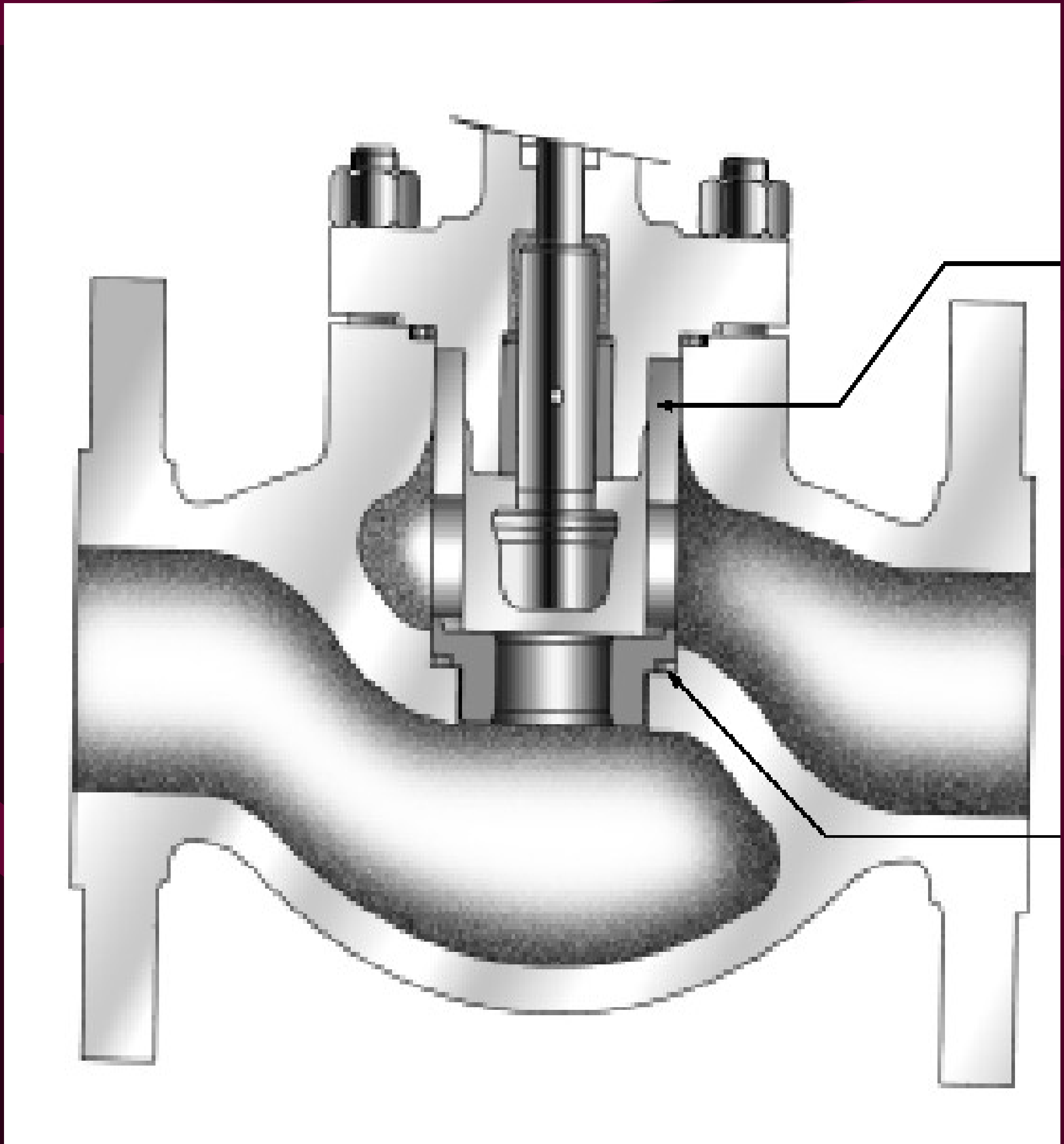
Air Filter Regulator



Air Lock



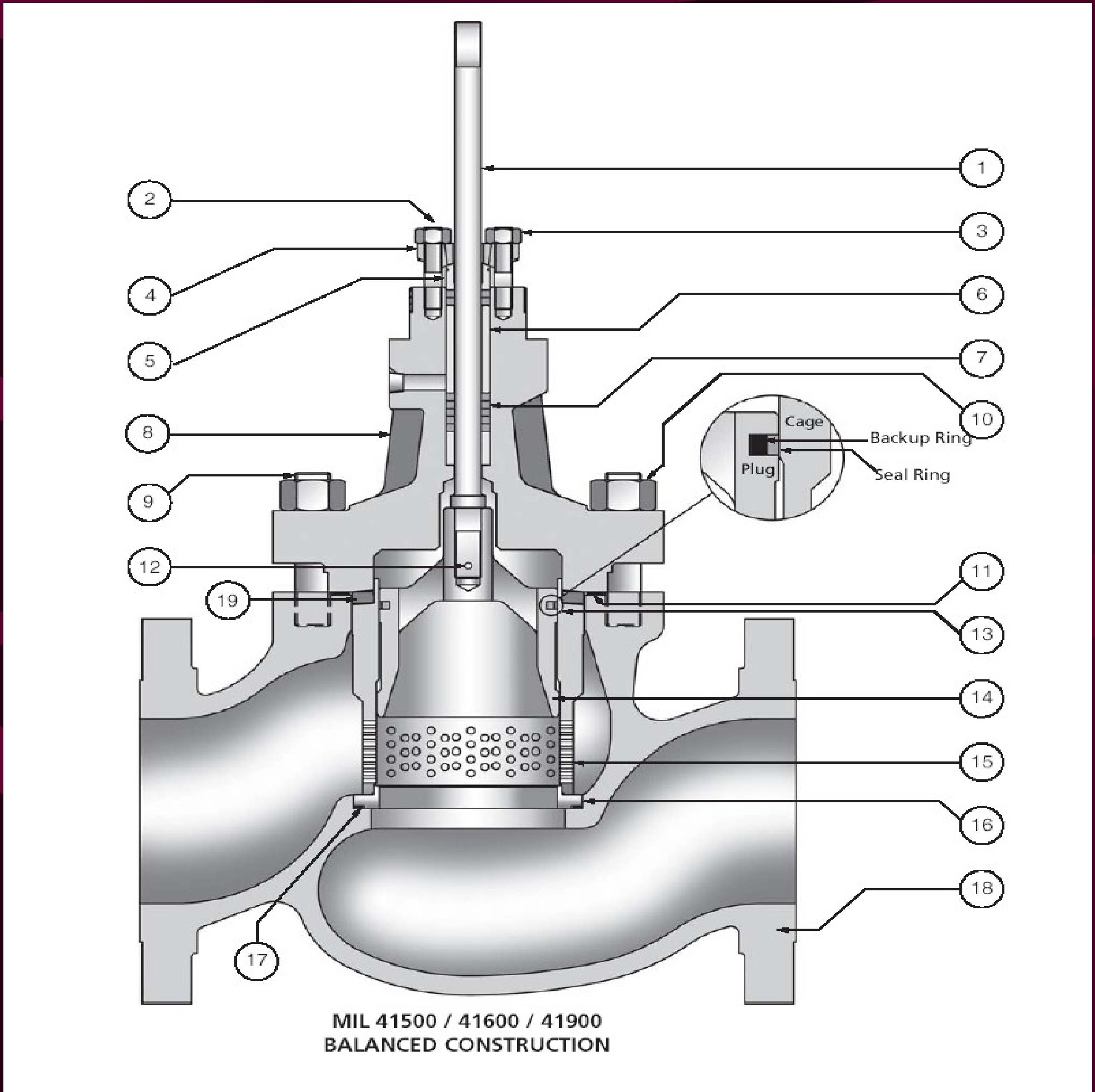
Typical 21000Series MIL valve



Top Guided, simple construction and used commonly for tight shut off requirement and where there is no chance of cavitation and dp is low.

Size ½” to 10”

Typical 41000 series MIL valve



Cage guided, well suited for high temperature, low noise and anti cavitation trim with leakage class II to V.

THANK YOU