Fujikin of America, Inc.

Fine Ceramic Mini-Control Valves

Cosmix® Mini-Control Valve
Operation and Maintenance Manual

Please Read This Manual Before Installing!

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Section
1

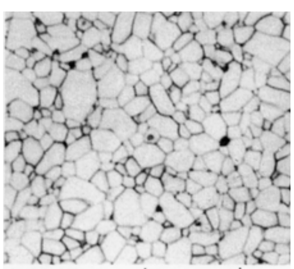
Characteristics of Ceramics

Ceramics not only meet the stringent requirements mandatory for today's industry, they represent the leading edge of the materials revolution.

Alumina ceramics are the most widely used technical ceramics. With but minute traces of impurities, 100% alumina ceramics are most commonly known as sapphires or rubies. We however, prefer not use such expensive materials in the manufacturing process of our valves. Fujikin offers many types of ceramic materials for use in valves - each one possessing specific unique characteristics. The following paragraphs will describe why ceramics are becoming an important material in the industrial world, and why they have become the preferred choice for the most severe valving applications.

☑ Available Through Fujikin

Alumina Ceramics (Al_2O_3)



3N Alumina 25 µm

With a hardness next to diamond, boron carbide, and silicon carbide, alumina ceramics possess superior wear resistance compared to alternate materials. The most widely used type of ceramic, alumina offers in conjunction to its high abrasion-resistant properties, high corrosion resistance - virtually inert to almost any media found in today's industrial plants.

The melting point of alumina is 2,050°C, but the use of ceramic valves is limited to the oxidation temperature of the packing used to seal the individual ceramic components.

The compressive strength of alumina is seven to ten times its flexural strength. This is extremely high compared to other materials. Consequently, alumina is excellent in compression (when mounting a valve in piping, for example), but must be used with extreme caution under tensile or flexural force generating conditions.

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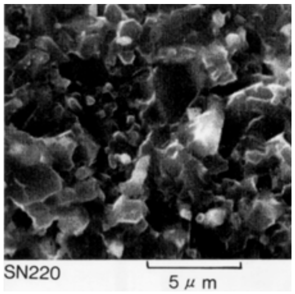

Silicon Nitride Ceramics (Si_3N_4)

Silicon nitride ceramics exceed other ceramics in thermal shock resistance. Its strength does not deteriorate at elevated temperatures, therefore it is most appropriate for applications that require high heat resistance. This ceramic is so stable at elevated temperatures that it can be used with molten metals. Other applications for silicon nitride include engine and gas turbine parts, turbo-charger rotors, diesel engine glow plugs and hot plugs.

Mullite Ceramics ($3Al_2O_3 \bullet 2SiO_2$)

Mullite has a low thermal expansion coefficient and is used primarily in parts requiring heat and thermal shock resistance. Based on specific application needs, there are two types of mullite ceramics: one for electrical insulation and heat resistance, and the other a porous material with especially low thermal expansion for high heat resistance use. Typical applications for mullite ceramics include burner nozzles and tiles.

Titania Ceramics (TiO_2)

Titania excels in surface smoothness and wear resistance. Having a very low coefficient of friction, titania ceramics are suitable for thread guides in the textile industry and tape guides in computers. When it is necessary to ground the static electricity built up by friction, electrically conductive titania ceramics can safely be used. With the addition of CaO and BaO titania, the material's conductivity resistance allows it to be used in static-free applications such as glides and sliders.

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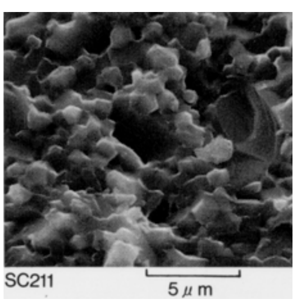

Silicon Carbide Ceramics (SiC)

Silicon carbide retains its strength at elevated temperatures as high as 1,400°C. It has the highest corrosion resistance of all fine ceramic materials, making it the "last resort" option for even the toughest highly abrasive applications. Applications for silicon carbide include valve seats, mechanical seals, and pump parts.

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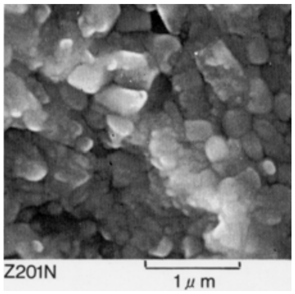


Zirconia Ceramics (ZrO_2)

At room temperature zirconia has the highest strength and toughness of all engineered and commonly available ceramics, but its properties decrease with increasing temperatures. Before the introduction of Zirconia as an engineered ceramic, ceramics were considered impractical for applications such as scissors or knifes. With its excellent surface smoothness, zirconia can also be used for moving parts in valves and pumps.

Performance Characteristics

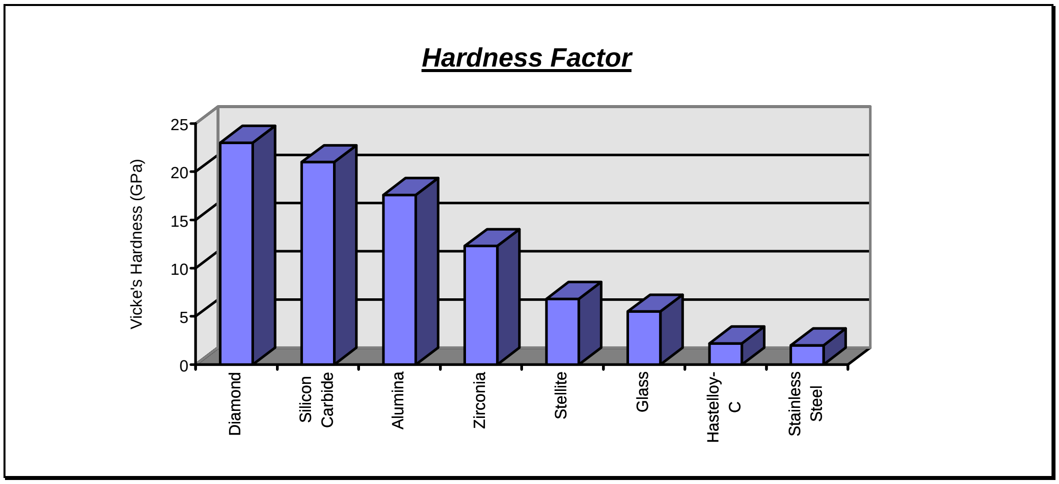
Materials available in Fujikin valves are shown in the table below with their respective characteristics. Each ceramic possesses a unique characteristic to suit any application.

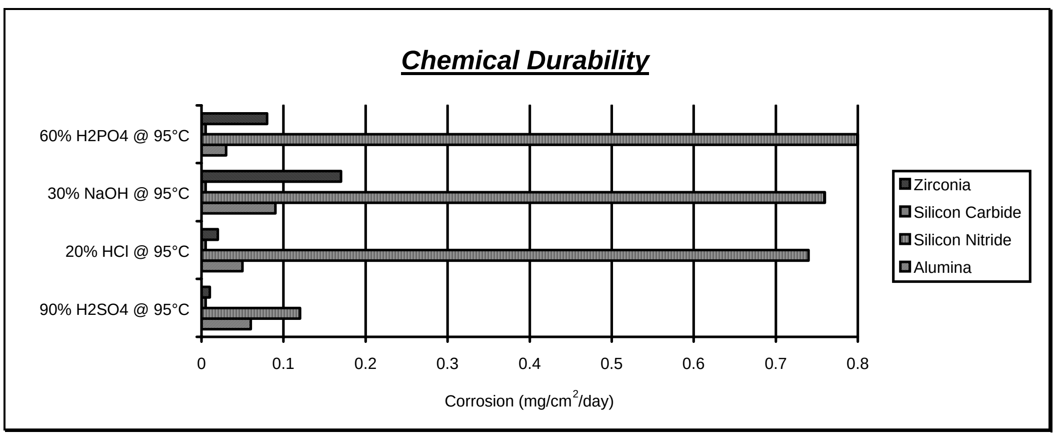
	99.5% Alumina (Al_2O_3)	99.9% Alumina (Al_2O_3)	Silicon Nitride (Si_3N_4)	Silicon Carbide (SiC)	Zirconia (ZrO_2)
Color	White	Ivory	Black	Black	Ivory
Bulk Density	3.8	3.9	3.2	3.0	6.0
Rockwell Hardness (GPa)	83	90	90	88	77
Flexural Strength (MPa)	323	313	590	490	980
Young's Modulus of Elasticity (GPa)	363	372	294	372	206

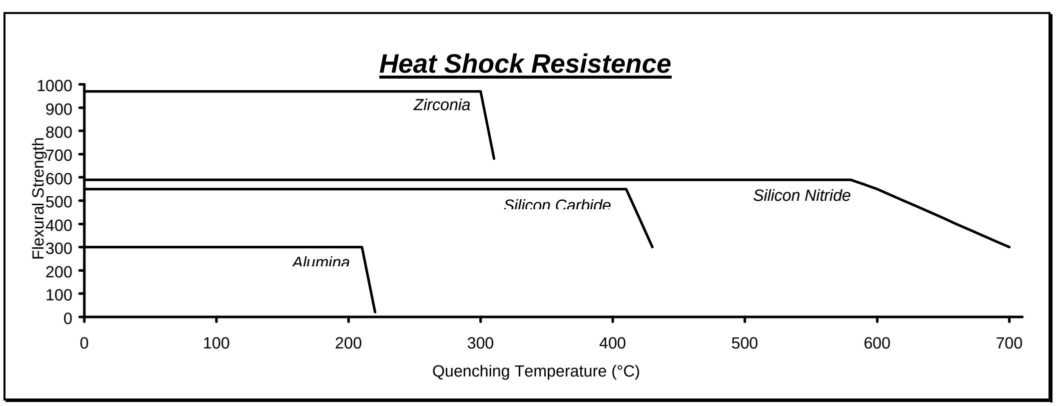
The Final Product

Present-day industry creates a specific demand for advanced precision technology. Technology is constantly improving to present new ceramic materials and new methods of achieving even higher tolerances than those possible only a few years ago. All Fujikin valve components are subjected to the strictest Quality Assurance procedures, assuring the end-user a product that is flawless in its craftsmanship.

The data on the following page show the unique characteristics of the ceramic materials used in the manufacturing of Fujikin valves. (Note that some characteristics may vary when complex shapes are manufactured from raw ceramic materials - for example temperature shock).


Hardness Factor
Vicke's Hardness (GPa)
0
5
10
15
20
25
Diamond
Silicon Carbide
Alumina
Zirconia
Stellite
Glass
Hastelloy-C
Stainless Steel


Chemical Durability
60% H2PO4 @ 95°C
30% NaOH @ 95°C
20% HCl @ 95°C
90% H2SO4 @ 95°C
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Corrosion (mg/cm2/day)
Zirconia
Silicon Carbide
Silicon Nitride
Alumina


Heat Shock Resistence
Flexural Strength
1000
900
800
700
600
500
400
300
200
100
0
Zirconia
Silicon Nitride
Silicon Carbide
Alumina
0
100
200
300
400
500
600
700
Quenching Temperature (°C)

Section

2

Mini-Control Valve Operational Considerations

Combining a fully-ceramic design and proven valve technology, the mini-control valve is the finest in rugged ultra-low flow control and dependable service.

Maximum Operating Pressure

The maximum operating pressure for alumina mini-control valves is 285 psi (20 kg/cm^2). By utilizing other ceramic materials, the maximum operating pressure can increase to 570 psi (40 kg/cm^2).

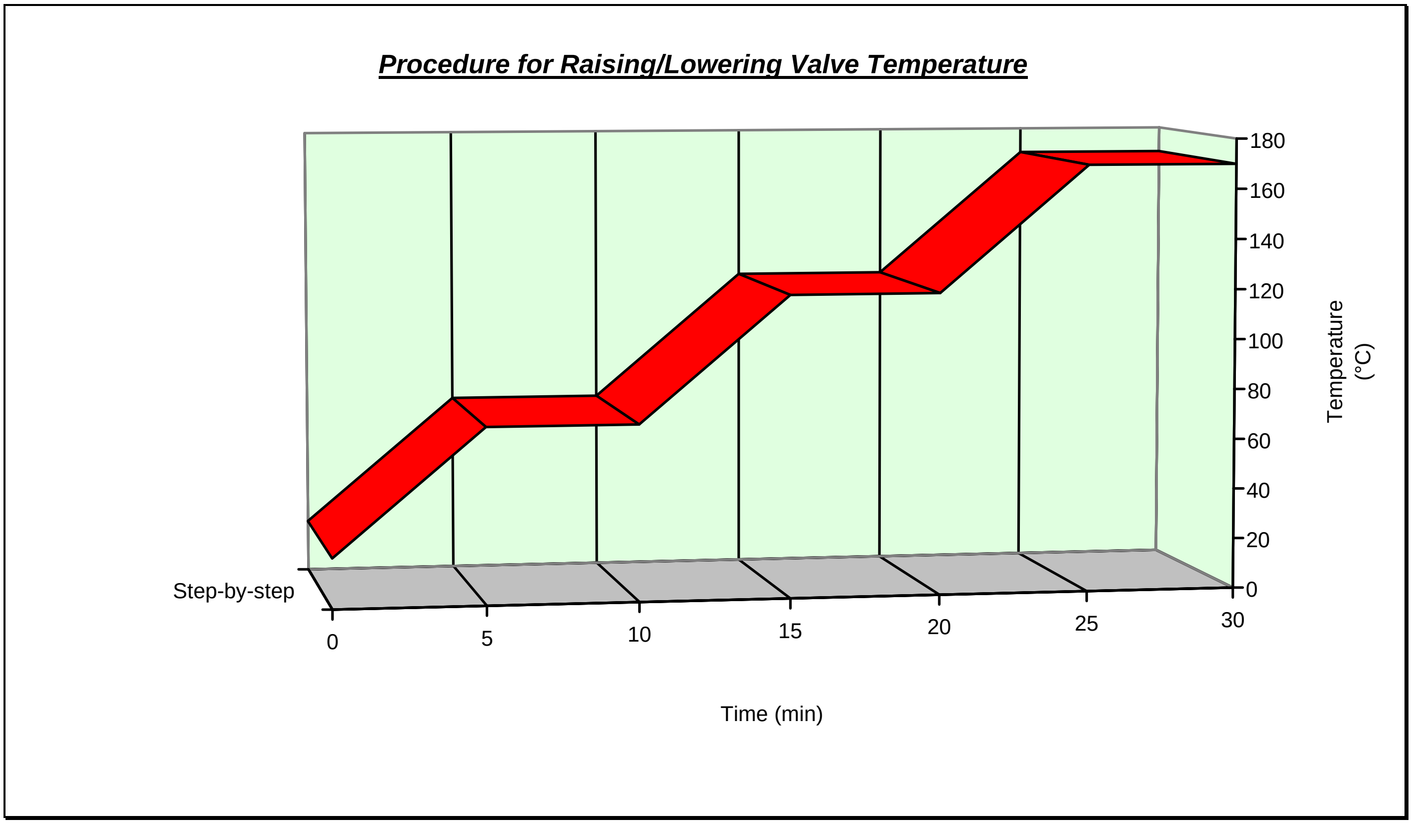
Maximum Operating Temperature

The melting point of alumina is 2,050°C, but the use of ceramic valves is limited to the oxidation temperature of the packing used to seal the individual ceramic components. The standard packing used in mini-control valves is a combination of Viton, Teflon, and ceramic. With standard packing the maximum operating temperature is 392°F (200°C), and with high-temperature packing the maximum is 1,112°F (600°C), or greater based on specific requirements. The lowest operating temperature allowed for all ceramic valves is –418°F (-250°C).

Maximum Differential Temperature

The maximum instantaneous differential temperature allowable between the existing temperature of the valve and the fluid is limited to 122°F (50°C) per ten minutes. Silicon carbide and silicon nitride ceramics can withstand a thermal shock of two to three times this amount. Since the thermal shock is also affected by the specific heat and other conditions of the fluid, please consult Fujikin if you have any special requirements, or if the thermal shock(s) indicated above do not meet your requirements.

When initially starting-up, flushing, or shutting down the line in which the mini-control valve is installed, it is absolutely imperative that the following raising/lowering procedure be followed. Failure to do so will result in ceramic component fracturing - which is not covered under the valve warranty.



It is acceptable to gradually raise the temperature of the valve to the desired operating temperature, but the step-by-step approach is preferred. Additionally the valve may be heat-traced or jacketed when the operating temperature and maximum/minimum temperatures exceed the allowable limits. Please consult Fujikin for proper implementation of heat-tracing devices.

Section
3

Flow Characteristics and C_v Values

With Cv's as low as 0.35 and a directly coupled stem, the mini-control valve is ideally-suited to ultra-low, ultra-accurate control of abrasive and corrosive media.

Flow Characteristics

The allowable seat leakage of the mini-control valve is between $1x10^{-3}$ and $1x10^{-4}$ of the maximum rated C_v value of the valve. This shut-off is achieved by high tolerances between the valve ceramic stem with the ceramic body.

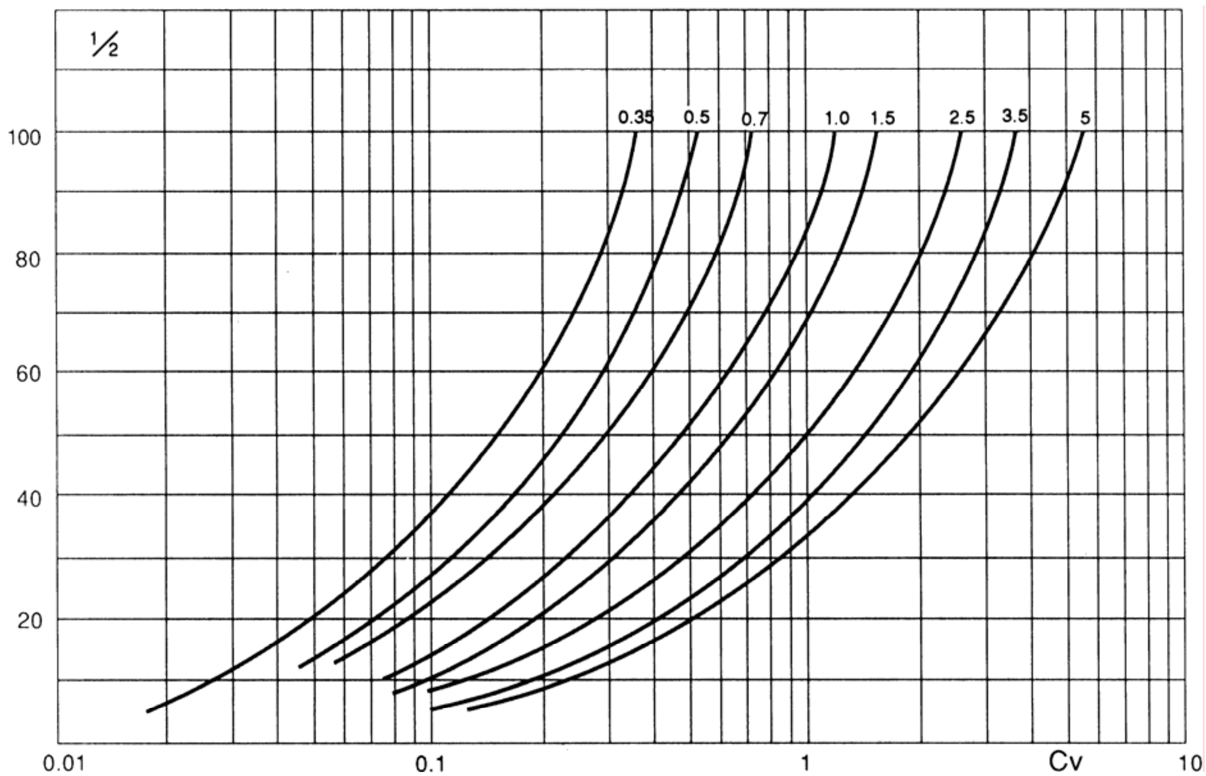
Wear is attributed to the abrasive media eroding corners and turns when it is traveling through a valve or other piece of instrumentation. Since the media is *always* flowing through the valve in a straight line, the valve will not wear as in other designs which divert flow (90° turn ball valves, globe, etc.).

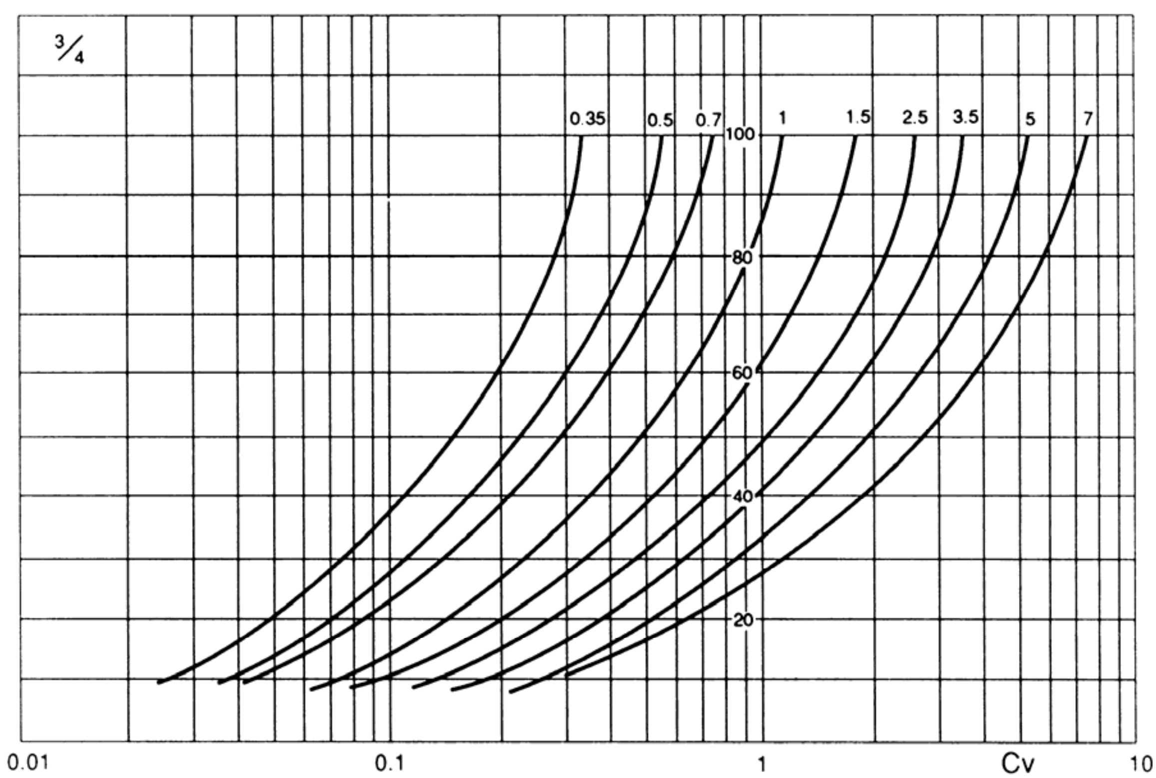
Below is a table of the standard available C_v ports. If a non-standard C_v is required to match a particularly fine control range, Fujikin may specially manufacture one to suit.

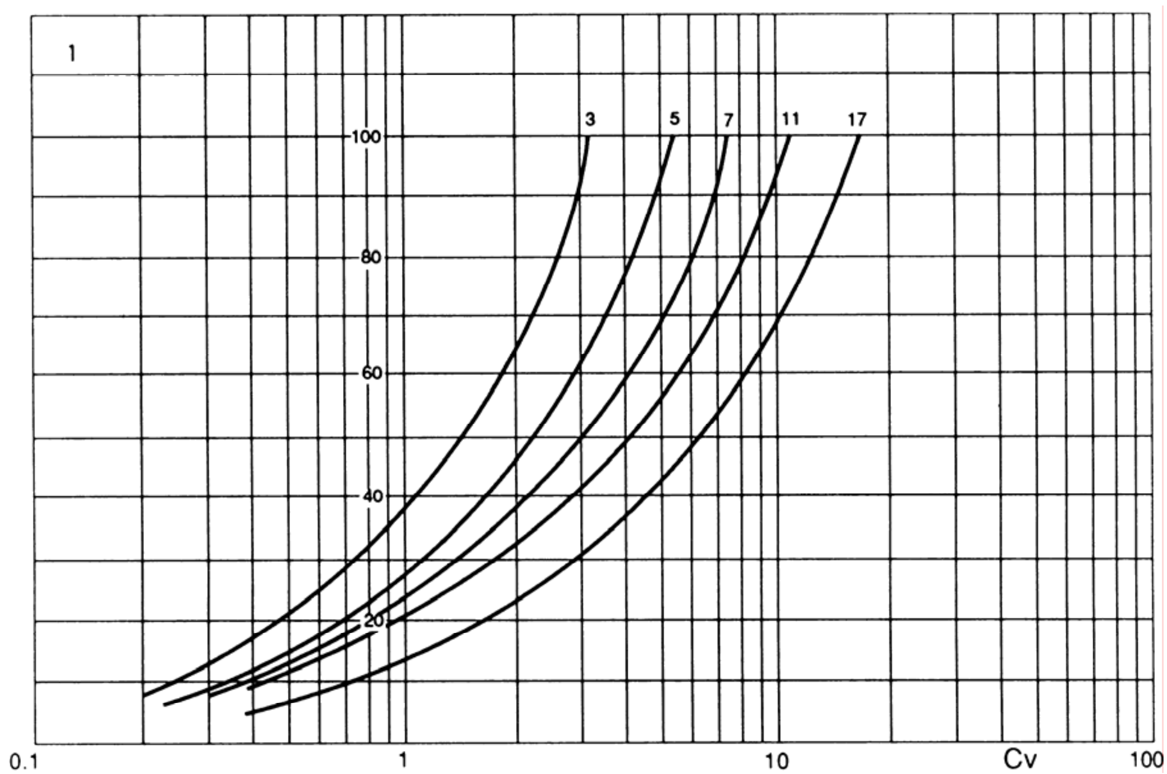
Size	Available Cv Values								
½"	5	3.5	2.5	1.5	1.0	0.7	0.5	0.35	
¾"	7	5	3.5	2.5	1.5	1.0	0.7	0.5	0.35
1"	17	11	7	5	3				
1½"	35	25	15	7					
2"	50	35	25	15					

Rangeability - 1:15

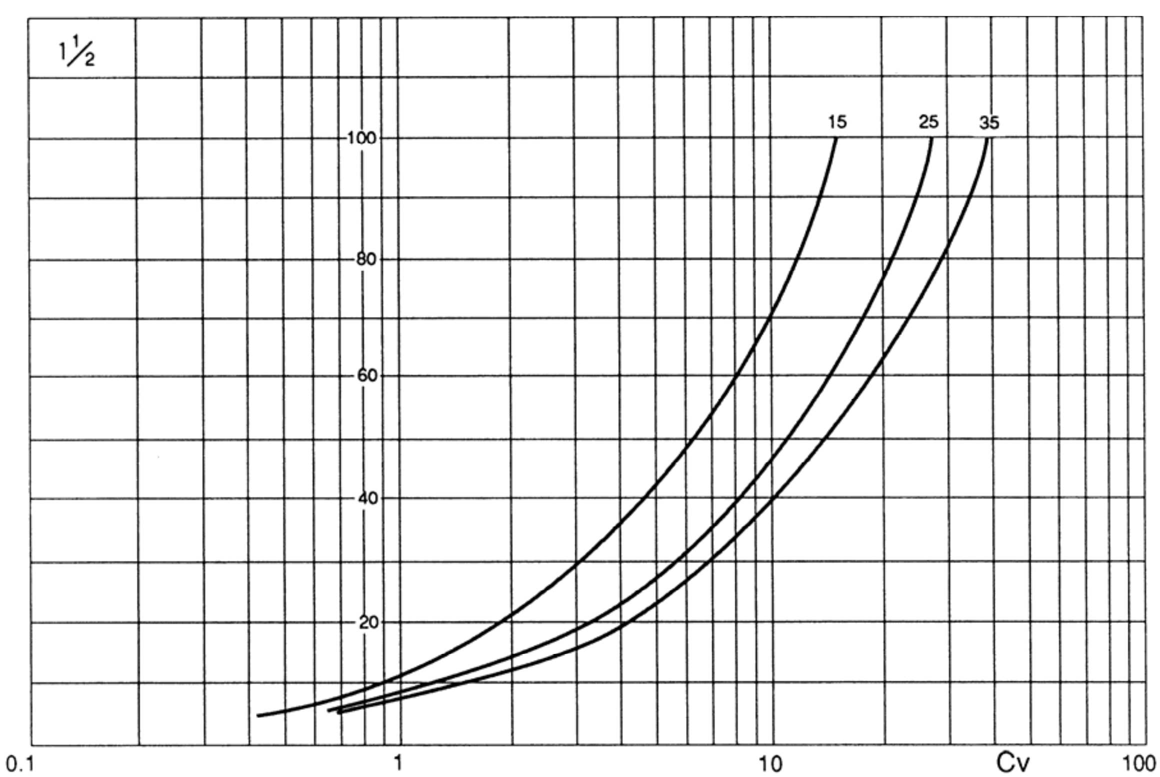
C_v Charts


½
0.35
0.5
0.7
1.0
1.5
2.5
3.5
5
100
80
60
40
20
0.01
0.1
1
Cv
10

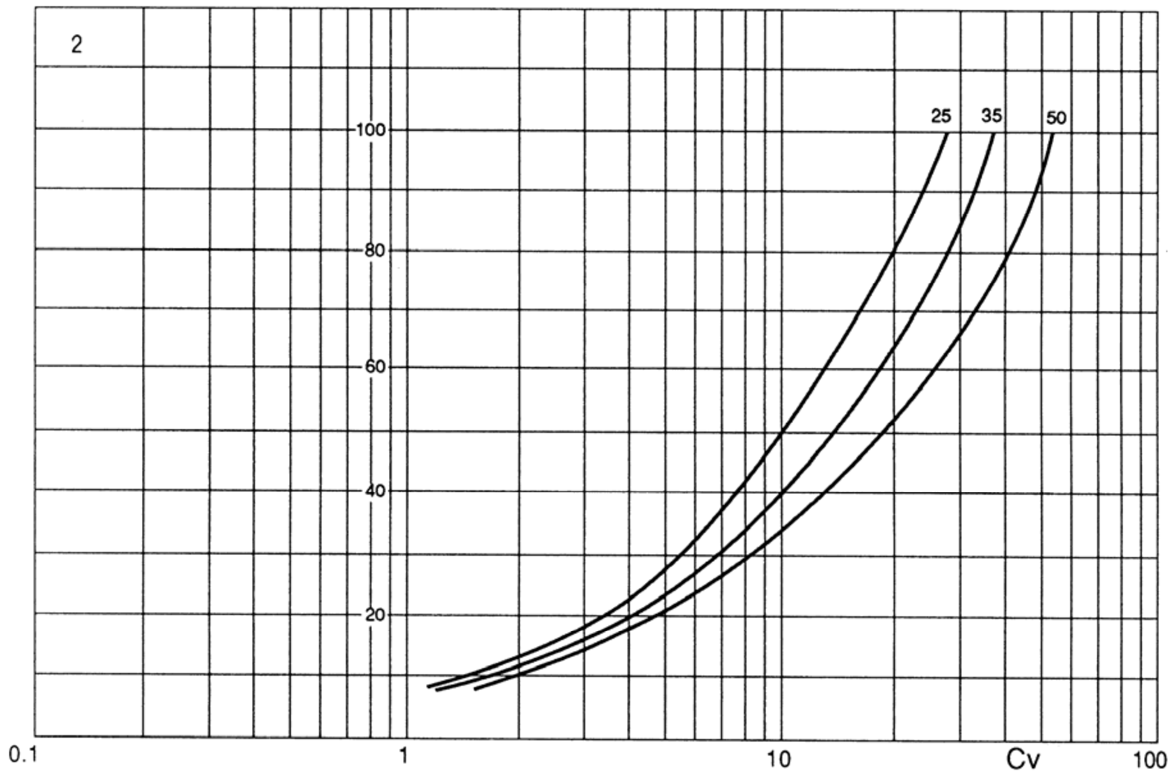

¾
0.35
0.5
0.7
1
1.5
2.5
3.5
5
7
100
80
60
40
20
0.01
0.1
1
Cv
10



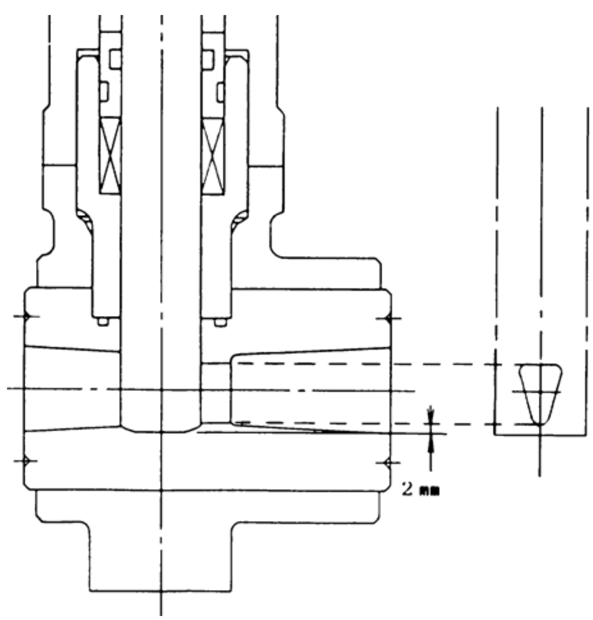
1
3
5
7
11
17
100
80
60
40
20
0.1
1
10
Cv
100



1½
15
25
35
100
80
60
40
20
0.1
1
10
Cv
100



Cross Section



When the supply air to the valve is disconnected, the stem will drop (over-travel) an additional 2mm below the zero to the red mark on the lift scale. This is to ensure a complete shut-off during outages and/or shut-downs.

Section 4

Actuator and Positioner

Fine control is achieved by eliminating hysterisis; the valve stem, actuator, and positioner are all directly coupled to provide a hysterisis of less than 1%.

Actuator

The actuator provided with the Fujikin mini-control valve is designed and manufactured by Fujikin. All valves operate sufficiently with 35 psig, (2.5 kg/cm^2) compressed air. The maximum allowable pressure to the actuator must not exceed 100 psig (7 kg/cm^2) to avoid any damage to the diaphragm. Although most of the heat from the valve portion will dissipate and not reach the actuator, the "rolling diaphragm" is made of high endurance NBR rubber, and the maximum temperature at or near the actuator should not exceed 175°F, (80°C).

Positioner

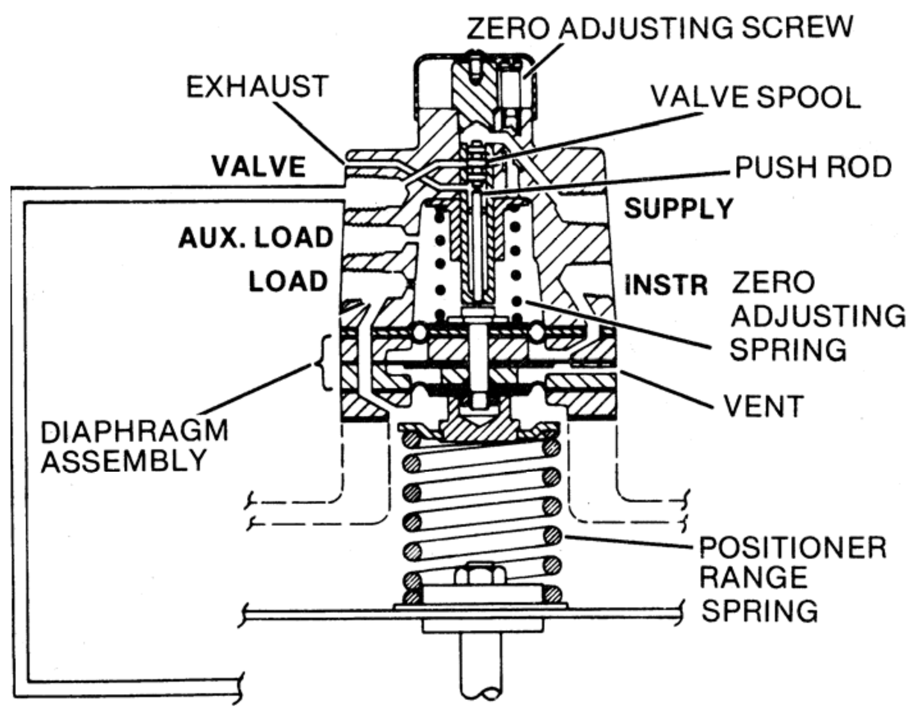
The positioners used with great success are manufactured by Moore Products, Company. The positioner is designed to operate the valve actuator to maintain the valve in a position determined by the control instrument.

The positioner is direct acting - with an increase in instrument pressure, the valve pressure (positioner output) will increase. Because the output is connected to the bottom of the actuator, the valve stem will in all cases move toward the positioner when instrument pressure (positioner input) increases.

The actuator's actual position is fed back to the positioner by the positioner range spring, as a force on the bottom of the positioner diaphragm assembly. The positioner pilot will continue to increase or decrease the positioner output until the force of the range spring balances the force created by the instrument pressure.

Instrument pressure from the controlling device is connected to the **INSTRUMENT** port and is exerted between the middle and upper diaphragms of the positioner diaphragm assembly. Because of the difference in diaphragm areas, the resultant force is exerted in a downward direction. As the "instrument" pressure increases, the diaphragm assembly moves downward, the push-rod and valve spool move down, and supply air is admitted to the positioner output to increase the output (up to full supply pressure if necessary). The positioner output at the **VALVE** connection is admitted to the bottom of the actuator. As this "valve" pressure exceeds the cushion-load pressure, the actuator diaphragm or piston moves upward. This upward movement increases the force exerted by the positioner range spring on the positioner diaphragm assembly. When this force equals the force exerted by the "instrument" pressure, the supply is closed and the actuator remains in a balanced position.

Conversely, with a decrease in "instrument" pressure, the air in the bottom of the actuator will exhaust through the positioner until the forces on the positioner diaphragm assembly are in balance.



Section 5

Assembly / Disassembly / Calibrating Procedures

Mini-control valves are designed to be easily maintained and serviced, and require little time and no special tools.

Disassembly

Please refer to the exploded-view of the valve further on in this manual to facilitate the identification of parts.

1. If media has solidified in the **Body (1)**, it may facilitate removal by flushing the valve or soaking it in water prior to disassembly. **Remove Hex Bolts (17)** from the valve **Housing (3)**, and pull valve **Housing (3)** containing the valve **Body (1)** downward. *The assembly must not be forced in any way to avoid damaging the ceramic* ***Stem (2)***.

Disassembly of the valve body is now complete.

2. Remove ceramic **Packing Box (5).**
3. Remove **Hex Bolts (16)** and pull **Lid (4)** away from **Yoke (18)**.
4. Unscrew **Adjuster (15)** to remove from **Disk Cap (14)**. The **Stem (2)** is now completely disassembled.

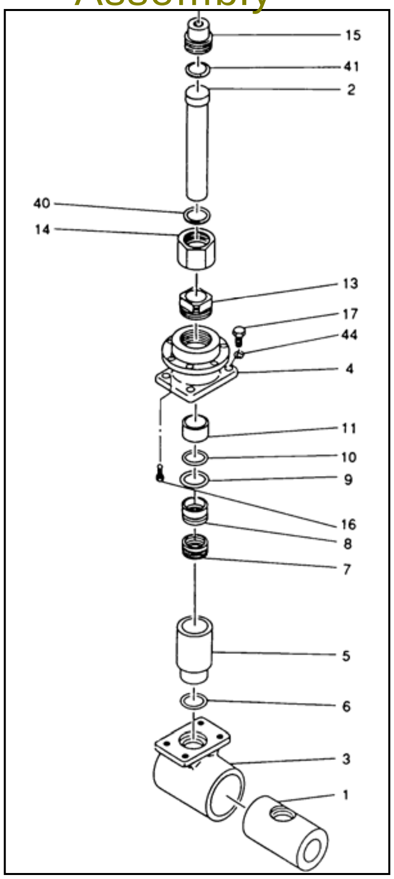
Disassembly of the ceramic valve portion is now complete.

5. To disassemble the actuator portion, remove **Hex Bolts (38)**, and loosen **Adjusting Nut (23)** by keeping the **Spindle (25)** from turning. This will decompress **Springs (26)** and **(27)**.

6. Keeping the **Spindle (25)** stationary with a wrench, unscrew the **Pressure Bolt (34)**. The **Spindle (25)** may now be removed from the **Yoke (18)**.

7 Remove positioner **Bolts (45)** and **Fittings (43)**, and the **Positioner (39)** may now be removed from the **Diaphragm Cover (36)**.

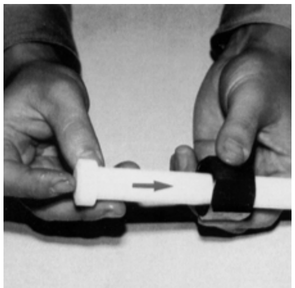
Assembly



42/44	Lock Washer
41	Teflon Gasket
40	Rubber Gasket
17	Hex Bolt
16	Hex Bolt
15	Adjuster
14	Disk Cap
13	Packing Retainer
11	Spacer
10	O-ring
9	O-Ring
8	O-Ring Holder
7	Gland Packing
6	O-Ring
5	Packing box
4	Lid
3	Housing
2	Stem
1	Body
#	**Name**

1. Using silicone lubricant, completely lubricate **Rubber Gasket (40).**

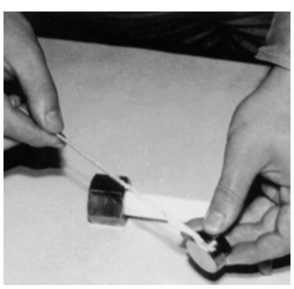
2. Install the **Rubber Gasket (40)** into the **Adjuster "A" (14).**



3. Slide **Stem (2)** into **Disk Cap (14).**

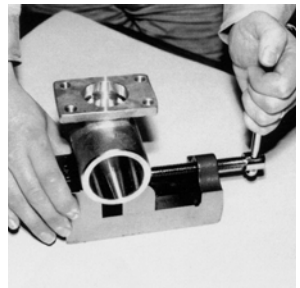
4. Place **Teflon Gasket (41)** into the Disk Cap…

5. …until it sits in properly and evenly with the stem top

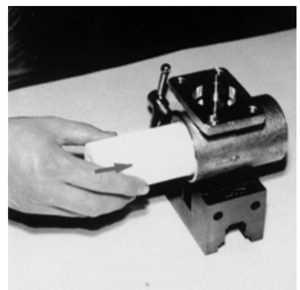


6. Apply a thin film of lubricant onto the threads of the **Adjuster (15).**

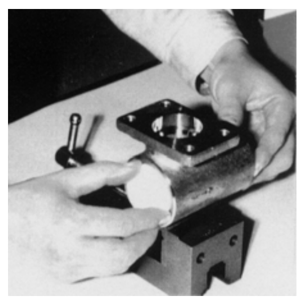
7. Tighten **Adjuster (15)** into **Disk Cap (14)** until the **Stem (2)** is firm with the **Adjuster** and **Disk Cap.**



8. Place the stainless steel **Housing (3)** into a vice, and secure firmly.

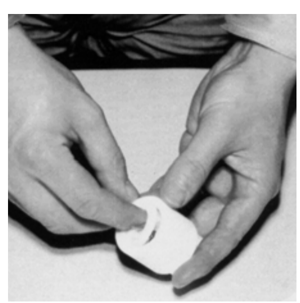


9. Slide **Body (1)** into **Housing (3)**, keeping the body as straight as possible to keep it from jamming.

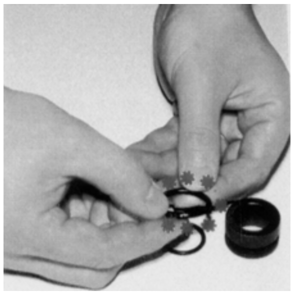


10. Align the stem-hole of the **Body (1)** with the opening in the **Housing (3)**.

11. Apply silicone lubricant to each ring of **Packing (7)**.

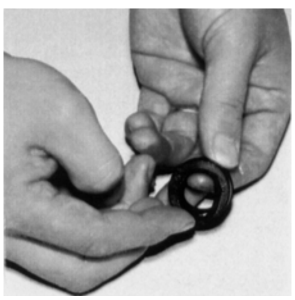


12. Insert each ring of **Packing (7)** into the **Packing Box (5)**, (do not damage any ring and confirm they all sit evenly and straight).

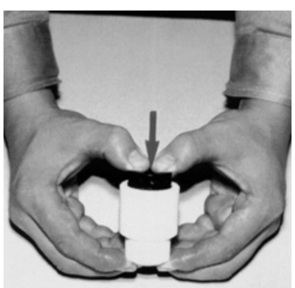


13. Fully lubricate **O-Rings (9) and (10)**, and **O-Ring Holder (8).**

14. Slide the larger **O-Ring (9)** into the groove on the outside of the **O-Ring Holder (8).**

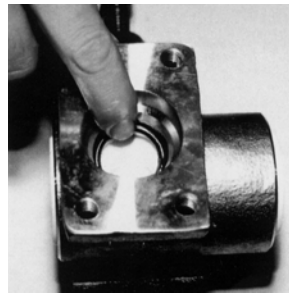


15. …and the **smaller O-Ring (10)** into the groove on the inside of the **O-Ring Holder (8).**

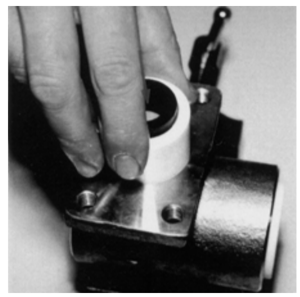


16. Slide the **O-Ring Holder (8)** into the **Packing Box (5)**. The side with the **O-Ring (9)** goes in first - above the **Packing (7)** -- careful not to damage the outer **O-Ring (9)**.

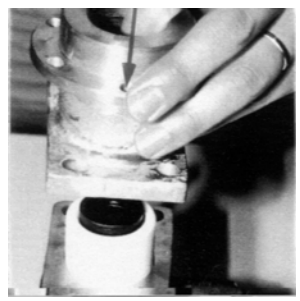
17. Fully lubricate **O-Ring (6)**.



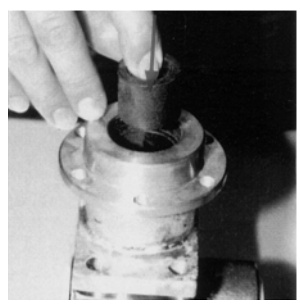
18. Place the **O-Ring (6)** into the groove on the **Body (1)**, making sure it is fully seated and flush.



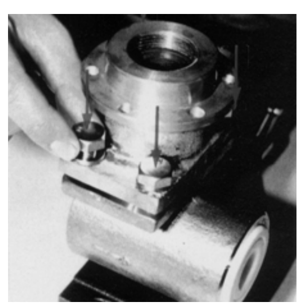
19. Slide the **Packing Box (5)** containing all the various packing into the **Hosing (3)** until it seats onto **the Body (1)** and **O-Ring (6)**.



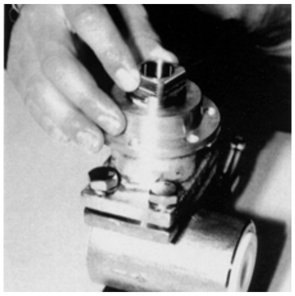
20. Place the **Lid (4)** onto the **Hosing (3)**, carefully lowering it so that the **Packing Box (5)** does not jet jammed in the **Lid (4)**.



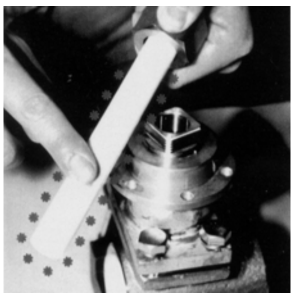
21. Slide the **Spacer (11)** into the **Lid (4)**.



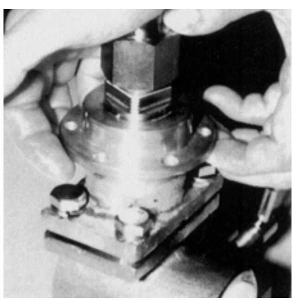
22. Coat the threads of the **Hex Bolts (17)** with either thread-lock or silicone lubricant, and finger-tighten at this point (include **Lock Washers (42 or 44)**).



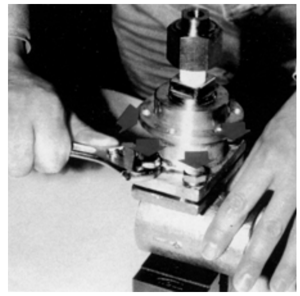
23. Coat the threads of the **Packing Retainer (13)** with either thread-lock or silicone lubricant, and screw onto the **Lid (4).**



24. Fully lubricate the **Stem (2)** with silicone lubricant.

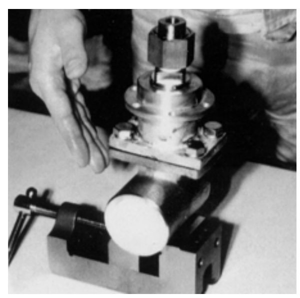


25. Slide the **Stem (2)** through the **Packing Retainer (13)** until it bottoms out. Careful not to use too much force, although the fit might be snug.

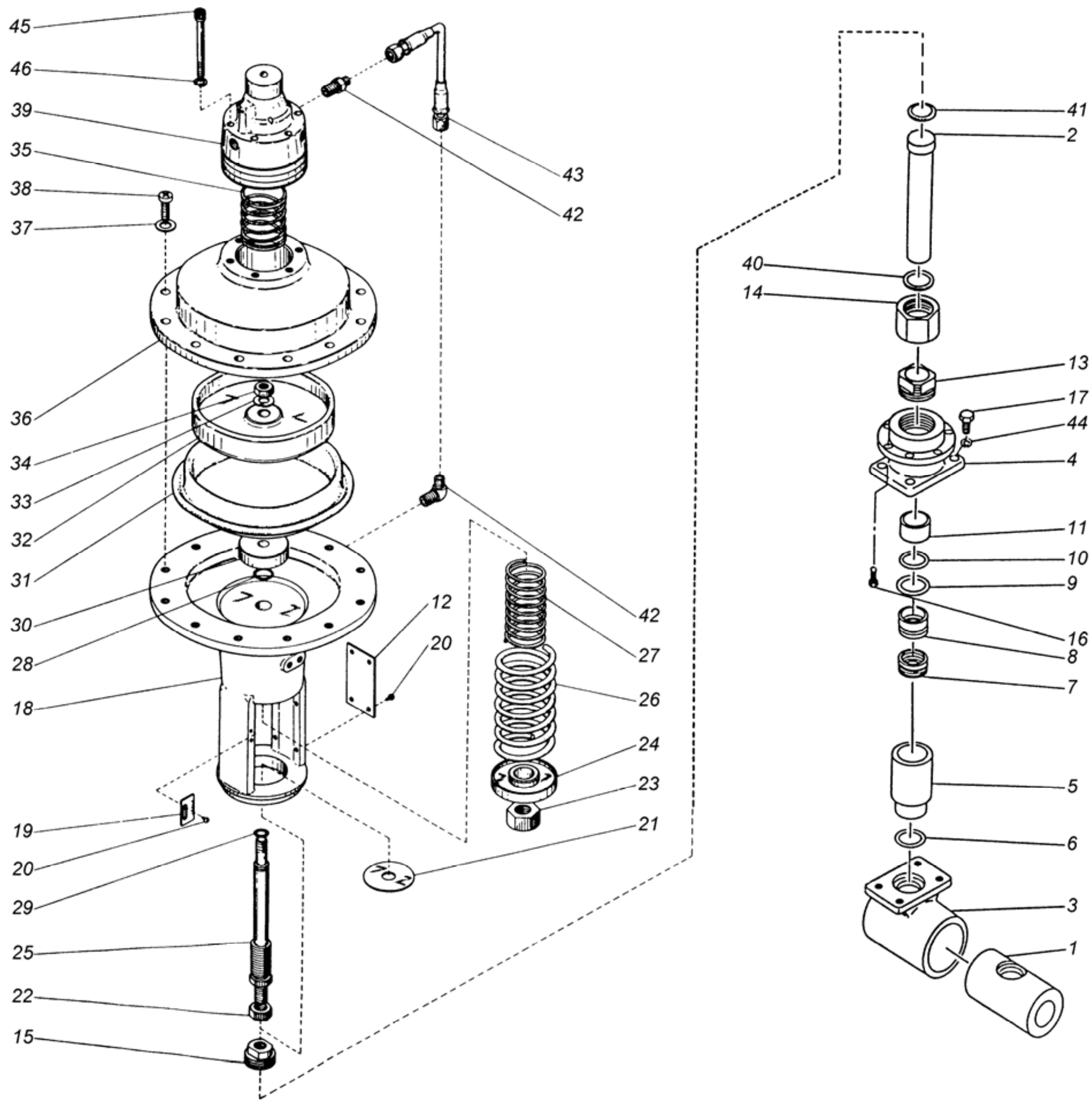


26. Alternating between all four **Hex Bolts (17)**, tighten each one a small amount each time, so the **Lid (4)** sits evenly and flush onto the **Housing (3)**.

27. Slide the stem up-and-down to check that the movement is smooth. If so, assemble the actuator on top. When the complete valve and actuator is assembled, tighten the **Packing Retainer (13)** a small amount to energize the packing.

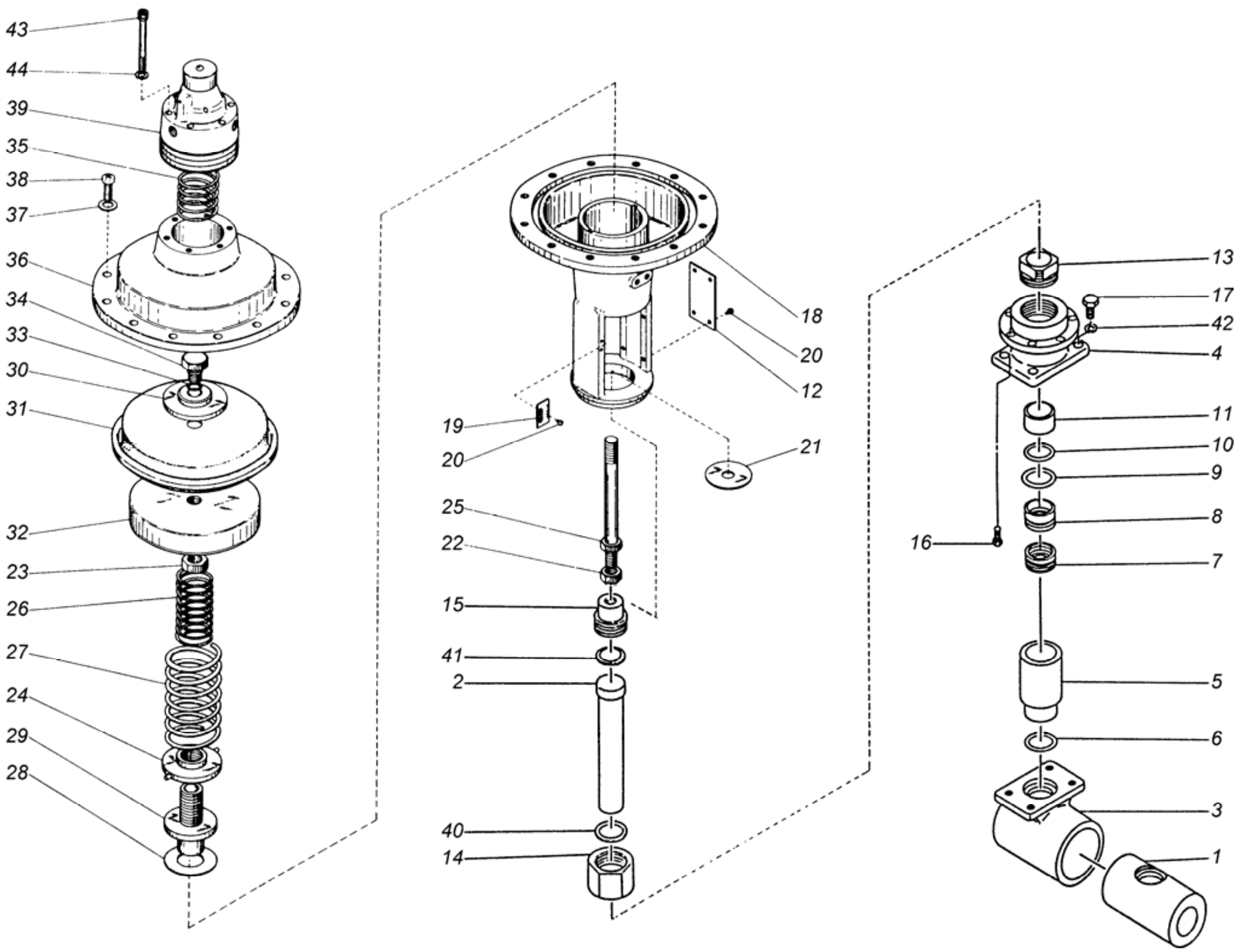


Assembly is now complete!



Parts List - Air to Open Configuration

44 Lock Washer
43 Copper Tubing
42 Fitting
41 PTFE Sheet
40 Rubber Sheet
39 Positioner
38 Hex Bolt
37 Plain Washer
36 Diaphragm Cover
35 Range Spring
34 Hex Nut
33 Lock Washer
32 Diaphragm Disk
31 Diaphragm
30 Retainer
29 O-Ring
28 O-Ring
27 Spring
26 Spring
25 Spindle
24 Spring Retainer
23 Adjusting Nut
22 Hex Nut
21 Lift Indicator
20 Screw
19 Lift Scale
18 Yoke
17 Hex Bolt
16 Hex Bolt
15 Adjuster
14 Disk Cap
13 Packing Retainer
12 Name Plate
11 Spacer
10 O-Ring
9 O-Ring
8 O-Ring Holder
7 Gland Packing
6 O-Ring
5 Packing Box
4 Lid
3 Housing
2 Stem
1 Body



Parts List - Air to Close Configuration

44 Washer	35 Range Spring	26 Spring	17 Hex Bolt	8 O-Ring Holder
43 Mounting Bolt	34 Bolt	25 Spindle	16 Hex Bolt	7 Gland Packing
42 Lock Washer	33 O-Ring	24 Spring Retainer	15 Adjuster	6 O-Ring
41 PTFE Sheet	32 Diaphragm Disk	23 Adjusting Nut	14 Disk Cap	5 Packing Box
40 Rubber Sheet	31 Diaphragm	22 Hex Nut	13 Packing Retainer	4 Lid
39 Positioner	30 Retainer	21 Lift Indicator	12 Name Plate	3 Housing
38 Hex Bolt	29 Retainer Guide	20 Screw	11 Spacer	2 Stem
37 Plain Washer	28 Gasket	19 Lift Scale	10 O-Ring	1 Body
36 Diaphragm Cover	27 Spring	18 Yoke	9 O-Ring	

Range Adjustment

The range adjustment is not possible without installing a new range spring below the positioner. However, this should not be necessary under normal operating conditions.

Alternatively the range can be set with proper adjustment of the adjusting nut (23) on the spindle (25).

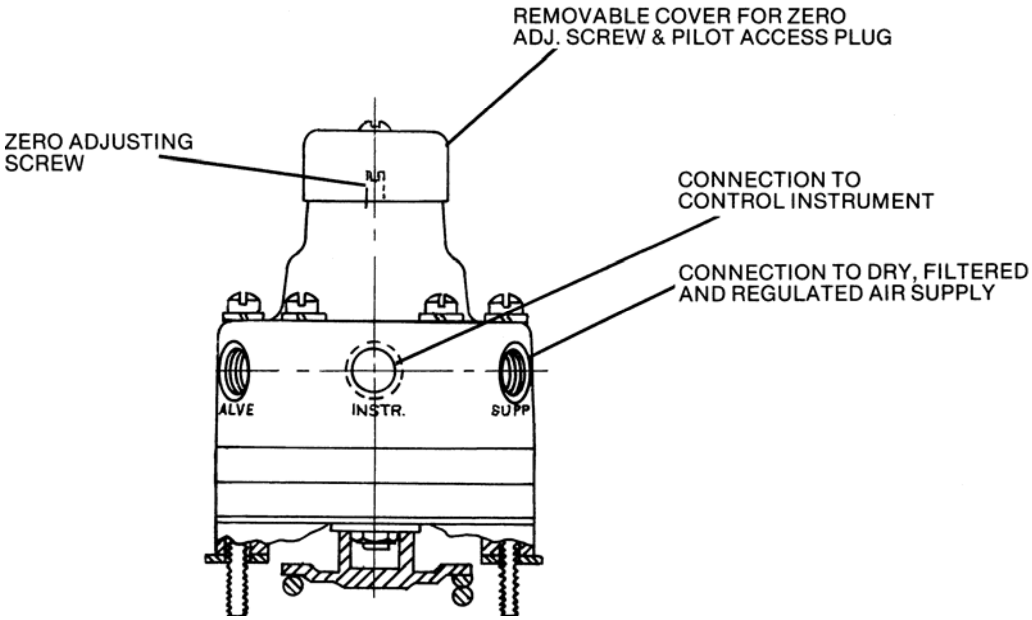
Zero Adjustment

The only adjustment that can be made on the positioner is the zero adjustment. The zero adjusting screw is located under the positioner's top cover.

To adjust the zero, set the instrument air pressure to the midpoint of its span, and turn the zero adjustment until the valve is at the midpoint of its stroke.

In some cases, valve shut-off or opening may be required at a specific instrument pressure. To zero the positioner at this point, set the instrument signal at the specific pressure and turn the zero adjustment screw until the valve reaches the required position. A slight change of instrument pressure should start to move the valve.

The valve stroke for a given span may also be suppressed or shifted to the desired range by means of the zero adjusting screw.



Section 6

Troubleshooting

If any of the below procedures do not solve your specific problem, contact Fujikin for additional instructions.

Problem	Possible Cause(s)	Solution
Valve does not respond to the instrument signal	1. Supply pressure to the actuator/positioner is too low. 2. The remaining (not used) ports on the positioner are plugged. 3. Solid material has been lodged in the ceramic body, or the media has solidified. 4. The ceramic body has shifted, and is no longer concentrically aligned with the ceramic stem. 5. The line pressure exceeds the operational limit.	1. Calibrate the supply pressure to 35 psig (2.5 kg/cm²) 2. Remove all unused plugs from the positioner, and leave the ports venting. 3. Disassemble the valve and thoroughly clean all the parts to remove all foreign materials. 4. Disassemble the valve, and re-align the body and stem. 5. Reduce the line pressure to within limits.
Stem movement is erratic	6. One or more of the above causes may be attributed to this 7. Actuator is defective.	6. Take action as outlined above. 7. Return the actuator to Fujikin for repair.
Valve is hunting	8. The actuator's output cannot adequately overcome the valve's required force to open/close.	8. Disassemble and clean the valve. If not effective, reduce the differential pressure across the valve.
Signal not corresponding to the valve's position	9. The range or zero adjustment is improper.	9. Re-calibrate the valve range and zero.
Fluid is leaking from the stem packing	10. The packing retainer has come loose. 11. The gland packing and/or o-rings may have broken or deteriorated.	10. Tighten packing retainer. 11. Disassemble valve and replace packing as necessary.
Stem wears out too quickly	12. High differential pressure and fluid velocity across the valve.	12. Replace the existing valve with the next larger valve size.

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Section 7

Important Notes for Proper Valve Operation

Every piece of precision instrumentation requires it to be handled with the utmost care and attention. Following the guidelines below will insure that your ceramic valve remains in its new condition.

Storage Instructions

1. The valve should be stored in its original packaging until use.
2. Keep indoors, and away from excessive vibrations or shock.
3. When transporting the valve be careful not to drop the valve or hit it against any hard object.
4. Do not load heavy objects onto the valve packaging.

Piping Instructions

1. If the valve needs to be transported by using a crane or other lifting device, be sure that no force be applied on the positioner.
2. Flange bolts should be tightened diagonally, alternately, and gradually. Each both must be tightened equally, sufficiently enough for the gaskets to seal.
3. Never strike any of the valve components - ceramic fracturing will occur.
4. Do not subject the valve to piping stress.
5. Support the assembly if necessary to eliminate stress on the valve portion.

Cautions During Operation

1. Never remove or loosen any component of the valve when there is pressure in the line. The stem may shoot out causing serious injury and even death.

2. After the valve has been installed, gradually increase the temperature of the valve to operating temperature - avoiding thermally shocking the valve.

3. If the media has a tendency of solidifying or crystallizing at low or ambient temperatures, take measures against this by heat-tracing the valve or flushing.

4. If the valve ceases to operate, never increase the supply pressure. Remove the valve from the line and follow the recommendations in the **Troubleshooting** section.

5. The output of the actuator is very high; when performing any maintenance on the valve or during installation, never keep the supply air connected until the valve is fully installed in the piping. Always keep hands and fingers away from moving parts.

6. During regular maintenance, it is acceptable to switch the location of the o-ring holder and the V-packing within the packing box.

7. The valve lift indicator will drop to the red mark on the lift scale when the supply air is removed. Due to the design of the triangular port. it is normal to get initial flow anywhere between 3 to 5 psi signal.

8. It is normal to experience leakage of $1x10^{-3}$ of the maximum C_v value.

9. If the valve is installed in a non-vertical position, it is normal to experience higher than normal lift when the signal is increased. Contact Fujikin for additional information and instructions.

All safety precautions and conditions cannot be covered in an operation manual. Use extreme caution when working on valves, or any kind of pressure containing instrument. Be sure that you read and understand all the procedures and methods in this manual before attempting to install.

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