Instruction Manual for the VRP-CH Valve Regulator Pilot

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Introduction

The Becker VRP-CH series Double Acting Pilots 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-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 Model VRP-CH Double-Acting Pilot provides pressure control when utilized with a double-acting piston actuated control valve. The VRP-CH measures downstream sensing pressure and positions the double-acting actuator to maintain the desired downstream pressure. The VRP-CH Pilot may be utilized for pressure control applications with setpoints ranging from 1 psig to 1300 psig. The –CH design pilot represents Becker's commitment to continuos development of new products and updating of existing products to maximize their performance while retaining simple operation and minimum maintenance.

Technical Assistance

Should you have any questions, contact your local Becker Precision sales representative or Becker Precision technical assistance at:

Becker Precision Equipment
Dresser, Inc.
Attn: Technical Assistance
1550 Greenleaf Avenue
Elk Grove Village, IL 60007
Toll Free: (800) 323-8844
Tel: (847) 437-5940
Fax: (847) 437-2549

Email: becker@dresser.com
www.dresser.com

Scope of Manual

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

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NOTE: Only those qualified through training or experience should install, operate, or maintain Becker positioners. If there are any questions concerning these instructions, contact your Becker sales representative, sales office, or manufacturer 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. Small net force will be transferred to the pilot body resulting in negligible dead band shift when changing setpoint.
   Dead band drum turns easier
3. The Need for a flat diaphragm for some pilot models is eliminated meaning…
   Five pilot model numbers instead of 11
   Less trouble-shooting during assembly
4. The VRP 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 %.

Applications

- Primary Pressure Control
- Overpressure Protection (Monitor)
- Underpressure Protection (Standby)
- Relief Valve
- Backpressure Control
- Power Plant Type Applications*
- Unique "Bleed to Pressure System" BPS™ feature can be utilized
- Any large downstream systems (city gate stations, inter-system pressure limiting)
- Suction control to reciprocating compressors*
- Double-stage cut (working monitor regulator*
- High Gain systems that require fast stroking speed (power plants, fertilizer plants)*
- Large volume control valve actuators

* (consult Becker for additional information)

Guidelines for Usage

Large Volume Control Valve Actuators: Control Valves that require large volume actuators may require Model VB-250 Volume Boosters to ensure adequate stroking speed. Volume Boosters are typically required for Becker RPDA and LPDA Series actuators size 12T or larger (2200 in^3)

Bleed to Pressure System: The VRP-CH Pilot is typically utilized for applications with a discharge pressures of 350 psig or less in order to ensure adequate speed of operation. Bleed to pressure system eliminates atmospheric emissions by keeping discharge gas in the piping system.

High Gain Systems: Power plant feeds and other similar systems require fast stroking speed in order to satisfy required “gain” of the VRP-CH 3 November 2000 VRP-CH Pilot Applications system. The VB-250 Volume Boosters are applied based upon actuator size and required stroking speed.

CVE Globe Pattern Control Valves: The Model VRP-CH is the only double-acting pilot compatible with the Model CVE Globe Pattern Valve.

Compatible Actuators:

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

*consult Becker for additional information

Retrofit Compatibility:

Optimum performance is achieved by pairing the VRP-CH with genuine Becker control valve actuators. Should you already have existing control valve actuator(s) in service, the addition of a Model VRP-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

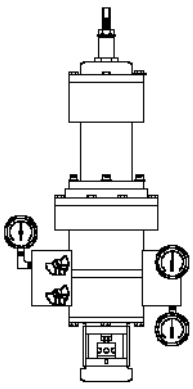
Technical Information

Technical Specifications	
Steady State Gas Consumption	(see 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	250 psig (1724 kPa)
Minimum Supply-Discharge Differential	50 psig (348 kPa)
Operative Ambient Temperature Range	-20°F to 160°F (-28°C to 70°C)
Approximate Weight	12 pounds (5.4 kg)
Minimum Deadband	0.2% instrument signal
Control Accuracy	± 0.75% of setpoint
Maximum Sensing Pressure	1300 psig
Setpoint Range	1 psig – 1300 psig 10 kPa – 8966 kPa
Housing	meets NEMA 3 Classification
Installation Orientation	vertical position recommended Custom bracket supplied with Becker Actuators 2" pipe mount provided for retrofit to other manufacturer's actuators

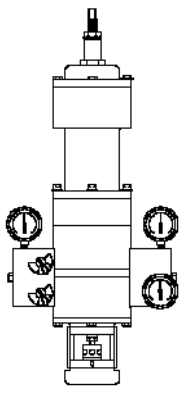
Materials of Construction	
External Parts	anodized AL 2024 SS available (for marine environments)
Internal Parts	316 Stainless Steel and 2024 Anodized Aluminum
Springs	plated steel
Diaphragms	Buna-N with Nylon Reinforcement
Seats & O-Rings	Buna-N
Tubing & Tubing Fitting	316 Stainless Steel
Gauges	2½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

Model Number Explanation

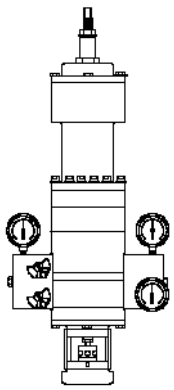
- The VRP-CH pilot is available in four different models to cover sensing pressures from 1 psig to 1300 psig.
- The number expressed in the VRP model designation is the maximum sensing pressure (for example, a VRP-600-CH has a maximum sensing pressure of 600 psig).



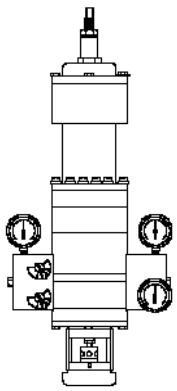
VRP-175-CH



VRP-600-CH



VRP-1000-CH



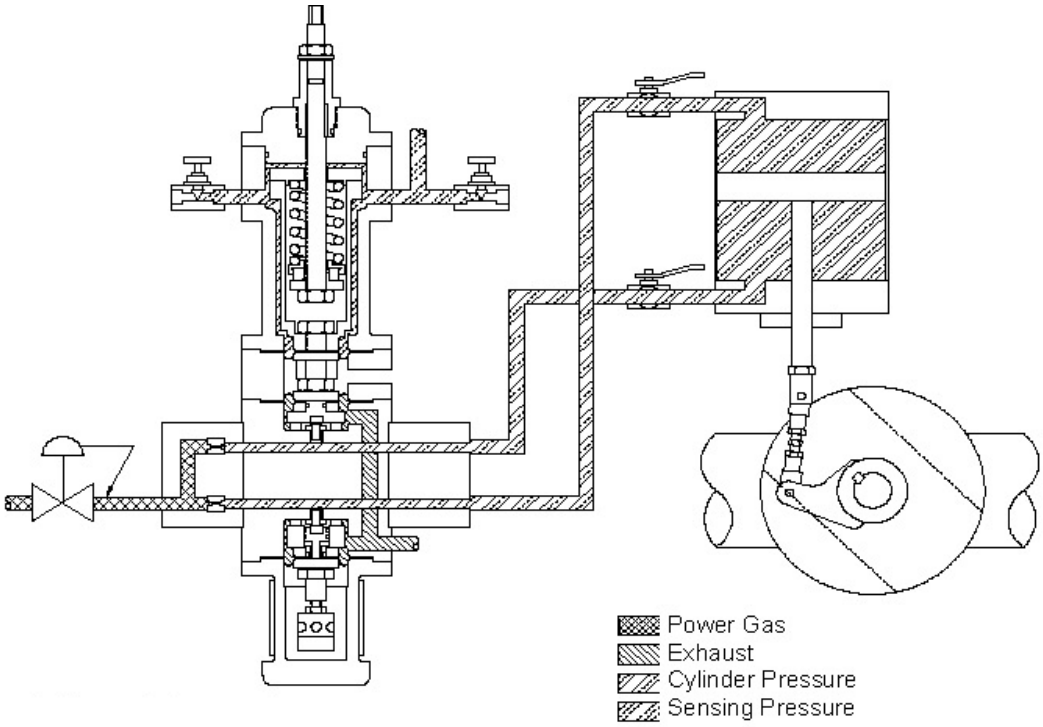
VRP-1300-CH

VRP-CH PILOT SPRING RANGES							
VRP-CH Model Number	**Control Range (psig/kPa)**	**Spring Color**	**Part Number**	**Setpoint change per revolution of setpoint screw (psig/kPa)**	**Repair Kit Part Number**	**Setpoint Range Discreet remote control (SM-1100)**	**Setpoint Range Analog (4-20MA) remodel (SM-1000)**
VRP-175-CH*	1 – 10 psig 6.9 – 69 kPa	Gold	25-8236	0.57 psig 3.9 kPa	30-9002	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	30-9002	11 psig 75.8 kPa	23 psig 159 kPa
	15 – 50 psig 103 – 345 kPa	Burgundy	25-8239	3.0 psig 21 kPa	30-9002	16.5 psig 114 kPa	35 psig 241 kPa
	20 – 85 psig 138 – 596 kPa	Pink	25-8240	6.4 psig 44 kPa	30-9002	35.2 psig 243 kPa	65 psig 448 kPa
	50 – 175 psig 345 – 1207 kPa	Yellow	25-1306	23 psig 157 kPa	30-9002	125 psig 862 kPa	125 psig 862 kPa
VRP-600-CH	5– 40 psig 34 – 276 kPa	Gold	25-8236	2.1 psig 14.6 kPa	30-9004	11.5 psig 79 kPa	35 psig 241 kPa
	25 – 140 psig 172 – 965 kPa	Beige	25-8238	7.4 psig 51 kPa	30-9004	41 psig 283 kPa	115 psig 793 kPa
	50 – 175 psig 345 – 1207 kPa	Burgundy	25-8239	11.3 psig 78 kPa	30-9004	62 psig 427 kPa	125 psig 862 kPa
	135 – 300 psig 931 – 2069 kPa	Pink	25-8240	24 psig 164 kPa	30-9004	132 psig 910 kPa	165 psig 1138 kPa
	275 – 600 psig 1896 – 4137 kPa	Yellow	25-1306	85 psig 586 kPa	30-9004	425 psig 2930 kPa	425 psig 2930 kPa
VRP-1000-CH	550 – 1000 psig 3792 – 6895 kPa	Yellow	25-1306	143 psig 990 kPa	30-9005	700 psig 4826 kPa	700 psig 4826 kPa
VRP-1300-CH	800 – 1300 psig 5516 – 8964 kPa	Gray	25-1562	227 psig 1565 kPa	30-9005	900 psig 6205 kPa	900 psig 6205 kPa

*These models should only be used for applications that require high gain. Consult Becker 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-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. After passing through each adjustable orifice, gas flow is divided. One passage leads to the respective port of the cylinder while the other is exhausted through the internal nozzle of the pilot.

At equilibrium, distances between each internal nozzle and its respective seat are equal, resulting in equal amounts of pilot output pressure to the top and to the bottom of the cylinder as well as bleed gas. The control valve remains stationary.

When the control pressure rises above the set point, the pilot pistons move downward. As the distance between the bottom internal nozzle and its seat increases, the distance between the top internal nozzle and its seat decreases. The bottom nozzle starts to bleed more gas, and the top nozzle starts to bleed less. 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 set point, the pilot output pressures automatically return to equilibrium at the new valve position. If the control pressure falls below the set point, the opposite reaction takes place.

Your VRP-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.

Adjustment Procedure

The sensitivity adjustment drum in the center of the pilot determines the sensitivity of the unit. The set point adjustment screw determines the set point at which the pilot operates. The variable orifices determine the speed of response 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-CH in order to ensure proper operation of the system and all accessories. The adjustable orifices are utilized to control the volume of gas that is supplied to the VRPCH. 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. Refer to Fine Tuning for more information on utilizing unequal adjustable orifice settings. Set both orifices according to the table below.

NOTES:

- If the VRP-CH is NOT equipped with VB Series Volume Boosters, set the variable orifices to the recommended value per the Table below. If equipped with volume boosters, see note below the table below. 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" bore).
- If equipped with a PS sensor and/or VB-250, volume boosters, see page 20.

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

NOTE: For VRP-CH equipped with VB Series Volume Boosters, set variable orifices between 1 and 2 regardless of the cylinder size. Steady state gas consumption is minimized at
1. For additional information on VB Series Volume Boosters refer to Accessories section of this manual.

3. Disable PS-2 Series Non Bleed Sensor (if equipped):
   The PS-2 Non Bleed Sensor should be disabled prior to commencing initial adjustment procedures. Failure to disable the PS Non-Bleed Sensor may prevent initial adjustments from being completed properly. To disable the PS-2 Series Non Bleed Sensor(s) rotate the adjustment screw of the PS-2 clockwise until it extends approximately 1.75" from the top surface of the PS-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 counterclockwise 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-CH from the control valve actuator. This prevents unintended stroking of the control valve and simplifies setting the VRP-CH.

6. Close the valve on the sensing line:
   It is imperative that a shut off valve be installed as close to the sensing port of the VRP-CH as possible. The volume of gas between the VRPCH sensing port and the block valve on the sensing line should be minimized. It is also imperative that the fittings between the VRP-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-CH Sensing line. Confirm that the VRP-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 VRPCH will not be possible.

7. Apply a "False Signal" to the Sensing port of the VRP-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 utilized to provide a false signal pressure above the available pipeline gas pressure.

NOTE: It is recommended that a calibrated pressure gage be utilized to ensure accuracy of the "False Signal" pressure.

WARNING: DO NOT turn the sensitivity adjustment drum without first applying a sensing pressure and initial spring tension on the adjusting screw. If these forces are not present, one of the two pilot seats will be "cut" on the internal nozzle due to the pressure between the seat and nozzle.

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

9. Adjust the Setpoint Adjustment Screw:
   Turn the Setpoint Adjustment screw on top of the VRP-CH unit until Cylinder Top and Cylinder Bottom pressure gauges show equal pressure. Clockwise rotation increases Cylinder Top pressure. Turn Setpoint Adjustment only when pressures are not equal.

10. Final Sensitivity Drum Adjustment:
    Turn the Sensitivity Adjustment to set the Cylinder Top and Cylinder Bottom at the proper Cylinder Balance Pressure (P_c) - See Equation 1 and 2 below. Turn Sensitivity Adjustment to the right (decreasing numbers on the scale) to increase the Cylinder Top/Cylinder Bottom Pressures. Turn Sensitivity Adjustment to the left (increasing numbers on the scale) to decrease the Cylinder Top/Cylinder Bottom Pressures.

The correct Cylinder Balance Pressure (P_c) is found using the Cylinder Balance Pressure equations:

VRP-CH Discharge to PRESSURE SYSTEM (NO Volume Boosters)
$P_c = P_d + [0.4*(P_s - P_d)]$ (Equation 1.a)

VRP-CH Discharge to Atmosphere (NO Volume Boosters)
$P_c = 0.4*P_s$ (Equation 1.b)

VRP-CH Discharge to PRESSURE SYSTEM (EQUIPPED with Volume Boosters)
$P_c = P_d + [0.2*(P_s - P_d)]$ (Equation 2.a)

VRP-CH Discharge to ATMOSPHERE (EQUIPPED with Volume Boosters)
$P_c = 0.20*P_s$ (Equation 2.b)

Variables:
P_c = Cylinder Balance Pressure (psig)
P_d = Discharge Pressure (psig)
P_s = Power Gas (Supply) Pressure

11. Typically, only one of the Cylinder output gages will respond at first. Continue rotating Sensitivity Adjustment until at least one of the gages indicates a pressure equivalent to the proper Cylinder Balance Pressure (P_c).

12. At this point, rotate the Setpoint Adjustment in order to equalize Cylinder Bottom and Cylinder Top pressures. Repeat Steps 10 and 11 until the proper cylinder output pressures are achieved. As the VRP-CH nears the proper adjustment, both Cylinder Top and Cylinder Bottom gages will respond simultaneously when the sensitivity drum is turned.

    VRP-CH setpoint is achieved when both Cylinder Top and Cylinder Bottom equalize at a pressure equivalent to the proper Cylinder Balance Pressure (P_c).

13. Verify "False Signal":
    Upon achieving setpoint, inspect the gage 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-CH Sensing port should be equivalent to the desired pressure setpoint of the VRP-CH. Upon readjustment of the "False Signal" repeat step 12 until setpoint is achieved.

14. Remove "False Signal" Pressure from Sensing port of VRP-CH.

15. Open valve on sensing line.13. Verify "False Signal":
    Upon achieving setpoint, inspect the gage 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-CH Sensing port should be equivalent to the desired pressure setpoint of the VRP-CH. Upon readjustment of the "False Signal" repeat step 12 until setpoint is achieved.

14. Remove "False Signal" Pressure from Sensing port of VRP-CH.

15. Open valve on sensing line.

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

    Regulator is now ready for service. The Initial Adjustments are utilized to set the VRP-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-CH Setpoint only:
In the case where the VRP-CH only requires a change in setpoint only, the Setpoint Adjustment may be rotated to achieve a new setpoint while the VRP-CH is in service. No other adjustments need to be made. Becker 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 on page 5 of this manual.

To change the VRP-CH Sensitivity:
In the event that the VRP-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. An increase (lower numbers) in the Sensitivity of the pilot, will require the Setpoint Adjustment to be decreased. A decrease (higher numbers) in the Sensitivity of the pilot, will require the Setpoint Adjustment to be increased.

NOTE: After the pilot is put into service, the Cylinder Top and Cylinder Bottom pressures may not remain at the originally adjusted Cylinder Balance Pressure. Typically, the pressure will rise above the appropriate Cylinder Balance Pressure. This occurs due to the recovery process of the rubber seats. The pressure may also rise if the temperature of the incoming gas changes. After initial installation, allow the unit to operate for a few hours, then bring the Cylinder Top and Cylinder Bottom pressures back to the appropriate values by turning the sensitivity adjustment drum in the proper direction.

While the regulator is in control, the Cylinder Top and Cylinder Bottom gauges may not be equal: The Cylinder Balance Pressure (PC) is attained by averaging the pressures of the cylinder top and bottom.

Example:
Power gas = 100 psig
Discharge gas = 0 psig (bleed to atmosphere)

While in control, gauges read:
Cylinder Top = 65 psig
Cylinder Bottom = 35 psig

The average pressure is:
(65 + 35)/2 = 50 psig

The average pressure needs to be readjusted according to Equation 1.b
$P_C = 0.4*P_S$ (Equation 1.b)

While the VRP is still in control, turn the Sensitivity Adjustment until the Average Cylinder Pressure is equal to Cylinder Balance Pressure (PC) in the appropriate equation. The Cylinder Top and Cylinder Bottom pressures change at the same rate.
Note that adjusting the Sensitivity drum will require a re-adjustment to the Pilot Setpoint.

NOTE: Cylinder Balance Pressure (Pc) may fluctuate after VRP-CH is put into service!

After the adjustment is completed, it is normal for the Cylinder Top and Cylinder Bottom to fluctuate during a 24- hour cycle. When the control valve changes its position due to change in demand (typically found in early morning conditions) the Cylinder Top and Cylinder Bottom start to settle at only 10-30% of the difference in supply and discharge pressures. This occurs due to frequent contact of seats and internal nozzles of the pilot (seats do not have enough time to recover).

The VRP pilot does not require readjustment unless the balance pressures are found to be outside the range of 30-70% of the power gas pressure.

Once adjusted, the Becker VRP 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 below the 40% range. The cylinder pressures will go down. Typically good control is achieved within one or two numbers 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 40% range 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 average value of the cylinder top and cylinder bottom pressures should be as specified in Step 10 of the Initial Adjustment. To further improve sensitivity, the system supply pressure must be increased.

NOTE: Check with Becker before increasing originally specified power gas in order to prevent equipment failure due to overpressure.

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 bottom adjustable orifice (controlling the opening speed of the regulator) at #6, and reduce the top 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 bottom adjustable orifice (controlling opening speed of the regulator) to # 3, and increase the top 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 set point adjustment screw clockwise to increase the set point. Changing the set point 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 orings, 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 seats by changing the sensing pressure 5% above and 5% below the setpoint. One cylinder pressure gauge should climb to full power gas and the other to zero when the pressure is raised. If VRP-CH is equipped with NBV Sensor, the “EX” port should be bubble tight. The gauge output should reverse when the pressure is dropped. Failure to build output pressure to full 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 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

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 take apart and reassembled.

Control Valve Type	Opening Orifice (#)	Closing Orifice (#)	Sensitivity Drum (%)
Ball Valve Regulator w/VB-250 Bleeds to atmosphere	1 1/2	4 1/2	0
Ball Valve Regulator w/VB-250 Bleeds to a pressure System	2	5	50
Globe Valve Regulator with or without VB-250 bleeds to a pressure system	2	6	80

VRP-CH Series Double-Acting Pilot Annual Maintenance Checklist

Refer to Inspection Procedure on page 13 of Operations Manual VRP-CH Series Double-Acting Pilot.

1. _____ Clean and inspect Adjustable Orifice Assemblies. Refer to Number 3, Page 8
2. _____ Check integrity of VRP-CH Pilot Seats. Refer to Number 5, Page 8
3. _____ Soap test all diaphragm mating surfaces and Adjustable Orifice Assembly to check for leaks. Refer to Number 6, Page 8
4. _____ Replace rubber goods utilizing Becker Model VRP-CH Pilot Seal Kit if necessary. See the Assembly Manual for the VRP-CH Series Double-Acting Pilot.
5. _____ Confirm Power Gas Supply Pressure is correct. Refer to original Becker invoice paperwork for proper power gas setting.
6. _____ Check sensitivity of VRP-CH Pilot. Confirm proper cylinder balance pressures. Refer to Adjustment Procedures, Equation 1 or Equation 2, Page 6
7. _____ Observe operation of gages and replace if defective.
8. _____ Perform Internal Friction Test Refer to Internal Friction Test, Page 8
9. _____ Inspect and verify proper operation of all VRP-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 Precision Equipment instrumentation or instrumentation accessories on a regular basis. However, common practice suggests that replacement of rubber goods on a 5-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 #30-0010.

Key	Description	Part No.
1	Outside Piston	25-1018
2	O-Ring -012	95-2615
3	Nozzle, 1/8”	25-1030
4	Orifice Assembly	35-1015
5	¼-20 x 2 ½” HHCS	98-3180
6	Inside Piston	25-8247
7	¼-28 Jam Nut	98-3214
8	Adjusting Drum	35-1520
9	Lexan Cover	25-1034
10	Buna-N Seat	25-1031
11	3/16 x 1/2” Roll Pin	98-3089
12	½-20 Jam Nut	98-3056
13	Valve Adjusting Screw	25-8248
14	Washer	25-1016
15	Pilot Base	30-7005
16	8-32 x ½ SHCS	98-2614
17	Pilot Post	25-8249
18	1/4-20 x 3/4 HHCS S.S.	98-3137
19	Diaphragm w/ Convolute	25-1027
20	5-40 x 1/4 SHCS	98-2629
21	Double Pilot Body	25-8246
22	O-Ring -010	95-2609
23	O-Ring -014	95-2632

Seal Kit

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

VRP-CH Pilot Model	Repair Kit Part No.
VRP-175-CH	30-9002
VRP-600-CH	30-9004
VRP-1000/1300-CH	30-9005

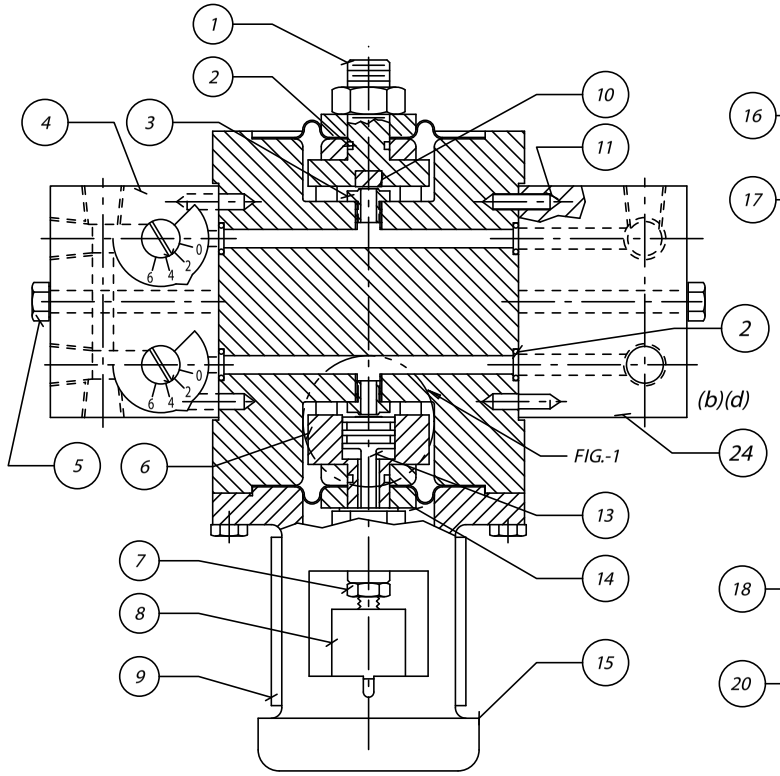
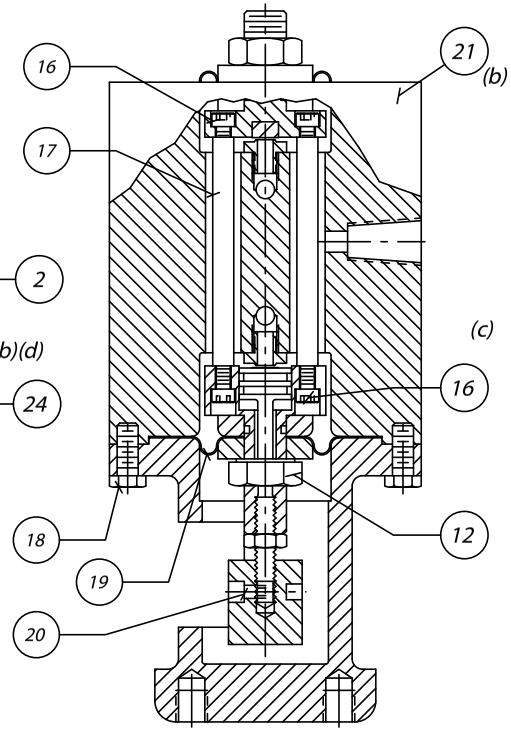


FIG.-1



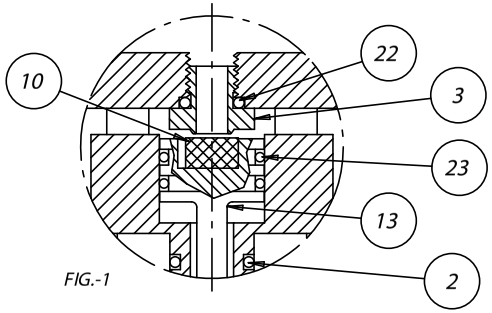


FIG.-1

Item	Qty	Part No.	Description
1.	1	25-1018	Outside Piston
2.	4	95-2615	O-Ring -012
3.	2	25-1030	Nozzle, 1/8"
4.	1	35-1015	Orifice Assy.
5.	2	98-3180	1/4-20 x 2 1/2 HHCS
6.	1	25-8247	Inside Piston
7.	1	98-3214	1/4-28 Jam Nut
8.	1	35-1520	Adjusting Drum
9.	1	25-1034	Lexan Cover
10.	2	25-1031	Buna-N Seat
11.	4	98-3089	3/16 x 1/2 R Pin
12.	2	98-3056	1/2-20 Jam Nut
13.	1	25-8248	Valve Adj. Screw
14.	4	25-1016	Washer
15.	1	30-7005	Pilot Base
16.	4	98-2614	8-32 x 1/2 SHCS
17.	2	25-8249	Pilot Post
18.	6	98-3137	1/4-20 x 3/4 HHCS SS
19.	2	25-1027	Diaphragm w/Convol.
20.	1	98-2629	5-40 x 1/4 SHCS
21.	1	25-8246	Double Pilot Body
22.	2	95-2609	O-Ring -010
23.	2	95-2632	O-Ring -014

NOTES:

1) ITEMS NO. 3, 18 AND 24 ARE TORQUED TO 95-100 IN. Lbs.

REP#	BY	DATE	REVISION	S.S.=
N/A	TS	10-26-99	(d) #24 WAS ADDED BACK 35-1013	
N/A	TRD	7-99	(c) QTY FOR ITEM #16 WAS 2	
	TRD	6-99	(b) QTY FOR ITEM #5 WAS 4 (b) REMOVE GAUGE MANIFOLD (35-1013)	
N/A	TS	1-19-99	(a) ALL REF TOL WLD. ARE DONE	

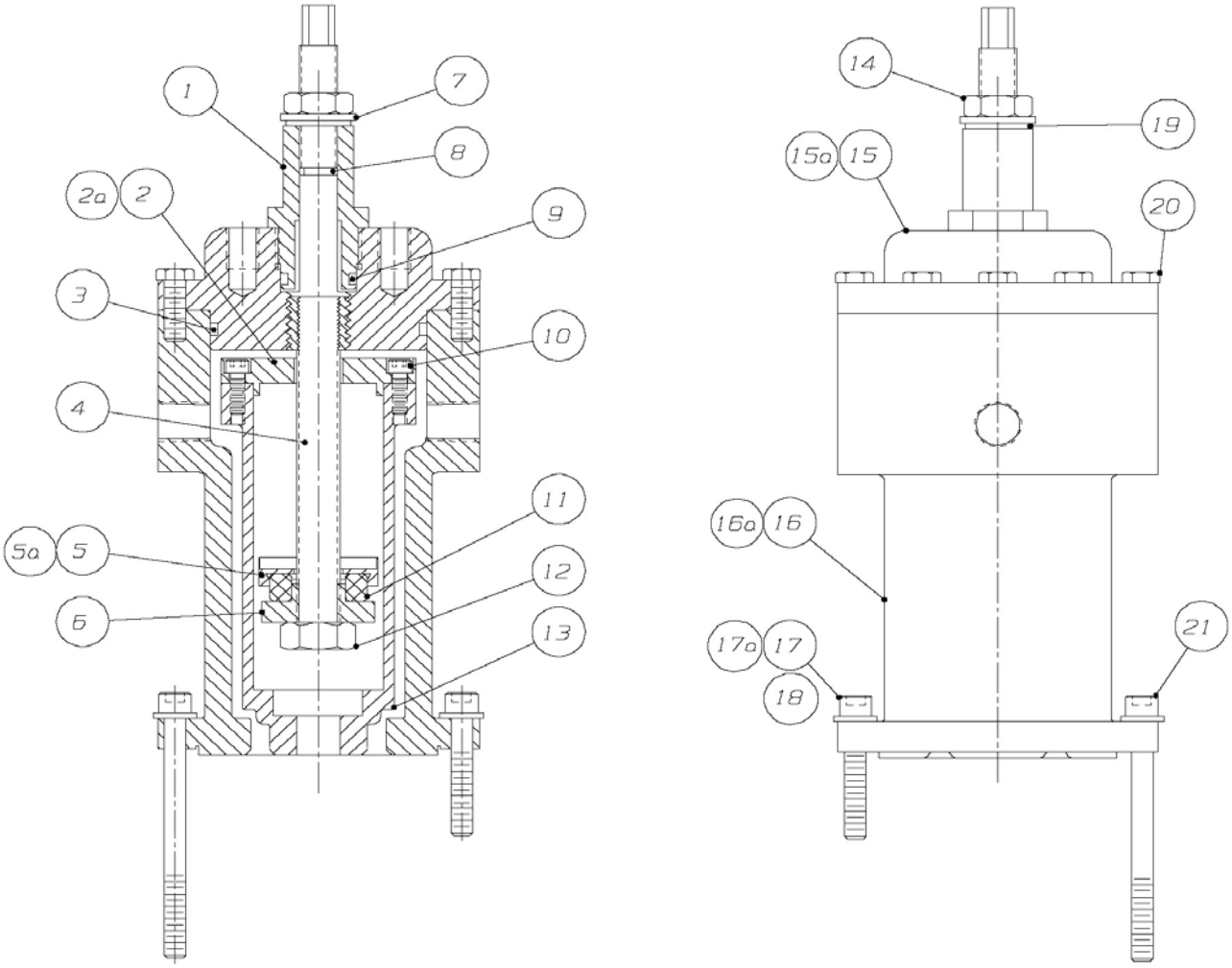
BECKER PRECISION EQUIPMENT INC.

APPROVED BY:	
DRAWN BY	TS
DATE:	1-19-99
REVISED:	REVISED BY:
SCALE:	1:3/4

VRP-CH BLANK ASSY.

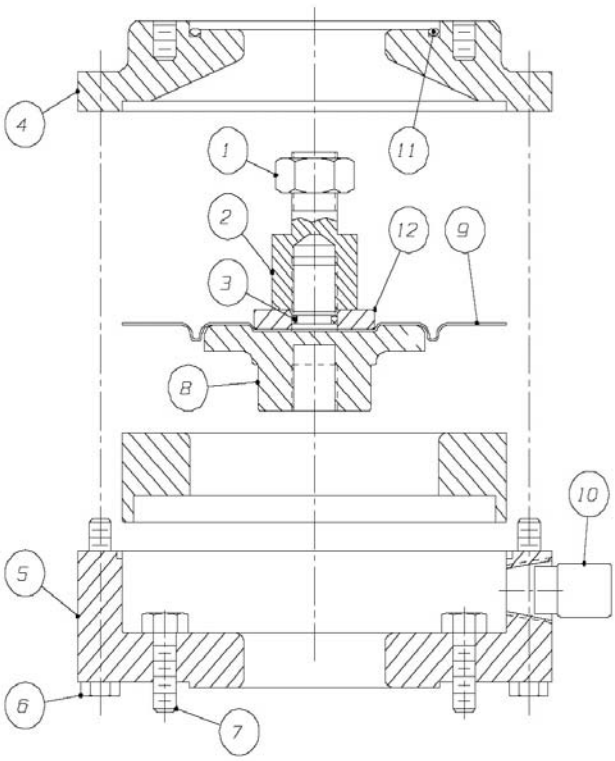
SEAT & NOZZLE DESIGN

DRAWING NUMBER 30-0010

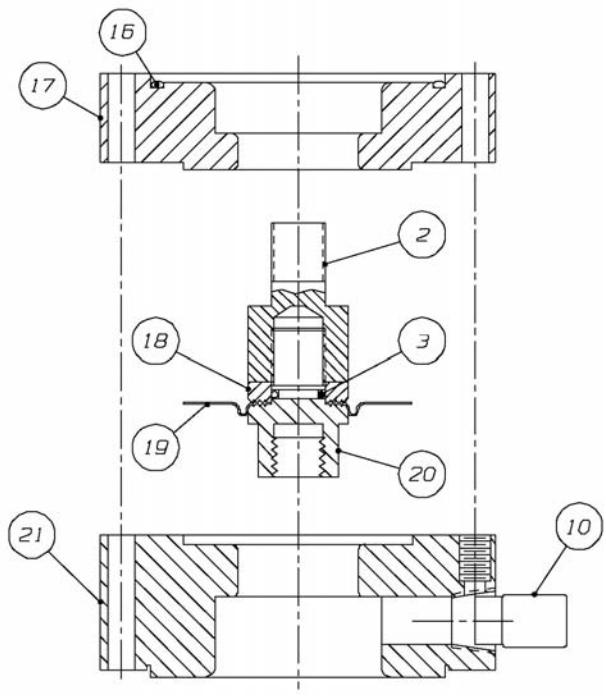


Key	Description	Part No.
1	Seal Neck	30-7009
2	Tube Cap	30-7007
2a	Tube Cap for 1300 CH	30-7026
3	O-Ring –141	95-2671
4	Adjusting Screw	30-7022
5	Bearing Case	30-7006
5a	Bearing Case for 1300 CH	30-7027
6	Bearing Nut	30-7001
7	7/16 Flat Washer S.S.	98-3181
8	O-Ring -108	95-2672
9	O-Ring -115	95-2670
10	8-32 x 1/2 SHCS	98-2614
11	Thrust Bearing	25-1062

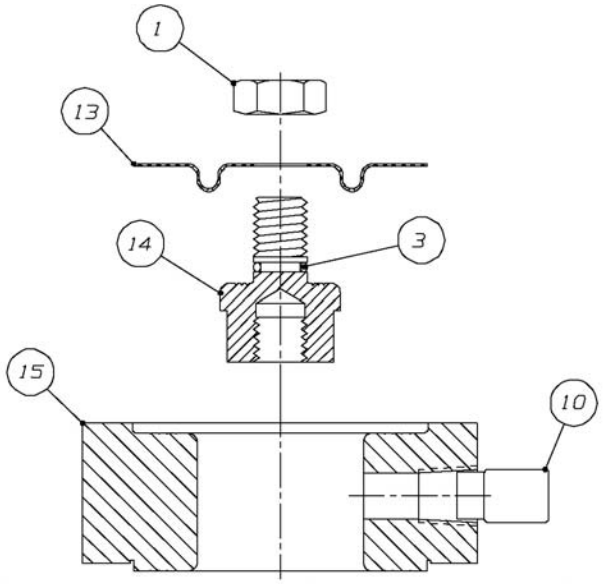
Key	Description	Part No.
12	LH 1/2-20 Jam Nut	98-3213
13	Inner Tube	30-7003
14	7/16-20 Jam Nut	98-2500
15	Cartridge Cap	30-7040
15a	Cartridge Cap for 175/600 CH	30-7008
16	Spring Cartridge	30-7023
16a	Spring Cartridge for 175/600 CH	30-7002
17	1/4-20 x 1-1/2” SHCS	98-3229
17a	1/4-20 x 2” SHCS for 175/600 CH	95-2609
18	1/4” Fiberglass Washer	98-3227
19	7/16 Thread Seal	30-7017
20	1/4-20 x 3/4” HHCS	98-3137
21	1/4-20 x 3” SHCS for 1000/1300	98-3231



VRP-175-CH Sensing Assembly



VRP-1000/1300-CH Sensing Assembly



VRP-600-CH Sensing Assembly

Key	Description	Part No.
1	1/2-20 Hex Jam Nut	98-3056
2	Thread Extension	30-7015
3	O-Ring –012	95-2615
4	Cartridge Spacer	30-7024
5	Bottom Flange	35-1548
6	1/4-20 x 1-1/2” HHCS	98-3153
7	1/4-20 x 3/4” HHCS	98-3137
8	Piston	30-7025
9	Diaphragm w/ Hole	30-7012
10	1/4” NPT Vent Elbow	01-2572
11	O-Ring –038	95-2656
12	Washer	30-7020
13	Diaphragm w/ Convolute	25-1027
14	Bottom Piston	25-1177
15	Bottom Spacer	25-1176
16	O-Ring –145	95-2665
17	Adapter Block	30-7016
18	Small Washer	30-7014
19	Diaphragm w/ Hole	30-7011
20	Bottom Piston	30-7010
21	Bottom Spacer	25-1568

Flow Calculations

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

Critical Flow
Variables:
Qc = critical flow across the inlet orifice in scfh
P_1 = supply pressure to the pilot in psig
Cv = flow factor
G = specific gravity of the gas
T = temperature of the gas in °F

Steady State Consumption
Variables:
Qssc =steady state consumption
Qc1 = critical flow across the top orifice in scfh
Qc2 = critical flow across the bottom orifice inscfh
Cv = 0.00447 x n1.656242
n = number of the orifice setting on orifice block (1 through 6)

Qssc = Qc1 + Qc2

Supply Regulator Capacity

Qsrc = 2Qc

Variables:
Qsrc = supply regulator capacity
Cv = 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.

a) pilot bleeds to the atmosphere:

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

Variables:
t = time in seconds
S = cylinder stroke in inches
D = cylinder diameter in inches
Cv = flow factor (for orifice or booster)
Cv(Booster) =3.13

b). pilot bleeds to a pressure system:

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

Gas Consumption Table

Supply Gas (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 or Standby valve. For pilot gas consumption while in control, multiply by 2.

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 accessory, contact Becker.

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 10%-20% 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 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.

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

PS 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 7 for initial pilot adjustment information.

NOTE: DPS Series Sensors must be used with Becker CV series Globe valves

VB Series Volume Boosters:
Provides additional volume capacity to the VRP-CH for use with large volume control valve actuators. The VB Series Volume Boosters may also be utilized 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 orifice sand sensitivity drum. Refer to the pilot initial adjustment procedures for further information.

PS-2 Series Sensor Adjustments

1. Turn the adjusting screw of the PS-2 sensor clockwise until it extends about 1-3/4" from the top of the spring cartridge.
2. Adjust the VRP-CH according to the pilot adjustment procedures. For a normally open regulator (Monitor):
3. Bleed off the sensing pressure.
4. Wait until the pressure reading on the cylinder top gauge is equal to power gas. For normally closed (standby) regulator:
3. Increase the sensing pressure 5% above setpoint.
4. Wait until the pressure reading on the cylinder bottom gauge is equal to power gas.
5. Turn the adjusting screw of the PS-2 sensor counterclockwise until the exhaust port of the VRP-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-CH is changed, the sensor must be reset. and sensitivity drum. Refer to the pilot initial adjustment procedures for further information. VB-250

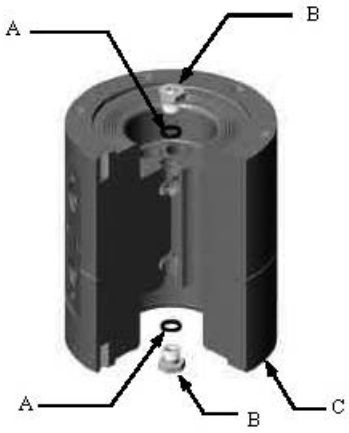
Troubleshooting

If the Volume Boosters bleed gas even when the control valve is not moving, or if the control valve continually cycles, turn the pilot sensitivity adjustment drum to the left (increasing numbers on the scale) by small increments until stability is achieved and the exhaust ports of the Volume Boosters do not bleed gas. To ensure maximum sensitivity of the system, make the control valve slightly unstable by turning the pilot sensitivity adjustment drum to the right (decreasing numbers) and then turn back to the left (increasing numbers) by small increments until stability is achieved.

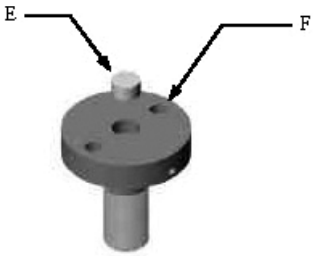
Assembly Procedures

NOTE: During assembly moisten all O-rings, threads, thrust bearings and the recess in spring seat with a light weight silicone grease.

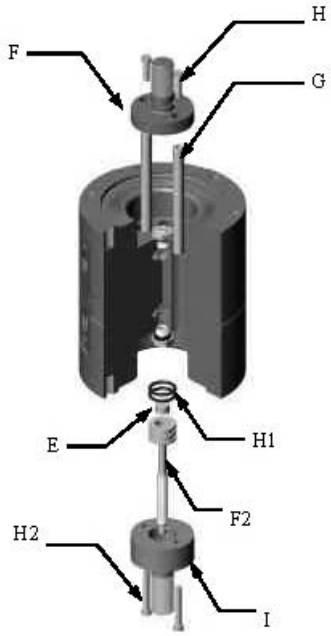
Step 1. Install –010 O-rings (A) on nozzles (B) and install nozzles into the top part and bottom part of the body (C).



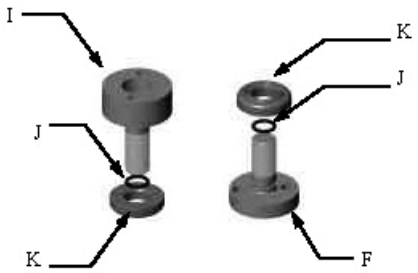
Step 2. Press fit seat (E) into outside pistons (F). Make sure the seats are bottomed in the cavities. Tap them down if necessary. The properly installed seat rises 0.005" to 0.020" above the piston surface.



Step 3. Attach outside piston (F) to pilot posts (G) with 8-32 x 1/2" SHCS (H). Install O-rings -014 (H1) in the valve adjusting screw (F2). Press fit seat (E) into the valve adjusting screw (F2). Then install the assembly into inside piston (I) and connect it to the posts (G) with 8-32 x 1" SHCS (H2).



Step 4. Install all -012 O-rings (J) on inside (I) and outside (F) pistons. Install washers (K) on all pistons. Grooves on the washers must face the diaphragms.

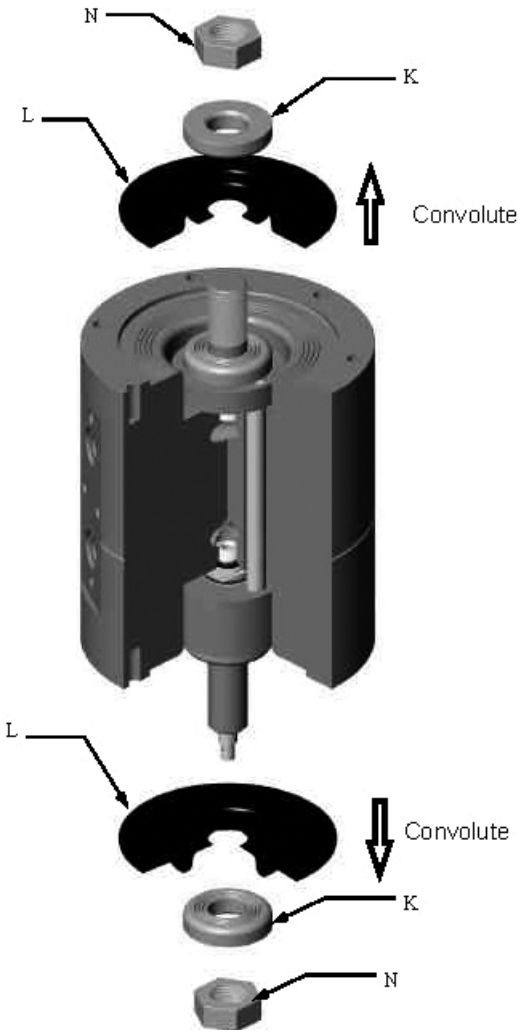


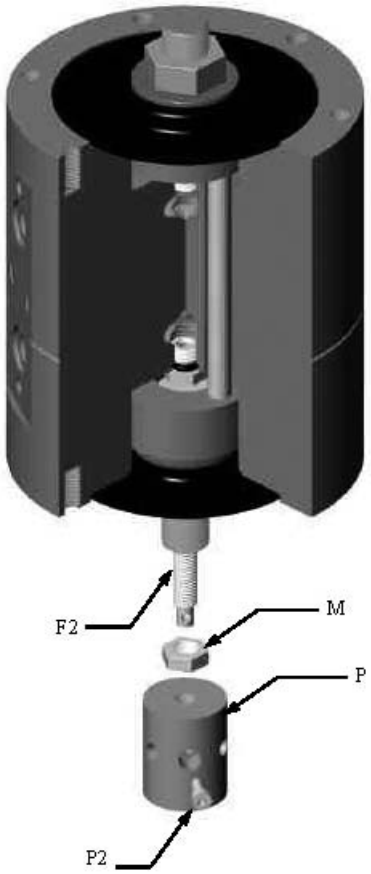
Step 5. Install convoluted diaphragms (L). Make sure convoluted diaphragms face the direction shown.

Step 6. Install washers (K) on bottom and top of diaphragms (L) and fasten them with 1/2-20 jam nuts (N). Tight all nuts. Torque to 95-100 in-lbs.

Step 7. Install 1/4-28 jam nut (M) and adjusting drum (P) in the valve adjusting screw (F2). Connect the adjusting screw (F2) and drum (P) with 5-40 x 1/4 SHCS (P2) as shown.

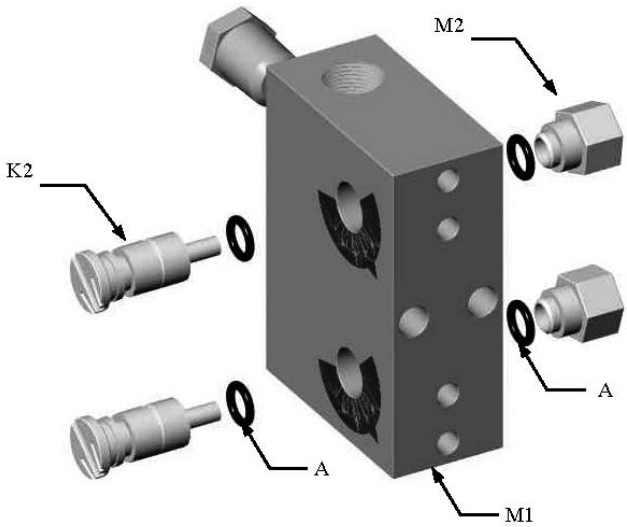
NOTE: Jam nut (M) should touch the drum (P). This will allow free drum rotation for adjustment





Step 8. Place O-ring -010 (A) in the adjusting orifice (K2). Place the assembly in the orifice manifold (M1) as shown.

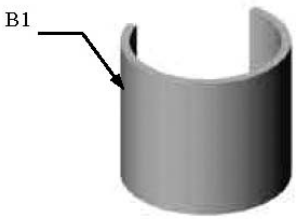
Step 9. Place O-ring -010 (A) in the nuts (M2) and secure the adjusting orifice (K2) with nuts (M2) in the orifice manifold (M1) as shown.

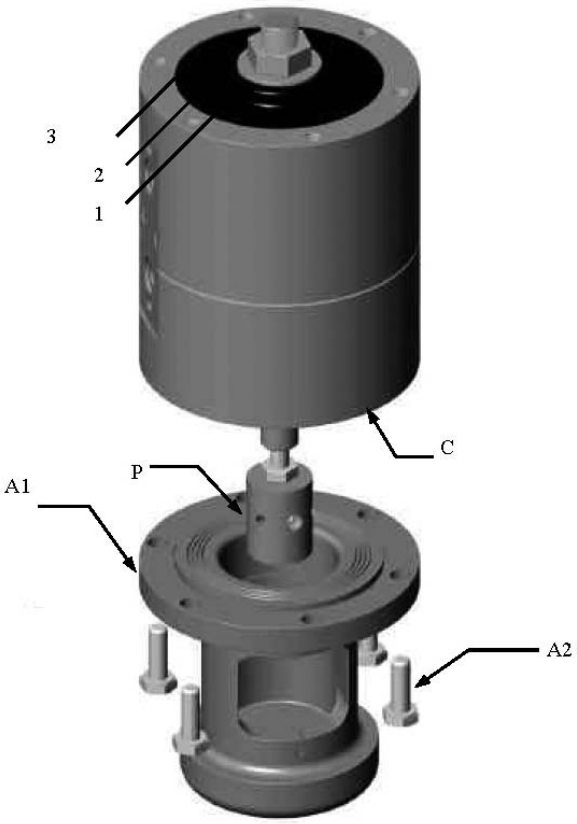


NOTE: To center the diaphragm, rotate it to the left, mark 1; rotate it to the right, mark 3. Center the diaphragm between 1 and 3, mark 2. Then proceed to step 8

Step 10. Bolt pilot base (A1) to the bottom part of the body (C) with six 1/4 - 20 x 3/4" screws (A2).

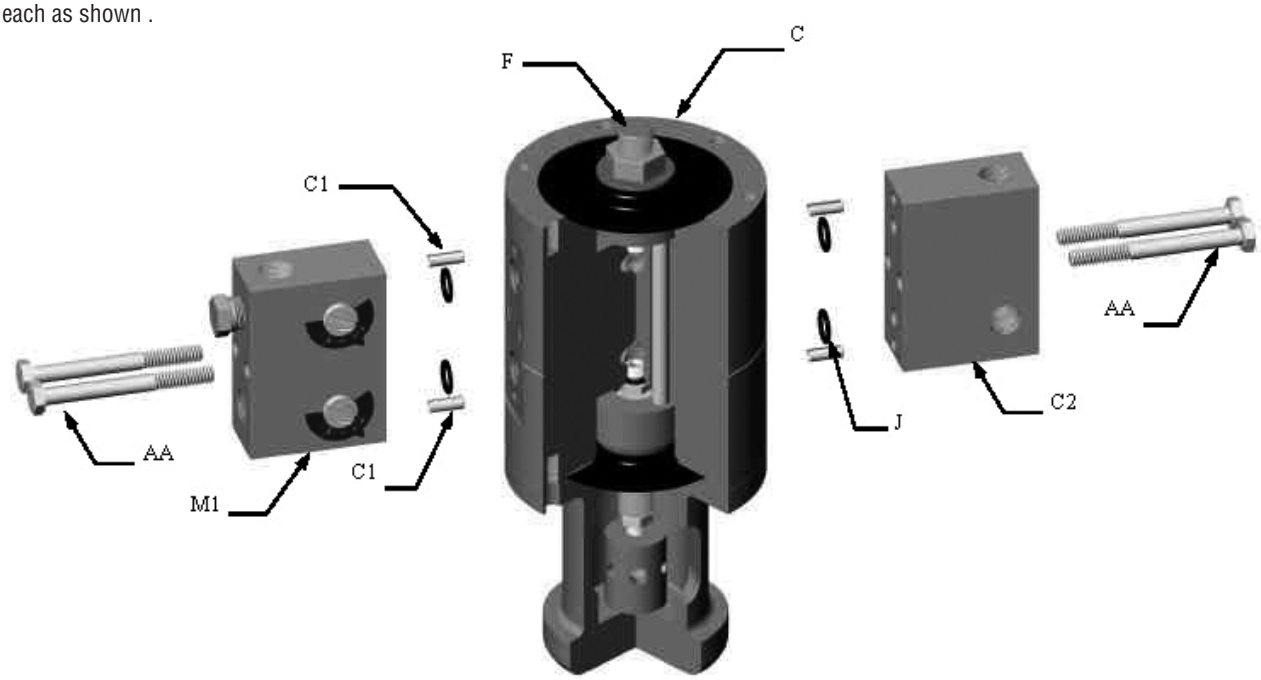
Step 11. Place Lexan cover (B1) in the outside of the pilot base (A1) so that it protects the adjusting drum (P) after the adjustment.



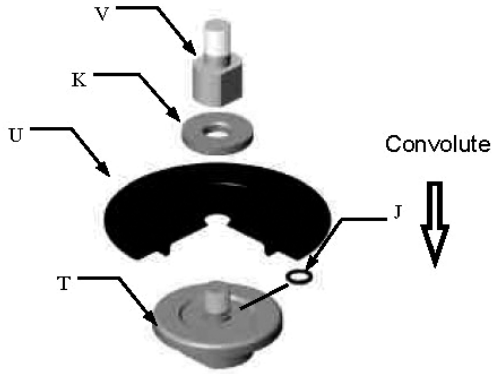


Step 12. Install the four 3/16 x 1/2 Roll Pins (C1) into the body (C) and the four O-rings-012 (J) as shown.

Step 13. Bolt gauge manifold (C2) and orifice manifold (M1) to the body (C) with two1/4 - 20 x 2 1/2" HHCS (AA) each as shown .

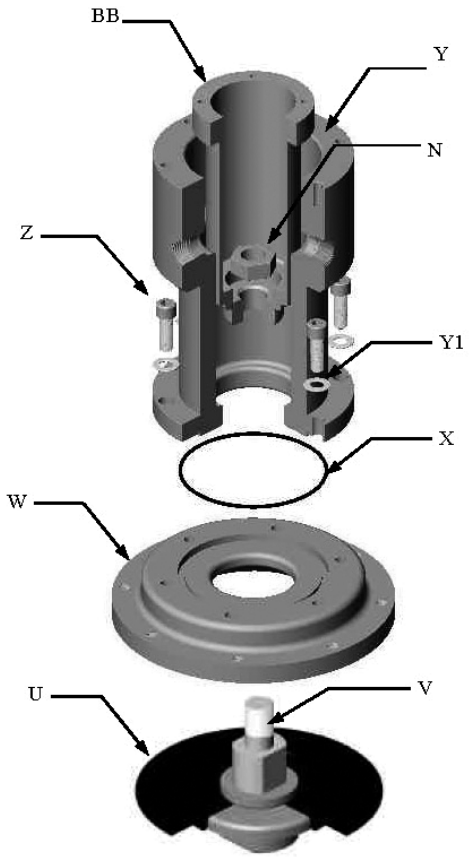


Step 14. Diaphragm preassembly.
Place O-ring-012 (J) in piston (T). Place diaphragm with hole (U) on top of piston (T) with convolute facing down as shown. Place washer (K) on top of diaphragm (U) with serations facing the diaphragm (U). Install thread extension (V) in piston (T). Tighten the diaphragm preassembly to 95-100 in-lb.



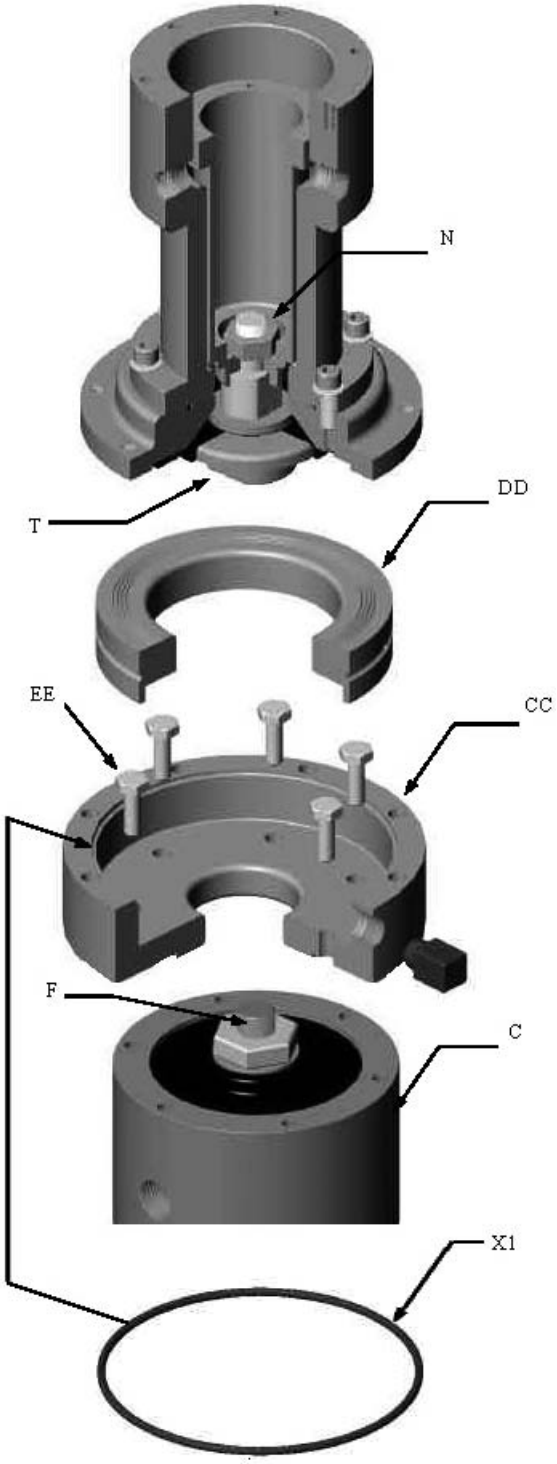
Step 15. Place O-ring -145 (X) in the cartridge spacer (W). Bolt the cartridge spacer (W) to the spring cartridge (Y) with six 1/4 -20 x 3/4 SHCS (Z) using the washers (Y1) in the direction shown.

Step 16. Install the diaphragm preassembly in step 14 by threading the 1/2-20 jam nut (N) to the thread extension (V), using a socket wrench extension. Place inner tube (BB) inside the spring cartridge (Y) and between the thread extension (V) and the nut (AA), as shown. Tighten to 95-100 in-lb.



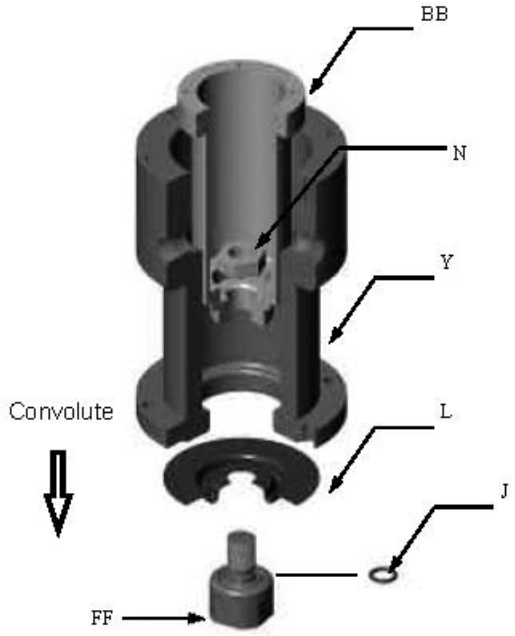
(FOR VRP-175-CH)
Step 17. Bolt bottom flange (CC) to the pilot body (C) using six 1/4-20 x 3/4 H.H.C.S (EE) and O-ring -046 (X1) in the O-ring grove in the bottom flange (CC) as shown. Then, place spacer (DD) on top of bottom flange (CC).

Step 18. Placing a socket wrench extension in nut (N), thread bottom part of piston (T) to the outside piston (F), until is just hand tight, do not force it.



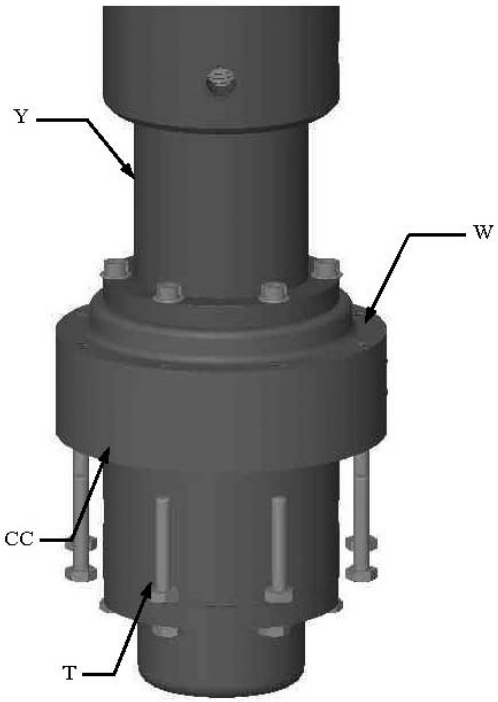
(FOR VRP-600-CH)

Step 19. Slide O-ring-012 (J) into the bottom piston (FF). Place diaphragm (L) with convolute facing away from threads. Place inner tube (BB) inside spring cartridge (Y) and on top of diaphragm (L) as shown. Tight assembly with one 1/2 - 20 nut (AA). When placing the nut (AA), use a socket wrench extension and keep the bottom piston (FF) from moving using either the vise or a tool. Tighten to 95-100 in-lb

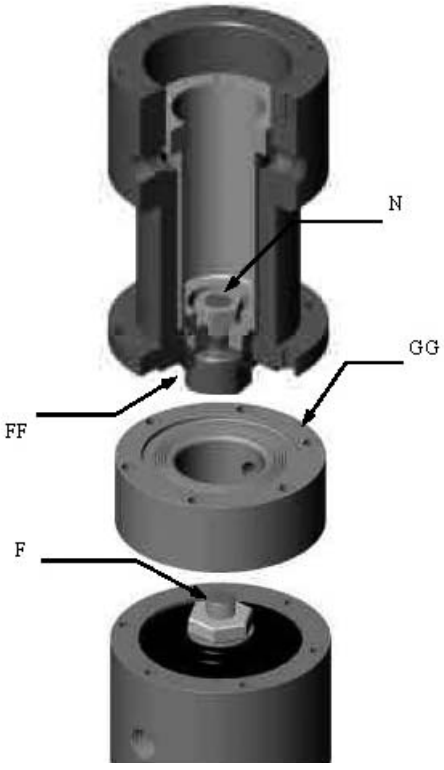


(FOR VRP-175-CH)

Step 21. Bolt bottom flange (CC) to cartridge spacer (W) using eight 1/4-20 x 1 H.H.C.S (T) as shown.

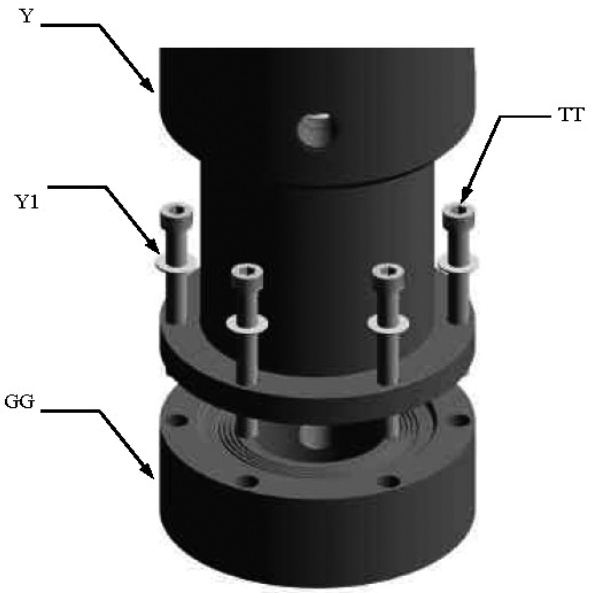


Step 20. Placing a socket wrench extension on top of nut (Y), thread bottom of piston (FF) to outside piston (F) placing the spacer (GG) in between them, until is just hand tight, do not force it, as shown.



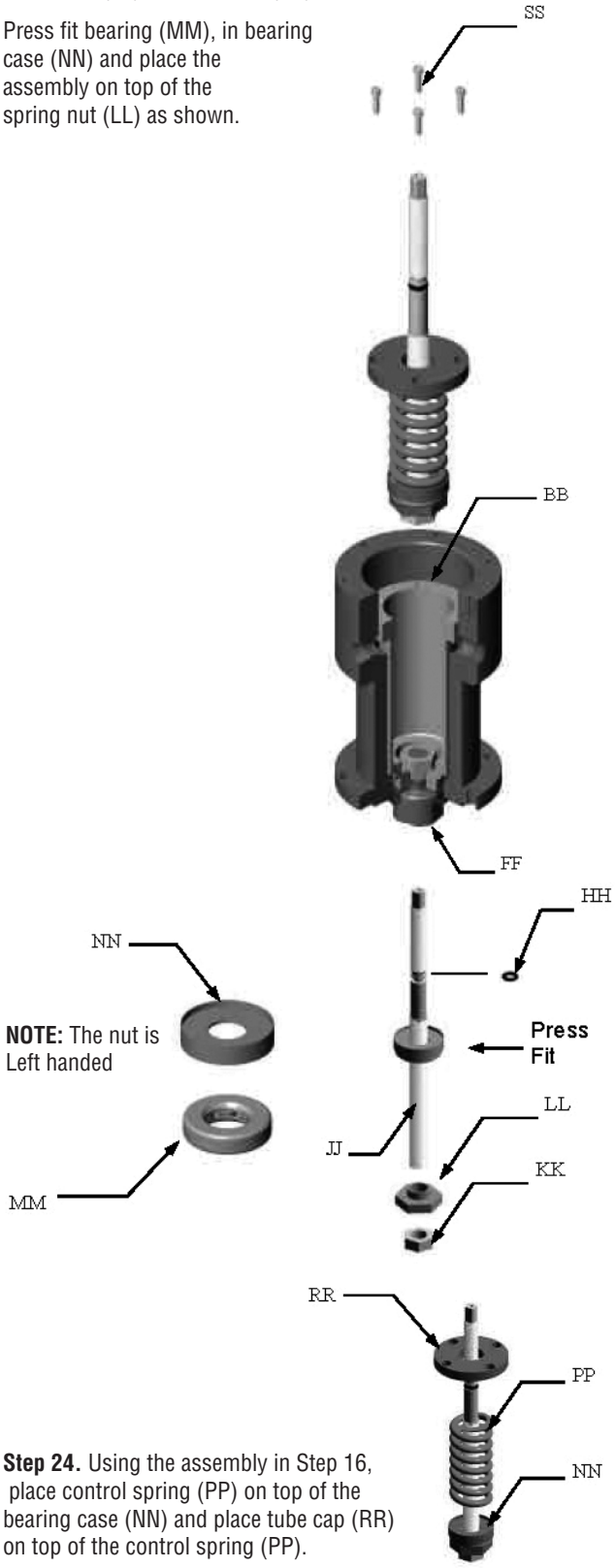
(FOR VRP-600-CH)

Step 22. Bolt spring cartridge (Y) to spacer (GG) using six 1/4-20 x 1-1/2 S.H.C.S (TT) and the washers (Y1), as shown.



Step 23. Slide O-ring –108 (HH) in adjusting screw (JJ). Place left hand nut (KK) at the bottom part of the adjusting screw (JJ). Install spring nut (LL) on top of nut (KK) and tight one against each other.

Press fit bearing (MM), in bearing case (NN) and place the assembly on top of the spring nut (LL) as shown.



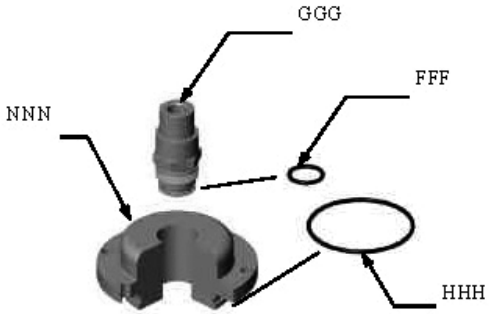
Step 24. Using the assembly in Step 16, place control spring (PP) on top of the bearing case (NN) and place tube cap (RR) on top of the control spring (PP).

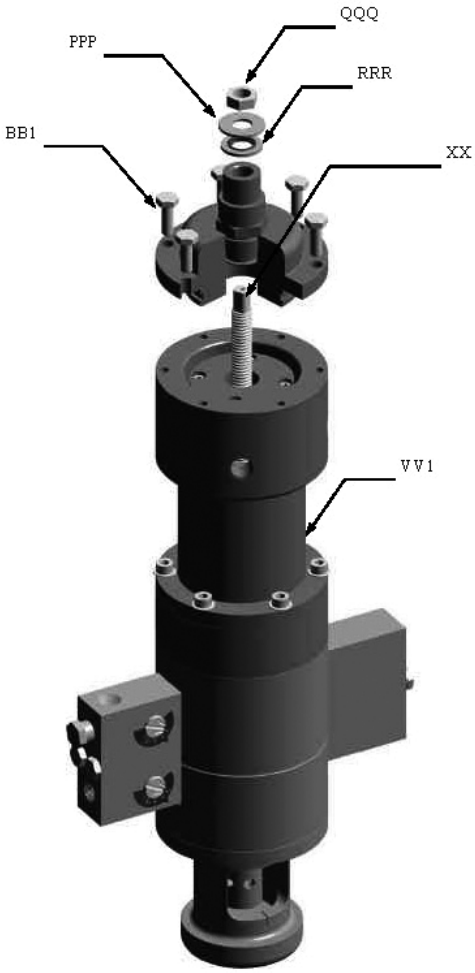
Step 24. Secure the assembly in Step 17 inside the inner tube (BB) using four 8/32 x 1/2" SHCS (SS).

Step 26. Place O-ring-141 (UU) in the cartridge cap (VV) and place O-ring -115 (WW) in seal neck (XX). Tighten the seal neck (XX) in the cartridge cap (VV) as shown.

Step 27. Thread the assembly in step 21 into the adjusting screw (JJ) by rotating it counterclockwise until adjusting screw (JJ) is fully exposed. Then rotate adjusting screw (JJ) clockwise until cartridge cap (VV) is fully seated in the spring cartridge (Y). Rotate cartridge cap (VV) to align the mounting holes. Bolt together using six 1/4-20 x ¾" HHCS (EE).

Step 28. Place 7/16 thread seal (YY) and washer (ZZ) on top of the seal neck (XX) and tighten the7/16 nut (AAA) as shown.





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Becker Precision Equipment
Dresser, Inc.
1550 Greenleaf Avenue
Elk Grove Village, Illinois 60007 USA
Ph: 847.437.5940 Fax: 847.437.2549
Toll Free Phone: 800.323.8844 Email: becker@dresser.com

www.dresser.com