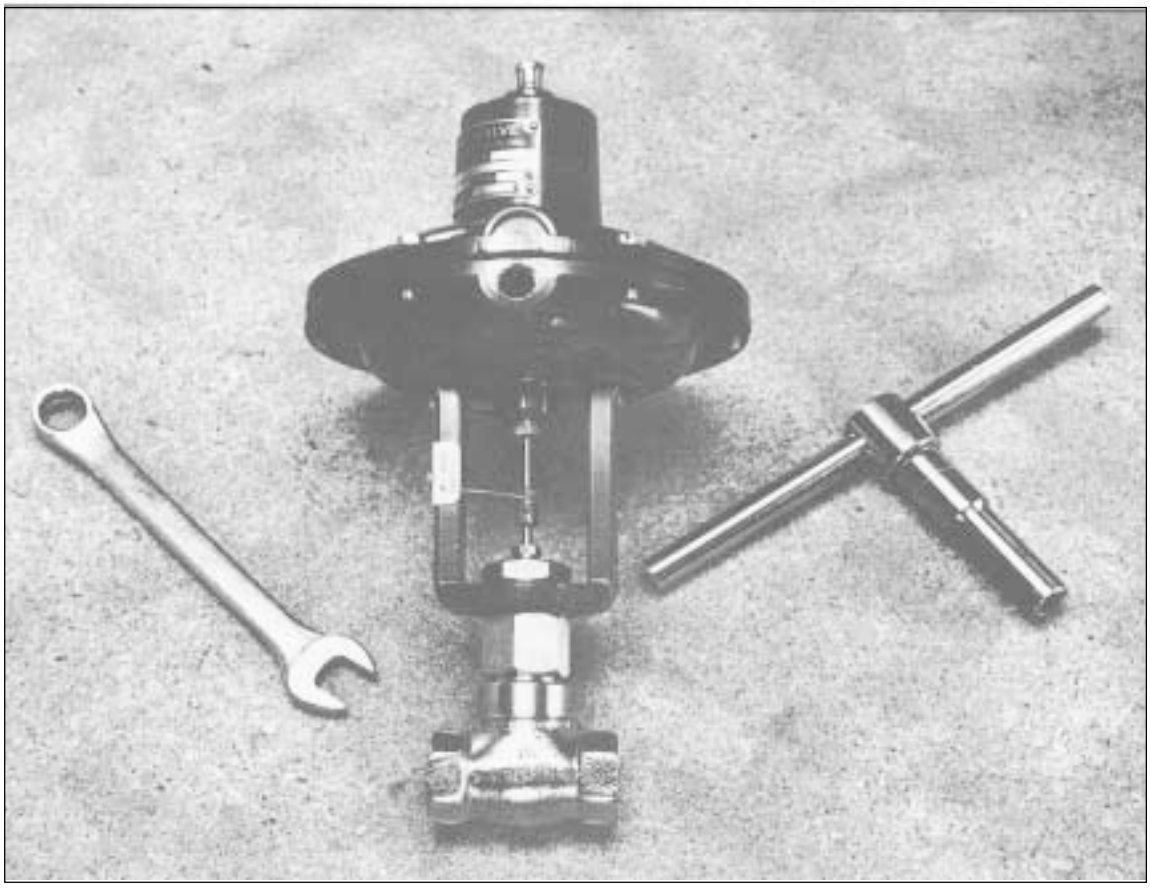
	RESEARCH® CONTROL **Valves**	**Installation & Operation Manual**



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General

The purpose of these instructions is to supply pertinent information for installation of original equipment, repair, adjustments, retrimming, repacking and other information necessary to achieve the best possible service from Research Control Valves.

Research Control Valves are engineered, designed, and manufactured with the end user in mind. Most parts are interchangeable with any other like assembly. The inner components (spare trims) are available in 39 different flow coefficient (Cv) sizes and in many different materials compatible with most process conditions.

Installation

After inspecting the valve (or valves) and determining that the valve (or valves) meets the specifications, install as follows:

1. Normal installation is directly into any 1/4", 1/2", 3/4", or 1" piping system with flow direction arrow on body pointing downstream. This allows the stem packing to see the lowest pressure conditions after the pressure drop occurs. It should be noted that chevron ring stem packing is a dynamic seal that needs pressure to be energized.

2. Valves, especially plastic, should be bracket mounted in high vibration areas or where they may be subjected to damage from shock. If necessary, provide as required, bypass, manual block valve, filters, etc. When installing valves that have the Low Flow "P" Series innervalves, small micron filters should be used where process permits.

3. Connect instrument air supply to diaphragm case using appropriate NPT fittings (1/8" NPT for 1/4" valves and 1/4" NPT for 1/2", 3/4", and 1" valves) to the desired tubing size adaptor (normally 1/4" tube fittings). All connections to standard positioners, Moore products or Badger®, are 1/4" NPT. (For positioner data, see paragraph under Positioners.)

4. All standard production valves as shipped are adjusted and preset at the factory with 90 PSIG air piped to the inlet port of the body. Air-to-open valves are adjusted to come off seat at approximately 3.25 PSIG instrument signal and be fully opened at 15 PSIG. Air-to-close valves are set to close when signal is at 14.75 PSIG and be fully open at 3 PSIG. Process conditions may dictate additional adjustment of the spring adjuster to hold unbalance created by higher pressure on actual application. It should be noted that on air-to-close valves with no pressure, the travel indicator will show over travel. With 3 PSIG to actuator, the indicator will be very close to the open position.

Disassembly and Reassembly

(Best done at instrument shop bench)

For the purpose of these instructions, consider the topworks or actuator as a complete sub-assembly not to be dismantled except for replacing diaphragms or topworks packing. The only necessary topworks adjustment is made with the spring adjuster and/or the zero adjustment on positioner-equipped valves (see paragraph on Positioners). To position the stem, travel in relation to the 3-15, 3-9, 9-15 PSIG etc. instrument signal operating the valve.

Replacing Trim Sets

Installing innervalve trim sets is accomplished with the body and bonnet subassembly separated from the topworks using appropriate wrenches. (Tool kits are available at a nominal cost for 1/4", 1/2", 3/4", and 1" valves.) To separate the body bonnet assembly from the topworks on ATO valves, apply 6-9 PSIG instrument air to the operator, lifting innervalve off seat to prevent damage to the valve seating surfaces. (Not necessary for ATC valves.)

FIG. 1

1 .With innervalve off seat, use two open-end wrenches (1/4" for 1/4" valves and 3/8" for 1/2", 3/4", and 1" valves), one holding the stem connector in position, and with the other loosen the topworks stem nut above travel pointer; remove travel pointer.

2. With valve body in vise (clamp on ends), loosen the yoke to bonnet locknut (yoke locknut) with a slotted end wrench (7/8" boxed end for 1/4" valves, 1-1/8" for 1/2", 3/4" and 1" valves), and unscrew completely.

3. With the open-end wrench, turn the stem connector counterclockwise (right hand threads), unscrewing from the topworks stem completely. (Fig. 1)

4. Remove topworks from body bonnet assembly.

5. With the valve body in vise, loosen and unscrew bonnet from body using open-end or crescent wrench.

FIG. 2

6. Remove seat from body using a deep thin wall socket and T-handle assembly (3/8" hexagon for 1/4" valves, 5/8" hexagon for 1/2", 3/4" hexagon for 3/4"valves, and 15/16" hexagon for 1" valves).
⚠CAUTION Some purchased long set sockets (heavyduty) will not fit body cavity without turning O.D. to fit past body threads.
(Fig. 2)

7. Most standard innervalves “K” through “P18” in 1/4" valves and “F” through the “P” series trim in 1/2" valves can be removed upward from the bonnet through the packing, all others by removing stem connector and withdrawing downward through the packing. When removing the larger trims down through packing, it is best to withdraw stems until threaded portion is in contact with packing and then rotate stem and allow the threads to screw through the packing area.

Installing Trim Sets

(Matching pairs do not separate)

With all parts cleaned in an appropriate solvent, install desired trim set in body bonnet assembly as follows:

FIG. 3

1. With trim as shown in Figure 3, apply a coating of Neolube (graphite dry film lubricant), process permitting, to the threads and seating surfaces of the seat. Air dry for 30 seconds. Do not use any thread sealing compounds containing metal particles. NOTE: New replacement innervalves, come pre-coated with NeoLube except those specially cleaned.

2. Remove seat from innervalve and place hex first into the long set socket wrench and T-handle assembly. NOTE: Tissue paper can be stuffed into the socket to prevent seat from falling through.

FIG. 4

3. With body inverted in palm of hand as shown in Figure 4, start seat threads into body, invert body and tighten seat. Do not over-torque. Standard torque figures using new parts at the factory are: 10/11 ft/pounds on “P” trim seats, 8.5 ft/pounds on other 1/4" seats, 35 ft/pounds on 1/2", 3/4" and 1” seats. It should be noted that torque figures are applicable to new parts and may not be the same for used parts. For longest service life, on new or used parts, it’s best to use procedure detailed in paragraph 4.

4. Torque seat firmly into body with the short T- handle assembly. Check seat to body seal, by making body a bubble chamber, using a pointed plastic plug in seat to seal as shown in Figure 5 with downstream port plugged and 50 psi air pressure upstream, check for leak. If leak exists, re-torque seat and recheck until bubble-tight seal is accomplished. On smaller letter or "P" series trim sets, over-torquing seat in the body can reduce the orifice size to where interference between innervalve and seat can cause a premature mechanical failure (galling) when stroking valve.

FIG. 5

5. With body in vise, again clamping across ends of body not sides of body, place body bonnet gasket in place. (Process permitting, coat each side of gasket with lubricant such as Dow Corning or Dupont Krytox valve seal.) With the stem section of the trim set installed in the bonnet, coat the bonnet threads (body end) with lubricant.

6. Screw bonnet into body and tighten with open-end or crescent wrench. Apply the proper torque to bonnet/ body joint as listed on the back side of individual technical briefs.

7. Stroke innervalve manually to check for misalignment. Should misalignment exist, check straightness of innervalve or packing. (See Packing Installation.)

NOTE: All replacement trim sets have been prelapped at the factory. When installed per instructions, trims should leak no more than 1/10 of one percent of maximum flow for the given size, (ANSI Class III). If necessary, with care, bubble-tight shutoff can normally be achieved by lapping in seating surfaces with the innervalve set installed in the body bonnet assembly using lapping compound (white aluminum oxide 38-1000 grit) with the packing removed, using the packing glands as the upper guide (brass lap bushing available at factory). See Figure 6. Lapping should be done with a

FIG. 6

clockwise, counterclockwise motion between the thumb and forefinger, lifting the innervalve off seat and repositioning periodically to achieve a uniform lap ring. After each lapping operation, remove bonnet from body and clean innervalve and seat from body. Clean seat by submerging body in solvent and swabbing orifice with wetted pipe cleaner and blow dry with air. After cleaning, reassemble and check leak rate as shown in Figure 7. **Caution should be taken to not overlap.**

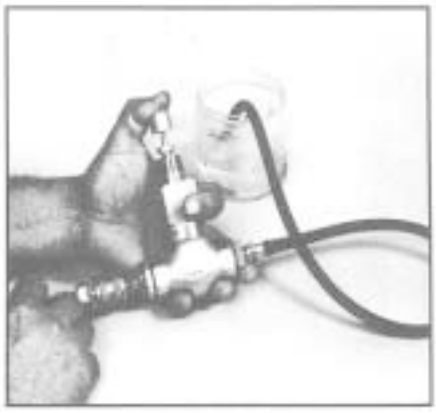

FIG. 7

Lapping Sequence

Lap for about 30 seconds, clean and check leak rate; repeat sequence until desired shutoff is achieved. If after lapping three or four times leak still exists, check the seating surfaces of both innervalve and seat for excess nicks, scratches, or indication of galling if the trim has previously been in service. **Do not lap for shutoff any of the "P" series trims.**

Assembly

1. With body in vise, place topworks yoke on bonnet with yoke locknut slipped over the stem connector and down on bonnet threads (6-9 PSIG air on air-to-open topworks).

2. With topworks in correct position relative to the centerline of the body, tighten yoke locknut using a boxed-end (slotted) wrench.

3. Raise innervalve and screw the stem connector on topworks stem until the two stems are butted together.

4. Install travel pointer between stem connector and locknut on topworks stem. Hold stem connector in place and tighten topworks stem nut against the travel pointer positioned 1/32" to 1/16" away from travel scale.

Stroke Adjustment and Pressure Test

1. With valve completely assembled and with a manually regulated supply (3-15 PSIG) to the topworks, adjust with spring adjuster until valve stroke is corresponding to the normal 3-15 PSIG instrument signal. To set this precisely, pipe 90 PSIG air to the upstream port and with rubber tubing piped from downstream port, bubble check shutoff point. (Fig. 8)

2. Set air-to-open valves to open at 3-1/4" PSIG.

FIG. 8

3. Set air-to-close valves to close at 14-3/4" PSIG.

4. Nominal stem travel of 7/16" for 1/4" valves and 9/16" for 1/2", 3/4", and 1" valves is fixed in the topworks spring rate for a 12 PSIG span. If valve has been set with a high bench setting because of pressure, full travel may not occur at 15 PSIG.

5. If necessary, reposition travel scale relative to stroke.

6. Pressure test all seals with 90 PSIG air piped to the upstream port, downstream port plugged with valve open. Using a plastic squeeze bottle filled with a soapy water solution, flood each joint and inspect for leaks. Check and tighten packing just until no leak is visible. **Do not over-tighten.** (Fig. 9)

FIG. 9

7. Normal hysteresis (dead band) in valve stroke should be no more than 1/4 PSIG instrument signal. This can be checked by placing the thumb and forefinger on the valve stem in contact with the packing gland and regulating manually the 3-15 PSIG instrument signal (gauge in line), visually watching gauge and feeling movement. (Fig. 10)

FIG. 10

Packing, Chevron Ring

1. Proceed with disassembly of body-bonnet assembly as in changing trims.

2. Remove the packing gland and all components from within the cavity. If the Teflon packing follower has been damaged due to over tightening and extruded into the threads of the packing cavity, a standard screwdriver can be driven into the teflon to unscrew the follower. In this case, the packing follower needs to be replaced.

3. Clean and inspect cavity and parts for damage.

4. Place packing adaptor in the cavity making sure the flat side is down and in place.

5. Place the first ring into the cavity at a 90 degree angle to its seated position. When the ring is at the bottom of the cavity, tip it over with the cup side down using a small plastic or wooden probe. Continue this procedure with the two additional rings. This method prevents the threads of the cavity from damaging the lips of the rings.

6. Place the packing follower on top of the rings, making sure the inverted "V" is down. (The arrangement for reversed Cv ring vacuum packing requires special parts.)

7. Replace the packing gland. Tighten until contact is made with the packing follower.

8. If the plug portion of the trim is machined integral on the stem, the stem connector should be tightened onto the stem before insertion into the bonnet and may be inserted through the packing from the top of the bonnet. If the plug portion of the trim is screwed onto the stem, the stem should be placed through the packing from the bottom of the bonnet by gently screwing the stem threads through the packing. The stem connector can then be tightened onto the stem.

9. Retract the stem sufficiently to keep the trim from seating and screw the bonnet into the body. Be sure to install gasket.

10. Apply the proper torque to bonnet/body joint as listed on the back side of individual technical briefs under pressure/temperature ratings.

11. Proceed with assembly and adjustments per Page 3.

12. Test packing by tightening gland 1/4 turn past fingertight. Do initial test with low pressure (80 to 100 psi). If packing leaks, tighten gland just until leak stops. Excess torque can damage Teflon components. Once this procedure is complete, the valve can be tested at higher pressures.

⚠CAUTION Do not tighten gland more than is necessary to stop leaks.

NOTE: On valves supplied prior to October 1993, the packing follower on all valves was virgin Teflon and packing adaptor was the same metal material as valve. To improve on the total packing function in regard to sealing and replacement, both the follower and adaptor materials have been changed to now available, Teflon PFA. This denser Teflon material allows the guide diameter to be closer for better alignment and solves the cold flow problem of the original virgin Teflon follower.

Braided Teflon and Graphoil

The original packing for Research Control Valves was braided Teflon which used a smaller gland nut. After molded chevron rings became available and for a period of time, there was a difference between the bonnet packing cavity, depending on type of packing used. The components parts were not interchangeable until the current design was introduced in 1972, standard 1981, using a common cavity for all types packing.

1. Braided Teflon is available and used in current packing cavity by putting in a dummy stem to fit the packing over as shown in Figure 11. Fill the cavity

FIG. 11

with sock or rope type packing, tamping into the cavity with a packing tool or piece of appropriate size copper tubing as shown in Figure 12, until cavity is full with a couple threads showing. Screw gland in and tighten to compress packing.

FIG. 12

FIG. 13

Remove gland and blow or pick out any small pieces that may be in the threads. (Fig. 13) Replace gland finger tight and remove dummy stem Figure 14 and replace with new innervalve and stem. Tighten packing gland and test seal at final assembly the same as with chevron ring packing.

FIG. 14

2. Graphoil Packing

Depending on the application, graphoil packing is available in preformed rings to fit standard packing cavities for all Research Control Valves. When a process must run hot to prevent material from solidifying or for other purposes where finned bonnets are used to dissipate heat to protect the packing are not applicable, graphoil may be the solution. If the application is quick opening (on-off) and graphoil packing is used, the standard actuator will work with higher operating pressure. If application is to control, a positioner should be used to overcome additional drag, or hysteresis, created by graphoil making stem seal, especially on high pressure gases.

Bellows

General

On applications involving toxic gases, radioactive materials and others where the primary seal at the valve stem is critical, a metal bellows stem seal can be used to preclude leakage as long as the integrity of the bellows remains intact. Extreme care should be exercised in removing and/or installing the Bellows Seal Assembly to preclude damage. The metal thickness of the low pressure bellows is only 0.005" to 0.007" thick, and excess torsion will twist and deform the convolutions, damaging the assembly.

FIG. 15

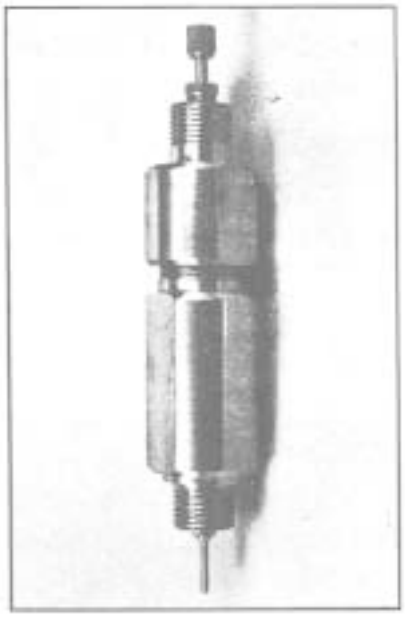

FIG. 16

FIG. 17

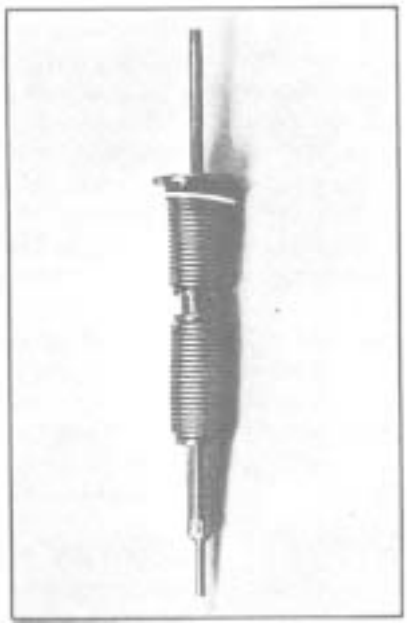

FIG. 18

Removal of Assembly from Valve

1. Remove the valve from the process line and hold valve in a bench vise clamped on the body ends.

2. On air-to-open valves apply air pressure to diaphragm to raise innervalve off seat. (Not necessary for air-to - close valves).

3. Loosen stem connector locknut above travel indicator.

4. Loosen yoke nut holding topworks to bonnet.

5. Rotate entire topworks counterclockwise; top-works stem will unscrew from stem connector.
⚠CAUTION - Unscrew straight up or stem could be bent.

6. Finish unscrewing yoke nut and lift off topworks.

7. Loosen and unscrew bonnet assembly from body. (Fig. 16)

8. Loosen and unscrew bonnet cap and bellows assembly from bonnet. (Fig. 17)

9. Grasp bonnet stem located immediately under connector with sharp nose pliers and remove connector without allowing stem to turn.

10. Remove the bellows from the bonnet cap. At times it is necessary to cut and fish out the Teflon bellows gasket in order to free up the bellows assembly for removal.

Removing Innervalve from Bellows Assembly and Seat from Body

1. Hold stem of bellows in a lathe collet or suitable holding device (1/8" for 1/4" valves or 3/16" for 1/2", 3/4", and 1" valves) and gently unscrew innervalve counterclockwise using a small end wrench fitting the flats on the innervalve. Avoid any side motion or bending. If the bellows stem threads unscrews before the innervalve unscrews, make a strap wrench by cutting a strip of 80 grit emery paper the width of the bellows length and roll about three revolutions clockwise around the bellows assembly with the coarse side against the bellows. Grasp the emery paper by hand and with the wrench on the innervalve flats, remove the innervalve from the bellows. Normally this procedure prevents damaging the bellows because the emery paper wrapped around the bellows gives it more support transferring the twisting forces to where the bellows is welded to the lower end plate.

2. Do not try to remove stem from bellows assembly.

3. Do not grasp the bellows in any manner other than above nor allow it to twist.

4. Unscrew seat from body with a long set socket wrench.

NOTE: If the above procedure is being done because of bellows failure, it is not necessary to be concerned about damage to the bellows.

Installing Bellows Seal Assembly, Innervalve and Seat

Generally the foregoing steps are the reverse of disassembly, but best results will be experienced by processing in the following sequence:

1. Screw innervalve into bellows assembly **only hand tight.**

2. If the secondary packing in bonnet cap has not been damaged, proceed; otherwise, remove old packing but do not replace until later.

3. Place bellows-bonnet gasket carefully over bellows to flange.

4. Insert stem into bonnet cap, carefully turning in a clockwise direction until flange is seated all the way into bonnet cap.

5. Be sure gasket is home and not damaged.

6. With bellows upward, carefully screw bonnet into bonnet cap **by hand** until it is seated.

7. Holding bonnet in a vise, screw bonnet cap home firmly with a wrench.

8. At this point install new secondary packing if necessary, tightening gland firmly by finger tight as with a standard packed valve. (See paragraph on packing.)

9. Remove from vise and hand-install connector by hand.

10. With small wrenches on connector and flats on the innervalve, tighten firmly **but prevent using any side motion.**

11. With body held in a vise as instructed, screw the bonnet, bellows seal and innervalve assembly into the body.

12. When body bonnet assembly is complete, the innervalve should be off seat with the bellows in its free state and should move approximately 1/8" when pushed down before touching seat.

13. ⚠CAUTION - With valves having “P” trims, be sure the plug enters the seat before starting the bonnet threads into the body.

14. Assemble the topworks to the body-bonnet assembly in the **exact** reverse order from dismantiling. On air-to open topworks **remember** to have air on the diaphragm, rotating the topworks until the topworks and bellows stem butts together in the middle of the connector. Use two wrenches to tighten travel indicator lock nut to preclude twisting the bellows. If the topworks is not in the correct position with the stems butted together in the middle of the connector, rotate the topworks counterclockwise to the correct position before locking down the stem locknut. Do not rotate more than 90°

15. See stroke adjustment and pressure test.

Valve Positioners

General

Badger’s valve positioners use the full force of the air supply pressure to drive the diaphragm or piston of the pneumatic actuator to a position corresponding to the pneumatic instrument signal output from a controller (pressure, temperature, flow, etc.) and hold that position, regardless of the forces which tend to change valve position.

Like all valve positioners, Badger’s have a feedback circuit which measures position of the actuator’s diaphragm or piston. The built-in valve positioner supplies or vents air in response to the control-instrument signal stroking the valve to the required position.

Integral Mounting

Badger’s compact valve positioners incorporate a single axis force-balance principal of operation to insure accurate and stable positioning of Research Control Valves. The positioners become an integral part of the valve actuator. In all cases, including bottom loading applications, the built-in valve positioner is mounted directly on the topworks with no external piping or other exposed mechanisms.

Range Springs

The position of the diaphragm or piston in the valve actuator is sensed by the amount of compressive force exerted by the range spring on the valve actuator diaphragm assembly. Standard strokes are 7/16" and 9/16". Standard signal ranges are 3-15, 3-9, 9-15, and 6-30 PSIG. Consult the factory for other ranges.

Top Loading, Air-to-Close

Air pressure from the control instrument is exerted between the two lower diaphragms. Because of the difference in the two diaphragm areas, the resultant force is exerted in an upward direction. In balance condition, the pneumatic force on the diaphragm plus

the upward force exerted by the range spring is balanced by the downward force of the zero adjustment spring. In balance condition, positioner vents to atmosphere.

When control-instrument pressure increases, the diaphragm assembly will move upward closing the exhaust port and opening the pilot valve allowing supply air to pass directly to the actuator diaphragm. The supply air will drive the actuator downward. As the actuator moves down, the range spring relaxes until its force decreases enough to offset the increase in control-instrument pressure, allowing the pilot valve to close and exhaust to open. On air-to-close valves with positioners, the supply pressure should be sufficient for function, but never excessive. For function the positioner supply pressure needs to be a minimum of 3 PSIG above instrument signal. Excessive supply pressure can result in damage to trims when the innervalve touches the seat and the signal continues down. The positioner sees this as resistance and reacts, causing the full supply pressure to be applied to the main diaphragm in the actuator.

Bottom Loading, Air-to-Open

Air pressure from control instrument is inserted between the dual upper diaphragms and the center diaphragm. Because of the difference in the two diaphragm areas, the resultant force is exerted in a downward direction. In balance condition, the pneumatic force on the diaphragm, plus the downward force exerted by the zero adjustment spring, is balanced by the upward force of the range spring. In balance condition, positioner vents to atmosphere.

When control-instrument pressure increases, the diaphragm assembly will move downward allowing the spool valve to close the exhaust port and allow the supply air to pass through interior porting to the bottom side of the diaphragm or piston in the actuator. The supply air will drive the actuator upward. As the actuator moves up, the range spring will compress until its force increases enough to offset the increase in control-instrument pressure causing the spool valve to move, shutting off supply air to the actuator and opening exhaust.

Adjusting Zero

For ATC valves with type TLDA or Moore 73N12F positioners, zero adjustment is made with 15 psi instrument air (for 12 psi span) to the positioner, turning zero adjustment screw until valve seats at 15 psi. For ATO valves with type BLRA or Moore 73B positioners, zero adjustment is made with 3 psi instrument air to the positioner, turning zero adjustment screw until valve seats at 3 psi. Full travel within tolerances governed by the range spring should occur on ATO or ATC valves using the standard 3-15, 3-9, 9-15, etc. instrument signal.

NOTE: Factory zero adjustments are made on Research Control Valves with positioners, using 90 PSIG air pressure piped to the upstream valve port, connecting a Tygon or rubber tubing to the downstream port and immersing the end in a water filled container to detect any leakage across the seat during zero adjustment.

Servicing

Badger's valve positioners must be isolated from the system before service or removal can be accomplished. (Recommended procedure is to move complete valve with positioner to instrument repair bench where necessary tools and manual set air regulators are available.)

To clean pilot or spool valve, remove brass hex head sealing screw under top cap and with small sharp nose pliers, tweezers or other device, remove and clean pilot or spool valve and replace. On air-to-close TLDA and Moore 73N positioners, the pilot is a one piece unit that seldom fails due to dirty air or material such as Teflon tape getting into the pilot and causing malfunction. On air-to-open BLRA and Moore 73B positioners, the functional clearances around the spool valve is very close and more likely to fail due to dirty air or Teflon tape. Clearance is a function of bleed and must be close as possible, but large enough to function. To replace the diaphragm assembly, it is necessary to unscrew the six screws holding the positioner to the adaptor and remove the positioner assemble. Invert positioner and remove the two assembly screws in the bottom ring. When assembling the positioner diaphragm assembly to the main housing, make sure to align index grooves.

Positioners must be correctly assembled in order to function. Individual sub-assemblies such as the diaphragm assembly should be replaced as one unit.

TERMINOLOGY

PCV - *Pressure Control Valve*

LCV - *Level Control Valve*

TCV - *Temperature Control Valve*

FCV - *Flow Control Valve*

Topworks (Actuator) - *The assembly that provides force*

Positioner - *Instrument added or attached to topworks for more precise control*

ATO - *Air to Open. Increasing air signal opens valve*

ATC - *Air to Close. Increasing air signal closes valve*

F/O - *(Fail Open) Valve opens on air failure*

N/O - *(Normally Open) Valve opens on air failure*

F/C - *(Fail Close) Valve closes on air failure*

N/C - *(Normally Close) Valve closes on air failure*

Body Bonnet Assy - *That assembly consisting of body, bonnet, gasket, innervalve, stem, seat, packing, gland and yoke nut*

Trim Set - *The interchangeable components in a set consisting of innervalve, stem and seat*

=% - *Equal Percentage. Lift versus flow characteristic*

Lin. - *Linear lift versus flow characteristics*

Q.O. - *Opening - ON-OFF service*

P1 - *Inlet pressure to valve*

P2 - *Downstream pressure from valve*

△P - *Delta P - Pressure drop across valve*

C_v - *Flow Coefficient - Water flow at 1 PSI pressure drop*

Chevron Rings - *Packing, molded V-rings (normally 3 per set)*

Braid Tef. - *Packing, rope-type braided Teflon with Teflon suspensoid lubricant*

Notes

Special Information

Use this page for recording special operator information not included in the preceding (i.e., internal and supplier phone numbers, addreses, etc.)

Please see our website at
www.badgermeter.com
for specific contacts.

Due to continuous research, product improvements and enhancements, Badger Meter reserves the right to change product or system specifications without notice, except to the extent an outstanding bid obligation exists.

BadgerMeter,Inc.
6116 E. 15th Street, Tulsa, Oklahoma 74112
(918) 836-8411 / Fax: (918) 832-9962
www.badgermeter.com