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VRP-B-CH Series

Valve Regulator Pilots

Instruction Manual (Rev. C)

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Table of Contents

Introduction

The Becker VRP-B-CH series balanced seat design, double-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. When in control, in a steady state, the VRP-B-CH series pilots have a very low gas consumption rate to minimize fugitive emissions. Furthermore, the VRP-B-CH 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-B-CH balanced seat, double-acting pilot provides pressure control when utilized with a double-acting piston actuated control valve. The VRP-B-CH measures downstream sensing pressure and positions the double-acting actuator to maintain the desired downstream pressure. The VRP-B-CH pilot may be used for pressure control applications with setpoints ranging from 3 psig to 1500 psig. The Becker CH pilot design represents our commitment to continually develop new products and update existing ones to increase their performance while retaining simple operation and low maintenance.

Technical Assistance

Should you have any questions, please contact your local Baker Hughes sales representative.

Scope of Manual

This manual provides information on the installation, operation, adjustment, and maintenance of the Becker VRP-B-CH double-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-B-CH Pilot Controllers

1. The Spring is protected against corrosion caused by exposure to the outside weather conditions and condensation.
2. Small net force will be 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 5 pilot model numbers are needed, instead of 11, and there is less troubleshooting during assembly.
4. The VRP-B-CH pilots will have only 3 diaphragms (as opposed to 5).
5. Larger measured variable chamber volume and surface area dampens control pressure signal, helping to compensate for vibration induced by poor location of sensing tap in area of flow pulsation and turbulence.
6. Number of fittings and tubing is minimized with “manifold” body design.
7. Sensing gauge is brought up to eye level.
8. Control springs can be replaced without disturbing any diaphragms.
9. Springs are guided by the outside resulting in less likelihood of friction from poorly aligned spring.
10. The accuracy of pilots is guaranteed to be ±3/4 percent.

Applications

- Primary pressure control
- Overpressure protection (monitor)
- Underpressure protection (standby)
- Relief valve
- Backpressure control
- Unique “Bleed to Pressure System” BPS* (when feature can be utilized)
- Any large downstream systems (city gate stations, inter-system pressure limiting)
- Suction control to reciprocating compressors[1]

Guidelines for Usage

Large downstream systems:
City gate stations, inter-system pressure limiting, overpressure protection for custody transfer stations, and mainline relief valve applications are all suited to this pilot.

No “Low” pressure available:
The low steady state consumption of the pilot makes it a first choice for any pressure control application covered above in which the downstream pressure exceeds 300 psig and there are no alternative pipeline systems nearby operating below 300 psig as well. Without a system to “dump” the pilot bleed gas, the VRP-B-CH makes an exceptional choice since it bleeds <10 scfh while in control at steady state.

The Becker ***BPS*** Bleed to a pressure system:

When adjusted to bleed to a pressure system, the VRP-B-CH sensitivity is set up to open the internal balance valves for further control accuracy. This adjustment places the gas consumption rate of the VRP-B-CH pilot equal to that of the VRP-CH pilot.

Compatible Actuators:

- Becker RPDA Actuators (Rotary Piston Double-Acting)
- Becker LPDA Actuators (Linear Piston Double-Acting)
- Other manufacturer’s double-acting piston actuators[1]

Retrofit Compatibility:
Optimum performance is achieved by pairing the VRP-B-CH with genuine Becker control valve actuators. Should you already have existing control valve actuator(s) in service, the addition of a VRP-B-CH can improve performance and minimize atmospheric bleed emissions.

Some compatible actuators:

- Bettis™ T-Series piston actuators
- Rotork™ Series XX actuators
- Fisher™ Type 470 piston actuators
- Fisher™ Type 1061 piston

(1) Consult Baker Hughes for additional information

Technical Information

Technical Specifications	
Steady State Gas Consumption	<10 scfh when bleeding to atmosphere When bleeding downstream, see consumption table in Appendix
Supply Gas	Dry, filtered (100 micron) gas
Maximum Flow Capacity	850 scfh (24 scmh)
Maximum Supply Pressure	400 psig (2758 kPa)
Maximum Supply – Discharge Differential	150 psig (1034 kPa)
Minimum Supply – Discharge Differential	50 psig (348 kPa)
Operative Ambient Temperature Range	-20°F to 160°F (-29°C to 71°C)
Approximate Weight	12 pounds (5.4 kg)
Minimum Deadband	0.2% instrument signal
Control Accuracy	± 0.75% of setpoint
Maximum Sensing Pressure	1500 psig
Setpoint Range	3 psig – 1500 psig 21 kPa – 10342 kPa
Housing	Meets NEMA 3 classification
Installation Orientation	**Vertical position recommended** • Custom bracket supplied with Becker Actuators • 2-in pipe mount provided for retrofit to other manufacturers' actuators

Materials of Construction	
External Parts	AL 2024 Anodized Aluminium/316 Stainless Steel
Internal Parts	316 Stainless Steel/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	2-1/2 inch dial liquid filled brass connection w/ stainless steel case[1] (standard issue with units of psig dual units of psig/kPa available).

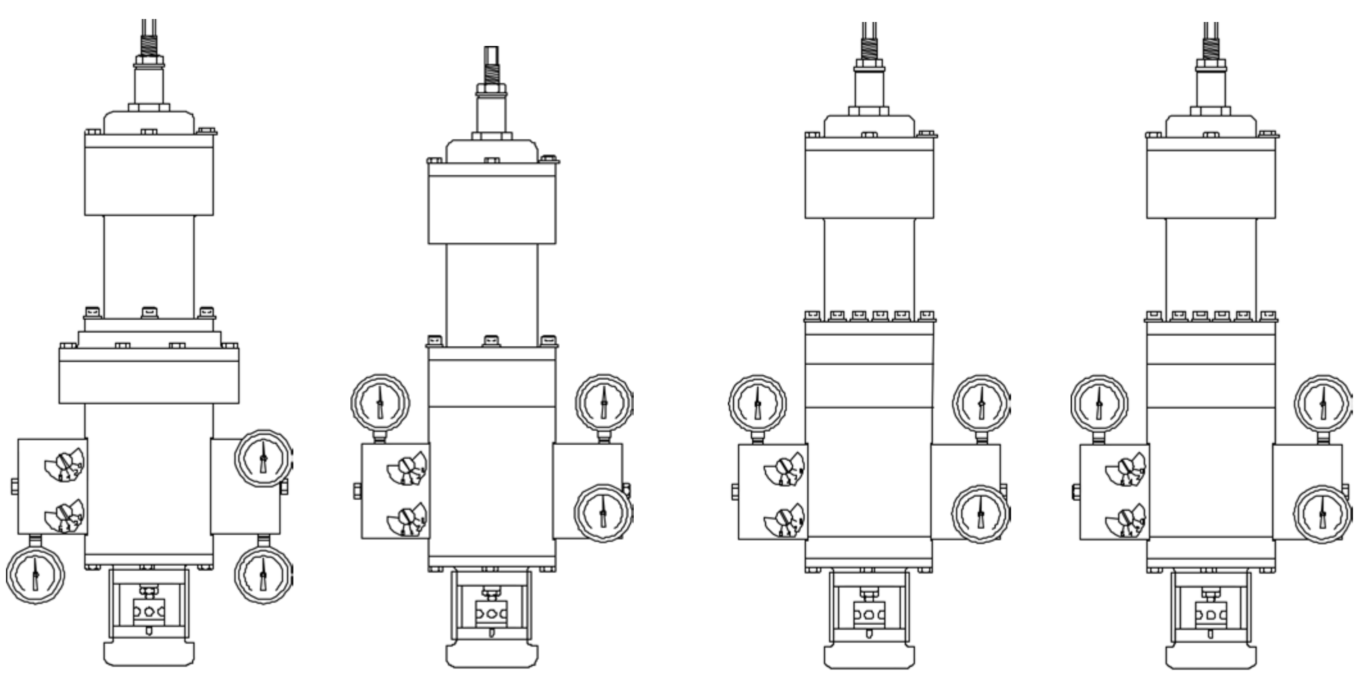
[1] Consult Baker Hughes for additional information.

Model Number Explanation

- The VRP-B-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-B-600-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-B-175-CH VRP-B-600-CH VRP-B-1000-CH VRP-B-1500-CH

VRP-B-CH pilots – model numbers

VRP-B-CH Pilot Selection Chart					
Model Number	**Control Range (psig/kPa)**	**Spring Color (Part Number)**	**Setpoint Change per Revolution of Setpoint Screw**	**Setpoint Range Discrete Remote Control (SM-1100)**	**Setpoint Range Analog (4-20 mA) Remote Control (SM-1000)**
VRP-B-175-CH[1]	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-B-600-CH	5 - 40 psig 34 - 276 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
	275 - 600 psig 1896 - 4137 kPa	Yellow (25-1306)	85 psig 586 kPa	425 psig 2930 kPa	425 psig 2930 kPa
VRP-B-1000-CH	550 - 1000 psig 3792 - 6895 kPa	Yellow (25-1306)	143 psig 990 kPa	700 psig 4826 kPa	700 psig 4826 kPa
VRP-B-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

[1] These models should only be used for applications that require high gain. Consult Baker Hughes prior to selecting these models.

Remote Setpoint Change Options

- The SM-1000 series motors accept a 24 VDC or 120 VAC input. The SM-1100 series motors accept a 4-20 MA signal and require a separate 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 Becker VRP-B-CH pilot and double-acting cylinder actuator can be used in conjunction with varying valve types to provide a complete package for stable, accurate pressure control over a wide range of applications. The energy for control valve operation comes from the pressure differential between the pilot supply and discharge pressures.

The power gas channels through two adjustable orifices which feed the top and the bottom portion of the cylinder independently.

Both sides of the actuating cylinder are under full power gas pressure at steady state since both balanced valves are closed.

When the sensing pressure resides within the pilot deadband region, bleed gas is virtually eliminated. The pilot therefore operates on the design concept of a deadband within which a non-bleeding, force-balanced state is achieved. Deadband can be defined as the amount of change necessary in the sensing pressure to the pilot to create a change in the output pressure to the cylinder.

When the control pressure rises above the set point, the pilot pistons move downward. As the top inside piston unloads the cylinder top balance valve, the bottom piston moves away from the balance valve plunger and maintains pressure on the bottom of the actuator cylinder. This causes an increase in cylinder bottom pressure and a decrease in cylinder top pressure.

The pressure differential creates the force needed to close the valve and lessen the flow of gas. When the control pressure returns to the setpoint, the pilot output pressures automatically return to power gas at the new valve position.

If the control pressure falls below the setpoint, the opposite reaction takes place.

The deadband region can be increased and decreased with the pilot's sensitivity adjustment drum. Increasing the deadband increases the pilot's error in controlling setpoint. Decreasing the deadband reduces the error, with the tradeoff of increasing bleed gas. Therefore, deadband is adjusted to produce an adequate pilot response to a small change in sensing pressure, while producing the minimum amount of bleed gas while the pilot is in a steady state.

The variable orifices provide tuning of the stroking speed of the actuator. Increasing the variable orifice number increases the stroking speed. The two separate orifices allow tuning in both directions to match the pilot response to a wide variety of valves and operating systems.

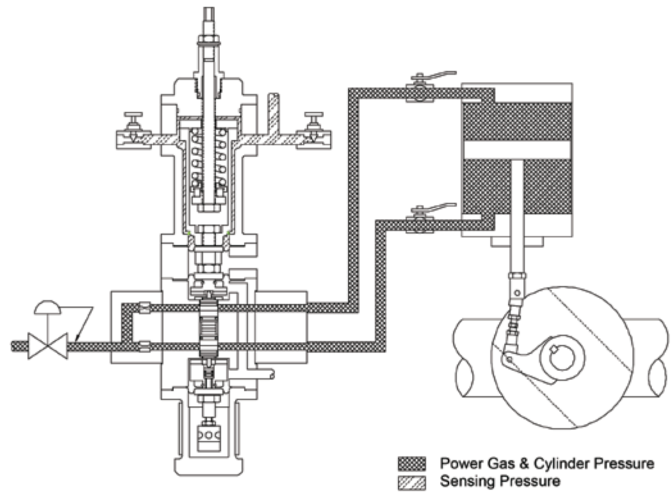


Figure 1a - VRP-B-CH Pilot principles of operation

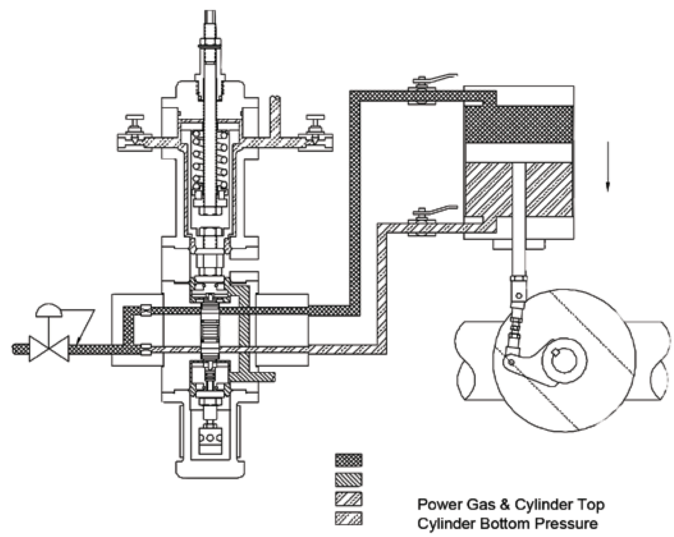


Figure 1b - VRP-B-CH Pilot principles of operation

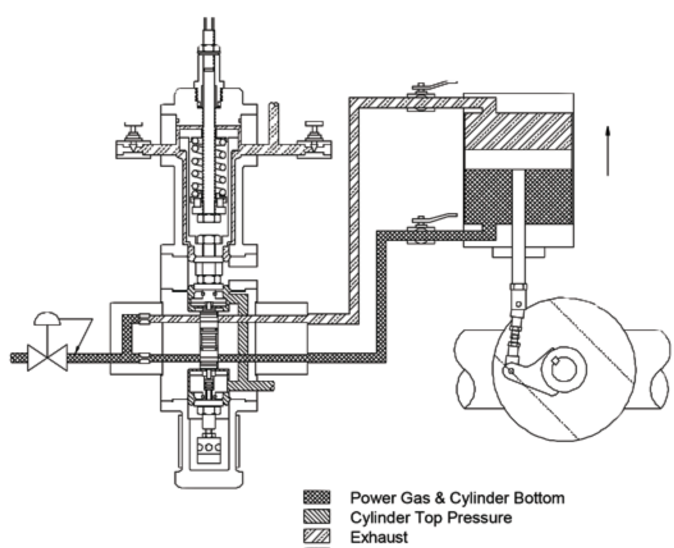


Figure 1c - VRP-B-CH Pilot principles of operation

Adjustment Procedures

Your VRP-B-CH pilot will come factory adjusted for your particular application. The use of the adjustment procedures will be necessary upon installation of a rubber goods replacement kit or any other disassembly or reassembly of the pilot.

The sensitivity adjustment drum in the center of the pilot determines the sensitivity of the unit.

The setpoint adjustment screw determines the setpoint at which the pilot operates. The variable orifices determine the response speed of the pilot.

Initial Adjustment

1. Adjust the supply regulator

   Adjust the supply regulator to the desired power gas pressure. Refer to the original invoice paperwork supplied with the product for the appropriate power gas pressure setting. It is imperative that adequate supply gas pressure be supplied to the VRP-B-CH in order to ensure proper operation of the system and all accessories.

2. Adjust the adjustable orifices

   The adjustable orifices are used to control the volume of gas that is supplied to the VRP-B-CH. The stroking speed of the system is proportional to the numerical value of the adjustable orifice. Adjustable orifice settings are typically equal for both orifices. However, a few applications may require unequal settings for each adjustable orifice. Set both orifices according to the table A below if pilot bleeds to atmosphere and table B if pilot bleeds to pressure system.

Notes:
To determine the cylinder bore, look at the model number stamped on the stainless steel tag on the top of the cylinder. The cylinder bore will be the first number following the first capital letter "H". This one or two digit number following the first "H" will be the diameter in inches and will be followed by another letter (for example, a unit with the model number 6H8F6FG-PCH has an 8-in. bore).

If equipped with a DPS sensor and/or AB-control, see ***page 20.***

3. Disable DPS-2 series non bleed sensor (if equipped):

   The DPS-2 non bleed sensor should be disabled prior to commencing initial adjustment procedures. Failure to disable the DPS non bleed sensor may prevent initial adjustments from being completed properly. To disable the DPS-2 series non bleed sensor(s) rotate the adjustment screw of the DPS-2 until it extends approximately 1.75-in from the top surface of the DPS-2 spring cartridge.

4. Disable AB series atmospheric bleed control (if equipped):

   The AB series atmospheric bleed control should be disabled prior to commencing initial adjustment procedures. Failure to disable the AB control may prevent initial adjustments from being completed properly. To disable the AB control rotate the adjustment screw of the AB control until it disengages. Then, tighten the nut on the AB sensor adjustment screw to seal threads on the cap.

5. Close cylinder block valves:

   Closing the cylinder block valves will isolate the VRP-B-CH from the control valve actuator. This prevents unintended stroking of the control valve and simplifies setting the VRP-B-CH.

6. Close the valve on the sensing line:

   It is imperative that a full-sealing valve be installed as close to the sensing port of the VRP-B-CH as possible. The volume of gas between the VRP-B-CH sensing port and the block valve on the sensing line should be minimized. It is also imperative that the fittings between the VRP-B-CH sensing port and the sensing line block valve be bubble tight in order to facilitate adjustment. It is recommended that a quarter-turn (locking) ball valve be utilized to isolate the VRP-B-CH sensing line.

   Confirm that the VRP-B-CH exhaust (discharge) line is open. The discharge line is connected to the port marked "EX". Should flow from the exhaust port be blocked, adjustment of the VRP-B-CH will not be possible.

7. Initialize the sensitivity adjustment:

   Turn the sensitivity adjustment drum to the left (increasing numbers on the scale) as far as it will turn. Then turn it one (1) complete rotation to the right (decreasing numbers on the scale).

Table A – Exhaust Vented to Atmosphere

Supply Pressure (psig)	Cylinder Bore (In.)						
	4	5	6	8	10	12	14
	Variable Orifice Number						
Up to 50	3	3	3	4	4	5	6
51-200	2	2	3	3	4	5	5
201-600	2	2	2	3	3	4	5

Table B – Exhaust Vented to Pressure System

Supply Pressure (psig)	Cylinder Bore (In.)						
	4	5	6	8	10	12	14
	Variable Orifice Number						
Up to 50	3	3	3	4	4	5	6
51-200	4	4	4	5	5	6	6
201-600	2	2	2	3	3	4	5

8. Apply a "False Signal" to the sensing port of the VRP-B-CH:

   The "False Signal" pressure should be equivalent to the desired setpoint pressure. Refer to the original invoice paperwork supplied with the product for the appropriate setpoint pressure setting. If the adequate gas pressure is not available from the pipeline, a nitrogen bottle with regulator may be utilized to introduce the proper "False Signal" pressure. Additionally, an SP series setpoint adjustment pump may be used to provide a false signal pressure above the available pipeline gas pressure.

Note: It is recommended that a calibrated pressure gauge be used to ensure accuracy of the "False Signal" pressure.

9. Adjust the setpoint adjustment screw:

   Turn the setpoint adjustment screw on top of the VRP-B-CH unit until cylinder top and cylinder bottom pressure gauges show equal pressure. Clockwise rotation decreases cylinder bottom pressure. Turn setpoint adjustment only when pressures are not equal.

Note: For pilots venting to atmosphere in control, continue, otherwise, skip forward to the adjustment section for pilots bleeding to a pressure system.

10. Final sensitivity drum adjustment

    Turn the sensitivity adjustment to set the cylinder top and cylinder bottom equal to power gas pressure. When equal, the exhaust port should stop bleeding gas. If not, turn the sensitivity adjustment drum to the left (increasing numbers) until the exhaust port just stops bleeding.

11. To check the deadband, Turn the setpoint adjustment screw clockwise until the cylinder bottom pressure just drops off. Then turn the setpoint adjustment screw counterclockwise until the cylinder top pressure just drops off. Keep track of the total rotation of the screw. Now place the setpoint adjustment screw in the middle of this rotation.

    Turn the sensitivity adjustment drum to the right (decreasing numbers) until the exhaust port just starts bleeding gas. Check the total deadband again and repeat this process until the deadband is eliminated and the following criteria is met:

    With a 3/4 percent change in the sensing pressure (above and below setpoint), the cylinder top and cylinder bottom pressure should develop a pressure differential equivalent to 20 percent of power gas.

Example:
Power gas = 100 psig
Orifice #3 top, #3 bottom
Setpoint = 400 psig
With a change of the sensing pressure to 403 psig, the cylinder top pressure should drop at least 20 psig.
With a change of the sensing pressure to 397 psig, the cylinder bottom pressure should drop at least 20 psig.

If the Pilot sensitivity is greater than this, bleed gas may further be reduced by turning the sensitivity again to insure the pilot meets the minimum criteria.

For VRP-B-CH pilots bleeding to a pressure system

10. Leave the pilot vent port attached to the system it normally discharges to and insure this discharge line is open. The pilot is properly adjusted when both gauges are equal at the pilots desired setpoint, the cylinder pressure are set at 90 percent of the power gas, and any movement to the adjustment drum causes an immediate response from the pilot output gauges.

11. Verify "False Signal":

    Upon achieving setpoint, inspect the gauge which measures the "False Signal." If the "False Signal" has deviated, readjust it to attain proper pressure. Remember that the "False Signal" applied to the VRP-B-CH sensing port should be equivalent to the desired pressure setpoint of the pilot. Upon readjustment of the "False Signal" repeat steps 10 & 11 until setpoint is achieved.

12. Remove "False Signal" pressure from sensing port of VRP-B-CH.

13. Open valve on sensing line.

14. Open cylinder block valves:

    Opening the cylinder block valves will reestablish communication between the VRP-B-CH and the control valve actuator and put the system back into service. Exercise caution when putting the VRP-B-CH into service to prevent unintended closure/opening of the valve.

Regulator is now ready for service.

The initial adjustments are utilized to set the VRP-B-CH at a point approximating the desired setpoint. In order to achieve optimum accuracy of setpoint and sensitivity, the fine tuning procedures need to be completed.

Fine Tuning Procedures

To change the VRP-B-CH setpoint only:

In the case where the VRP-B-CH only requires a change in setpoint only, the setpoint adjustment may be rotated to achieve a new setpoint while the VRP-B-CH is in service. No other adjustments need to be made. Baker Hughes recommends noting the setpoint change per revolution of the control spring installed in the pilot. Setpoint change per revolution of the control spring can be found in the table entitled VRP-B-CH Pilot Selection Chart on page 6 of this manual.

To change the VRP-B-CH sensitivity:

In the event that the VRP-B-CH requires a change in to the sensitivity adjustment, the setpoint adjustment will also require adjustment. Any changes in the sensitivity adjustment affect the setpoint adjustment. A decrease (higher numbers) in the sensitivity of the pilot, will require the setpoint adjustment to be decreased. An increase (lower numbers) in the sensitivity of the pilot, will require the setpoint adjustment to be increased.

Once adjusted, the Becker VRP-B-CH pilot typically requires very little or no readjustment.

Troubleshooting

Control problems generally fall into one of the following three categories:

1. Regulator is too sensitive: Position of the regulator will change frequently while control pressure is stable.
2. Regulator is not sensitive enough: Control pressure fluctuates while position of the regulator does not change (or changes very little).
3. Regulator is lagging behind changes in the control pressure: The control pressure fluctuates while the regulator is constantly changing its position.

Case # 1 Regulator is too sensitive:
Turn the sensitivity adjustment drum to the left (increasing numbers on the scale) by small increments. Typically good control is achieved within one or two divisions on the sensitivity adjustment drum.

⚠ WARNING

Do not turn the sensitivity adjustment drum to the left (Increasing numbers on the scale) more than one full turn (11 numbers) from the initial adjustment position. While certain VRP models will become insensitive on even minimal rotation, turning more than one full turn will guarantee excessive deadband on any VRP model.

Case # 2 Regulator is not sensitive enough:

The pilot should be able to meet the response criteria as described in the adjustment section (20 percent change in output differential with a 3/4 percent change in sensing pressure). If this adjustment does not produce satisfactory results, most likely the control valve torque has elevated. To further improve sensitivity, the control valve must be lubricated. See the Becker ball valve regulator maintenance manual for information on how to service the Becker control valve.

Case # 3 Regulator is lagging behind changes in the control pressure:
Increase both inlet orifice settings. This will cause the regulator to move faster. Turn the sensitivity adjustment drum to the left (Increasing numbers on the scale) in order to maintain the desired cylinder top and cylinder bottom pressures. Finally, turn the set point adjustment screw clockwise to increase the set point for the original desired pressure. Changing the set point will not change the sensitivity.

If the simultaneous increase of both adjustable orifices did not produce the desired result (i.e. the regulator is still unstable) it is necessary to set the adjustable orifices to open and close at different rates. This can be achieved by doing the following:

1. Open both adjustable orifices to #6 and note the total swing of the regulator. Leave the top adjustable orifice (controlling the opening speed of the regulator) at #6, and reduce the bottom adjustable orifice (controlling the closing speed of the regulator) to #3. If the swing has stopped, or at least reduced, the direction of speed adjustment is correct (the closing speed should be smaller than the opening speed). In order to find the optimum setting, try several combinations of adjustable orifice settings.
2. If the swing of the regulator has increased, change the direction of speed adjustment. Reduce the top adjustable orifice (controlling opening speed of the regulator) to # 3, and increase the bottom adjustable orifice to #6.
3. If stability of the unit cannot be achieved through different adjustable orifice setting combinations, the gain of the pilot is too high. Leave the adjustable orifices at the setting combination which generates the smallest swing. Turn the sensitivity adjustment drum to the left (decreasing numbers on the scale) by small increments until the stability is achieved.
4. Finally, turn the setpoint adjustment screw clockwise to increase the setpoint. Changing the setpoint will not change the adjusted mode.

Inspection Procedure

As with all precision equipment, it is necessary to periodically test the pilot to insure optimum performance. We recommend the following procedure once a year:

1. Close the cylinder block valves in order to prevent the control valve from moving.
2. Close valve on the sensing line.
3. Shut off supply pressure and bleed down at pilot. Note the settings of the adjustable orifices before removing them from the orifice assembly. Remove adjustable orifices and clean then thoroughly. Reinstall using new O-rings, being sure to install each orifice into the hole from which it was removed (the orifice and block have matching numbers for this purpose). Reset adjustable orifices to original settings.
4. Turn on supply pressure.
5. Check the integrity of the pilot balance valve seats by changing the sensing pressure 3/4 percent above and below the pilot setpoint. One cylinder pressure gauge should drop to 20 percent less than power gas when the pressure is raised. At setpoint the bleed gas should be minimal. If the exhaust port does bleed gas, you should be able to stop the venting by turning the adjustment drum a couple of numbers to the left. If the venting gas will never shut off with both gauges balanced and reading full power gas pressure, the balance valve seats are worn. Failure to stop venting supply pressure is a sign of a worn pilot seat. Shut off power gas supply, bleed off all remaining pressure, and rebuild pilot according to procedure in the Assembly section.
6. Reinstate power gas and soap test around all diaphragms, vents and orifice assembly. Unless a leak is found, it is not necessary to disassemble the pilot. If any leaks are found around the diaphragms, all rubber goods must be replaced.
7. Apply a “False Signal” pressure to the sensing chamber. Observe operation of the gauges. If any gauges are defective, replace them.
8. Perform the internal friction test.
9. Readjust the VRP-B-CH pilot if necessary.

Internal Friction Test

Friction may occur if the diaphragms were not centered properly during installation or dirt has accumulated inside the pilot. To test for this friction:

1. Adjust the pilot using the initial adjustment procedure.
2. With both cylinder output gauges balanced, turn the adjusting screw slightly clockwise to decrease cylinder bottom pressure. Once the pressure reading on the gauge stops falling, turn the screw back in the opposite (counterclockwise) direction. The gauge arrow should immediately reverse.
3. Follow the reverse procedure on the cylinder top gauge.
4. If either of the gauge needles dip first before climbing, the pilot has friction and must be taken apart, cleaned and reassembled.

Annual Maintenance Checklist

Refer to Inspection Procedure on previous page.

1. _________ Clean and inspect adjustable orifice assemblies. *Refer to Number 3, Page 8*

2. _________ Soap test all diaphragm mating surfaces and adjustable orifice assembly to check for leaks. *Refer to Number 6, Page 8*

4. _________ Replace rubber goods using the Becker VRP-B-CH pilot seal kit if necessary. *Refer to the Assembly Procedures Page 16*

5. _________ Confirm power gas supply pressure is correct. Refer to original Baker Hughes invoice paperwork for proper power gas setting.

6. _________ Check sensitivity of VRP-B-CH pilot. Confirm proper adjustment. *Refer to Adjustment Procedure, Step 10, Page 7*

7. _________ Observe operation of gauges and replace if defective.

8. _________ Perform internal friction test, *Refer to previous section.*

9. _________ Inspect and verify proper operation of all VRP-B-CH accessories. Refer to technical manual included with each specific instrumentation accessory for further instruction.

Note: It is not necessary to replace any rubber goods in Becker 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. See Drawing #30-0110.

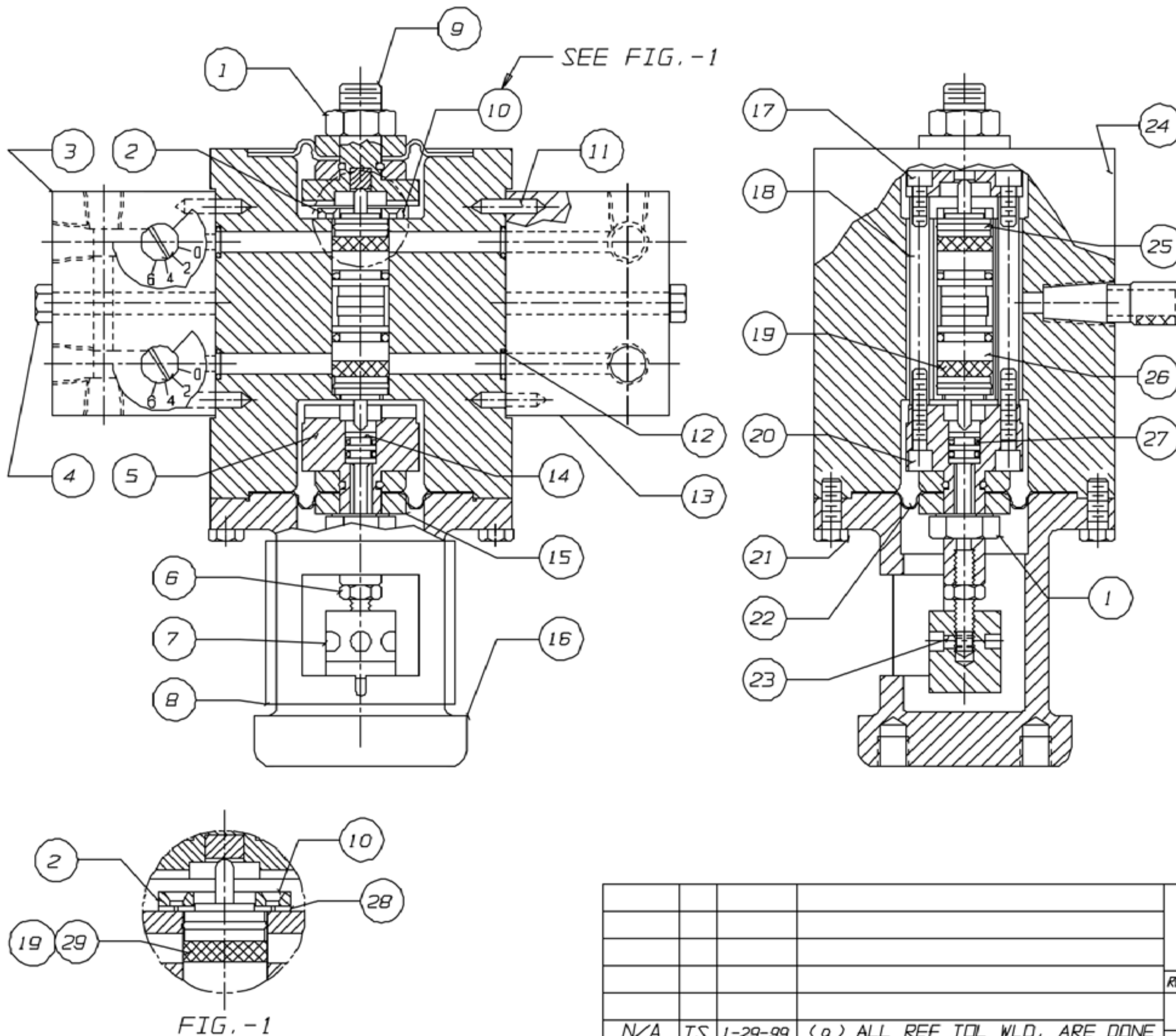
Key	Description	Part No.	Quantity
1[(1)]	1/2-20 Jam Nut	98-3056	2
2	Seat Cover	35-1519	1
3	Orifice Assembly	35-1015	1
4	1/4-20 x 2-1/2 HHCS	98-3180	4
5	Inside Piston	30-7004	1
6	-28 Jam Nut	98-3214	1
7	Adjusting Drum	35-1520	1
8	Lexan Cover	25-1034	1
9	Outside Piston	35-1506	1
10	10-32 x 3/8 FHMS	98-2684	2
11	3/16-1/2 Roll Pin	98-3089	4
12	O-Ring -012	95-2615	7
13	Gauge Manifold	35-1013	1
14	Valve Adjusting Screw	35-1517	1
15	Washer	25-1016	4
16	Pilot Base	30-7005	1
17	8-32 x 1/2 SHCS	98-2614	2
18	Pilot Post	35-1521	2
19	Spacer	35-1526	2
20	8-32 x 1" SHCS	98-3144	2
21[(1)]	1/4-20 x 3/4 HHCS S.S.	98-3137	6
22	Diaphragm w/ Convolute	25-1027	2
23	5-40 x 1/4 SHCS	98-2629	1
24	Double Pilot Body	35-1504	1
25	Seat Assembly	01-7082	2
26	Balance Valve Assembly	35-1510	2
27	O-Ring -010	95-2609	2
28[(2)]	#10 Lockwasher	98-3178	2
29	Strainer for Balance Valve	35-1559	2

[(1)] Torqued to 140-160 in-lbs.
[(2)] Torqued to 95-100 in-lbs.

Seal Kits

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

VRP-B-CH Pilot Model	Repair Kit Part No.
VRP-B-175-CH	30-9102
VRP-B-600-CH	30-9104
VRP-B-1000/1500-CH	30-9105



ITEM	QTY.	PART NO.	DESCRIPTION
1.	2	98-3056	1/2-20 JAM NUT
2.	1	35-1519	SEAT COVER
3.	1	35-1015	ORIFICE ASSY.
4.	4	98-3180	1/4-20 X 2 1/2 HHCS
5.	1	30-7004	INSIDE PISTON
6.	1	98-3214	1/4-28 JAM NUT
7.	1	35-1520	ADJUSTING DRUM
8.	1	25-1034	LEXAN COVER
9.	1	35-1506	OUTSIDE PISTON
10.	2	98-2684	10-32 X 3/8 FHMS
11.	4	98-3089	3/16 X 1/2 R PIN
12.	7	95-2615	O-RING - 012
13.	1	35-1013	GAUGE MANIFOLD
14.	1	35-1517	VALVE ADJ. SCREW
15.	4	25-1016	WASHER
16.	1	30-7005	PILOT BASE
17.	2	98-2614	8-32 X 1/2 SHCS
18.	2	35-1521	PILOT POST
19.	2	35-1526	SPACER
20.	2	98-3144	8-32 X 1" SHCS
21.	6	98-3137	1/4-20 X 3/4 HHCS SS
22.	2	25-1027	DIAPHRAGM W/CONVOL.
23.	1	98-2629	5-40 X 1/4 SHCS
24.	1	35-1504	DOUBLE PILOT BODY
25.	2	01-7082	SEAT ASSY.
26.	2	35-1510	BALANCE VALVE ASSY.
27.	2	95-2609	O-RING -010
28.	2	98-3178	#10 LOCKWASHER
29.	2	35-1559	STRAINER FOR B.V.

Notes:
1) Item no. 1 Is torqued to 140-160 in-lb.
2) Items no. 21 and 28 are torqued to 95-100 in-lb.'

REP#	BY	DATE	REVISION	
N/A	TS	1-29-99	(a) ALL REF TOL WLD. ARE DONE	S.S=

BECKER PRECISION EQUIPMENT INC.

REVISED 1-29-99 | REVISED BY: TS

APPROVED BY:
DRAWN BY: TS
DATE: 11-19-98
SCALE: 1:3/4

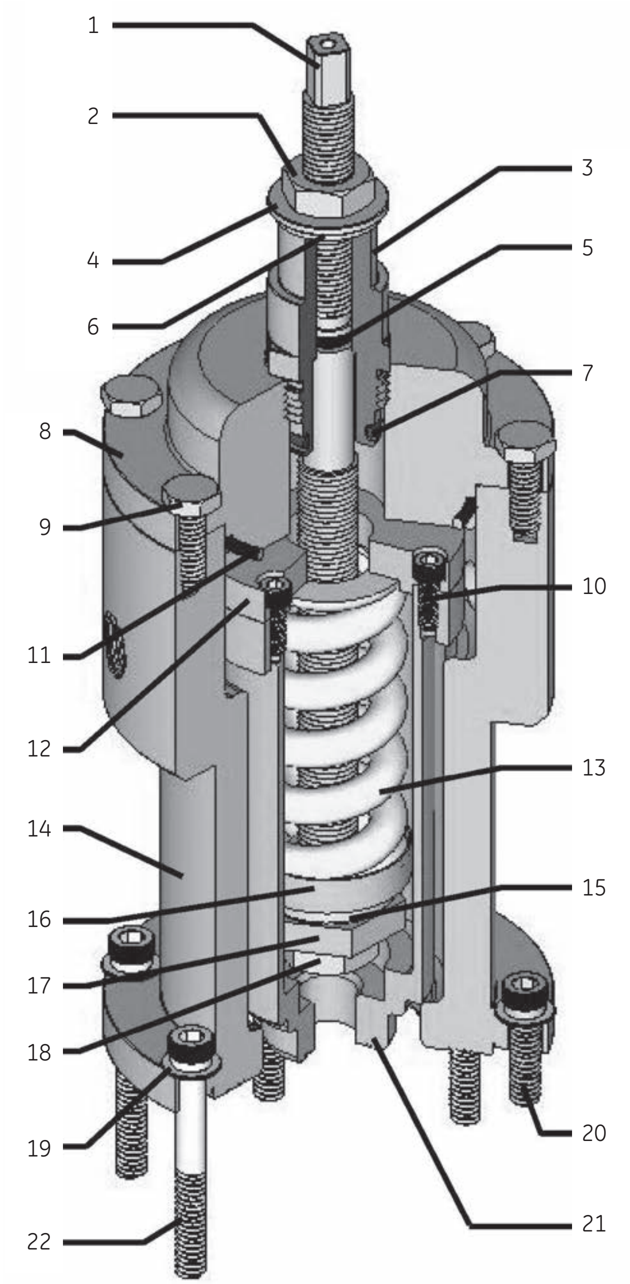
VRP-B-CH BLANK ASSY.

BALANCE VALVE DESIGN

DRAWING NUMBER 30-0110

VRP-B-CH Pilot Blank Parts

VRP-B-CH Pilot Spring Chamber Parts



175/600-CH Spring Chamber

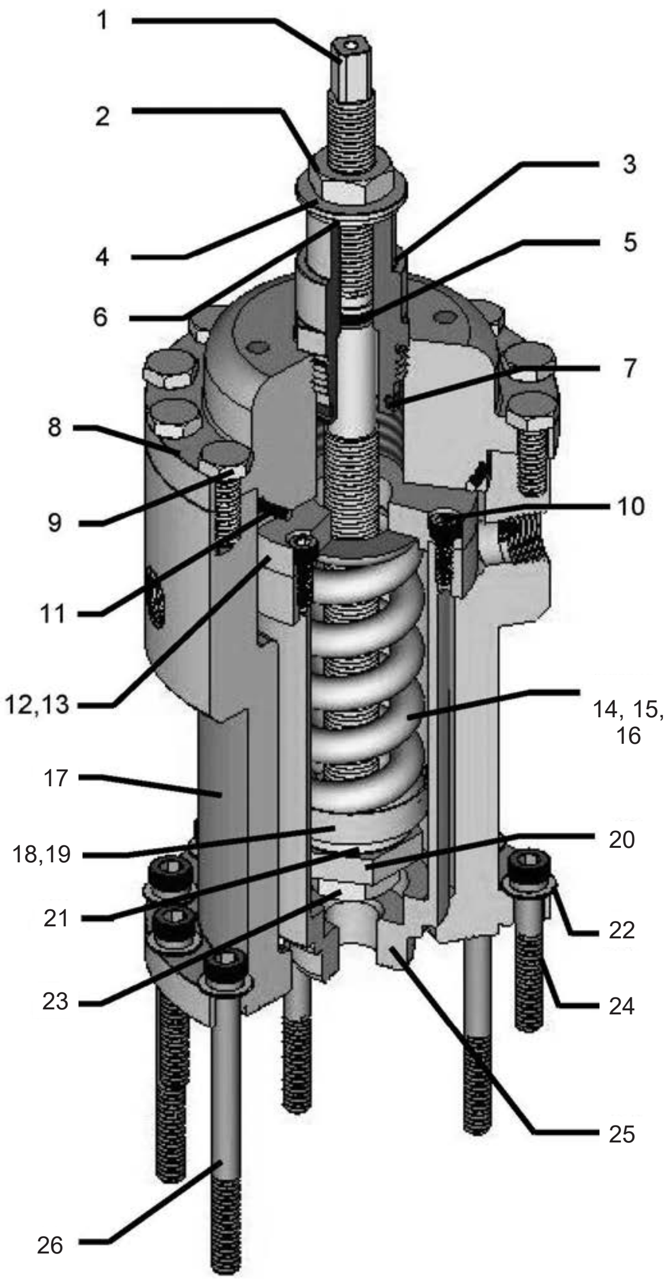
175/600-CH Spring Chamber Assembly Anodized Aluminum[1] Part # 30-0012

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

VRP-B-CH Pilot Spring Chamber Parts



1000/1500-CH Spring Chamber

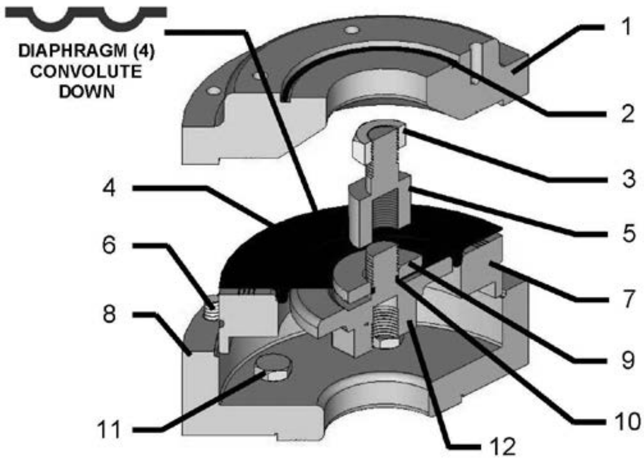
1000/1500-CH Spring Chamber Assembly
Anodized Aluminium(1) Part # 30-0013

Key	Part Number	Description
1	30-7022	Adjusting Screw
2	98-2500	7/16” - 20” 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” HHCS (SS)
10(2)	98-3269	8-32 x 1/2” SHCS (Alloy) (FEP and 1500-CH only)
11	95-2671	O-ring – 141
12	30-7007	Std. Tube Cap
13	30-7085	Tube Cap (SS) for 1500-CH
14	25-1306	Yellow Spring
15	25-1562	Grey Spring for 1500-CH (800-1300 psig)
16	25-8073	Violet Spring for 1500-CH (1000-1500 psig)
17	30-7023	Spring Cart. 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	.250” x .500” Washer (Fiberglass)
23	98-3213	1/2’20 LH Jam Nut (316)
24	98-3229	1/4 - 20 x 1-1/2” SCHS (SS)
25	30-7003	Inner Tube
26	98-3231	1/4-20 x 2” SCHS (SS)

(1) Stainless steel versions available

(2) Item #10 is 98-2614 (8-32 x ½” SS) for VRP models (except 1500-CH)

VRP-B-CH Pilot Sensing Chambers Parts

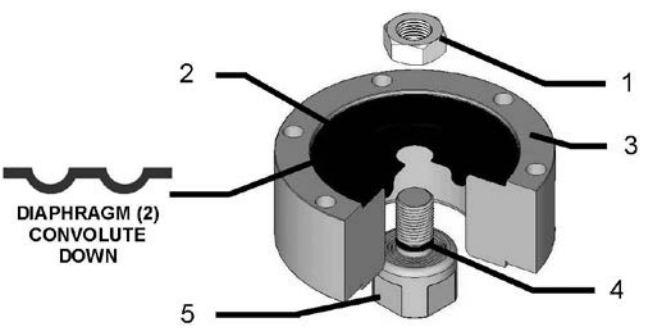


175-CH Sensing Chamber

Maximum allowable operating pressure (MAOP) = 225 psig

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	1/2-20 Jam Nut (316)
4	30-7012	Diaphragm w/Hole
5	30-7015	Thread Extension
6	98-3153	1/4-20 x 1-1/2” HHCS
7	35-1549	Spacer
8	35-1548	Bottom Flange
9	30-7020	Washer
10	95-2615	O-ring - 012
11	98-3137	1/4-20 x 3/4” HHCS
12	30-7025	Piston

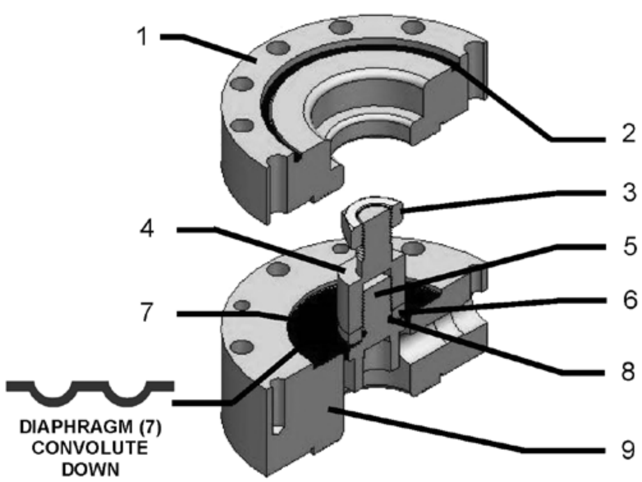


600-CH Sensing Chamber

Maximum allowable operating pressure (MAOP) = 600 psig

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/Conv.
3	25-1156	Bottom Spacer
4	95-2615	O-rIng - 012
5	25-1177	Bottom Piston



1000/1500-CH Sensing Chamber

Maximum allowable operating pressure (MAOP) = 1500 psig

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	Conv. Diaphragm w/Hole
8	95-2615	O-ring - 012
9	30-7058	Top Spacer

(1) Stainless steel versions available

Appendix

Flow Calculations

Critical Flow

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

Variables:

Q_C = critical flow across the inlet orifice in scfh

P_1 = supply pressure to the pilot in psig

C_V = $0.00447 \times n^{1.656242}$

G = specific gravity of the gas

T = temperature of the gas in °F

Steady State Consumption for downstream bleed*

*(<10 scfh for bleed to atmosphere)

Q_{SSC} = steady state consumption

Q_{C1} = critical flow across the top orifice in scfh

Q_{C2} = critical flow across the bottom orifice in scfh

C_V = $0.00447 \times n^{1.656242}$

n = number of the orifice setting on orifice block (1 through 6)

$Q_{SSC} = Q_{c1} + Q_{c2}$

Supply Regulator Capacity

$Q_{SRC} = 2Q_C$

Variables:

Q_{SRC} = supply regulator capacity

C_V = 0.0869 (calculated with n= 6)

Travel Time

Minimum travel time (the time the valve takes to move from one extreme position to another) is achieved when the signal deviates 5% or operation. The monitor or standby regulator pilot travel time is governed by the flow capability of the supply orifice. The control valve pilot travel time is governed by the exhaust capacity of the balanced valve. This is shown as t_1 below:

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

a) Monitor/Standby pilot bleeding to atmosphere or downstream:

Variables:

t = time in seconds

S = cylinder stroke in inches

D = cylinder diameter in inches

C_V = flow factor (for orifice or booster)

b) Working pilot time from 50 percent open to either extreme:

$t = t_1 + 0.0003906 \times S \times D^2 \times P2$

Gas Consumption Table[1]

Suppy Gas pressure (psig or psid)	Orifice number				
	2	3	4	5	6
100	29	56	90	130	176
150	41	80	130	187	253
200	54	105	169	244	330
250	66	129	210	301	407

Consumption (SCFH) for monitor and standby valve. For figure while in control, divide by 2.

(1)ONLY APPLIES TO VRP-B-CH WHEN BLEEDING TO A PRESSURE SYSTEM!

Accessories

The following Accessories are available to enhance the operation or provide additional features to your VRP-B-CH Series Double-Acting Pilot Control System. For additional information regarding a specific VRP-B-CH accessory, please contact Baker Hughes.

SP Series Set Point 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 20%-50% in excess of working pipeline pressure which eliminates the need for nitrogen bottles or electronic calibration devices.

Remote Set Point Module:

Provides remote adjustment of VRP-B-CH 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 optional. 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 6 for adjustment information.

NBV Series No Bleed Valve:

Achieves non-bleeding conditions at both full open and full closed positions without any adjustment. Selection based upon power gas pressure and discharge gas pressure.

DPS-2 Series Sensor Adjustments

1. Turn the adjusting screw of the DPS-2 sensor clockwise until it extends about 1-3/4” from the top of the spring cartridge.
2. Adjust the VRP-B-CH according to the pilot adjustment procedures.

<u>For a normally open regulator (Monitor):</u>

3. Bleed off the sensing pressure.
4. Wait until the pressure reading on the cylinder bottom gauge is zero.

<u>For normally closed (standby) regulator:</u>

3. Increase the sensing pressure 5 percent above setpoint.
4. Wait until the pressure reading on the cylinder top gauge is equal to zero.
5. Turn the adjusting screw of the DPS-2 sensor counterclockwise until the exhaust port of the VRP-B-CH stops bleeding gas. Then turn the adjusting screw an additional half turn in the same direction.
6. The pressure sensor is now set for the existing supply pressure. If the supply pressure to the VRP-B-CH is changed, the sensor must be reset.

DPS Series Non-Bleed Sensor:

achieves non-bleeding conditions in either full open or full closed positions. Selection based upon power gas pressure and discharge gas pressure.

Note: See Page 6 for initial pilot adjustment information.

Assembly Procedures

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

1. Using a 7/16-in deep well socket, insert the bottom seat (rubber facing upward) (E) into the pilot body block (F).

   1a. Install strainer for balance valves (D1) in the outside of the spacer (D) and insert assembly on top of the bottom seat (E).

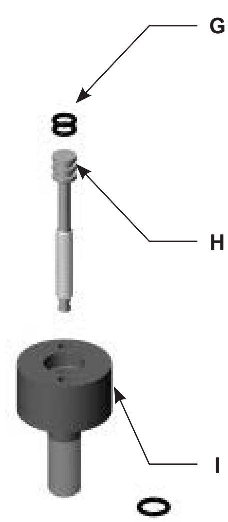
   1b. Insert the balanced valve assembly (C) with the stem facing downward.

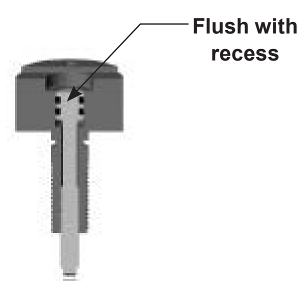
   1c. Insert the second balanced valve assembly (C) with the stem facing upward.

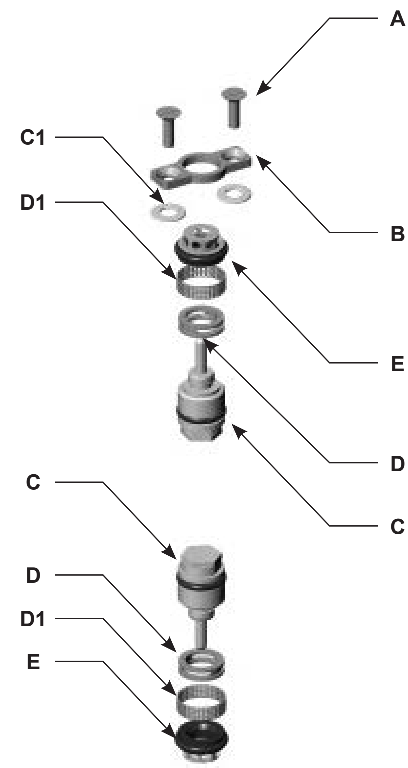
   1d. Insert the second strainer (D1) and the spacer (D) assembly.

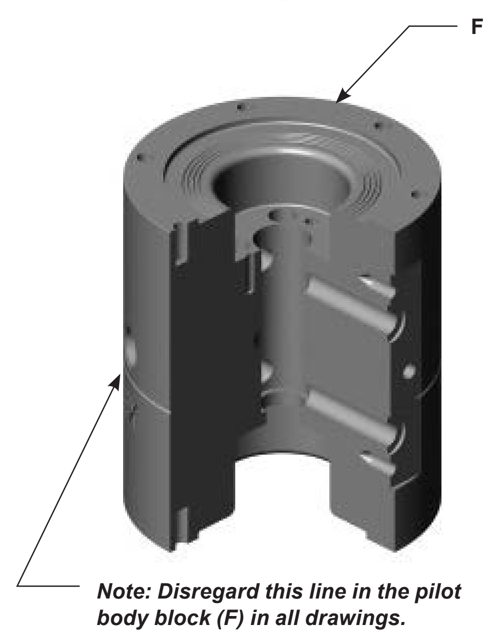
   1e. Insert the top seat (rubber facing downward) (E).

   1f. Secure the seat assembly to the pilot body block (F) with the two washers (C1), seat cover (B), and two Phillips head machine screws (A).









Note: Install the washers (C1) to compensate for tolerance variations.

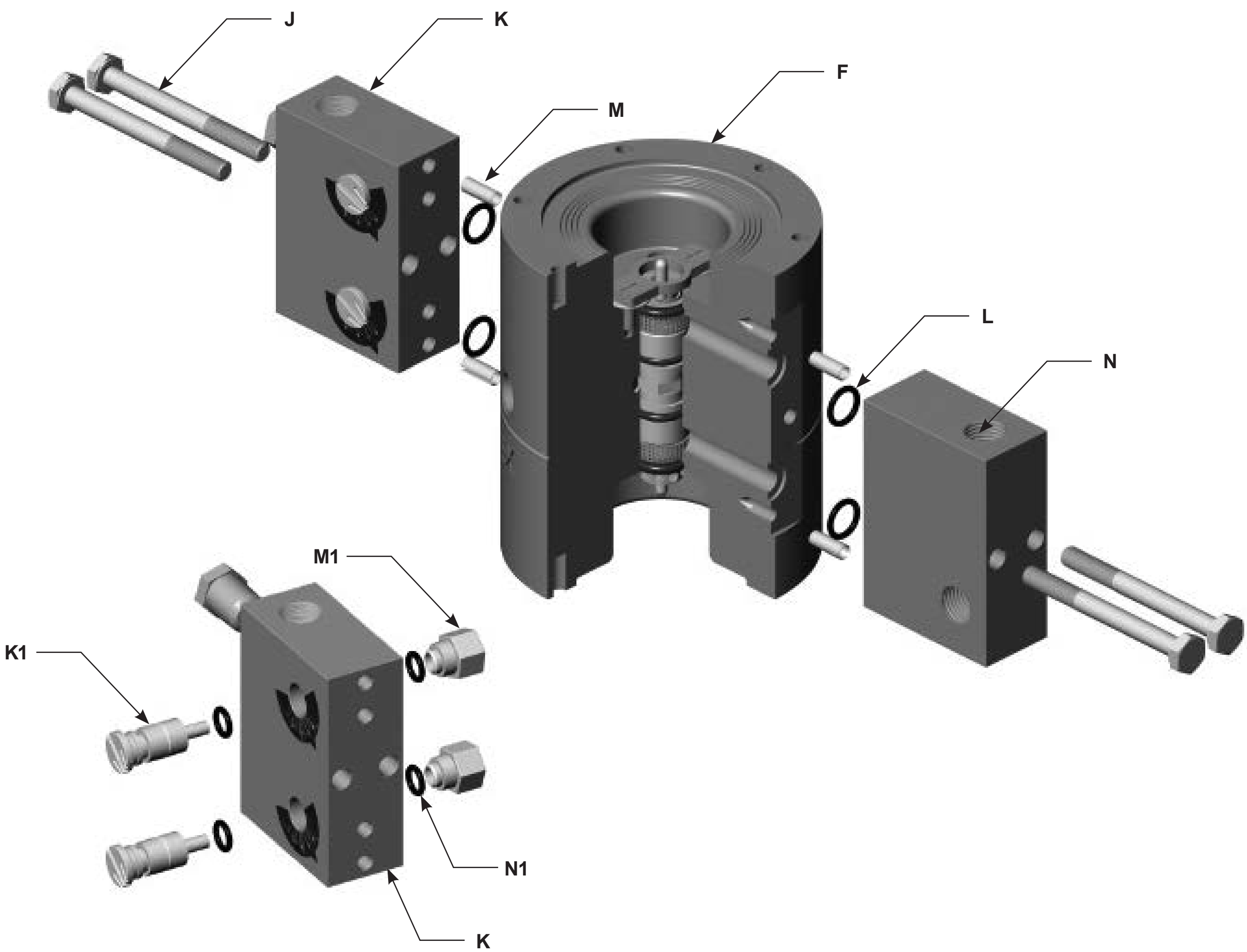
2. Slide two -010 O-rings (G) onto valve adjusting screw (H) and into the grooves at the top of the screw.

2a. Turn valve adjusting screw (H) into the outside piston (I) until the screw head is flush with the piston recess.

Orifice Block Assembly

1. Place O-ring -011 (N1) in the adjusting orifice (K1). Place the assembly in the orifice manifold (K) as shown.
2. Place O-ring -011 (N1) in the nuts (M1) and secure the adjusting orifice (K1) with nuts (M1) in the orifice manifold (K) as shown
3. Seat the four -012 O-rings (L) into the inlet and exhaust port recesses on the pilot body block (F). (Note the orientation of the body in relation to the orifice block).

   3a. Attach the orifice block (K) to the pilot body block (F) with two 1/4– 20 x 2-1/2-in stainless steel HHCS (J) by lining it up with roll pins (M) in pilot body block (F).



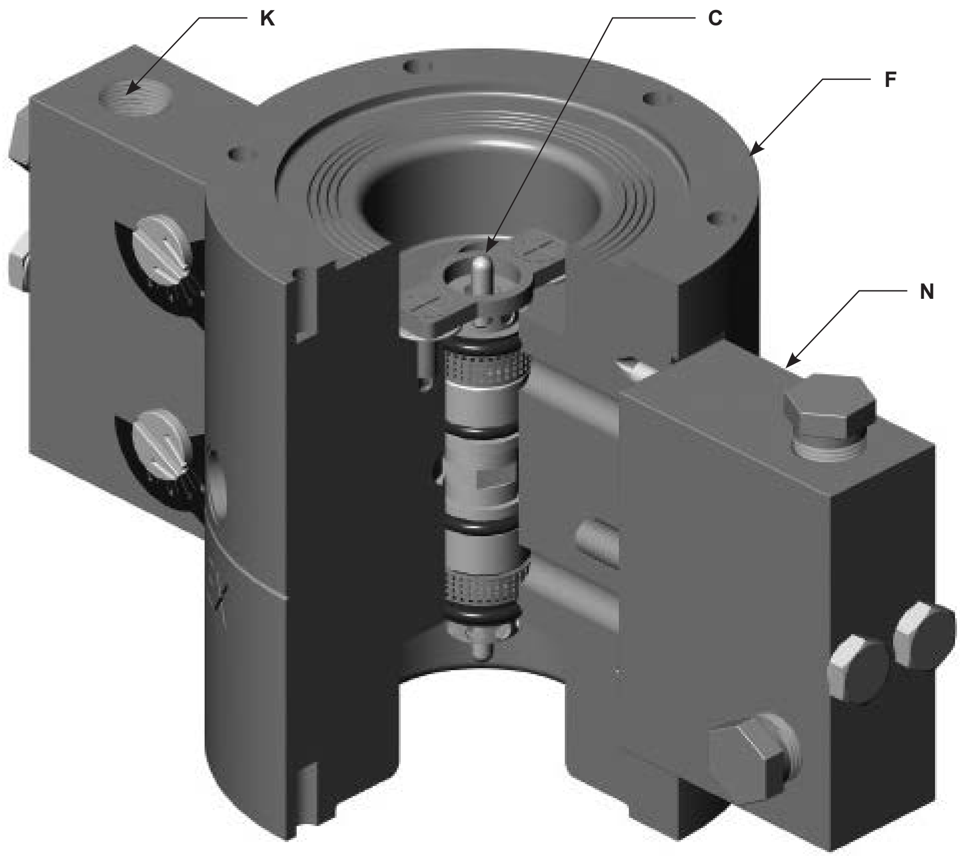
4. Test the pilot body block (F) for leakage. Using 1/4-in NPT plugs, plug the orifice block ports (K), and the gauge manifold (N).

   4a. Connect a pressure source to the orifice block (K) as shown. Use approximately 100 psig for testing.

   4b. With the pressure source activated, soap test around the balanced valve assembly (C) on both the bottom and the top of the pilot. Place a bubble on the exhaust port and check for leakage (cross drilled hole must be blocked in order to check “EX” port)

   4c If any leakage is detected, repeat the assembly procedure from step 1.

   4d. Remove all plugs from all blocks/manifolds (K and N).



5. Fasten the two posts (V) to the inside piston (W) with two 8-32 x 1-in SHCS (X).

   5a. Insert the assembly into pilot body block (F).

   5b. Fasten the outside piston (U) to the inside piston/post assembly with two 8-32 x 1/2-in SHCS (T).

6. Slide -012 O-ring (CC) onto the outside piston (U) and into the groove near its base.

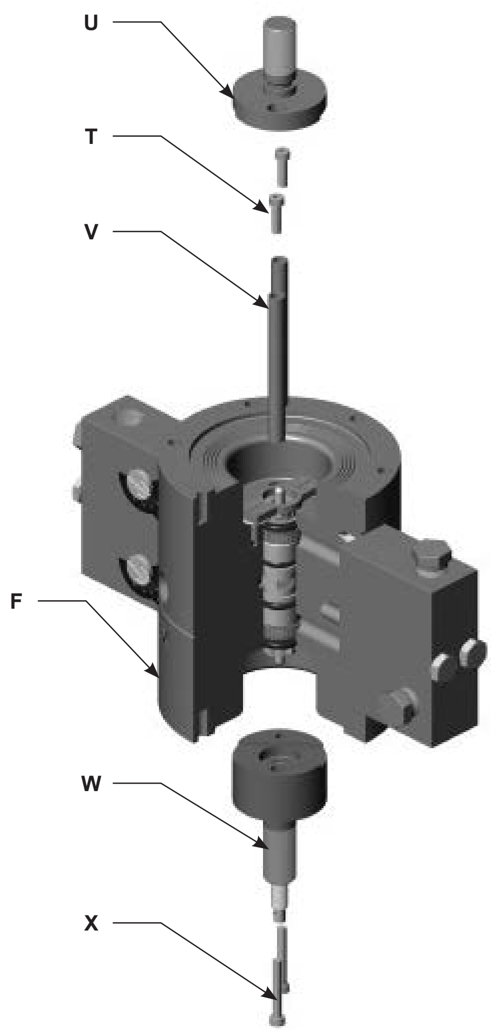
   6a. Install one washer (Z) onto the shaft of the outside piston with the grooves facing upward.

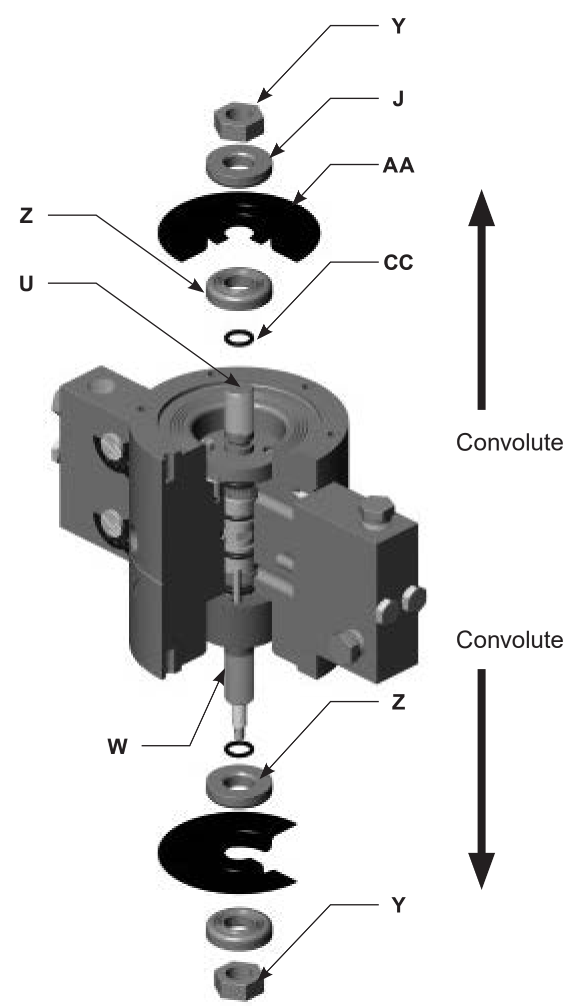
   6b. Install the convoluted diaphragm (AA) onto the shaft of the outside piston (U) as shown.

   6c. Install one washer (J) onto the shaft of the outside piston (U) with the grooves facing downward.

   6d. Assemble nut (Y) onto the outside piston (U) and torque it to 140-160 in. lbs.

   6e. To assemble the inside piston, repeat Steps 6 to 6d.





7. Attach the 1/4-28 jam nut (FF) to the valve adjusting screw (H).

    7a. Screw the adjusting drum (GG) on the screw (H) and fasten it with the 5-40 x 1/4 SHCS (HH1) threaded into the valve adjusting screw (H).

Note: The jam nut (FF) showed should be located against the drum (GG).

8. Center the pilot posts in the pilot body block (F) by:

    8a. Rotating the diaphragm assembly (from steps 5 and 6) counterclockwise until it stops (I).

    8b. Marking the diaphragm and the pilot body block (F) with a single line.

    8c. Rotating the diaphragm assembly clockwise until it stops (III).

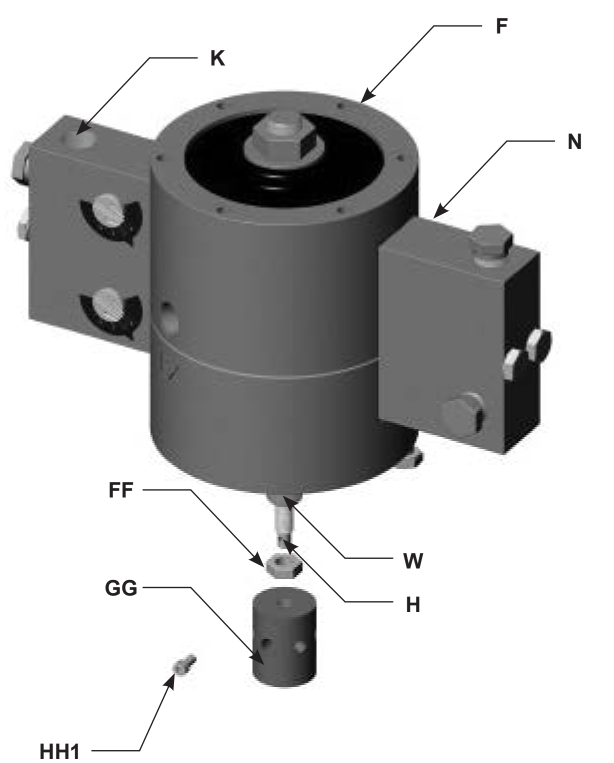
    8d. Marking the pilot body block (F) with a line extending from the existing line on the diaphragm.

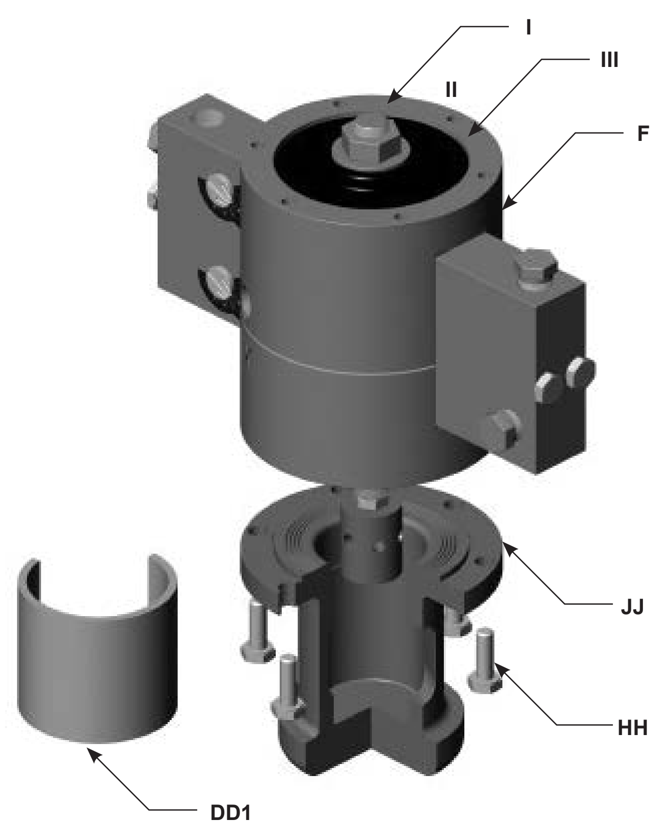
    8e. Centering the line on the diaphragm between the two existing lines on the pilot body block (II).

    8f. Keeping the diaphragm secure in the center of the lines, fasten the sensitivity spacer (JJ) to the pilot body block (F) with six 1/4-20 x 3/4 HHCS (HH). This will secure the diaphragm and prevent it from moving it any further.

    8g. Place the lexan cover (DD1) in the outside of the sensitivity spacer (JJ).

Note: The cutout should face the orifice block's supply port (K).





175-CH Chamber Assemblies

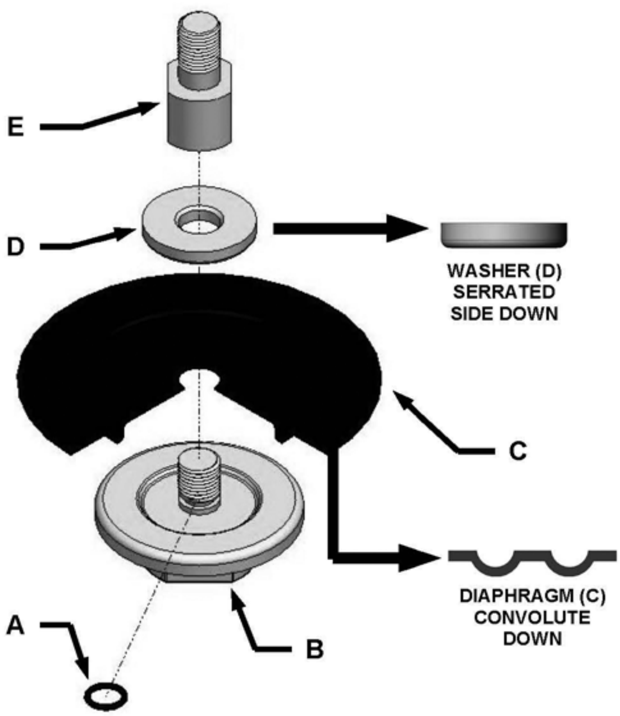


Figure 1: Assembling the diaphragm

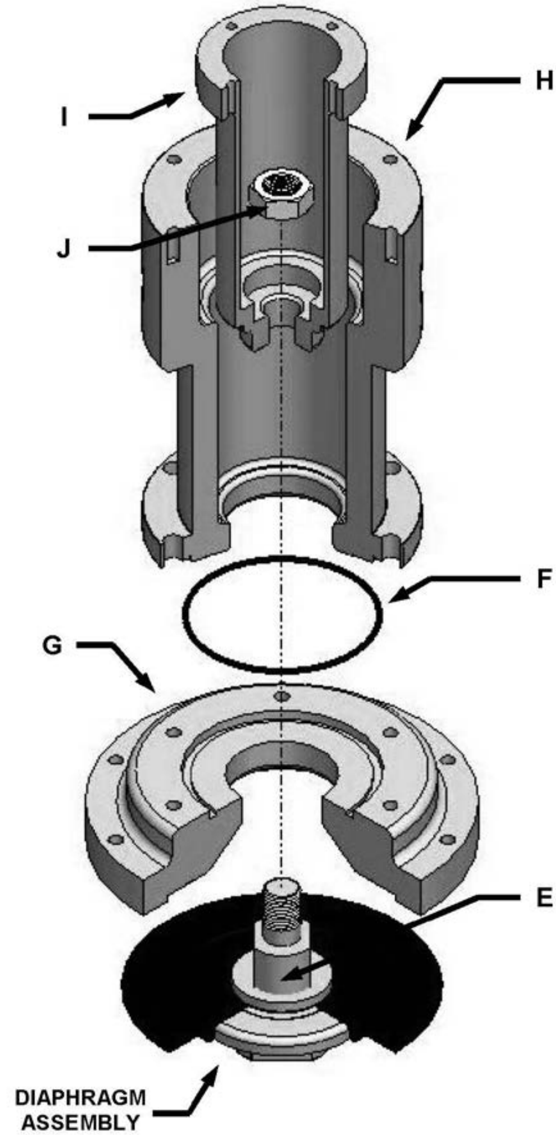


Figure 2: Fastening the thread extension

175-CH Diaphragm Assembly

Slide – 012 O-ring (A) onto piston (B). Place the diaphragm with the hole (C) onto the piston (B). Slide the washer (D) onto the piston (B). Attach the thread extension (E) onto the piston (B). Torque to 100-110 in.-lbs.

175-CH Cartridge Assembly

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

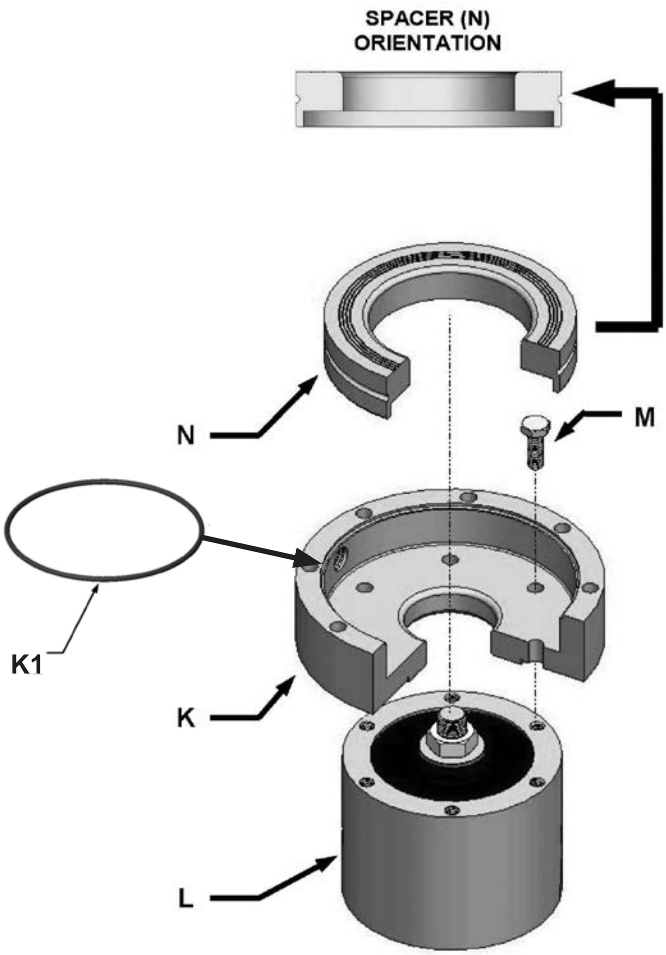


Figure 3: Fastening the Bottom Flange

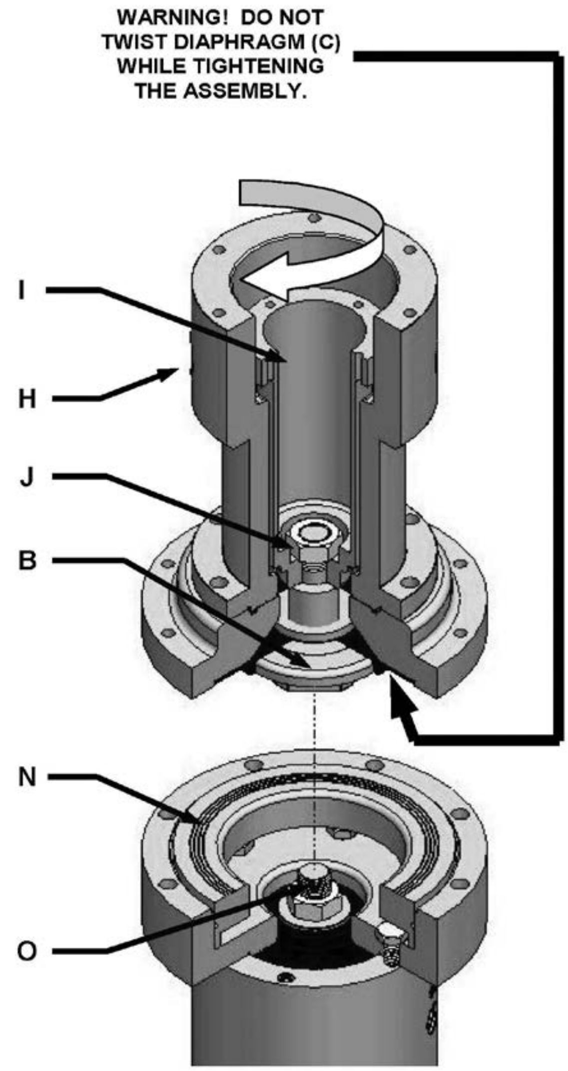


Figure 4: Connecting the Pistons

175-CH Bottom Flange Assembly

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. Place the spacer (N) inside the bottom flange (K).

175-CH Piston Assembly

Place Diaphragm Assembly onto Spacer (N).Making sure not to twist Diaphragm (C), thread Piston (B) into Outside Piston (O) by holding Spring Chamber (H), and rotating Inner Tube (I) clockwise. Inner Tube (I) is rotated with same socket wrench used to hold the Jam Nut (J) in the cartridge assembly step. When Inner Tube (I) cannot be rotated any more do not force it, this assembly should only be hand-tight.

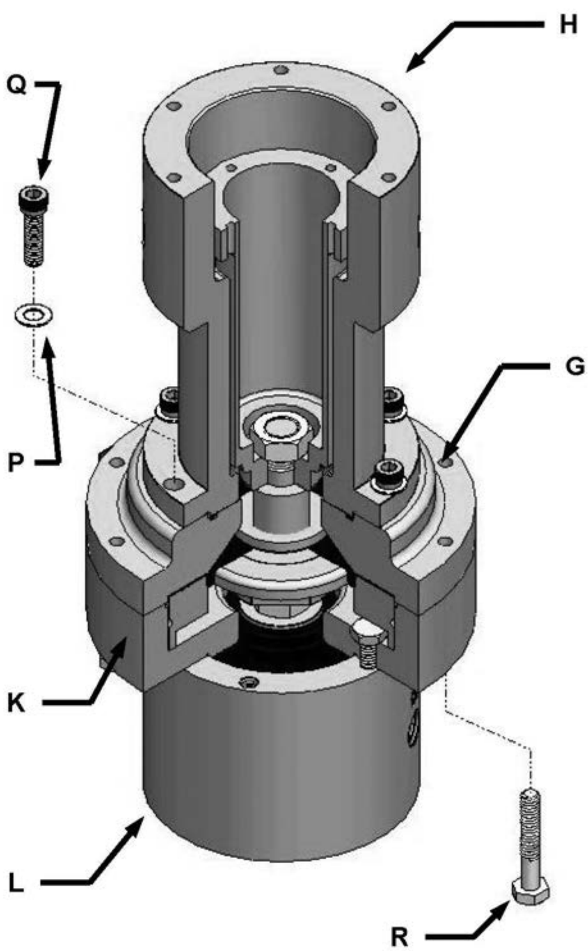


Figure 5: Bolting the spring chamber

175-CH Spring Chamber Assembly

Bolt Spring Chamber (H) onto Cartridge Spacer (G) using six (6) Fiberglass Washers (P) and six (6), 1/4-20 x 7/8” SHCS (Q). Bolt Bottom Flange (K) into Cartridge Spacer (G) using eight (8), 1/4-20 x 1 1/2” HHCS (R).

600-CH Chamber Assemblies

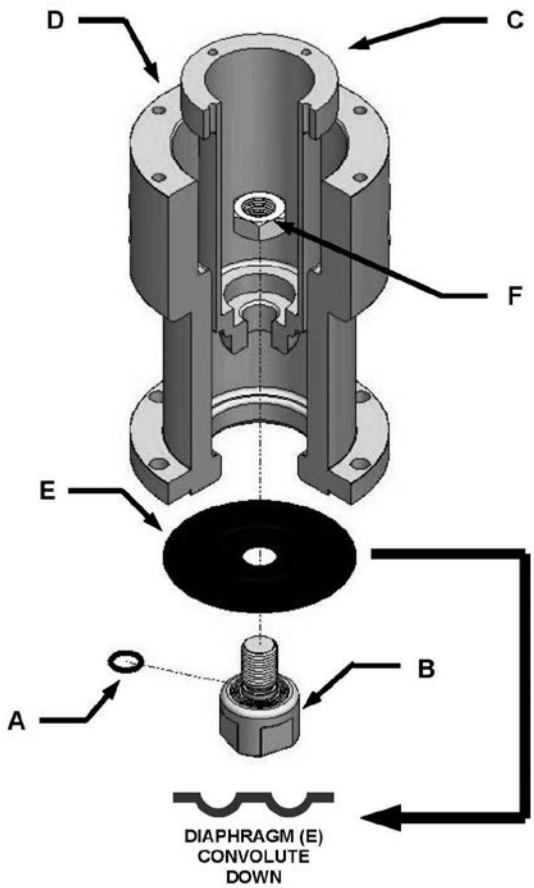


Figure 6: Assembling the diaphragm

600-CH Diaphragm Assembly

Insert - 012 O-ring (A) into the bottom piston (B). Insert the inner tube (C) into the spring chamber (D). Insert the bottom piston (B) into the diaphragm with convolute (E). Clamp the assembly together by holding the bottom piston (B) in a vise while threading 1/2-20-inch SS jam nut (F) onto the bottom piston (B). Torque the jam nut (F) to 140-160 in.-lbs.

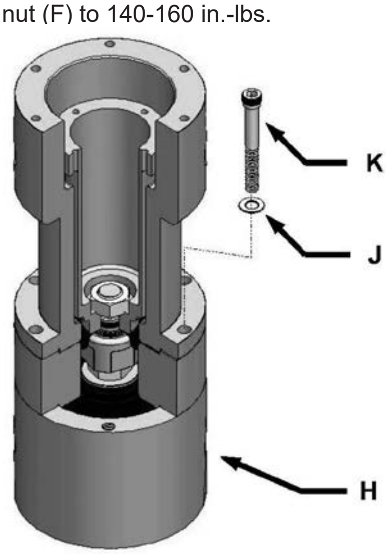


Figure 8: Bolting the spring chamber

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).

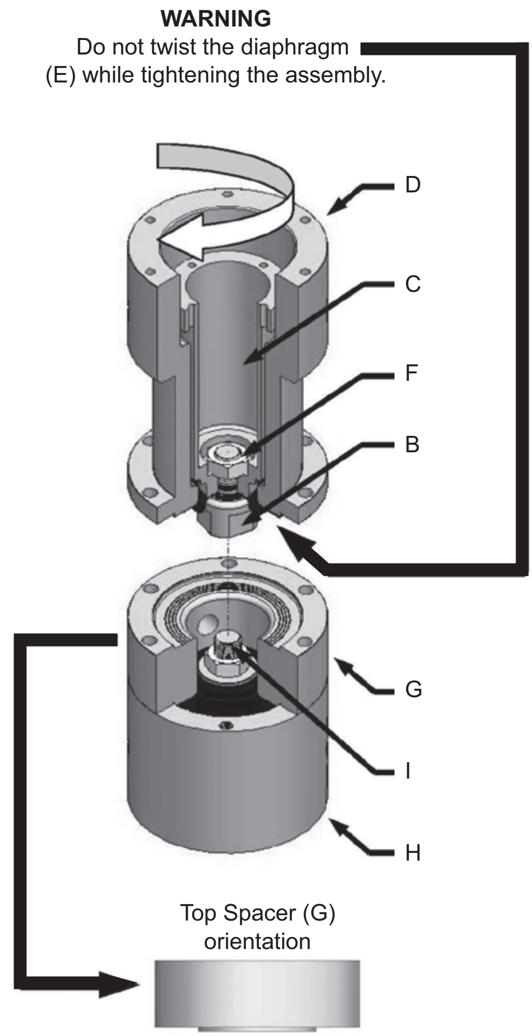


Figure 7: Connecting the pistons

600-CH Top Spacer Assembly

Orient Top Spacer (G) onto Top Body Assembly (H). Place diaphragm assembly onto Top Spacer (G). Making sure not to twist Diaphragm (E), thread Bottom Piston (B) into Outside Piston (I) by holding Spring Chamber (D), and rotating Inner Tube (C) clockwise.Inner Tube (C) is rotated with same socket wrench used to hold the Jam Nut (F) in the diaphragm assembly. When Inner Tube (C) cannot be rotated any more do not force it, this assembly should only be hand-tight.

1000/1500-CH Chamber Assemblies

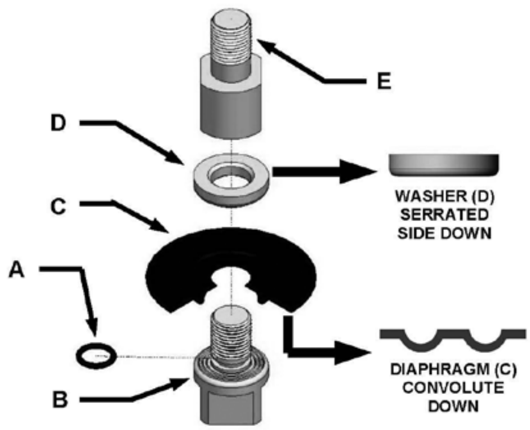


Figure 9: Assembling the diaphragm

1000/1500-CH Diaphragm Assembly

Slide – 012 O-ring (A) onto the small piston (B). Place the diaphragm with hole (C) onto the piston (B). Slide the small washer (D) onto the piston (B). Attach the thread extension (E) onto the small piston (B). Torque to 180-220 in.-lbs.

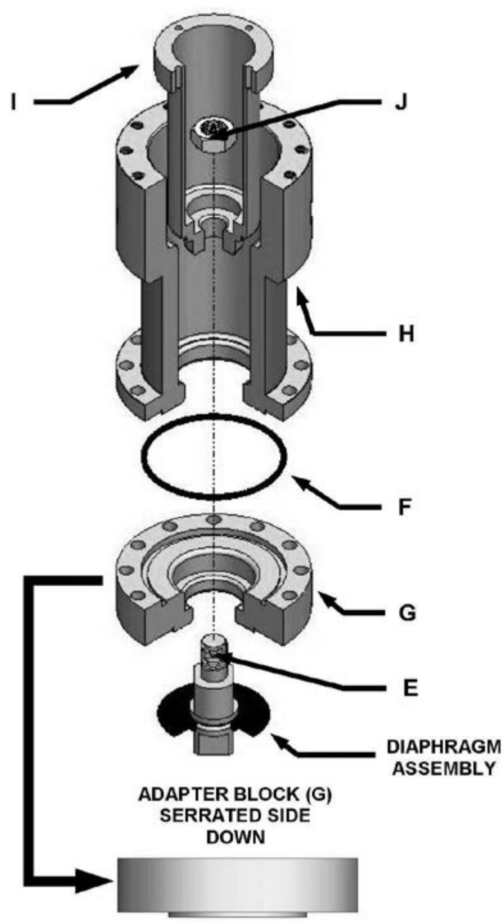


Figure 10: Assembling the diaphragm

1000/1500-CH Adapter Block Assembly

Insert – 145 O-ring (F) into the adapter block (G). Place the adapter block (G) between the diaphragm assembly and spring chamber (H) as shown in Figure 10. Slide the inner tube (I) through the spring chamber (H). Attach the thread extension (E) to the inner tube (I) using 1/2-20 SS jam nut (J). Torque the jam nut (J) to 180-220 in.-lbs.

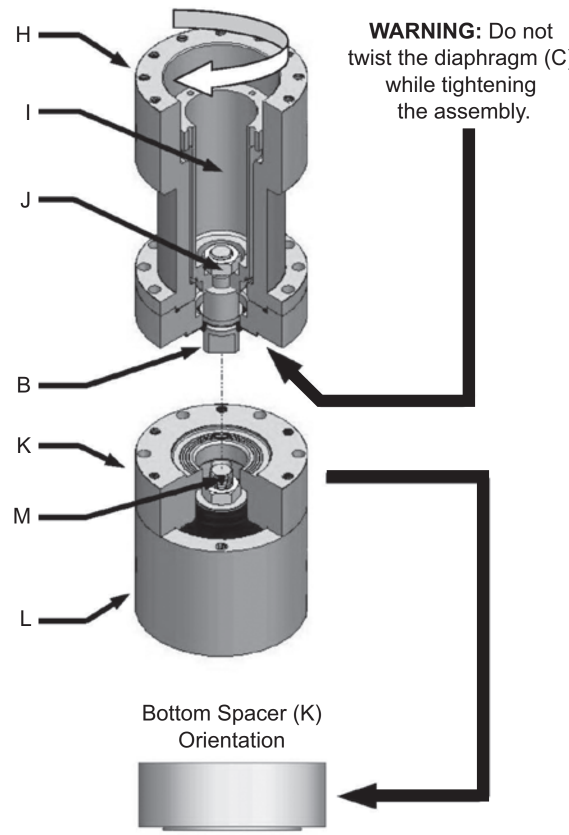


Figure 11: Connecting the two pistons

1000/1500-CH Bottom Spacer Assembly

Orient the bottom spacer (K) onto the top body assembly (L). Place the adapter block assembly onto the bottom spacer (K). 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. The inner tube (I) is rotated with the same socket wrench used to hold the jam nut (J) in the adapter block assembly. When the inner tube (I) cannot be rotated any more, do not force it; this assembly should only be hand-tight.

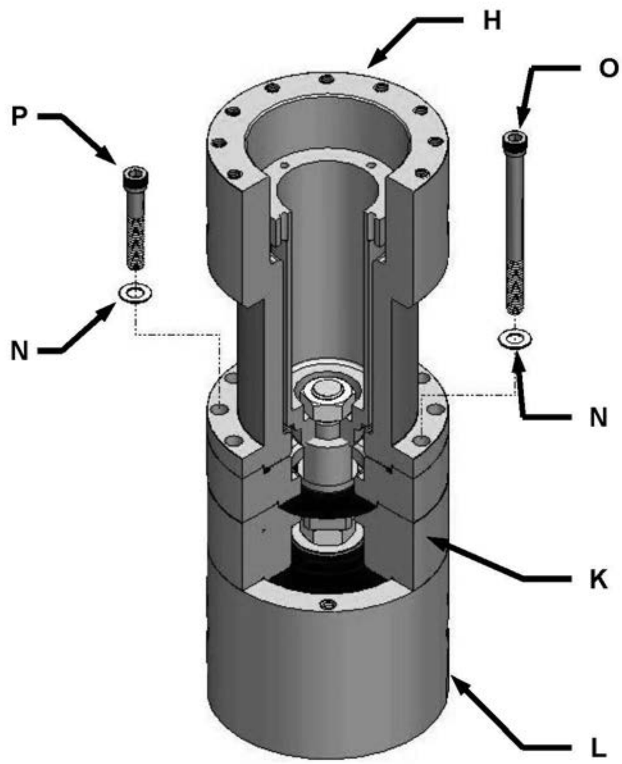


Figure 12: Bolting the spring chamber

1000/1500 Spring Chamber Assembly

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). 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).

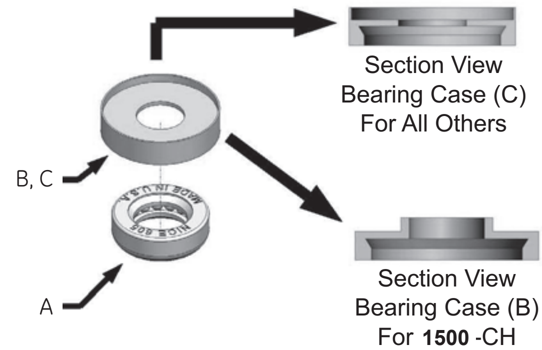


Figure 13: Thrust bearing assembly

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).

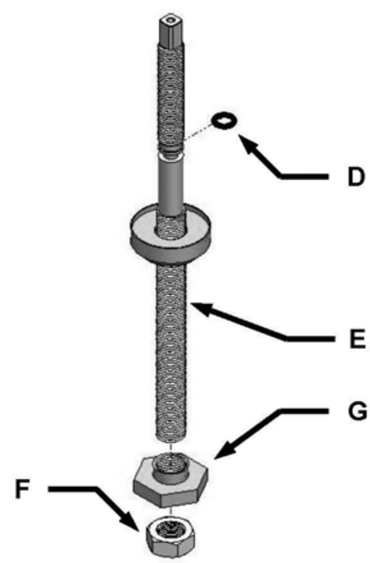


Figure 14: Adding aluminum bearing nut

Bearing Nut Assembly (All Models)

Slide a –108 O-ring (D) onto the adjusting screw (E) (as shown in Figure 14). Slide the bearing case assembly onto the adjusting screw (E). Thread the aluminum bearing nut (G) onto the screw (E) from the bottom. Leave some room below the bearing nut (G). Thread 1/2-20 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 15.

Control Spring Assembly

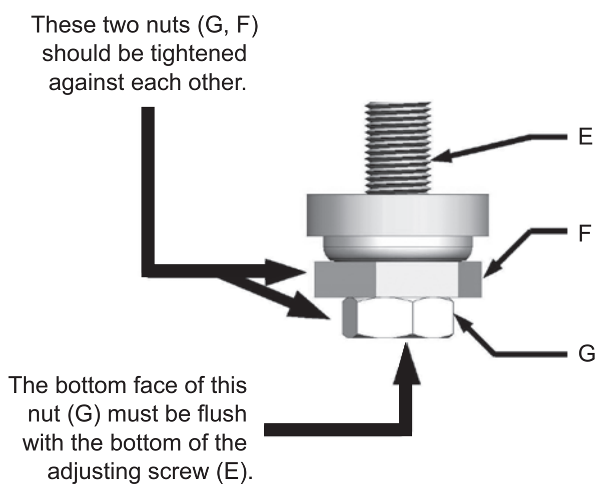


Figure 15: Tightening the bearing nut

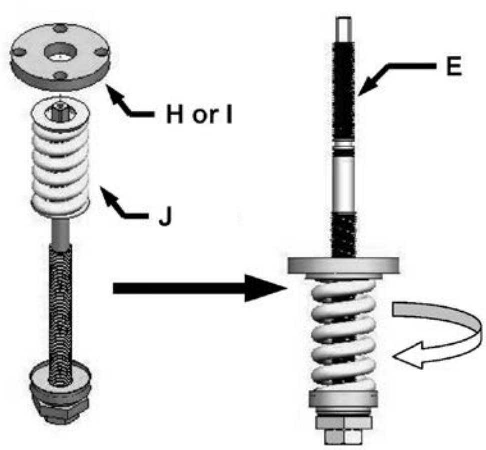


Figure 16: Spring concentricity test

Spring Concentricity Test

Place tube cap SS (H) (for 1500-CH models) or tube cap (I) (all other CH models) and the control spring (J) onto the adjusting screw (E). Check concentricity of the spring (J) by spinning the assembly. Make sure that the spring (J) touches no part of the 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.

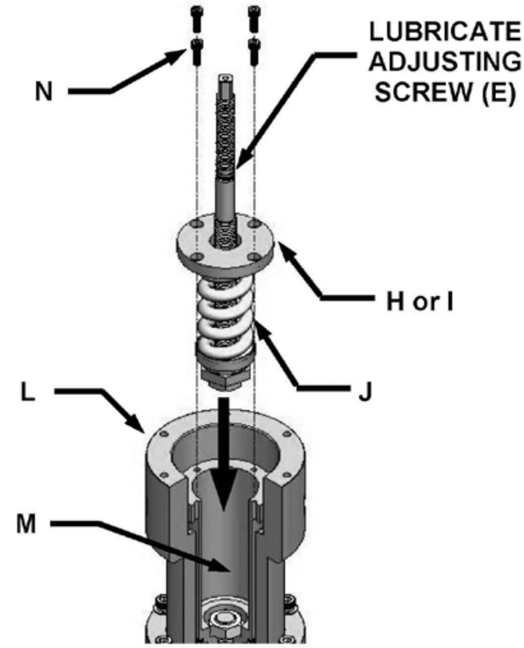


Figure 17: Inserting the spring assembly

Tube Cap Assembly (All Models)

Insert the control spring assembly into the spring chamber (L). 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

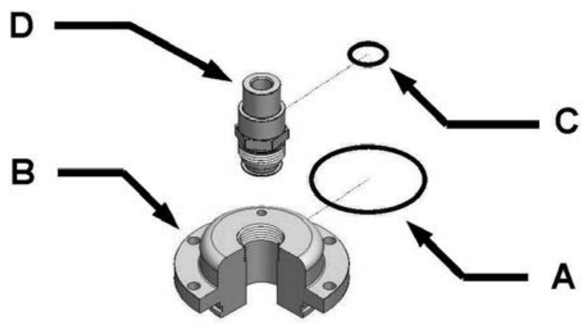


Figure 18: Inserting the seal neck

175/600-CH Seal Neck Assembly

Slide – 141 O-ring (A) over the cartridge cap (B). Slide –115 O-Ring (C) over the seal neck (D). Thread the seal neck (D) into the cartridge cap (B).

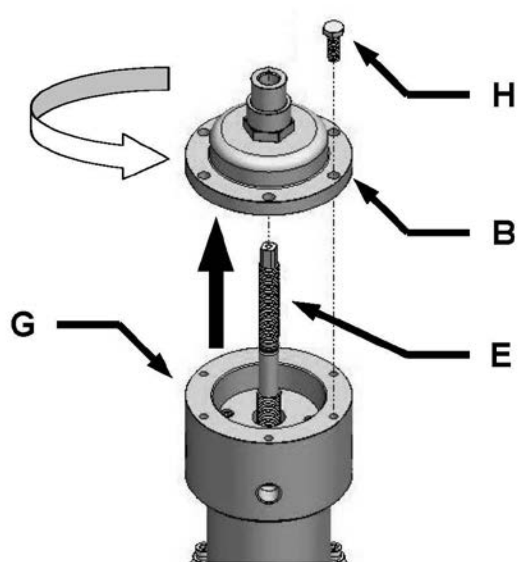


Figure 19: Bolting the cap to the spring chamber

175/600-CH Cap Assembly

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

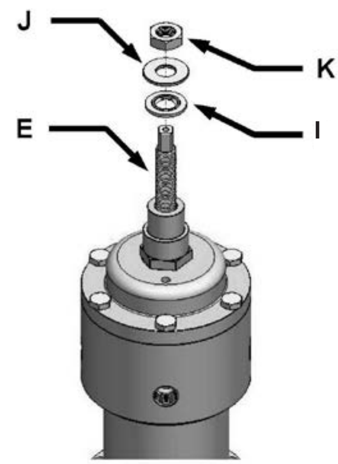


Figure 20: Finalizing the assembly

175/600-CH Thread Seal Assembly

Place the 7/16-inch SS thread seal (I) and the 7/16-inch SS flat washer (J) onto the adjusting screw (E). After all necessary adjustments on the pilot are made, thread the 7/16-inch SS jam nut (K) onto the adjusting screw (E). Be careful because over-tightening the jam nut (K) may cause damage to the adjusting screw (E).

1000/1500-CH Cap Assembly

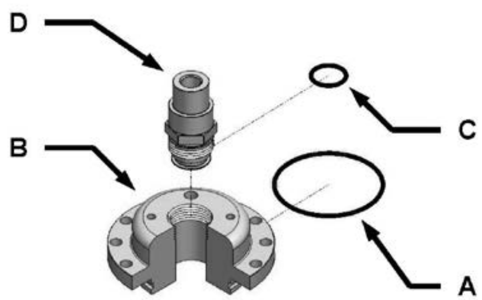


Figure 21: Inserting the seal neck

1000/1500-CH Seal Neck Assembly

Slide – 141 O-ring (A) over the cartridge cap (B). Slide –115 O-ring (C) over the seal neck (D). Thread seal neck (D) into the cartridge cap (B).

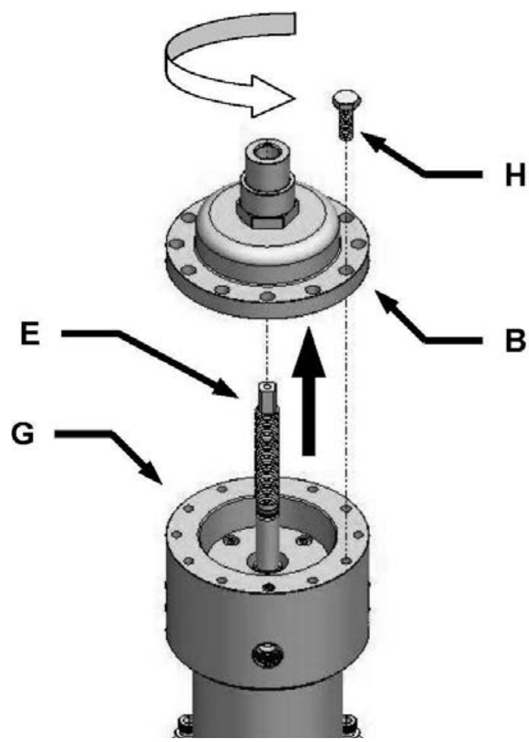


Figure 22: Bolting the cap to the spring chamber

1000/1500-CH Cap Assembly

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

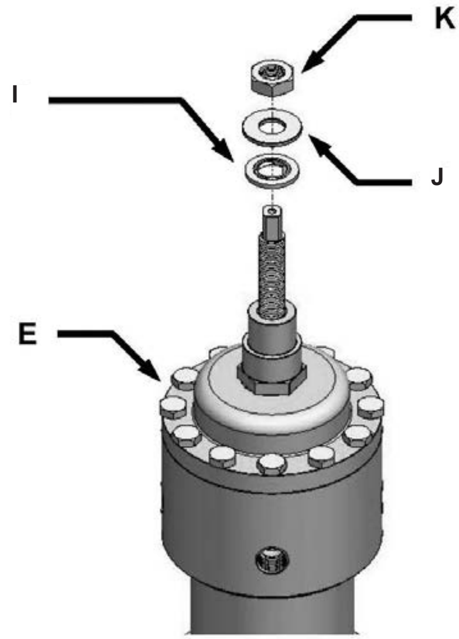


Figure 23: Finalizing the assembly

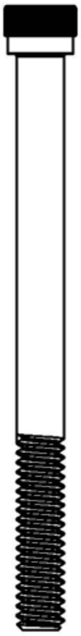
1000/1500-CH Thread Seal Assembly

Place 7/16-inch SS thread seal (I) and 7/16-inch SS flat washer (J) onto the adjusting screw (E). After all necessary adjustments on the pilot are made, thread the 7/16-inch SS jam nut (K) onto the adjusting screw (E). Be careful because overtightening the jam nut (K) may cause damage to the adjusting screw (E).

List of Recommended Tools:

1. Allen wrench. Sizes: 9/64-inch, 3/16-inch, 1/8-inch
2 Open wrench. Sizes: 7/16-inch, 3/4-inch, 11/16-inch, 5/16-inch
3. Socket wrench. 3/8-inch drive. Sizes: 7/16-inch, 3/4-inch (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" HHCS
316 SS

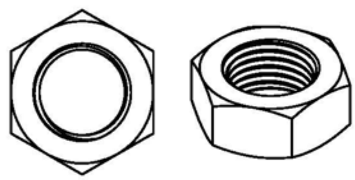
98-3230
1/4-20 x 2" SHCS
316 SS

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

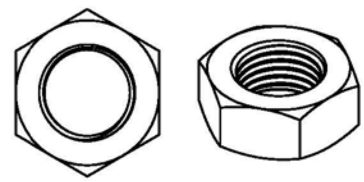
98-3228
1/4-20 x 7/8" SHCS
316 SS

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

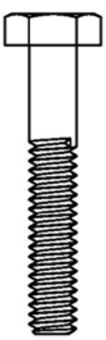
98-3269
8-32 x 1/2" SHCS
(ALLOY)



98-3056
1/2-20 HEX JAM NUT
316 SS

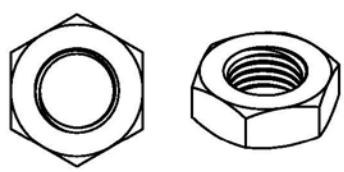


98-3213
LH 1/2-20 HEX JAM NUT
316 SS

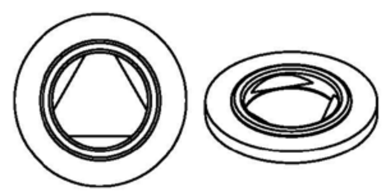


98-3153
1/4-20 x 1 1/2" HHCS
316 SS

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

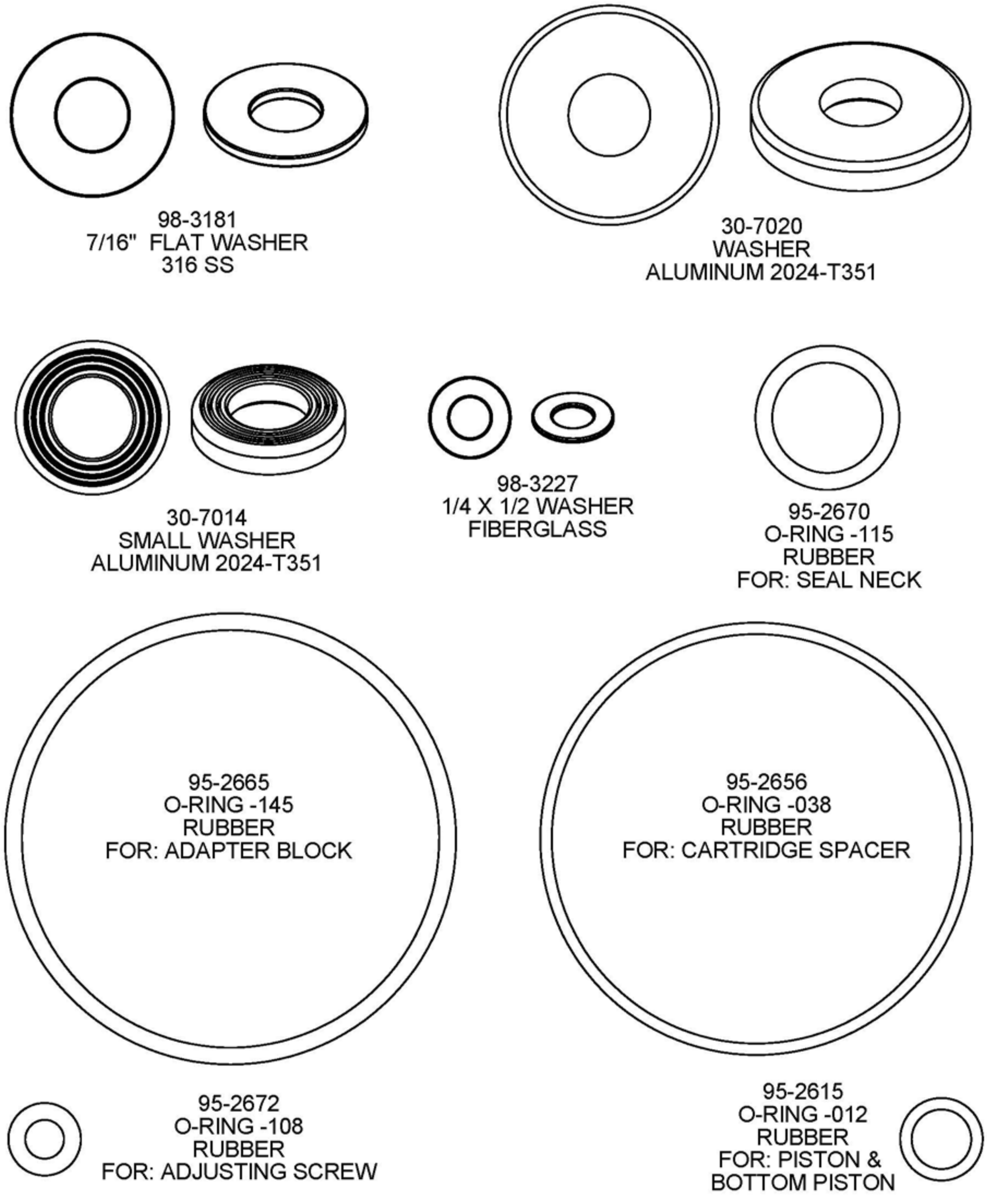


98-2500
7/16"-20 JAM NUT
316 SS

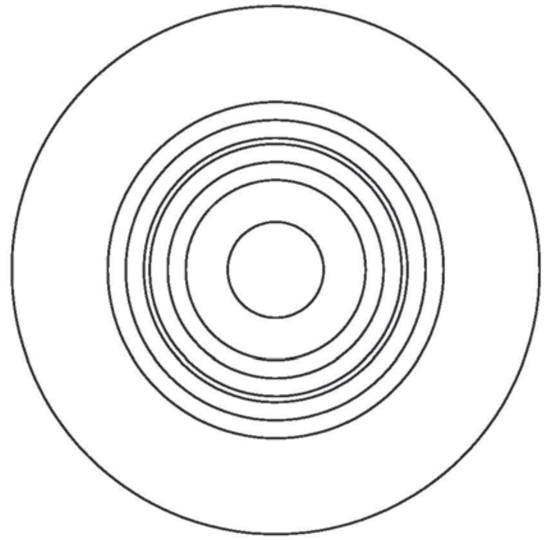


30-3017
7/16"-20 THREAD SEAL
PLATED STEEL W/ RUBBER INSERT

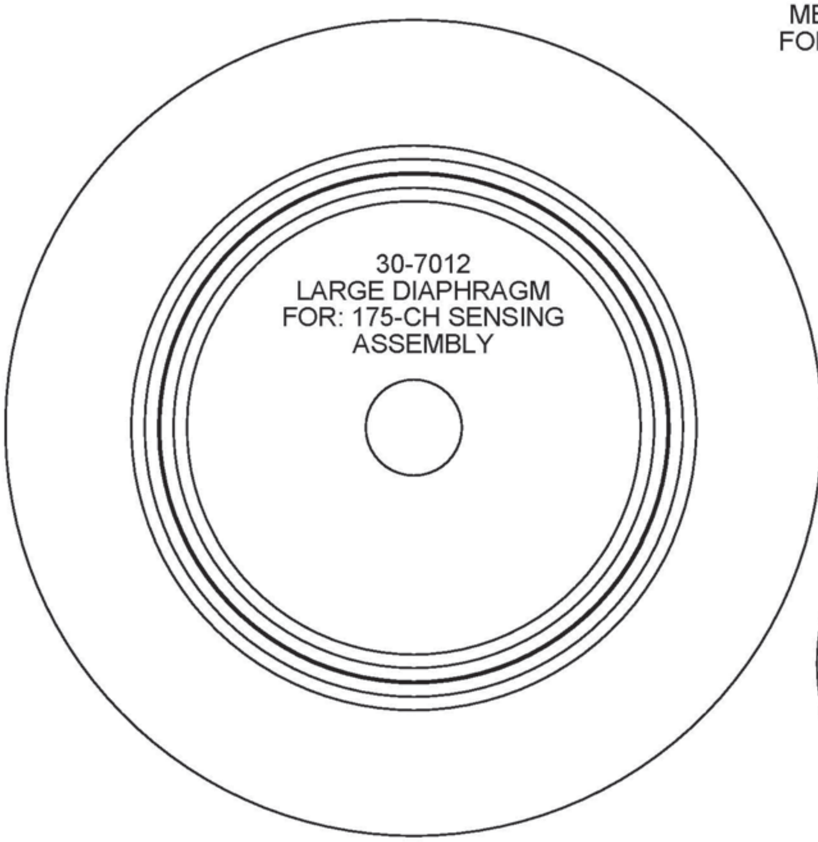
Parts Silhouettes



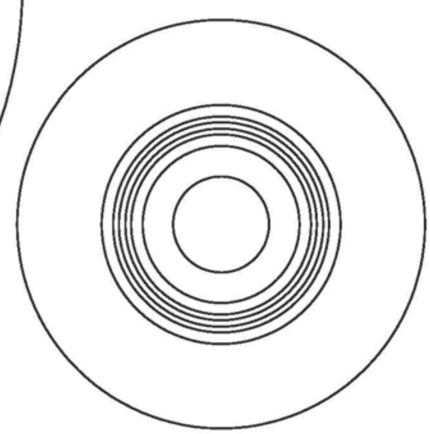
Parts Silhouettes



25-1027
MEDIUM DIAPHRAGM
FOR: 600-CH SENSING
ASSEMBLY



30-7011
SMALL DIAPHRAGM
FOR: 1000/1300-CH
SENSING ASSEMBLY



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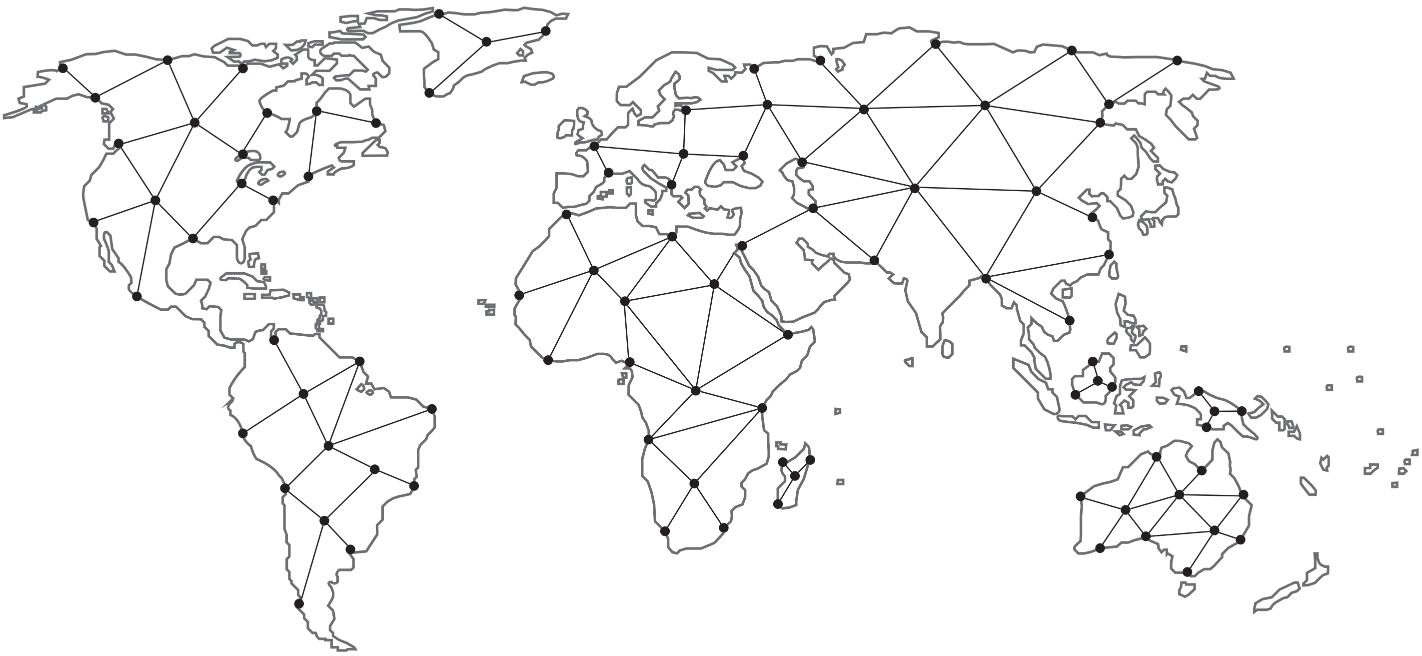

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