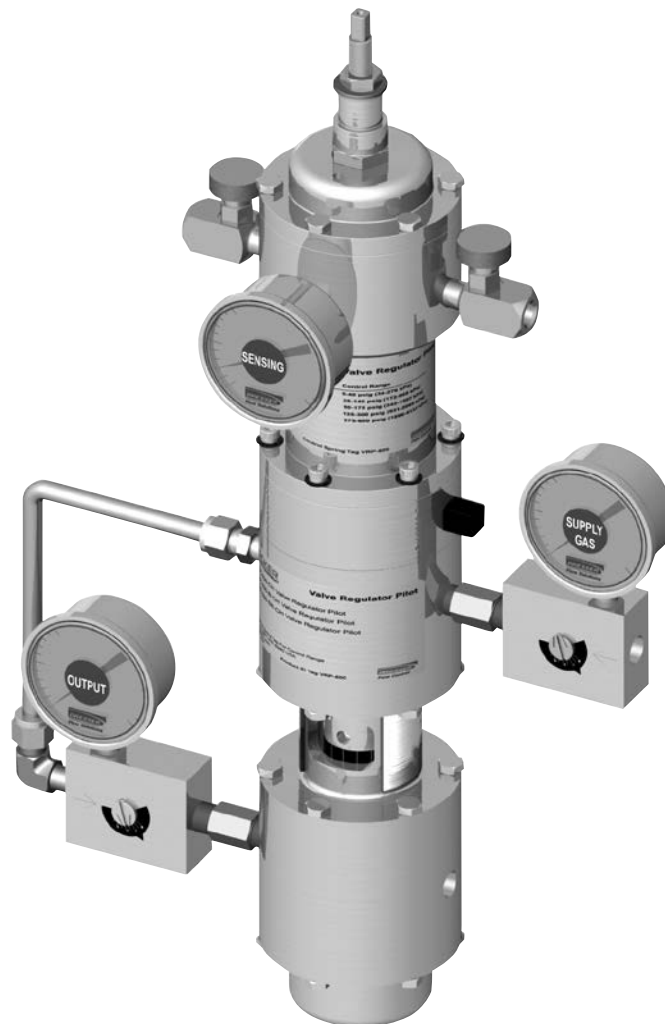


Becker™

VRP-SB-CH Series

Valve Regulator Pilots

Instruction Manual (Rev. D)



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Introduction

The Becker VRP-SB-CH single-acting pilot represents a breakthrough in valve control technology for the natural gas industry. Built to exacting specifications, this easily maintained unit offers highly accurate control characteristics over a wide range of operating environments. Furthermore, the VRP-SB-CH series pilots are designed to allow bleed gas to be routed to a lower pressure system, or downstream, for complete elimination of bleed gas. The elimination of this expensive bleed gas ultimately saves a significant amount of money for the operating company and reduces the environmental impact of atmospheric hydrocarbons and diminishing natural resources.

Description

The Becker VRP-SB-CH single-acting pilot provides pressure control when used with a single-acting piston actuated control valve. The VRP-SB-CH pilot measures downstream sensing

pressure and positions the single-acting actuator to maintain the desired downstream pressure. The VRP-SB-CH pilot may be used for pressure control applications with set points ranging from 3 psig to 1500 psig. The SB-CH pilot design represents our commitment to continuous development of new products and updating of existing products to maximize their performance while retaining simple operation and minimal maintenance.

Technical Assistance

Should you have any questions, you may contact your local Baker Hughes sales representative or technical assistance at e-mail address appearing on the back cover page of this Manual..

Scope of Manual

This manual provides information on the installation, operation, adjustment, and maintenance of the Becker VRP-SB-CH single-acting pilot. For information concerning actuators, valves, and accessories, refer to the instruction manuals provided with the specific product.

Note: *Only those qualified through training or experience should install, operate, or maintain Becker pilots. If there are any questions concerning these instructions, contact your Baker Hughes sales representative or sales office before proceeding.*

Advantages of the Combination Chamber VRP Pilot controllers

1. The spring is protected against corrosion caused by exposure to the outside weather conditions and condensation.
2. The dead band drum turns easier since small net force is transferred to the pilot body, resulting in negligible dead band shift when changing setpoint.
3. Because the need for a flat diaphragm for some pilot models is eliminated, only five (5) pilot model numbers are needed, instead of eleven (11), and there is less trouble-shooting during assembly.
4. Larger measured variable chamber volume dampens the control pressure signal, helping to compensate for vibration induced by poor location of the sensing tap in the area of flow pulsation and turbulence.
5. Sensing gauge is brought up to eye level.
6. Control springs can be replaced without disturbing any diaphragms.
7. Springs are guided by the outside, resulting in less likelihood of friction from a poorly aligned spring.
8. The accuracy of pilots is $\pm 3/4$ percent.

Applications

- Pressure Control
- Back Pressure Control

Guidelines for Usage

Bleed to Pressure System: The VRP-SB-CH pilot is typically used for applications with discharge pressures of 250 psig or less to help ensure adequate speed of operation. The bleed to pressure system eliminates atmospheric emissions by keeping discharge gas in the piping system.

CVE Globe Pattern Control Valves: The VRP-SB-CH pilot is the only single-acting pilot compatible with the model CVE globe pattern valve.

Compatible Actuators:

- Becker LPSR actuators (linear piston spring return)
- Becker LD actuators (spring and diaphragm)
- Other manufacturers' single-acting piston actuators⁽¹⁾

Retrofit Compatibility:

Excellent performance is achieved by pairing the VRP-SB-CH pilot with a genuine Becker control valves actuator. Should you already have existing control valve actuator(s) in service, the addition of a VRP-SB-CH pilot can improve performance and reduce atmospheric bleed emissions.

Technical Information

Technical Specifications	
Steady State Gas Consumption	Zero
Supply Gas	Dry, Filtered (100 micron gas)
Maximum Flow Capacity	2400 scfh (40scmh) (Cv=1.5)
Maximum Supply Pressure	400 psig (2860 kPa)
Maximum Supply-Discharge Differential	150 psig (1136 kPa)
Minimum Supply-Discharge Differential	100 psig (791 kPa) (Ball Valves) 20 psig (239 kPa) (Globe Valves)
Operative Ambient Temperature Range	-20 to 160°F -29 to 71°C
Approximate Weight	12 pounds (5.4kg)
Minimum Deadband	0.2% instrument signal
Control Accuracy	± 0.75% of setpoint
Maximum Sensing Pressure	1500 psig
Setpoint Range	3 psig - 1500 psig (20 kPa - 10342 kPa)
Housing	Meets NEMA 3 Classification
Installation Orientation	Vertical position recommended Custom bracket supplied with Becker Actuators 2-inch pipe mount provided for retrofit to other manufacturer's actuators

Materials of Construction	
External Parts	Anodized AL 2024/316 SS available (for marine environments)
Internal Parts	316 Stainless Steel and 2024 Anodized Aluminum
Springs	Plated Steel
Diaphragms	Buna-N with Nylon Reinforcement
Seats and O-Rings	Buna-N
Tubing and Tubing Fittings	316 Stainless Steel
Gauges	2½ inch dial liquid filled brass connection w/stainless steel case ⁽¹⁾ (standard issue with units of psig dual units of psig/kPa available)

⁽¹⁾ Consult Baker Hughes for additional information.

Model Number Explanation

- The VRP-SB-CH pilot is available in four different models to cover sensing pressures from 3 psig to 1500 psig.
- The number expressed in the VRP model designation is the maximum sensing pressure (for example, a VRP-600-SB-CH has a maximum sensing pressure of 600 psig).

Identification Tag

Each unit has a stainless steel control tag fastened under one of the bolts of the spring cartridge. The range of the control spring is stamped on the face side of the tag. The shipping date and seven-character part number are stamped on the bottom side of the tag. The letter after the seven-digit part number identify the pilot revision series.



VRP-175-SB-CH



VRP-600-SB-CH



VRP-1000-SB-CH



VRP-1500-SB-CH

VRP-SB-CH Pilots
Models and Identification Tag Numbers

VRP-SB-CH Pilot Selection Chart						
Model No.	Control Range (psig/kPa)	Spring Color (Part No.)	Setpoint Change per Revolution of Setpoint Screw (psig/kPa)	Setpoint Range Discrete Remote Control (SM-1100)	Setpoint Range Analog (4-20 mA) Remote Control (SM-1000)	
VRP-SB-175-CH	3 - 10 psig 20 - 69 kPa	Gold (25-8236)	0.57 psig 3.9 kPa	3.1 psig 21 kPa	9 psig 62.1 kPa	
	7 - 30 psig 48 - 207 kPa	Beige (25-8238)	2.0 psig 13.7 kPa	11 psig 75.8 kPa	23 psig 159 kPa	
	15 - 50 psig 103 - 345 kPa	Burgundy (25-8239)	3.0 psig 21 kPa	16.5 psig 114 kPa	35 psig 241 kPa	
	20 - 85 psig 138 - 596 kPa	Pink (25-8240)	6.4 psig 44 kPa	35.2 psig 243 kPa	65 psig 448 kPa	
	50 - 175 psig 345 - 1207 kPa	Yellow (25-1306)	23 psig 157 kPa	125 psig 862 kPa	125 psig 862 kPa	
VRP-SB-600-CH	5 - 40 psig 34 - 246 kPa	Gold (25-8236)	2.1 psig 14.6 kPa	11.5 psig 79 kPa	35 psig 241 kPa	
	25 - 140 psig 172 - 965 kPa	Beige (25-8238)	7.4 psig 51 kPa	41 psig 283 kPa	115 psig 793 kPa	
	50 - 175 psig 345 - 1207 kPa	Burgundy (25-8239)	11.3 psig 78 kPa	62 psig 427 kPa	125 psig 862 kPa	
	135 - 300 psig 931 - 2069 kPa	Pink (25-8240)	24 psig 164 kPa	132 psig 910 kPa	165 psig 1138 kPa	
VRP-SB-1000-CH	275 - 600 psig 1896 - 4137 kPa	Yellow (25-1306)	85 psig 586 kPa	425 psig 2930 kPa	425 psig 2930 kPa	
	550 - 1000 psig 3792 - 6895 kPa	Yellow (25-1306)	143 psig 990 kPa	700 psig 4826 kPa	700 psig 4826 kPa	
VRP-SB-1500-CH	800 - 1300 psig 5516 - 8964 kPa	Grey (25-1562)	227 psig 1565 kPa	850 psig 5860 kPa	850 psig 5860 kPa	
	900 - 1500 psig 6205 - 10342 kPa	Violet (25-8073)	276 psig 1903 kPa	950 psig 6550 kPa	950 psig 6550 kPa	

Remote Setpoint Change Options

- The SM-1100 series motors accept a 24 VDC or 120 VAC input. The SM-1000 series motors accept a 4-20 mA signal and require a separate 12 VDC, 24 VDC or 120 VAC power connection.
- The total motor rotation is adjustable. The maximum number of motor rotations possible coupled with the spring rate determines the total setpoint range.

Principles of Operation

The VRP-SB-CH pilot and single-acting cylinder actuator can be used in conjunction with varying valve types to provide a complete package for stable and accurate pressure control over a wide range of applications. The energy for control valve operation comes from pressure differential between the pilot supply and discharge pressures. The regulated power gas channels through two adjustable orifices that supply gas to the actuator and exhaust gas from the actuator.

When the measured variable is at setpoint, both balance valves are closed and output pressure is in equilibrium with the actuator spring. The control valve remains stationary and there is no “bleed gas”. As the measured variable rises above setpoint, the supply balance valve will open while the exhaust balance valve stays closed. Output pressure will increase, and the control valve will close and lessen the flow. The measured variable returns to setpoint and the supply balance valve will close. The output pressure will have a new higher value and be in equilibrium with the new position of the actuator spring. If the measured variable falls below setpoint, the exhaust balance valve will open while the supply balance valve stays closed. The output pressure will reduce, and the control valve will open and flow will increase, which will return the measured variable to the setpoint. If one of the balance valves remains open, the output pressure will continuously change (either increase or decrease, depending upon which valve is open) until the control valve moves to the exact setpoint. Then the balance valves will close, and the control valve remains stationary.

This feature represents the auto-reset or integral characteristic of the pilot. The balance valves can be adjusted with slight dead-band to minimize constant correction of the control valve position. This will reduce the total gas consumption of the pilot, but will introduce a small error in the setpoint. There is no principal difference between spring to close and spring to open systems. VRP-SB-CH pilot reverse action is achieved by tubing supply to P1, output to P2, and exhaust to P4.

Adjustment Procedures

Initial adjustment procedures must be followed after original installation, when changing operating conditions, or after disassembly.

To change the setpoint or the response of the regulator, skip to the procedure for Fine Tuning Adjustment.

Initial Adjustment

Step 1: Adjust supply regulator to designated pressure (supply and exhaust orifices or metering valves should be wide open).

Step 2: Close valve on measured variable line. Then adjust measured variable pressure to desired value using false signal valves.

Step 3: Close output block valve.

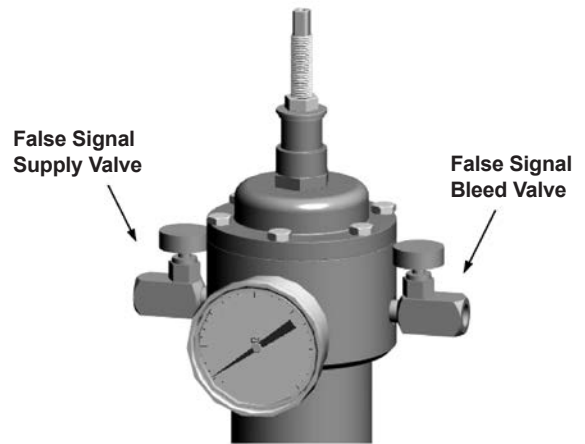


Figure 2 - Initial Adjustment

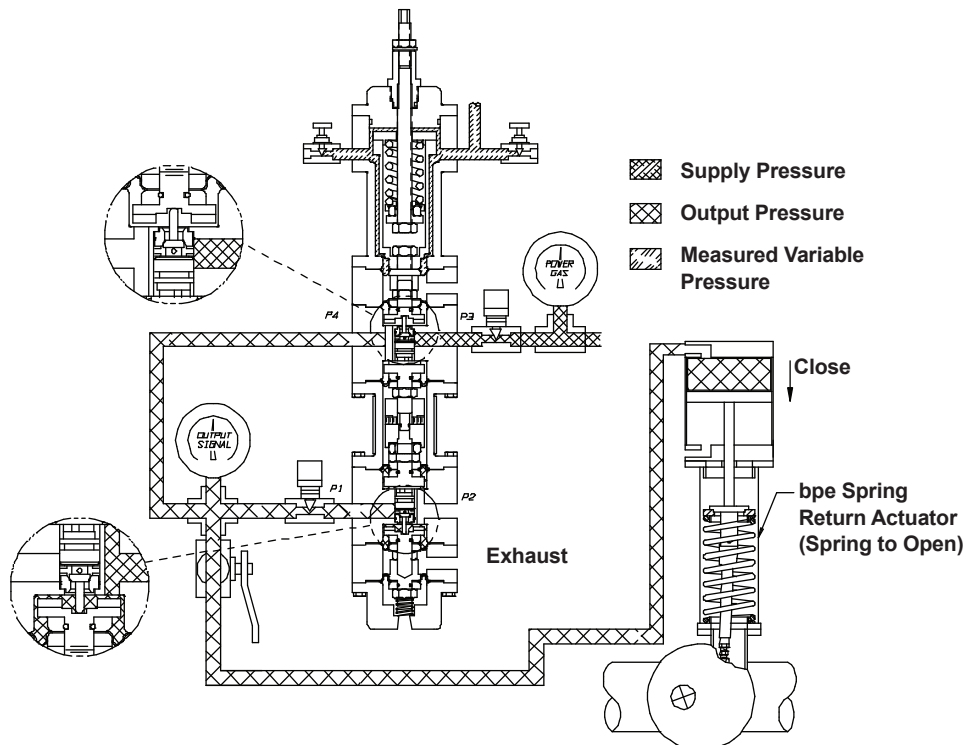
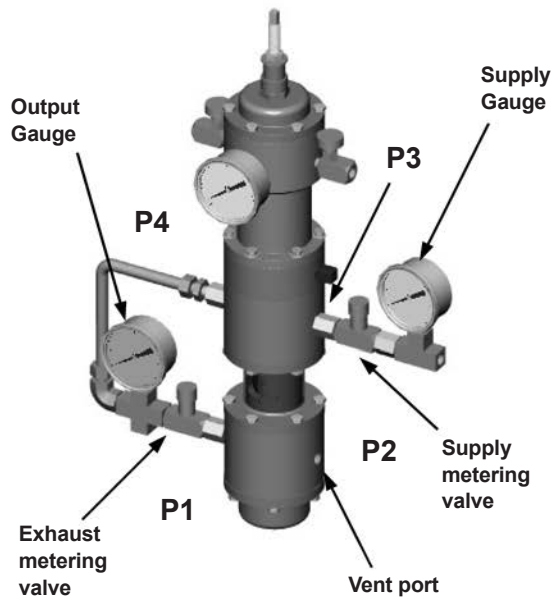


Figure 1 - VRP-SB-CH Pilot principles of operation

**DIRECT ACTING PILOT
(spring to open valve)**



**REVERSE ACTING PILOT
(spring to close valve)**

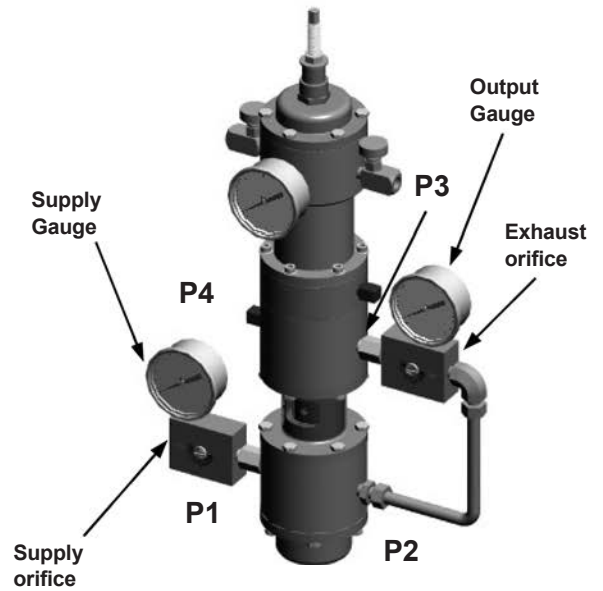
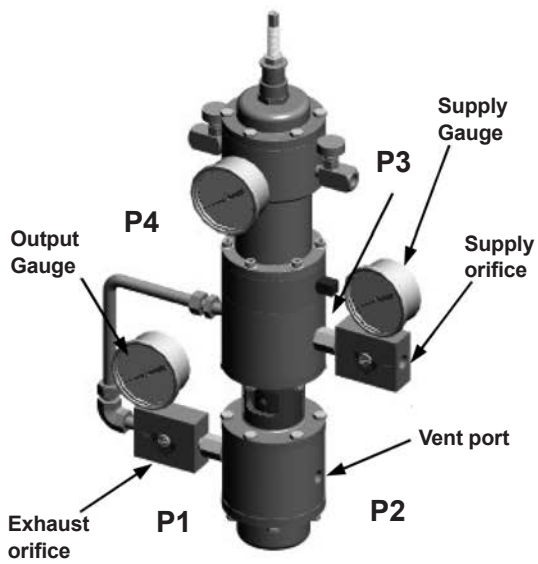
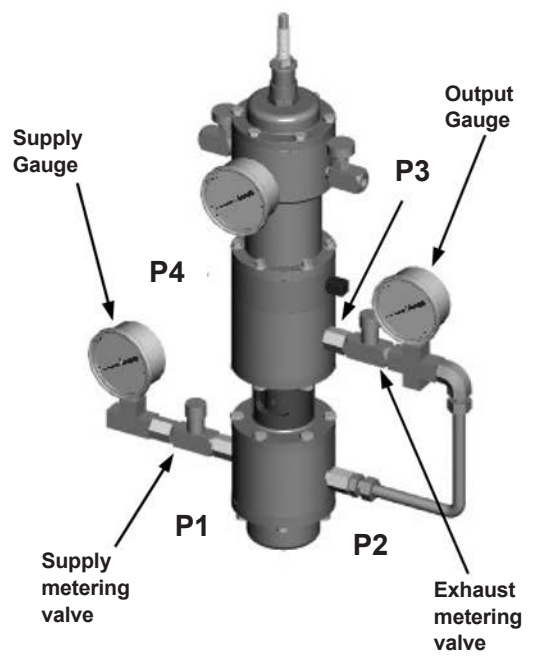


Figure 3 - Direct and Reverse Acting VRP-SB-CH Pilots

Step 4: Turn the adjusting screw counterclockwise until the control spring is fully unloaded. You will feel the screw becoming much easier to turn. (Refer to Figure 4)

Step 5: If this is the first time that the unit is being adjusted after assembly, first remove the locking set screw from the radial hole in the adjustment drum. This may require the drum to be rotated until the hole containing the set screw can be accessed. Once this is done, turn the sensitivity drum to the right as far as it will turn (in direction of increasing numbers). Then, turn the drum one (1) complete rotation to the left (use the numbers as a guide). (Refer to Figure 5)

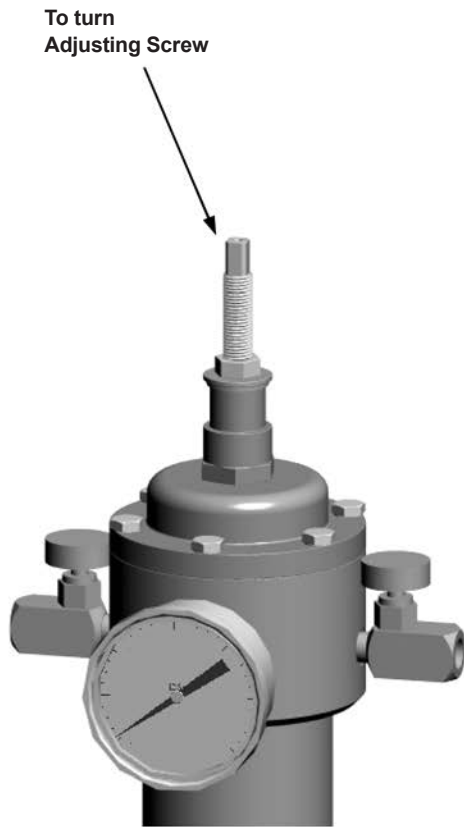


Figure 4 - Adjusting Screw

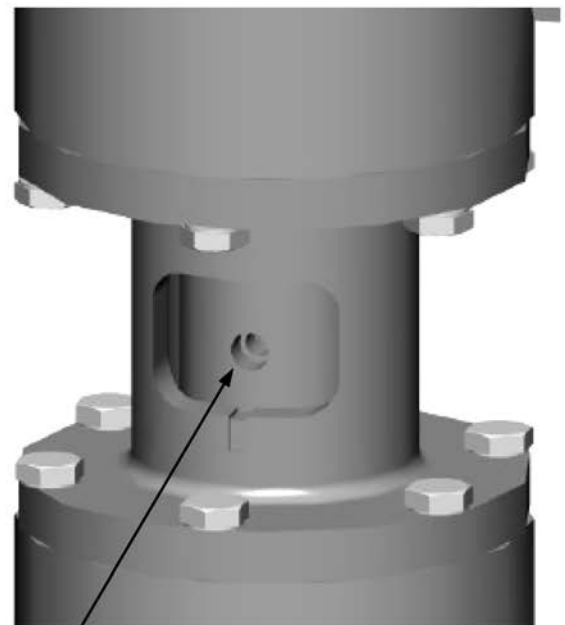


Figure 5 - Adjusting Drum

Radial holes: one contains the locking set screw and they can also be used to rotate the sensitivity adjustment drum.

• **For a Direct Acting Pilot** (supply gas to P3)

Step 6a: Turn the adjusting screw clockwise until the output gauge just drops off. (Refer to Figure 6)

For next step, go to Step 7.

• **For a Reverse Acting Pilot** (supply gas to P1)

Step 6b: Turn the adjusting screw clockwise until the output gauge just rises. (Refer to Figure 7)

For next step, go to Step 7.

Step 7: If the pilot vents gas, turn the adjusting drum to the left until the pilot stops venting gas. If pilot does not vent gas, turn the adjusting drum to the right until the pilot starts venting gas, then back off slightly to the left to stop the gas from venting.

Step 8: Adjust pilot at the set point by turning the adjusting screw.

Note: *The pilot is at set point when the output pressure is stationary and not at the maximum or minimum value.*

Step 9: If pilot vents gas turn the drum more to the left until it stops venting and then go back to step 8.

Step 10: When pilot is at set point and there is no vent gas, check if dead band is too large. Change the measure variable pressure above and below the set point about 3/4 percent of its value. The output pressure must reach its extreme values in about 5-10 seconds.

Step 11: To lock the deadband setting in place, insert the locking set screw into one of the radial holes in the sensitivity drum. Using a torque wrench, torque to 1 to 2 in-lbs. Care should be taken not to exceed this level, as if the screw is over-tightened it may affect the calibration of the pilot. If a torque wrench is not available, then torque the screw just enough so that it provides a light grip on the inner shaft.

Step 12: Open the block valve and measure variable line. Put pilot in control.

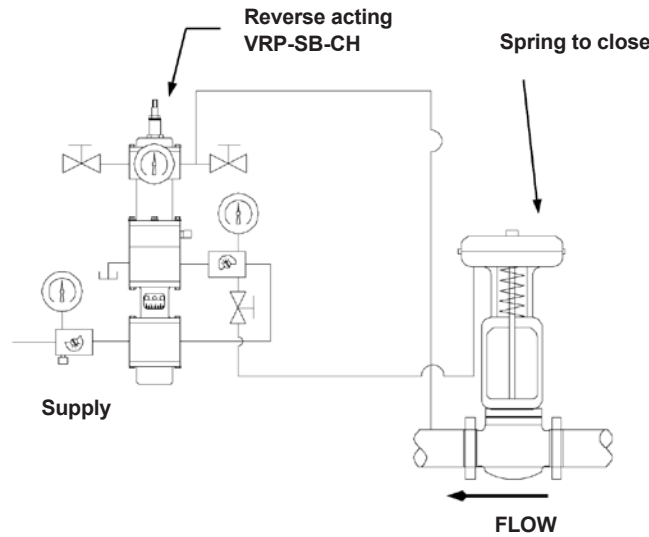


Figure 6

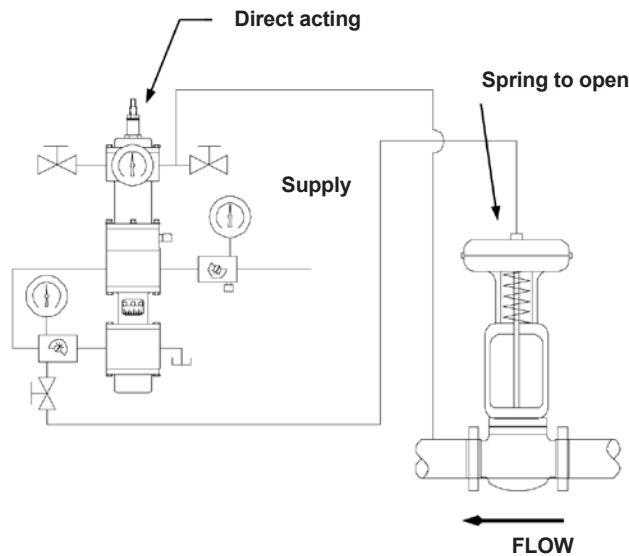


Figure 7

Fine Tuning Procedures

Dead Band

VRP-SB-CH pilot should be adjusted at the minimum dead band without steady-state bleed gas. In control, the dead band can be widened to decrease bleed gas further. The control accuracy will be reduced.

When adjusting deadband, make sure to first loosen the sensitivity drum locking set screw.

Once adjustment is complete, re-tighten locking screw as described in step 11 above.

Note: Steady state can be judged only when the control valve is stationary.

Speed of Response or Stability Adjustment

1. VRP-SB-CH pilot with globe-style control valve (spring and diaphragm actuator).

1.1. Standard Configurations

a. Power Gas

- 35 psig for 6-30 psig spring
- 20 psig for 3-15 psig spring
- 150 psig – maximum supply to VRP-SB-CH

b. Supply and exhaust orifices

Control valve “M”-medium, monitor valve “L” -large. If application is not known at the time of ordering, “M” orifices will be provided.

c. Installation

- VRP-SB-CH pilot should be installed as close as possible to the control valve.
- For actuators size 70 and larger, use ½ inch tubing between diaphragm motor and output of VRP-SB-CH pilot.
- Orifices are adjusted at the maximum value #6. If stability cannot be achieved, supply and exhaust orifices should be set at different values.

1.2. Stability Adjustment for Small Downstream System

The VRP-SB-CH pilot may be used with a damping tank. Supply and exhaust orifices are marked “M”, while the standard tank orifice is not marked.

This configuration is used for control valves installed for a short downstream system (for power plants use VRP-SB-PID controller).

- a. Start up the system with supply and exhaust orifices at the maximum value #6. The tank orifice should be at #1.
- b. If the control valve is unstable slowly increase the tank orifice until stability is achieved.
- c. If the control valve continues to cycle the supply and exhaust orifices should be set at different values.

Note: Supply or exhaust orifices should not be set less than #2 opening. If desired control is achieved with an orifice less than #2 opening, the orifice barrel should be replaced with a smaller one.

- d. If desired control cannot be achieved, VRP-SB-PID controller should be used.

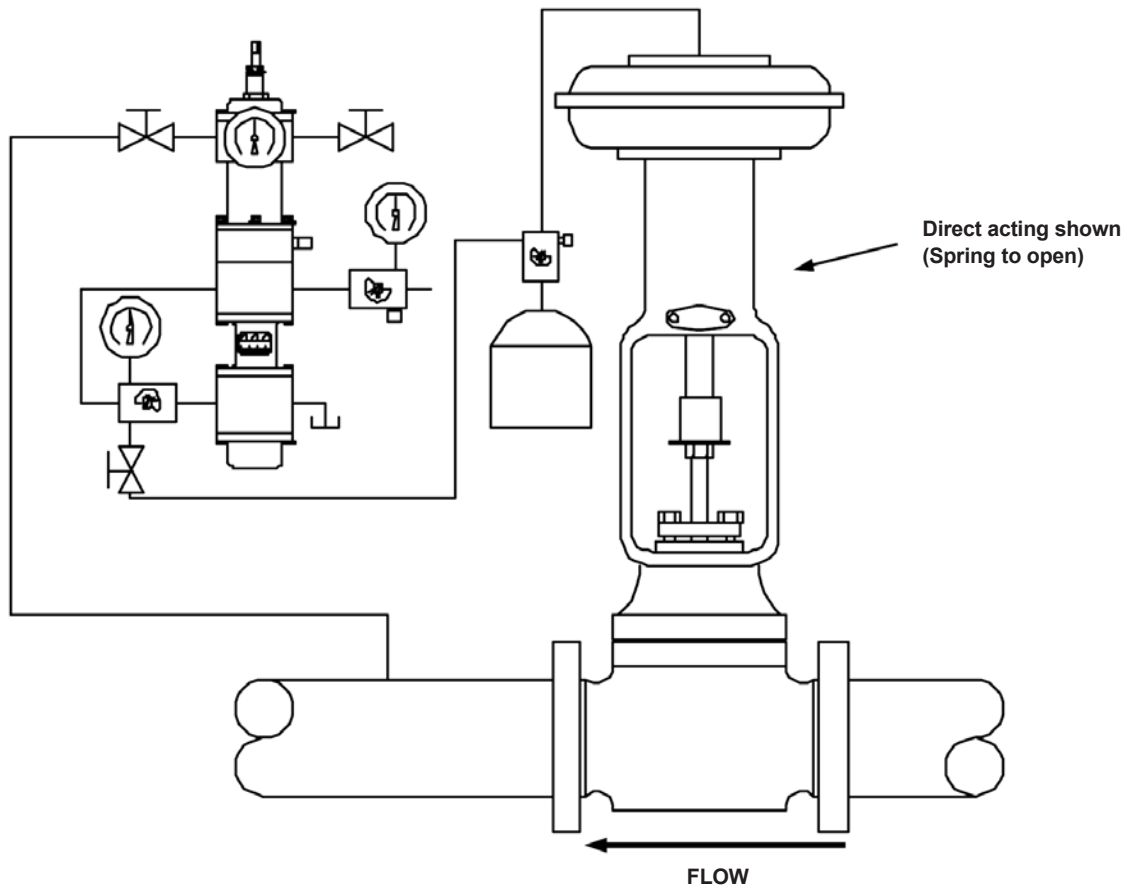


Figure 8

2. Spring and Piston Actuator (Single acting ball valve regulator BVR)

2.1. Standard configurations

- a. Typical power gas
 - 100-150 psig (discharge to atmosphere)
 - up to 400 psig (discharge to a pressure system)
 - 100 psig min. differential pressure required between power gas and discharge gas.
- b. Speed of response adjustment

1/4 inch NPT metering valves are used for supply and exhaust.

c. Installation

VRP-SB-CH pilot is typically mounted on the BVR.

When the VRP-SB-CH pilot is installed away from the BVR, 1/2 inch tubing is recommended.

2.2. Stability Adjustment

For short systems use VRP-SB-PID-150. Refer to section 1.2 (page 9). The same steps should be taken as outlined in the stability adjustment for a VRP-SB-CH pilot with spring diaphragm actuator.

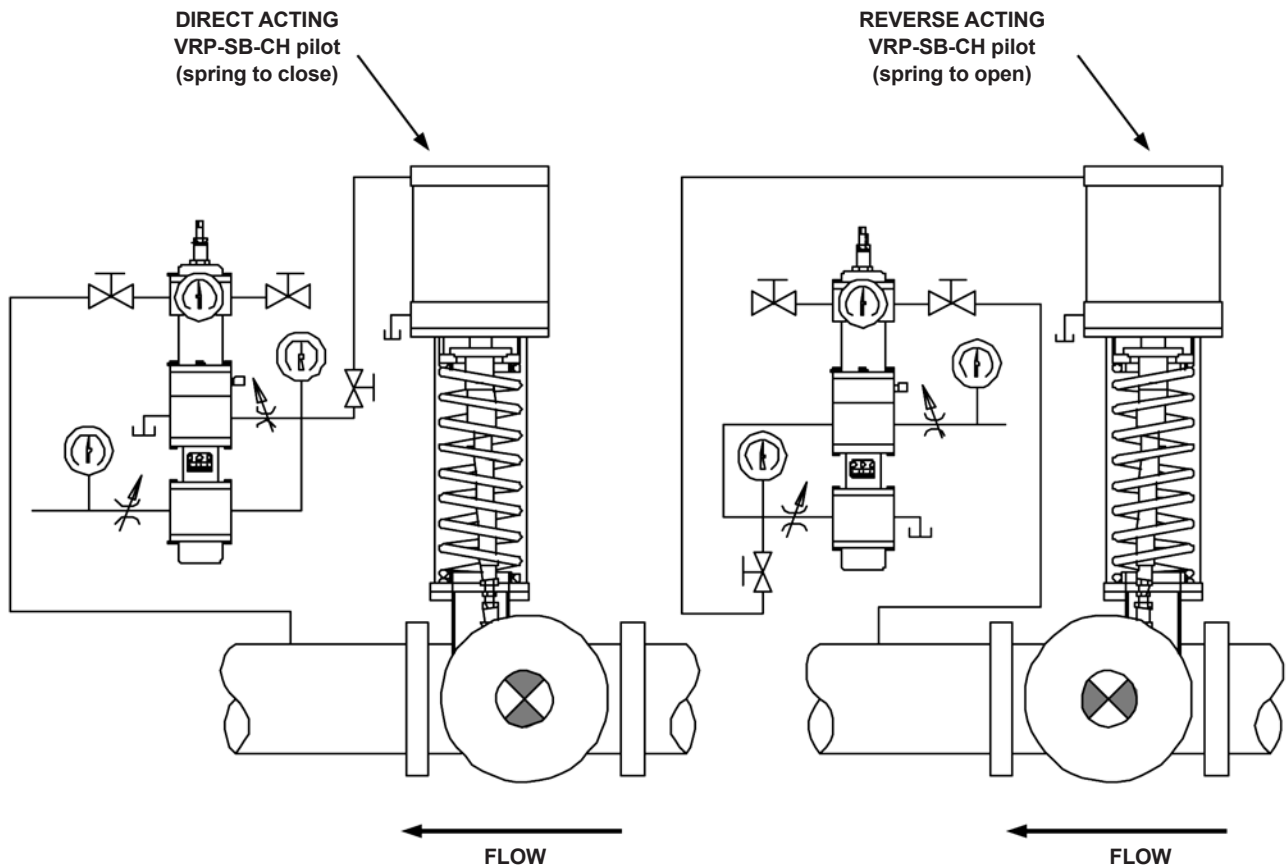


Figure 9

3. VRP-SB-CH pilot with pneumatic positioner (for large downstream systems only - for short systems, use VRP-SB-PID)

- a. Power gas
35 psig for 6-30 psi output
20 psig for 3-15 psi output
- b. Supply, exhaust and tank orifices
All orifices are "standard" (not marked).

c. Installation

- Use 3/8 inch tubing minimum between the VRP-SB-CH pilot and positioner.
- VRP-SB-CH pilot can be mounted directly on the control valve due to vibration resistance.
- Refer to table 4 for proper orifice settings

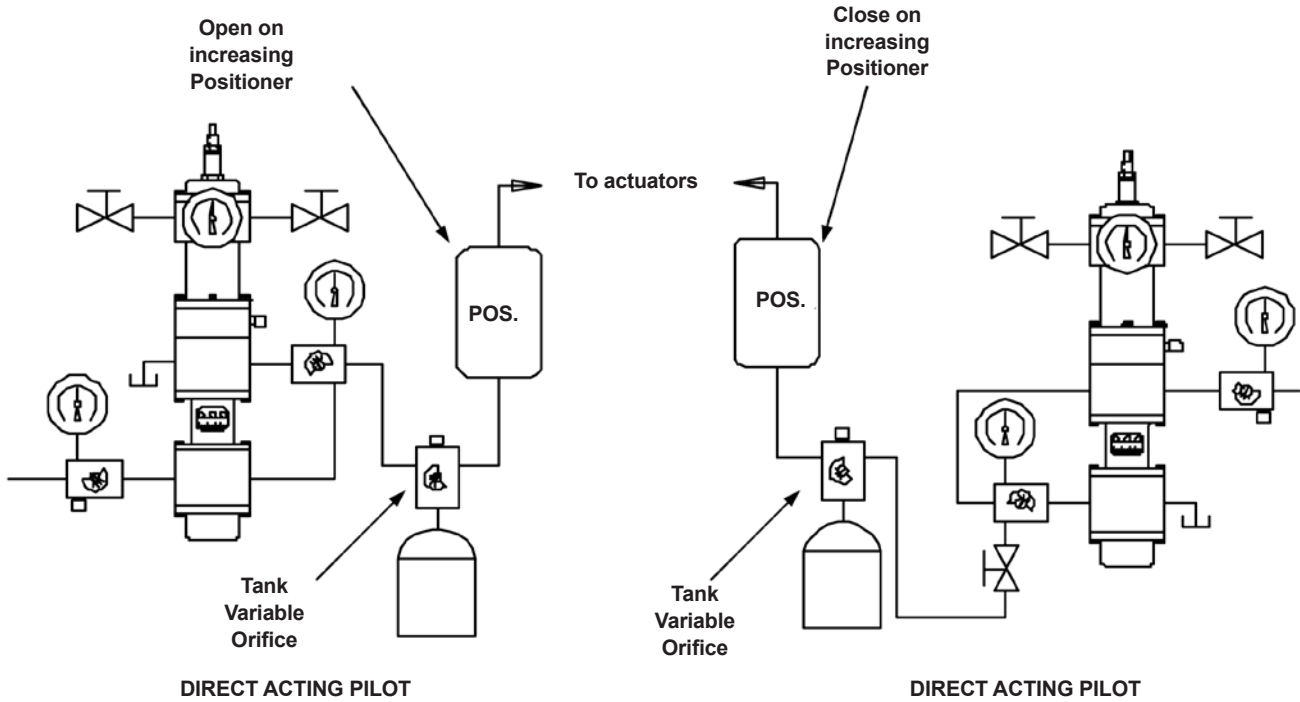


Figure 10

3.1 Stability Adjustment

- a. Set supply and exhaust orifices according to the following table:

Orifice Settings for VRP-SB-CH (Case 4)			
Distance in ft. between VRP-SB-CH and positioner	Supply and Exhaust orifice #	Distance in ft. between VRP-SB-CH and positioner	Supply and Exhaust orifice #
Up to 10	3	30	5
15	3½	35	5½
20	4	40	6
25	4½		

- b. Start up the system with all orifices set at #3.
- c. Control valve is in a slow cycle (1-3 minutes). Observe the regulator response. Adjust the tank orifice to smaller settings until full stability is achieved.

- d. If required opening of the tank orifice is approaching #1, increase the supply and exhaust orifices by a ½ number and then readjust the tank orifice.
- e. If the control valve is in a fast cycle (5-30 sec.), slow down the response by increasing the orifice in the tank orifice.

Note: A smaller number on the tank orifice represents faster response of the VRP-SB-CH pilot.

- f. If stability cannot be achieved, the supply and exhaust orifices must be adjusted to different settings.

Set Point

The setpoint may need adjustment when the regulator is placed in service after the initial adjustments. If so, refer to Table on page 4 to determine the change in setpoint pressure per turn of the adjusting screw. When the adjusting screw is properly set, tighten the adjusting screw locknut.

Inspection Procedure

As with all Becker pilots, it is necessary to periodically test the pilot to ensure optimum performance. We recommend the following procedure once a year.

1. Close the output block valve to prevent the control valve from moving. Close the valve on the measured variable line.
2. If the VRP-SB-CH pilot is equipped with speed control valves, skip this step and go to step 3. Shut off supply pressure and bleed down at pilot. Note settings of the adjustable orifices before removing them from the orifice assembly. Remove the adjustable orifices and clean them thoroughly. Reinstall using new O-rings, being sure to install each orifice in the same hole form which it was removed. Reset the adjustable orifices to original settings noted above. Turn on supply pressure.

3. Balance valve and seat inspection

Change the control pressure at least 5 percent above and below the set point using the “false signal” valves found on the bottom of the pilot. In each case soap test the exhaust port:

a. For Direct-Acting VRP-SB-CH, exhaust port is P2

When the control pressure is above the setpoint, the supply balance valve is open and the exhaust balance valve (bottom block) is closed. Gas exhausting from port P2 indicates wear and contaminants in the exhaust balance valve assembly (bottom block).

When the control pressure is below the setpoint, the supply balance valve is closed and the exhaust balance valve (bottom block) is open. Gas exhausting from port P2 indicates wear or contaminants in the supply balance valve assembly (top block).

b. For Reverse-Acting VRP-SB-CH, exhaust port is P4

The supply and exhaust balance valves are opposite to direct acting case above.

Note: If a leak is found through one balance valve only, it is not necessary to take apart both top and bottom blocks. Only the block with the damaged balance valve assembly requires disassembly.

4. Soap test around all diaphragms, vents, and orifice assembly. Unless a leak is found, it is not necessary to take the pilot apart. If any leak is found around the diaphragms, all rubber goods must be replaced. Take the pilot apart, replace all rubber goods, and reassemble the pilot.
5. Apply a “false signal” pressure in the sensing chamber. Observe operation of the gauges. If any gauges are defective, replace them.
6. Perform internal friction test.
7. Readjust the Becker VRP-SB-CH pilot if necessary.

Internal Friction Test

Friction may occur due to any one, or a combination of the following reasons:

- a. The diaphragms are not centered properly.
- b. The control spring is not seated properly over the spring nut, or defective.
- c. Dirt or ice build up inside pilot.

Step 1: Adjust the pilot using INITIAL ADJUSTMENT procedure. Keep pilot at the setpoint and close output block valve.

Step 2: Eliminate the dead-band by turning the drum to the right about one or two divisions (turn in the direction of increasing numbers). The VRP-SB-CH pilot must have slight continuous bleed gas. Turn the adjusting screw back and forth. Observe the output gauge response. If response of the output gauge hesitates or the pressure moves in the opposite direction of the adjusting screw rotation, the VRP-SB-CH pilot has internal friction. For example if the VRP-SB-CH is direct acting, as the adjusting screw is rotated clockwise the output gauge should go down without hesitation. If the gauge goes up or hesitates before going down, internal friction is present.

Step 3: If internal friction is found, take the VRP-SB-CH apart and reassemble it.

The above test procedure precisely indicates the mechanical and pneumatic condition of the Becker VRP-SB-CH pilot. Should you require any additional information or assistance, contact Baker Hughes for technical assistance.

Annual Maintenance Checklist

Refer to inspection procedure previously described.

1. _____ Depressurize the VRP-SB-CH valve regulator pilot and disassemble the adjustable orifice assembly (if equipped). Clean the adjustable orifice assembly rotors as needed and reassemble.
Refer to Step 2, Page 12.
2. _____ Soap test all diaphragm mating surfaces and the adjustable orifice assembly (if equipped) for leaks.
Refer to Step 4, Page 12.
3. _____ Pressurize the VRP-SB-CH upon reassembly. Confirm that the power gas pressure is correct.
Refer to Step 1, Page 5.
4. _____ Check the operation of all gauges and replace as necessary.
5. _____ Verify satisfactory operation of the balance valve/seat assemblies.
Refer to Step 3, Page 12.
6. _____ Perform an internal friction test.
Refer to Page 12.
7. _____ Perform the initial pilot adjustment procedure.
Refer to Page 5.
8. _____ Inspect and verify the proper operation of all VRP-SB-CH valve regulator pilot accessories.
Refer to Page 19.
9. _____ Return the VRP-SB-CH valve regulator pilot to service and perform fine tuning as needed.
Refer to Page 9.

Note: It is not necessary to replace any rubber goods in Becker control valve instrumentation or instrumentation accessories on a regular basis. However, common practice suggests that replacement of rubber goods on a five-year cycle basis provides adequate preventative maintenance.

Parts Ordering

The following is provided to allow the ordering of replacement parts. Please specify the Becker instrument serial number when ordering parts (this can be found on the stainless steel tab attached to the pilot by the 7/16 hex head cap screws). If the instrument was supplied as a complete valve regulator package, the stainless tag attached to the actuator piston can also provide the serial number. (Refer to Figure 11)

Key	Description	Part No.	Quantity
1	Top Inside Piston	35-1528	1
2 ⁽¹⁾	1/4-20 x 3/4 HHCS S.S.	98-3137	12
3	Bottom Inside Piston	35-1529	1
4	Outside Piston	35-1506	2
5	HPP-SB Top Body S.S	35-1546	1
6	Lexan Cover	25-1034	1
7	Seat Cover	35-1519	2
8	10-32 x 3/8 FSHMS S.S	98-2684	4
9	Strainer for B.V	35-1559	2
10	Washer	25-1016	8
11	Sensitivity Spacer S.S	25-8156	1
12	O-Ring -010	95-2609	1
13	Balance Valve Assy	35-1510	2
14	HPP-SB Bottom Body S.S	35-1545	1
15	Seat Spacer	35-1526	2
16 ⁽²⁾	1/2-20 Hex Jam Nut S.S	98-3056	2
17	Seat Assy	01-7082	2
18 ⁽²⁾	1/2-20 Alum Nut	25-1065	1
19	Thrust Bearing	25-1062	1
20	Adjusting Drum	35-1534	1
21	O-Ring -012	95-2615	4
22	Pilot Post	35-1535	4
23	8-32 x 1/2 SHCS	98-2614	8
24	Diaphragm w/ convolute	25-1027	3

⁽¹⁾ Torqued to 95 to 100 in-lbs.

⁽²⁾ Torqued to 140 to 160 in-lbs.

Seal Kits

A seal kit containing diaphragms, O-rings, seats, and balance valve assemblies for the VRP-CH pilot is available directly from Baker Hughes. Simply contact Baker Hughes and refer to the appropriate part number from the following table.

VRP-SB-CH Pilot Model	Repair Kit Part No.
VRP-175-SB-CH	30-9302
VRP-600-SB-CH	30-9304
VRP-1000/1500-SB-CH	30-9305

VRP-SB-CH Pilot Blank without Bottom Cartridge Parts

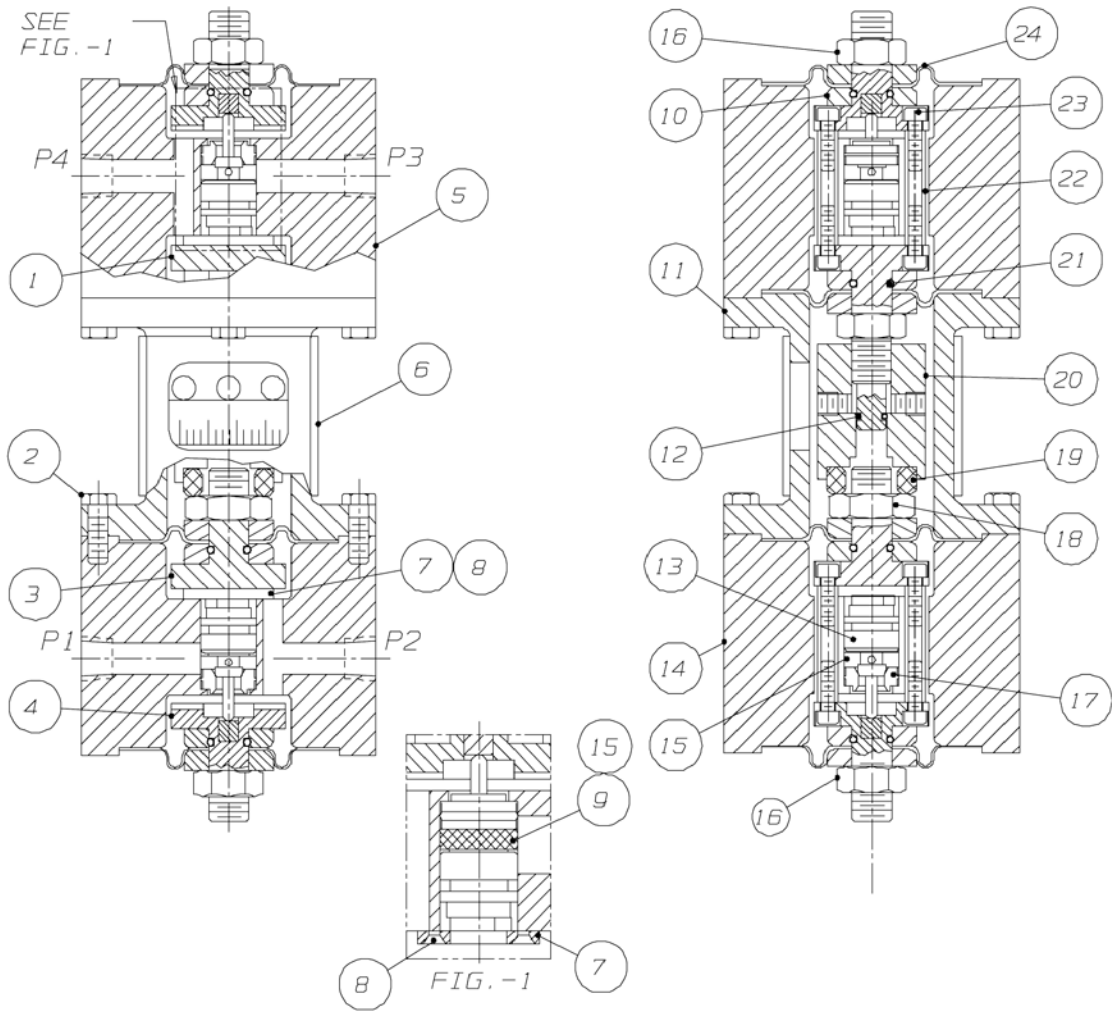


Figure 11 - VRP-SB-CH Pilot Blank without Bottom Cartridge

VRP-SB-CH Pilot Spring Chamber Parts

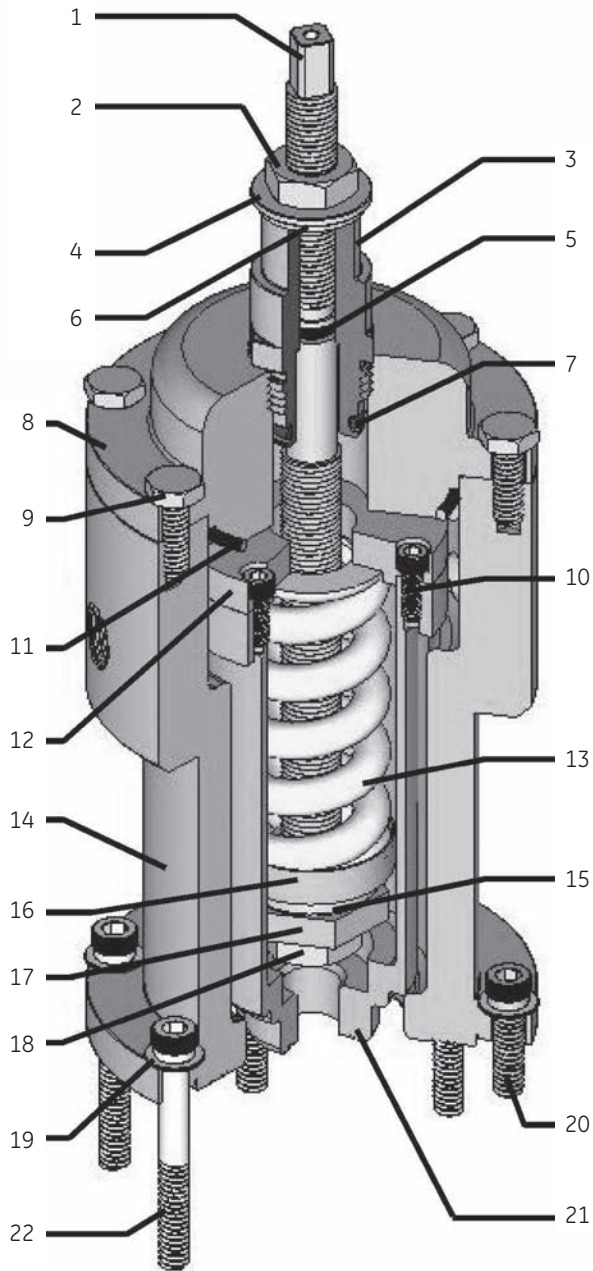


Figure 12 - 175/600-CH Spring Chamber

175/600-CH Spring Chamber Assembly Anodized Aluminum⁽¹⁾ Part # 30-0012

Key	Part Number	Description
1	30-7022	Adjusting Screw
2	98-2500	7/16 in. - 20 in. Jam Nut
3	30-7009	Seal Neck
4	98-3181	7/16 FT Washer (SS)
5	95-2672	O-Ring - 108
6	30-7017	7/16 Thread Seal
7	95-2670	O-Ring - 115
8	30-7008	Cartridge Cap for 175/600-CH
9	98-3137	1/4-20 in. x 3/4 in. HHCS (SS)
10 ⁽²⁾	98-3269	8-32 x 1/2 in. SHCS (Alloy) (FEP only)
11	95-2671	O-Ring - 141
12	30-7007	Standard Tube Cap
13	25-1306	Yellow Spring
14	30-7002	Spring Cartridge for 75/600-CH
15	25-1062	Thrust Bearing
16	30-7006	Standard Bearing Case
17	30-7001	Bearing Nut
18	98-3213	1/2 in. - 20 in. LH Jam Nut (316)
19	98-3227	0.250 in. x 0.500 in. Washer (Fiberglass)
20	98-3228	1/4-20 x 7/18 in. SCHS (SS) for 175-CH
21	30-7003	Inner Tube
22	98-3230	1/4-20 x 2 in. SCHS (SS) for 600-CH

⁽¹⁾ Stainless steel versions available

⁽²⁾ Item #10 is 98-2614 (8-32 x 1/2 inch SS) for VRP models

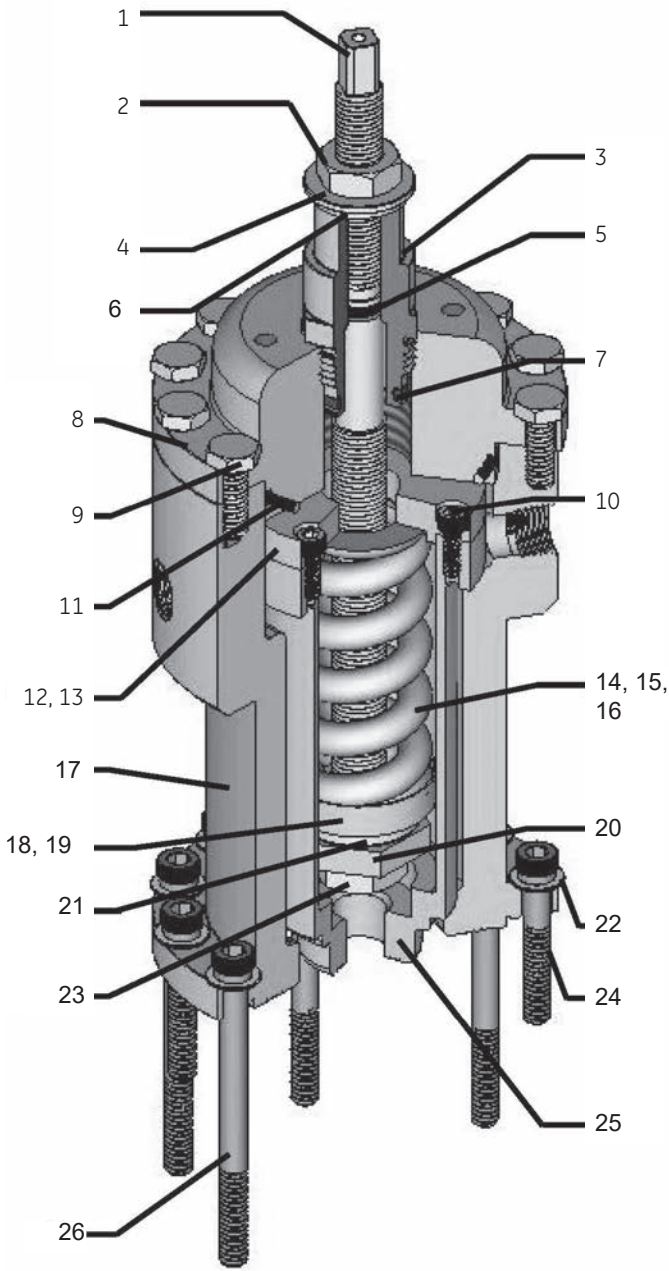


Figure 13 - 1000/1500-CH Spring Chamber

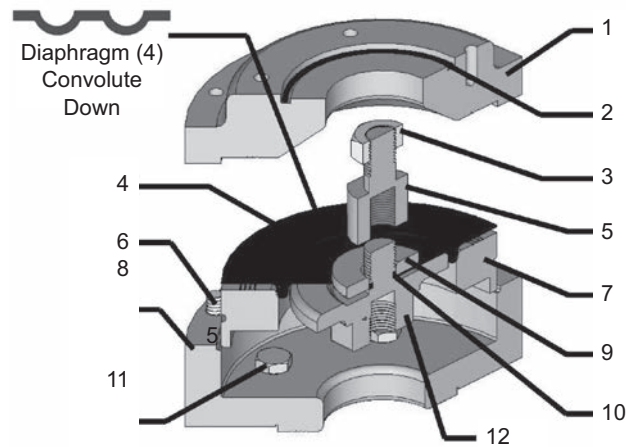
**1000/1500-CH Spring Chamber Assembly
Anodized Aluminum⁽¹⁾ Part # 30-0013**

Key	Part Number	Description
1	30-7022	Adjusting Screw
2	98-2500	7/16 in. - 20 in. Jam Nut
3	30-7009	Seal Neck
4	98-3181	7/16 FT Washer (SS)
5	95-2672	O-Ring - 108
6	30-7017	7/16 Thread Seal
7	95-2670	O-Ring - 115
8	30-7008	Cartridge Cap for 1000/1500-CH
9	98-3137	1/4-20 x 3/4 in. HHCS (SS)
10 ⁽²⁾	98-3269	8-32 x 1/2 in. SHCS (Alloy) (FEP and 1500-CH only)
11	95-2671	O-Ring - 141
12	30-7007	Standard Tube Cap
13	30-7085	Tube Cap (SS) for 1500-CH
14	25-1306	Yellow Spring
15	25-1562	Gray Spring for 1500-CH (800-1300 psig)
16	25-8073	Violet Spring for 1500-CH (1000-1500 psig)
17	30-7023	Spring Cartridge for 1000/1500-CH
18	30-7006	Standard Bearing Case
19	30-7027	Bearing Case for 1500-CH
20	30-7001	Bearing Nut
21	25-1062	Thrust Bearing
22	98-3227	0.250 in. x 0.500 in. Washer (Fiberglass)
23	98-3213	1/2 in. - 20 in. LH Jam Nut (316)
24	98-3229	1/4 - 20 x 1 1/2 in. SCHS (SS)
25	30-7003	Inner Tube
26	98-3231	1/4-20 x 2 in. SCHS (SS)

⁽¹⁾Stainless steel versions available

⁽²⁾Item #10 is 98-2614 (8-32 x 1/2 inch SS) for VRP models (except 1500-CH)

VRP-SB-CH Pilot Sensing Chamber Parts



Maximum Allowable Operating Pressure (MAOP) = 225 psig

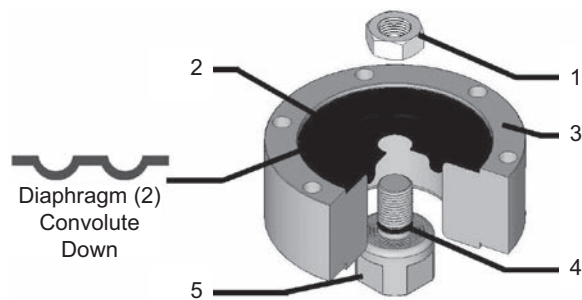
Figure 14 - 175-CH Sensing Chamber

175-CH Sensing Assembly Anodized Aluminum⁽¹⁾ Part # 30-0021

Key	Part Number	Description
1	30-7024	Cartridge Space
2	95-2656	O-Ring - 038
3	98-3056	1/2 in. - 20 in. Jam Nut (316)
4	30-7012	Diaphragm w/Hole
5	30-7015	Thread Extension
6	98-3153	1/4-20 x 1 1/2 in. HHCS
7	35-1549	Spacer
8	35-1548	Bottom Flange
9	30-7020	Washer
10 ⁽²⁾	95-2615	O-Ring - 012
11	98-3137	1/4-20 x 3/4 in. HHCS
12	30-7025	Piston

600-CH Sensing Assembly Anodized Aluminum⁽¹⁾ Part # 30-0020

Key	Part Number	Description
1	98-3056	1/23-20 Jam Nut (316)
2	25-1027	Diaphragm w/Convolute.
3	25-1156	Bottom Spacer
4	95-2615	O-Ring - 012
5	25-1177	Bottom Piston



Maximum Allowable Operating Pressure (MAOP) = 600 psig

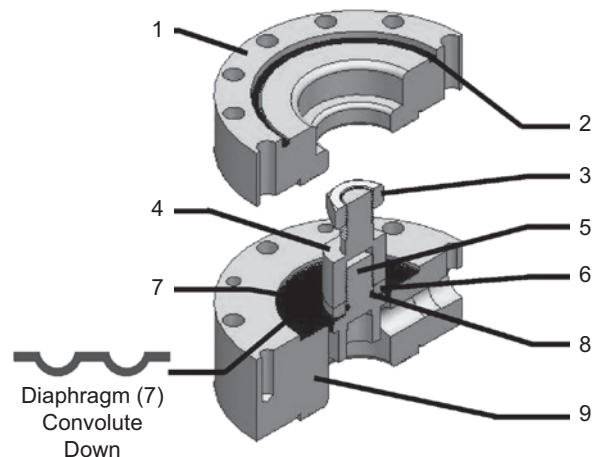
Figure 15 - 600-CH Sensing Chamber

1000/1500-CH Sensing Assembly Anodized Aluminum⁽¹⁾ Part # 30-0019

Key	Part Number	Description
1	30-7016	Adapter Block
2	95-2665	O-Ring - 145
3	98-3056	1/2-20 Jam Nut (316)
4	30-7015	Thread Extension
5	30-7010	Small Piston
6	30-7014	Small Washer
7	30-7011	Convolute Diaphragm w/Hole
8	95-2615	O-Ring - 012
9	30-7058	Top Spacer

⁽¹⁾Stainless steel versions available

⁽²⁾Item #10 is 98-2614 (8-32 x 1/2 inch SS) for VRP models (except 1500-CH)



Maximum Allowable Operating Pressure (MAOP) = 1500 psig

Figure 16 - 1000/1500-CH Sensing Chamber

Appendix

Flow Calculations

$$Q_C = 312.8 \times P_1 \times C_V \times \sqrt{\frac{1}{G \times (T + 460)}}$$

Critical Flow

Variables:

Q_C = critical flow across the inlet orifice in scfh

P_1 = supply pressure to the pilot in psig

C_V = flow factor

G = specific gravity of the gas

T = temperature of the gas in °F

Supply Regulator Capacity

$$Q_{SRC} = Q_{C(Max)}$$

Variables:

Q_{SRC} = supply regulator capacity

Travel Time

Minimum travel time (the time the valve takes to move from one extreme position to another) is achieved when the signal deviates 3 percent or more from the set point. This time can be calculated using the following empirical formulas and should be used for reference only. The formula is derived from the pilot.

$$t_1 = 0.148 \times \frac{S \times D^2}{C_V} \times \sqrt{\frac{G}{T + 460}}$$

a) Pilot bleeds to the atmosphere:

Variables:

t = time in seconds

S = cylinder stroke in inches

D = cylinder diameter in inches

C_V = flow factor (for orifice or booster)

b). Pilot bleeds to a pressure system:

$$T = t_1 + 0.0003906 \times S \times D^2 \times P_2$$

Orifices C_V Table								
Orifice	Opening Number							
	0	1	2	3	4	5	6	7
“STD”	0.003	0.004	0.009	0.026	0.042	0.071	0.099	0.122
“M”	0.043	0.046	0.063	0.09	0.135	0.173	0.212	0.250
“L”	0.043	0.062	0.173	0.327	0.462	0.577	0.635	0.674

Accessories

The following accessories are available to enhance the operation or provide additional features to your VRP-CH series double-acting pilot control system. For additional information regarding a specific VRP-CH pilot accessory, contact Baker Hughes.

SP Series Setpoint Change Pump:

Provides a simple and accurate method of applying false signal pressure during initial adjustment of the VRP pilot. The pump can provide a false signal pressure of 10 to 20 percent in excess of working pipeline pressure, which eliminates the need for nitrogen bottles or electronic calibration devices.



Remote Setpoint Module:

Provides remote adjustment of VRP-B pilot set point via an electrical signal. Standard input signals are 24 VDC pulse and 120 VAC pulse. A 4-20 mA input signal motor is available. All motors provide 4-20 mA setpoint feedback.



AB Series Atmospheric Bleed Control:

Maintains minimum pressure differential across the cylinder. AB control is required to provide the necessary output to operate the control valve under all design conditions.



Note: See page 7 for adjustment information.

Setpoint Change Indicator:

Provides a visual indication of the setpoint change from a known reference setpoint. This device reduces the time required to vary setpoint occasionally such as "winter" and "summer" setpoints for high and low pipeline system demand.



VB Series Volume Boosters:

Provides additional volume capacity to the VRP-SB-CH pilot for use with large volume control valve actuators. The VB series volume boosters may also be used for applications that require additional speed of operation. The VB-250 volume booster offers no adjustments. All adjustments to the boosters response are controlled through the pilot orifices and sensitivity drum. Refer to the pilot initial adjustment procedures for further information.



VB-250 Troubleshooting

In steady state the exhaust port of the VB-250 volume booster should be bubble tight. If the booster vents gas, the diaphragm assembly or main supply valve may be worn out or defective.

Assembly Procedures

Note: During assembly, moisten all O-rings, threads, thrust bearing, and the recess in the spring seat with lightweight silicone grease. Take special care to avoid applying grease to diaphragm sealing surfaces, as this may compromise diaphragm sealing.

Step 1: Using a 7/16-inch socket, press the seat assembly (E) with the rubber seat facing downward into the bottom body (F).

Step 1a: Insert the spacer (D) together with the strainer (D1).

Step 1b: Insert the balance valve assembly (C) with the stem facing downward.

Step 1c: Secure the assembly in the bottom body (F) with the seat cover (B) and two Phillips head machine screws (A).

Step 2: Repeat the process by inserting the second seat assembly (E) into the top body (G).

Step 2b: Insert the second spacer (D) together with the strainer (D1).

Step 2c: Insert the second balanced valve assembly (C).

Step 2d: Secure the assembly in the top body (G) with the seat cover (B) and two machine screws (A).

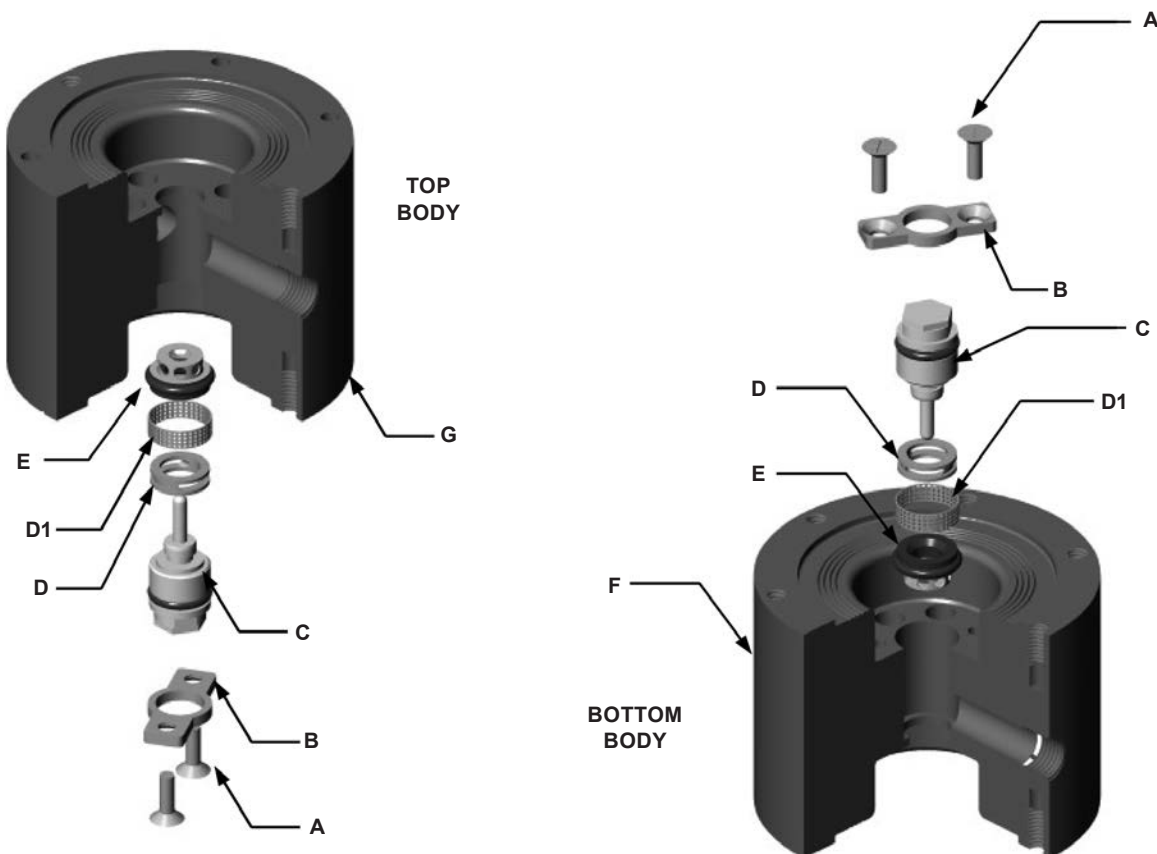


Figure 17 - Steps 1 and 2

Step 3: With the balance valve assemblies now installed, perform a leak test of the top and bottom valve bodies by doing the following:

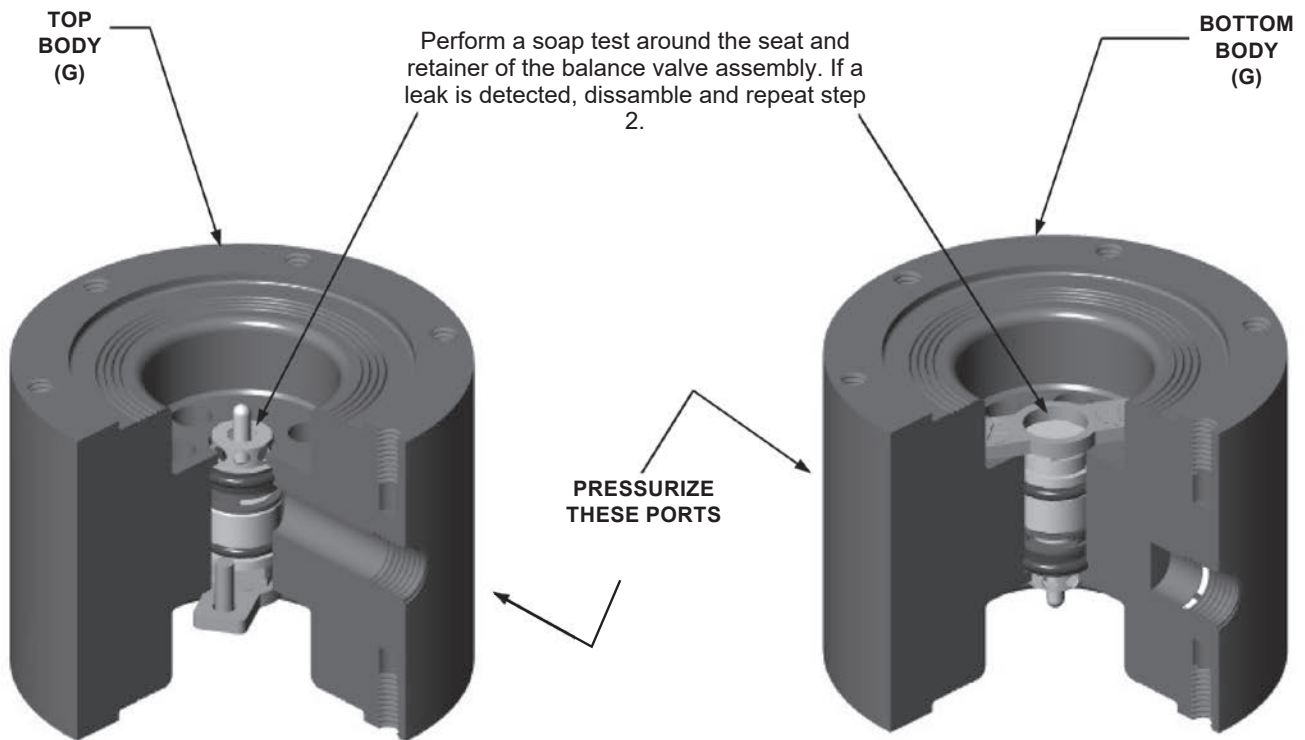


Figure 18 - Step 3

Step 3b: Apply approximately 100 psig air to the supply ports of the bottom and top valve bodies, marked 'P1' and 'P3' respectively. Soap around the valve seat (found on the stem side of the valve) and the back end of retainer. If a leak is found, check the O-ring integrity and contamination between the balance valve and the seat.

Step 4: Install -012 O-rings (J) onto the groove on each piston and -010 O-ring (N) onto the stem of the top body's inside piston (L).

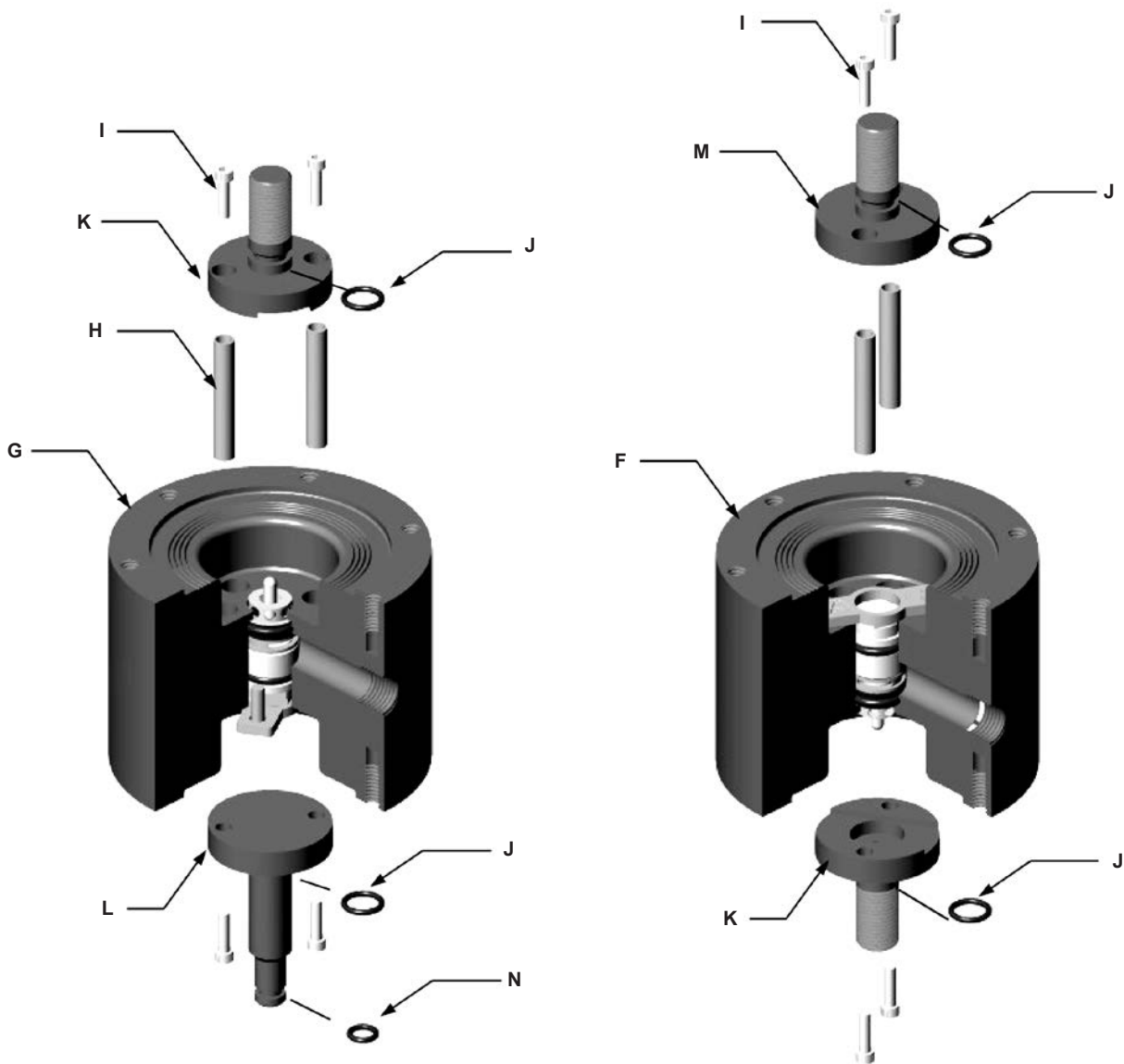


Figure 19 - Step 4

Step 4a:

Attach the posts (H) to the outside pistons (K) with 8-32 x 1/2 inch SHCS (I).

Step 4b:

Slide the posts and outside piston assemblies through the bodies and attach them to inside pistons (L and M) with 8-32 x 1/2 inch SHCS (I).

Step 5: Slide one grooved washer (O) onto each piston with the grooves facing away from the body.

Step 5a: Install convolute diaphragms (R) onto each piston as shown (see note).

Step 5b: Install another washer (O) onto each piston with grooves facing the diaphragms.

Step 5c: Secure the diaphragm assemblies by threading 1/2-20 hex jam nuts (S) onto the inside piston of the top body (G) and the outside piston of the bottom body (F).

Step 5d: Install the special flat nut (Q) onto the inside piston of the bottom body (F). Torque all nuts (S,Q) to 140 to 160 in-lbs.

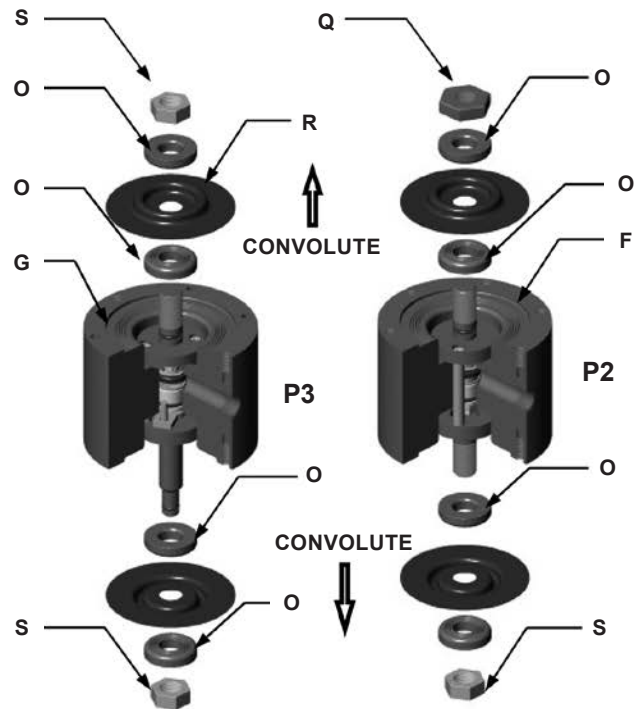


Figure 20 - Step 5

Step 6: Press fit the thrust-bearing (U) into the adjusting drum with the stamped letters side first (this will place the bearing case inside the drum with the bearing surface freely rotating).

Step 6a: Install the adjusting drum to the inside piston (L) of the top body (G) by threading the drum until it touches the 1/2-20 hex jam nut (S).

Step 6b: Insert the 1/4-20 x 1/2 inch SS set screw (GGGG) into the adjusting drum (T), but do not tighten it. The screw will be tightened after pilot set-point adjustment.

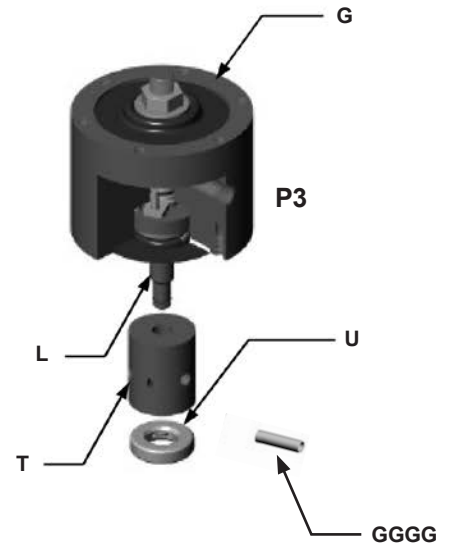


Figure 21 - Step 6

Step 7: Center the posts assemblies in the bodies (F and G) by:

1. Rotating the diaphragm assemblies (from step 5) counter-clockwise until they stop (1).
2. Marking the diaphragms and bodies (F and G) with a single line.
3. Rotating the diaphragm assemblies clockwise until they stop (3).

4. Marking bodies (F and G) with extensions from the lines on the diaphragms.
5. Centering the line on the diaphragm between the two lines on each body (2).

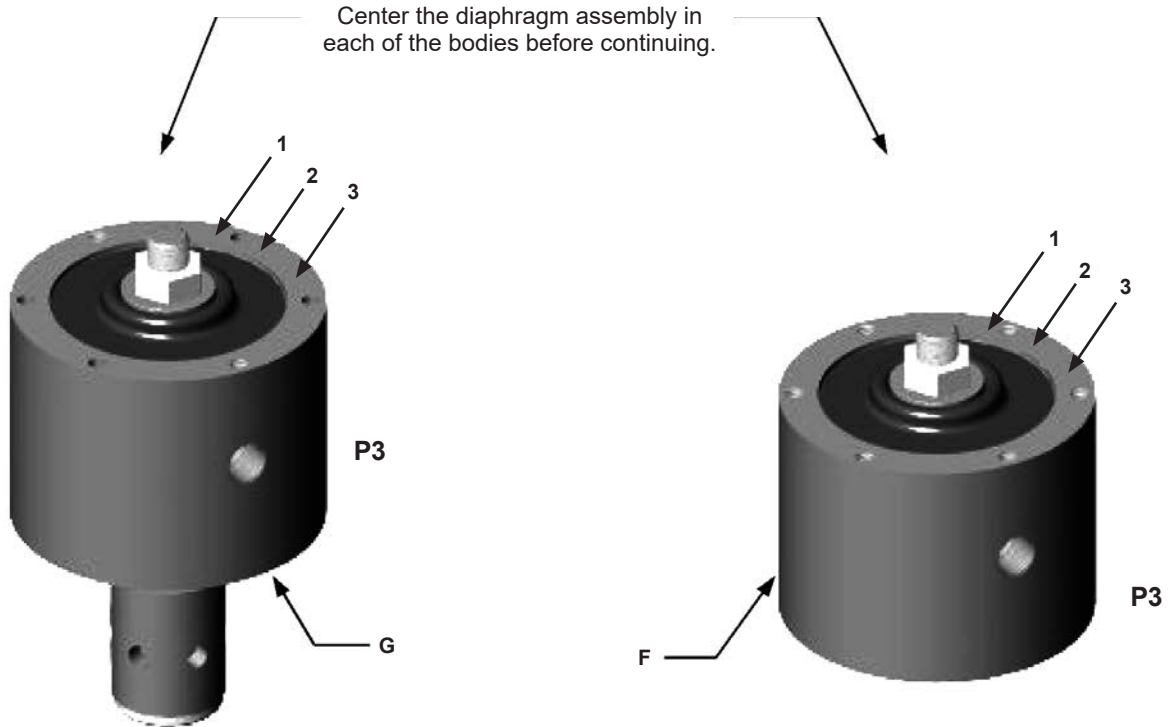


Figure 22 - Step 7

Step 8: Keeping the diaphragms securely in the center, between the inscribed lines, fasten the sensitivity spacer (V) to the top and bottom bodies (F and G) with twelve 1/4-20 x 3/4 inch HHCS (W). This will secure the diaphragm and prevent it from moving any further.

Place the bottom spring (P) into the cavity in the cartridge (Z). Bolt the cartridge (Z) to the bottom body (F) using six 1/4-20 x 3/4 inch HHCS (W).

Note: Align the numbers stamped on the pilot parts in numerical order.

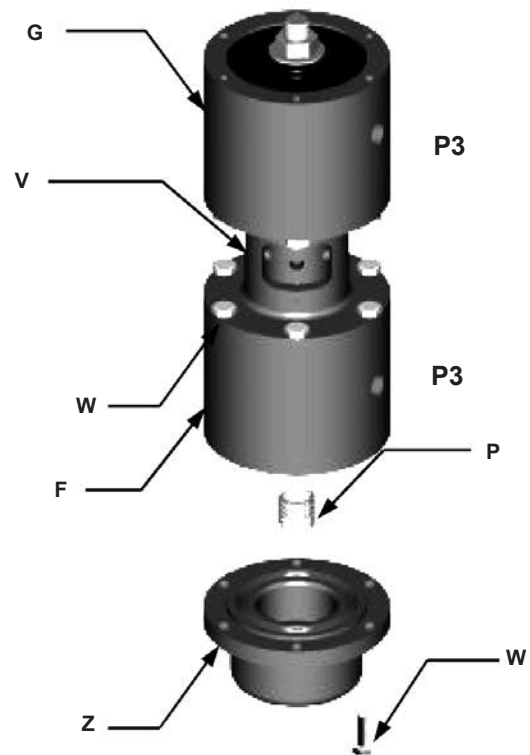


Figure 23 - Step 8

175-CH Chamber Assemblies

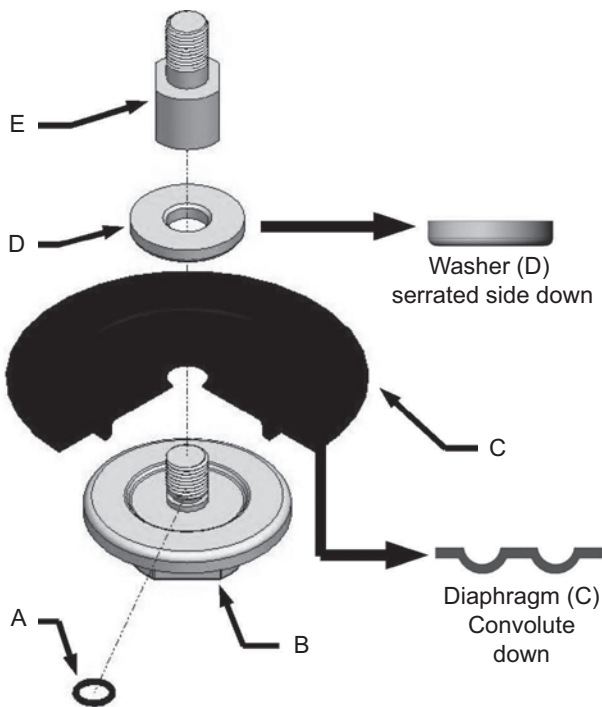


Figure 24 – 175-CH Diaphragm Assembly

175-CH Diaphragm Assembly

- Step 1:** Slide the 012 O-Ring (A) onto the piston (B).
- Step 2:** Place the diaphragm with the hole (C) onto the piston (B).
- Step 3:** Slide the washer (D) onto the piston (B).
- Step 4:** Attach the thread extension (E) onto the piston (B).
- Step 5:** Torque to 100 to 110 in-lbs.

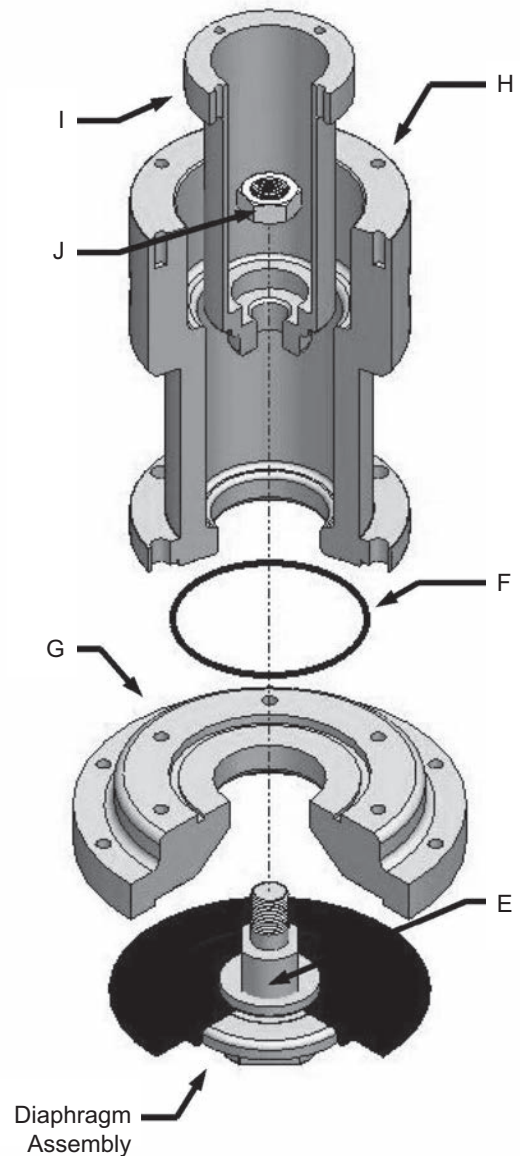


Figure 25 – 175-CH Cartridge Assembly

175-CH Cartridge Assembly

- Step 1:** Insert the 145 O-ring (F) into the cartridge spacer (G).
- Step 2:** Place the cartridge spacer (G) between the diaphragm assembly and spring chamber (H) as shown in Figure 25.
- Step 3:** Slide the inner tube (I) through the spring chamber (H).
- Step 4:** Attach the thread extension (E) to the inner tube (I) using the 1/2 in. - 20 in. SS jam nut (J).
- Step 5:** Torque the jam nut (J) to 100 to 110 in-lbs.

175-CH Chamber Assemblies (Cont.)

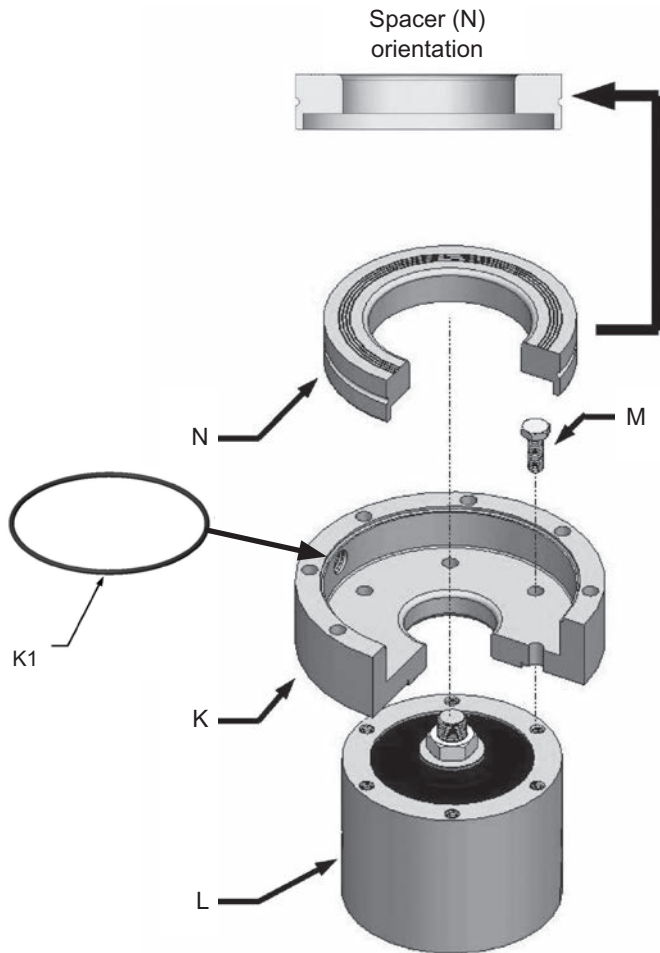


Figure 26 – 175-CH Bottom Flange Assembly

175-CH Bottom Flange Assembly

Step 1: Fasten the bottom flange (K) into the top body assembly (L) using six (6) 1/4-20 X 3/4 inch SHCS (M) and insert O-ring - 046 (K1) in the O-ring groove in the bottom flange (K) as shown in Figure 26

Step 2: Place the spacer (N) inside the bottom flange (K).

WARNING
Do not twist Diaphragm (C) while tightening the assembly.

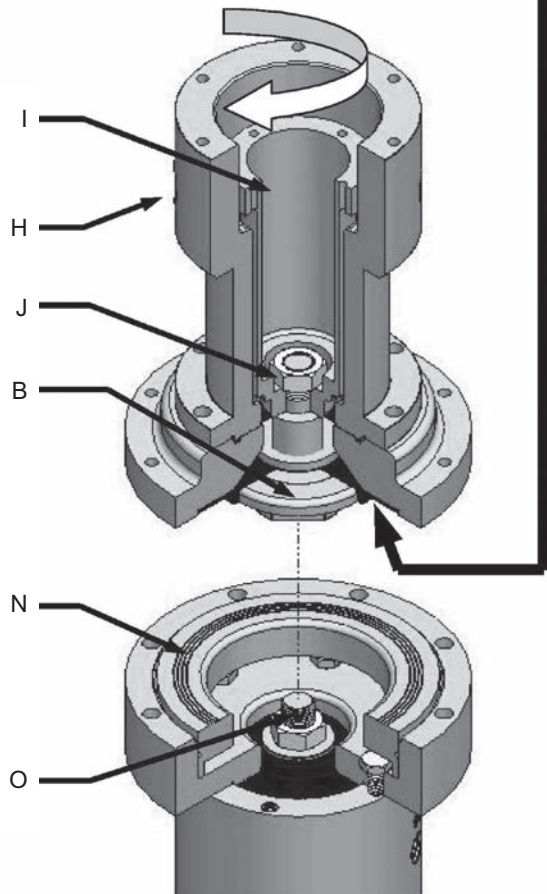


Figure 27 – 175-CH Pistons Assembly

175-CH Piston Assembly

Step 1: Place the diaphragm assembly onto the spacer (N), making sure not to twist the diaphragm (C).

Step 2: Thread the piston (B) into the outside piston (O) by holding the spring chamber (H) and rotating the inner tube (I) clockwise.

Step 3: Rotate the inner tube (I) with the same socket wrench used to hold the jam nut (J) in the cartridge assembly step.

Step 4: When the inner tube (I) cannot be rotated any more, do not force it; the assembly should only be hand-tight.

600-CH Chamber Assemblies

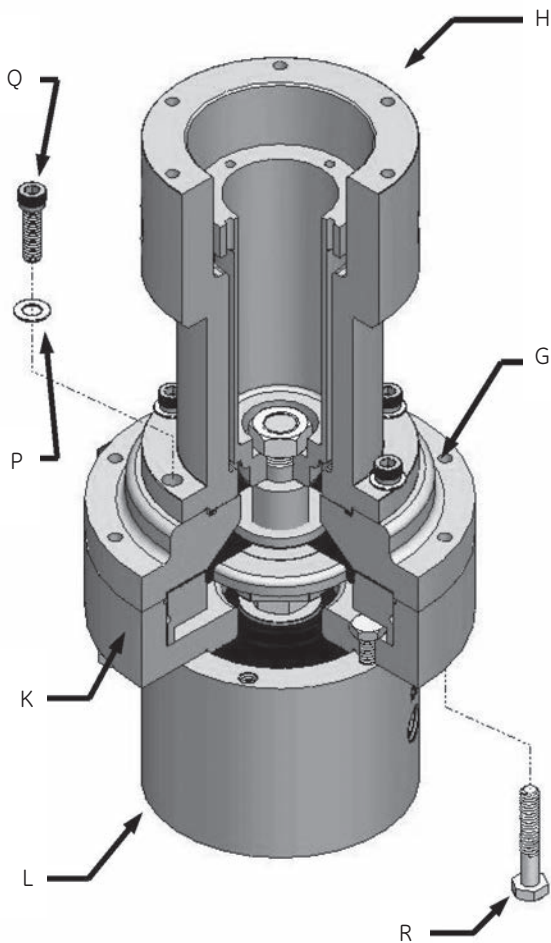


Figure 28 – 175-CH Spring Chamber Assembly

175-CH Spring Chamber Assembly

Step 1: Bolt the spring chamber (H) onto the cartridge spacer (G) using six (6) fiberglass washers (P) and six (6) 1/4-20 X 7/8 inch SHCS (Q).

Step 2: Bolt the bottom flange (K) into the cartridge spacer (G) using eight (8) 1/4-20 X 1 1/2 inch HHCS (R).

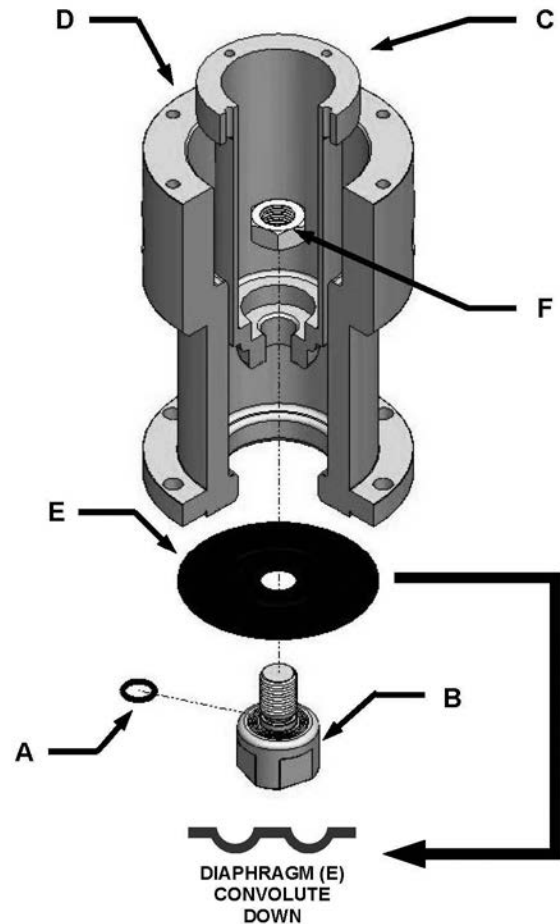


Figure 29 – 600-CH Diaphragm Assembly

600-CH Diaphragm Assembly

Step 1: Insert the O12 O-Ring (A) into the bottom piston (B).

Step 2: Insert the inner tube (C) into the spring chamber (D).

Step 3: Insert the bottom piston (B) into the diaphragm with convolute (E).

Step 4: Clamp the assembly together by holding the bottom piston (B) in a vise while threading a 1/2 inch-20 inch SS jam nut (F) onto the bottom piston (B).

Step 5: Torque the jam nut (F) to 140 to 160 in-lbs.

600-CH Chamber Assemblies (Cont.)

WARNING

Do not twist the diaphragm (E) while tightening the assembly.

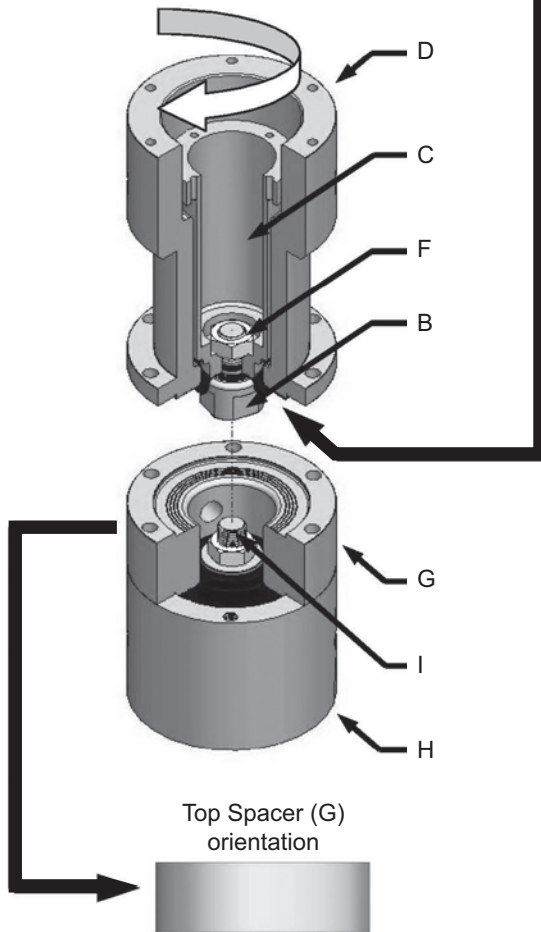


Figure 30 – 600-CH Top Spacer Assembly

600-CH Top Spacer Assembly

Step 1: Orient the top spacer (G) onto the top body assembly (H) as shown in Figure 30.

Step 2: Place the diaphragm assembly onto the top spacer (G).

Step 3: Making sure not to twist the diaphragm (E), thread the bottom piston (B) into the outside piston (I) by holding the spring chamber (D), and rotating the inner tube (C) clockwise.

Step 4: Rotate the inner tube (C) with the same socket wrench used to hold the jam nut (F) in the diaphragm assembly.

Step 5: When the inner tube (C) cannot be rotated any more, do not force it; the assembly should only be hand-tight.

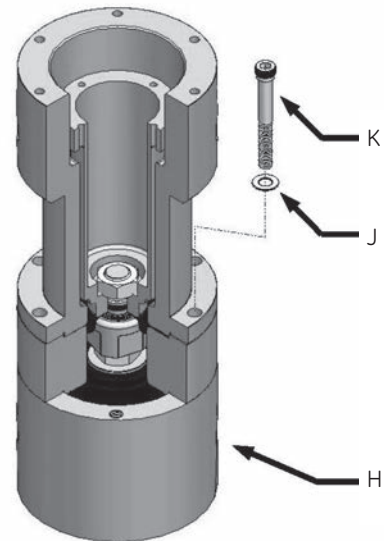


Figure 31 – 600-CH Spring Chamber Assembly

600-CH Spring Chamber Assembly

Bolt the spring chamber (D) to the top body assembly (H) using six (6) fiberglass washers (J) and six (6), 1/4-20 x 2 inch SHCS (K).

1000/1500-CH Chamber Assemblies

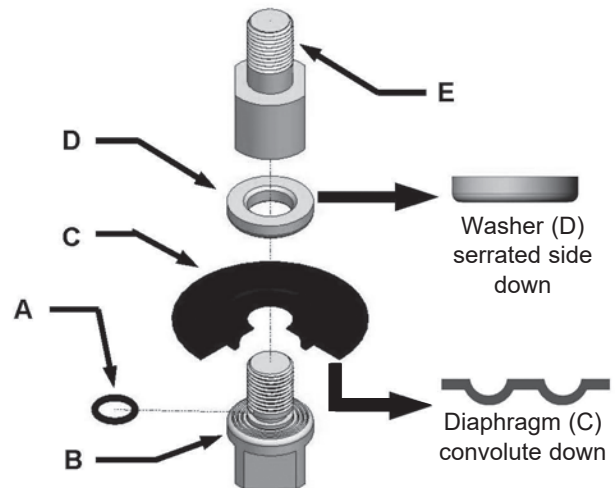


Figure 32 – 1000/1500-CH Diaphragm Assembly

1000/1500-CH Diaphragm Assembly

Step 1: Slide the O-ring (A) onto the small piston (B).

Step 2: Place the diaphragm with hole (C) onto the piston (B).

Step 3: Slide the small washer (D) onto the piston (B).

Step 4: Attach the thread extension (E) onto the small piston (B).

Step 5: Torque to 180 to 220 in-lbs.

1000/1500-CH Chamber Assemblies (Cont.)

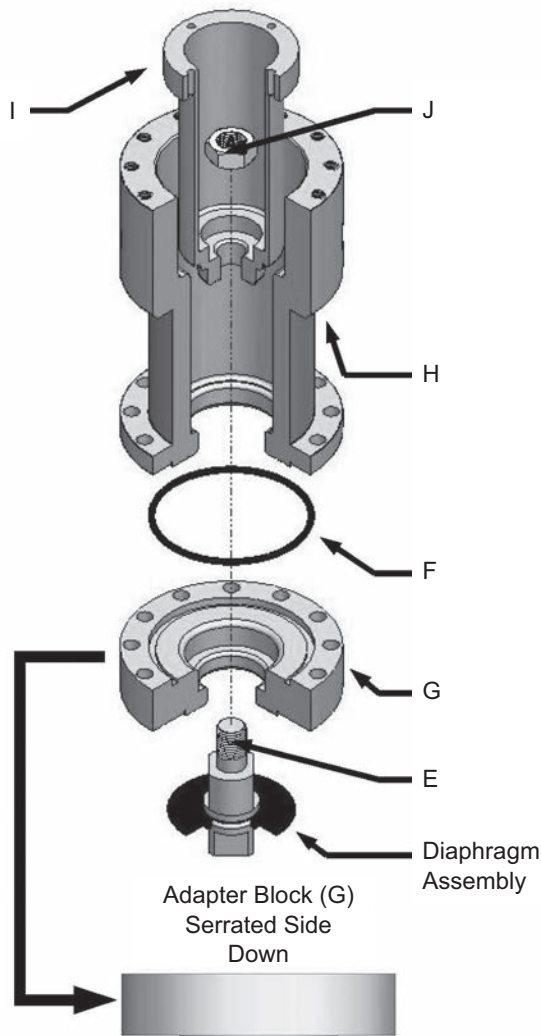


Figure 33 – 1000/1500-CH Adapter Block Assembly

1000/1500-CH Adapter Block Assembly

- Step 1:** Insert the 145 O-ring (F) into the adapter block (G).
- Step 2:** Place the adaptor block (G) between the diaphragm assembly and spring chamber (H) as shown in Figure 33.
- Step 3:** Slide the inner tube (I) through the spring chamber (H).
- Step 4:** Attach the thread extension (E) to the inner tube (I) using 1/2 inch - 20 inch SS jam nut (J).
- Step 5:** Torque the jam nut (J) to 180 to 220 in-lbs.

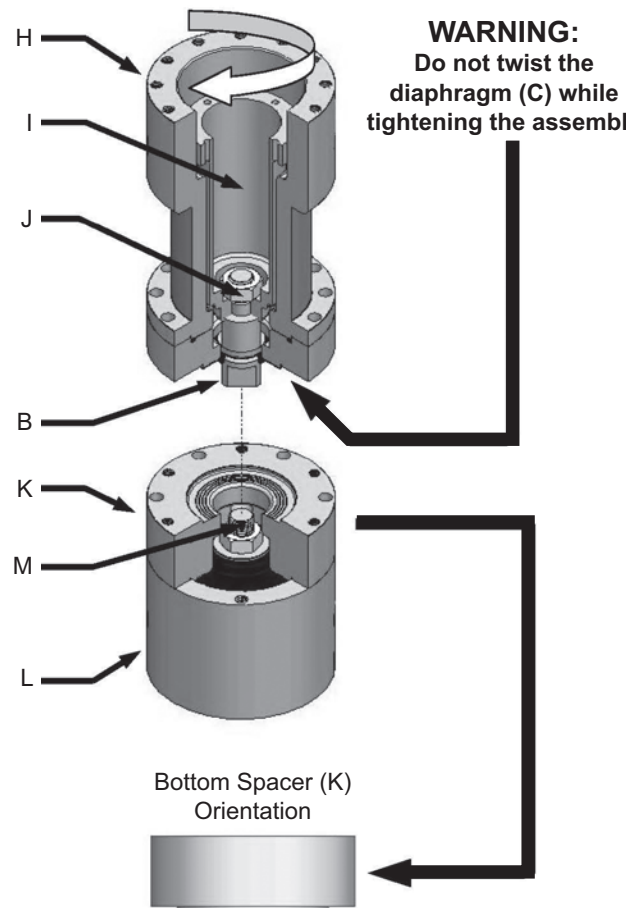


Figure 34 – 1000/1500 Bottom Spacer Assembly

1000/1500-CH Bottom Spacer Assembly

- Step 1:** Orient the bottom spacer (K) onto the top body assembly (L).
- Step 2:** Place the adapter block assembly onto the bottom spacer (K).
- Step 3:** Making sure not to twist the diaphragm (C), thread the small piston (B) into the outside piston (M) by holding the spring chamber (H) and rotating the inner tube (I) clockwise.
- Step 4:** Rotate the inner tube (I) with the same socket wrench used to hold the jam nut (J) in the adapter block assembly.
- Step 5:** When the inner tube (I) cannot be rotated any more, do not force it; the assembly should only be hand-tight.

1000/1500-CH Chamber Assemblies (Cont.)

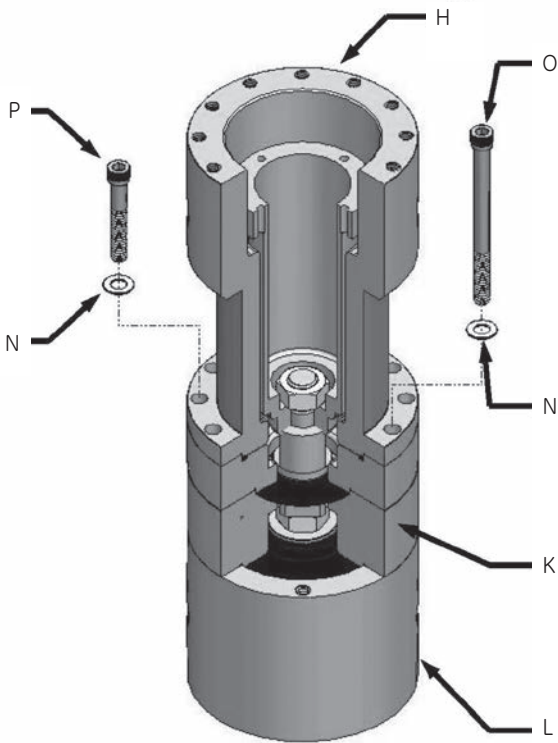


Figure 35 – Spring Chamber Assembly

Spring Chamber Assembly

Step 1: Fasten the bottom spacer assembly to the top body assembly (L) using six (6) fiberglass washers (N) and six (6), 1/4-20 x 3 inch SHCS (O).

Step 2: Bolt the spring chamber (H) into the bottom spacer (K) using six (6) fiberglass washers (N) and six (6), 1/4-20 x 1 1/2 inch SHCS (P).

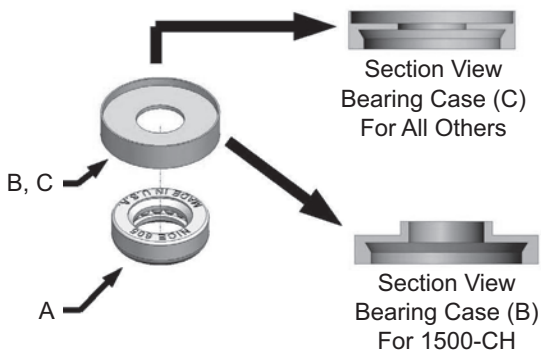


Figure 36 – Bearing Case Assembly

Bearing Case Assembly

For 1500-CH: Press fit the thrust bearing (A) into the bearing case (B).

For all other CH Models: Press fit the thrust bearing (A) into the bearing case (C).

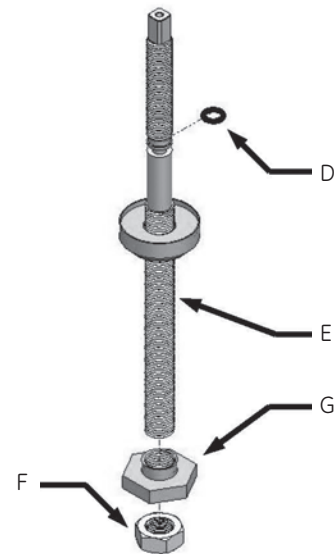


Figure 37 – Bearing Nut Assembly

Bearing Nut Assembly (All Models)

Step 1: Slide a 108 O-ring (D) onto the adjusting screw (E) as shown in Figure 37.

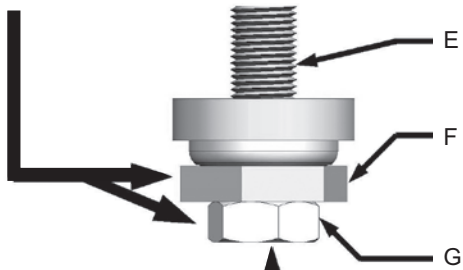
Step 2: Slide the bearing case assembly onto the adjusting screw (E).

Step 3: Thread the aluminum bearing nut (G) onto the screw (E) from the bottom. Leave some room below the bearing nut (G).

Step 4: Thread the 1/2 inch - 20 inch SS left-hand jam nut (F) onto the screw (E). The jam nut (F) and bearing nut (G) should be tightened against each other as shown in Figure 38.

Control Spring Assembly

These two nuts (G, F) should be tightened against each other.



The bottom face of this nut (G) must be flush with the bottom of the adjusting screw (E).

Figure 38 – Tightening the Bearing Nut

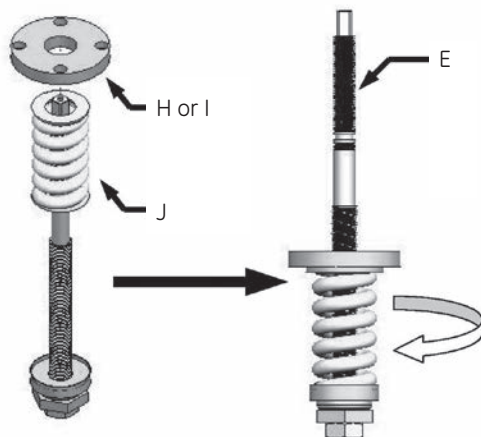


Figure 39 – Spring Concentricity Test

Spring Concentricity Test

Step 1: Place the tube cap SS (H for 1500-CH models) or tube cap (I for all other -CH models) and control spring (J) onto the adjusting screw (E).

Step 2: Check the concentricity of the spring (J) by spinning the assembly. Make sure that the spring (J) touches no part of screw (E) when spinning. If the spring (J) does touch any part of the screw (E), then replace the spring (J) and repeat the test. If the spring (J) is satisfactory, then move to tube cap assembly.

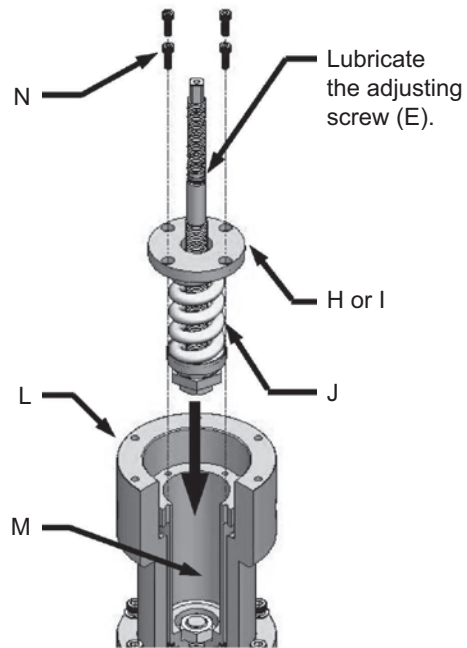


Figure 40 – Inserting the spring assembly

Tube Cap Assembly (All Models)

Step 1: Insert the control spring assembly into the spring chamber (L).

Step 2: Fasten the tube cap (H or I) to the inner tube (M) with four (4), 8-32 x 1/2 inch SHCS (N).

175/600-CH Cap Assembly

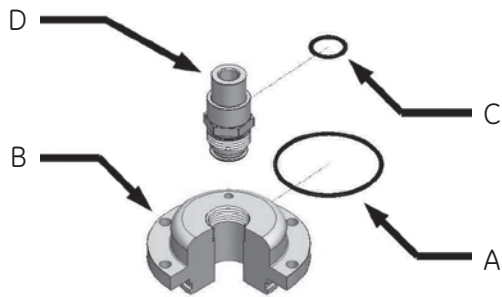


Figure 40 – 175/600-CH Seal Neck Assembly

175/600-CH Seal Neck Assembly

- Step 1:** Slide the 141 O-ring (A) over the cartridge cap (B).
- Step 2:** Slide the 115 O-ring (C) over the seal neck (D).
- Step 3:** Thread the seal neck (D) into the cartridge cap (B).

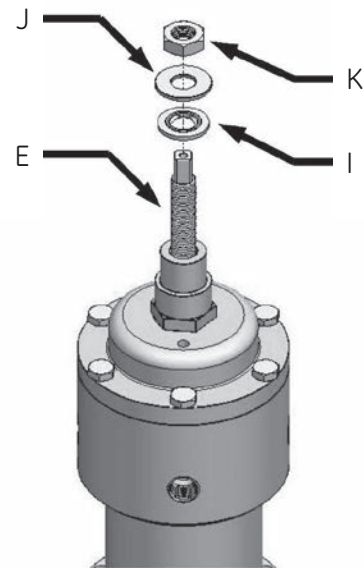


Figure 43 – 175/600-CH Thread Seal Assembly

175/600-CH Thread Seal Assembly

- Step 1:** Place the 7/16 inch SS thread seal (I) and 7/16 inch SS flat washer (J) onto the adjusting screw (E).
- Step 2:** After all necessary adjustments on the pilot are made, thread the 7/16 inch SS jam nut (K) onto the adjusting screw (E). Take care not to over tighten the jam nut (K); over tightening may damage the adjusting screw (E).

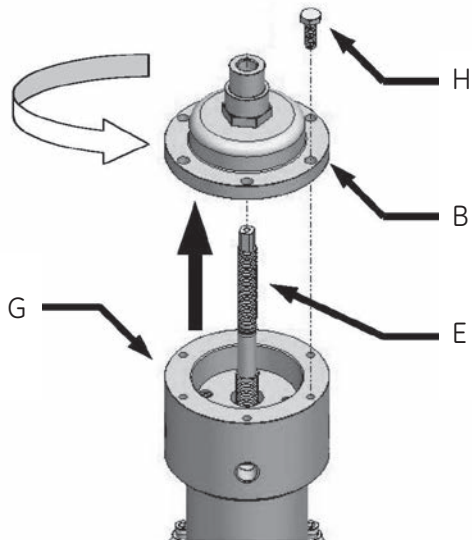


Figure 42 – 175/600-CH Cap Assembly

175/600-CH Cap Assembly

- Step 1:** Pull the adjusting screw (E) up while threading the cartridge cap (B) counterclockwise.
- Step 2:** After the cartridge cap (B) is engaged, turn the adjusting screw (E) clockwise while pushing the cap (B) down.
- Step 3:** When firm engagement of the cap (B) is felt, orient the cap (B) such that the mounting holes are in line with the top body assembly (F) pressure ports.
- Step 4:** Bolt the cap (B) to the spring chamber (G) using six (6), 1/4-20 x 3/4 inch HHCS (H).

1000/1500-CH Cap Assembly

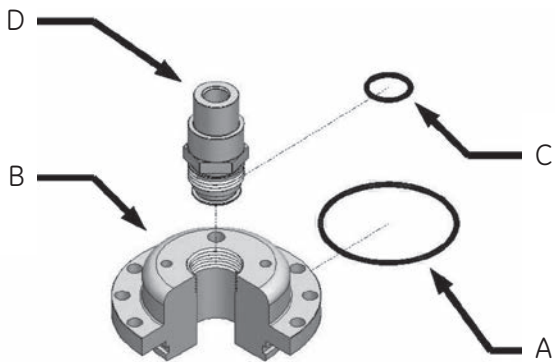


Figure 44 – 1000/1500-CH Seal Neck Assembly

1000/1500-CH Seal Neck Assembly

- Step 1:** Slide the 141 O-ring (A) over the cartridge cap (B).
Step 2: Slide the 115 O-ring (C) over the seal neck (D).
Step 3: Thread the seal neck (D) into the cartridge cap (B).

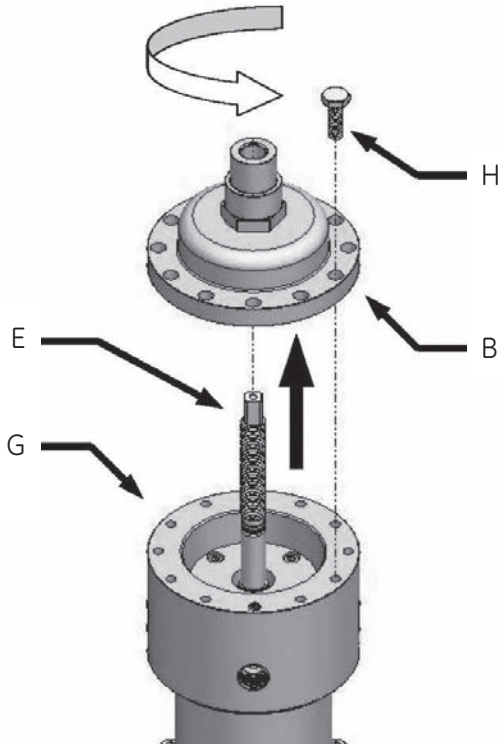


Figure 45 – 1000/1500-CH Cap Assembly

1000/1500-CH Cap Assembly

- Step 1:** Pull the adjusting screw (E) up while threading the cartridge cap (B) counterclockwise.
Step 2: After the cap (B) is firmly engaged, turn the adjusting screw (E) clockwise while pushing the cap (B) down.
Step 3: When firm engagement of the cap (B) is felt, orient the cap (B) such that the mounting holes are in line with top body assembly (F) pressure ports.
Step 4: Bolt the cap assembly (B) to the spring chamber (G) using twelve (12), 1/4-20 x 3/4 inch HHCS (H).

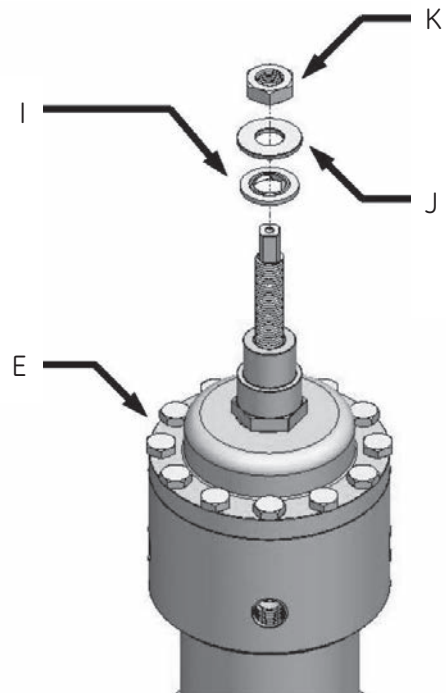


Figure 46 – 1000/1500-CH Thread Seal Assembly

1000/1500-CH Thread Seal Assembly

- Step 1:** Place the 7/16 inch SS thread seal (I) and 7/16 inch SS flat washer (J) onto the adjusting screw (E).
Step 2: After all necessary adjustments on the pilot are made, thread the 7/16 inch SS jam nut (K) onto the adjusting screw (E). Take care to not over tighten the jam nut (K); over tightening may damage the adjusting screw (E).

List of Recommended Tools:

1. Allen wrench sizes:
9/64 in., 3/16 in., 1/8 in.
2. Open wrench sizes:
7/16 in., 3/4 in., 11/16 in., 5/16 in.
3. Socket wrench -
3/8-inch drive sizes: 7/16 in., 3/4 in.
(Deepwell 12 PT.)
4. 6-inch adjustable wrench
5. Screwdriver models:
Phillips head, standard
6. Soft blow hammer
7. General assembly grease
8. Torque wrench - 3/8-inch drive

Parts Silhouettes



98-3231
1/4-20 x 1 1/2 in. HHCS
316 SS



98-3230
1/4-20 x 2 in. SHCS
316 SS



98-3229
1/4-20 x 1 1/2 in. SHCS
316 SS



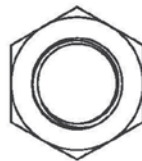
98-3228
1/4-20 x 7/8 in. SHCS
316 SS



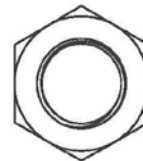
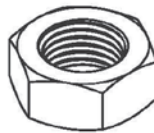
98-2614
8-32 x 1/2 in. SHCS
316 SS



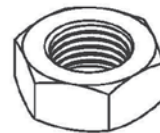
98-3269
8-32 x 1/2 in. SHCS
(Alloy)



98-3056
1/2-20 Hex Jam Nut
316 SS



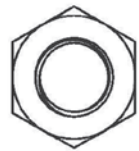
98-3213
LH 1/2-20 Hex Jam Nut
316 SS



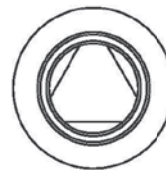
98-3153
1/4-20 x 1 1/2 in. HHCS
316 SS



98-3137
1/4-20 x 3/4 in. HHCS
316 SS



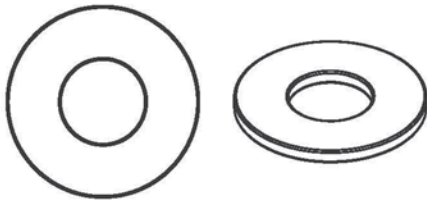
98-2500
7/16 in.-20 Jam Nut
316 SS



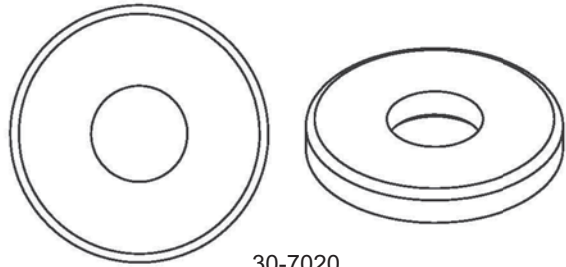
30-3017
7/16 in.-20 Thread Seal
Plated Steel with Rubber Insert



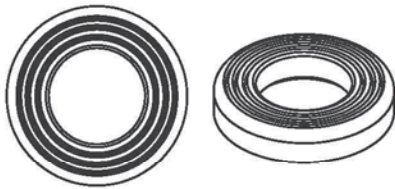
Parts Silhouettes (Cont.)



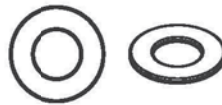
98-3181
7/16 in. Flat Washer
316 SS



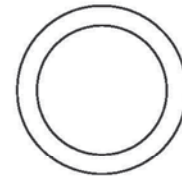
30-7020
Washer
Aluminum 2024-T351



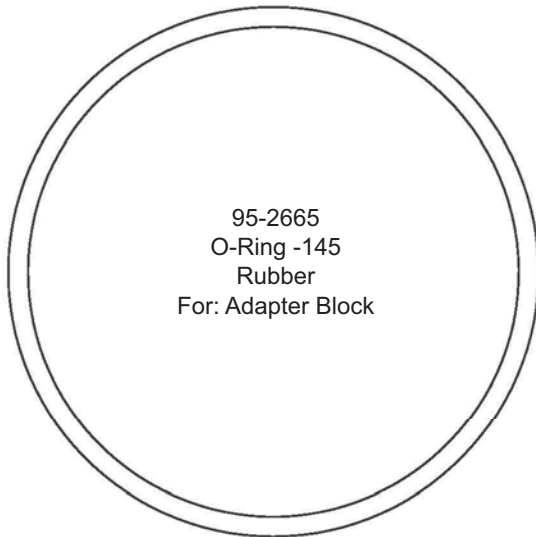
30-7014
Small Washer
Aluminum 2024-T351



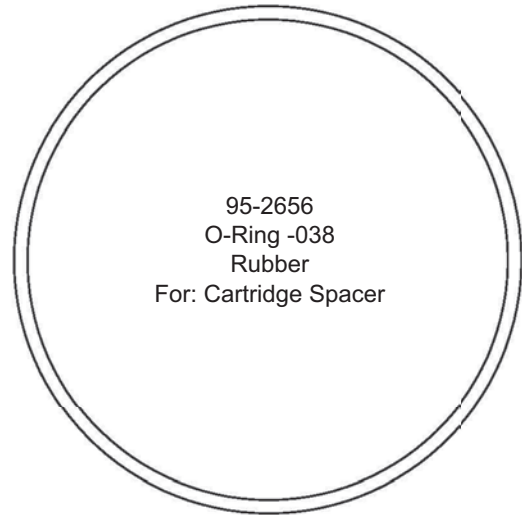
98-3227
1/4 x 1/2 in. Washer
Fiberglass



95-2670
O-Ring -115
Rubber
For: Seal Neck



95-2665
O-Ring -145
Rubber
For: Adapter Block

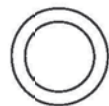


95-2656
O-Ring -038
Rubber
For: Cartridge Spacer

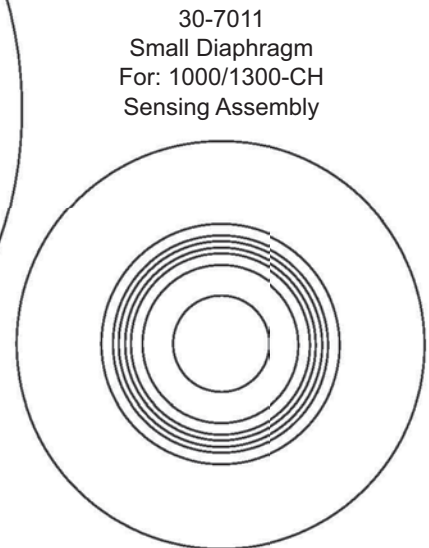
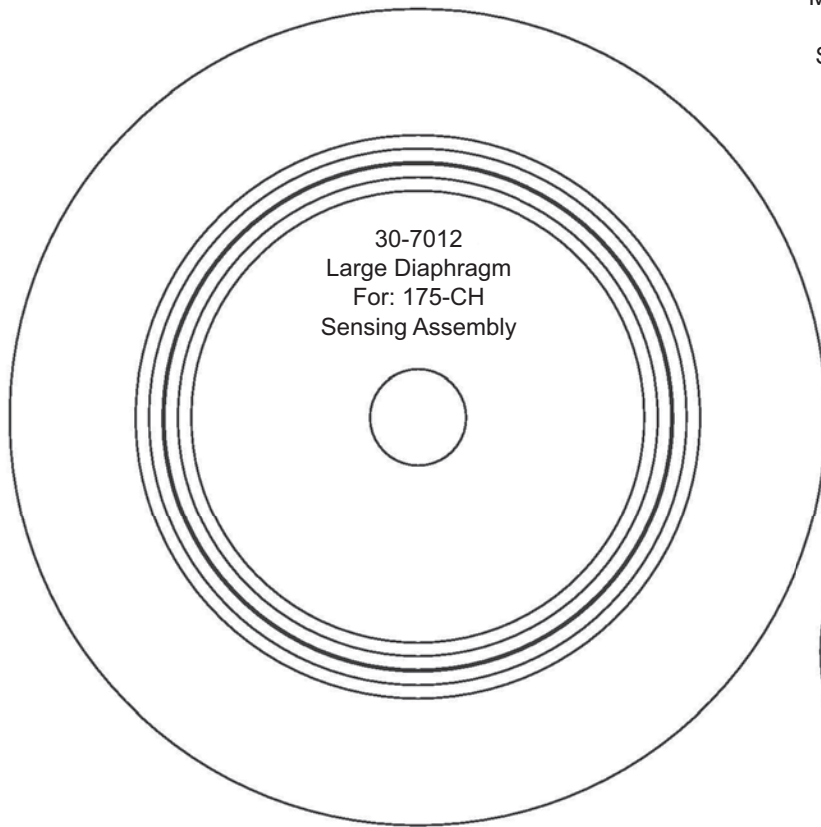
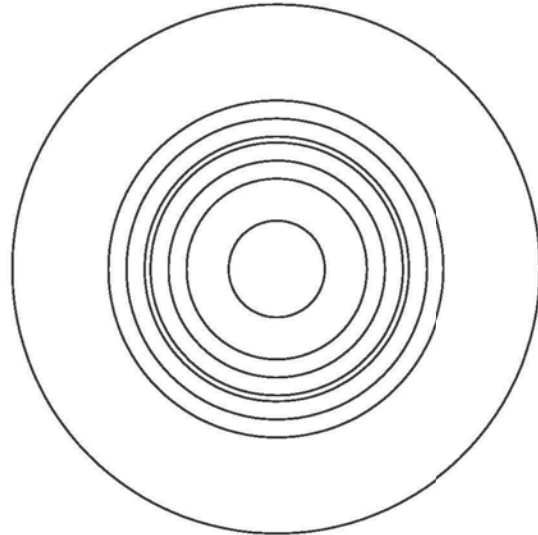


95-2672
O-Ring -018
Rubber
For: Adjusting Screw

95-2615
O-Ring -012
Rubber
For: Piston and
Bottom Piston



Parts Silhouettes (Cont.)



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