

# MODEL DA2 & 7

## DA2 - DIRECT-ACTING, POSITIVE BIAS DIFFERENTIAL PRESSURE REDUCING REGULATOR DA7 - DIRECT-ACTING, NEGATIVE BIAS DIFFERENTIAL PRESSURE REDUCING REGULATOR

### SECTION I

#### I. DESCRIPTION AND SCOPE

The Model DA2 & DA7 are differential pressure reducing regulators used to control differential pressure between downstream (outlet or P<sub>2</sub>) pressure and a loading (P<sub>Load</sub>) pressure to the spring chamber. Sizes for the DA2 are 1/2" (DN15), 3/4" (DN20), 1" (DN25), 1-1/4" (DN32), 1-1/2" (DN40), 2" (DN50), 2-1/2" (DN65), 3" (DN80) and 4" (DN100). Sizes for the DA7 are 1/2" (DN15), 3/4" (DN20), 1" (DN25), 1-1/4" (DN32), 1-1/2" (DN40) and 2" (DN50). With proper trim utilization, the unit is suitable for liquid, gaseous, or steam service. Refer to Technical Bulletin DA2/7-TB for design conditions and selection recommendations.

### SECTION II

#### II. REFERENCES

Refer to Technical Bulletin DA2/7-TB and DAG-TB for technical specifications of a Model DA2 & DA7 regulator.

#### ABBREVIATIONS

CCW – Counter Clockwise  
 CW – Clockwise  
 ITA – Inner Trim Assembly

### SECTION III

#### III. INSTALLATION



#### CAUTION A

**For socket welded installations, all internal trim parts, seals and diaphragm(s) must be removed from regulator body prior to welding into pipeline. The heat of fusion welding will damage non-metallic parts if not removed. NOTE: This does not apply to units equipped with extended pipe nipples.**

1. Regulator may be rotated around pipe axis 360 degrees. For ease of maintenance, the recommended position is with the spring chamber (4) upwards. In liquid service it is recommended that the spring chamber (4) be oriented downwards, and that a customer supplied and installed vent valve be provided at the external sensing connection to bleed-off trapped gas/air under the diaphragm.
2. Provide space below, above, and around regulator for removal of parts during maintenance.
3. Install block valves and pressure gauges to provide means for adjustment, operation, bypass, or removal of the regulator. An isolation valve on the loading line is not recommended.
4. An outlet pressure gauge should be located approximately ten pipe diameters downstream,

and within sight. A loading pressure (or differential pressure) gauge is recommended.

5. All installations should include a downstream relief device if the inlet pressure could exceed the pressure rating of any downstream equipment or the maximum outlet pressure rating of the unit.
6. Clean the piping of all foreign material including chips, welding scale, oil, grease and dirt before installing the regulator. Strainers are recommended.
7. In placing thread sealant on pipe ends prior to engagement, ensure that excess material is removed and not allowed to enter the regulator upon startup.
8. Flow Direction: Install so the flow direction matches the arrow cast on the body.
9. If the loading pressure is not lowered sufficiently prior to shutting off the process fluid supply, then the diaphragm will be damaged with the standard construction. The startup, shutdown, and emergency operating procedures should be reviewed to ensure that the loading pressure is less than 50% of the Diaphragm Proof Rating (See table

below) before shutting off the process fluid supply pressure. If the regulator is specified with a fully supported diaphragm, then the diaphragm will withstand a loading pressure equal to the Diaphragm Proof Rating for the fully supported diaphragm.

10. Downstream Sensing Installation Considerations – Internal or External Sensing:

- a. The regulator may be installed with internal or external sensing. Unless otherwise specified, the regulator is supplied by factory with internal sensing. The regulator may be converted in the field to external sensing (see Section VII Maintenance, Paragraph H).
- b. Reference DAG-TB, Table DAG-11 for recommendations for applying external pressure sensing.
- c. For internal sensing, no external line is required. For external sensing, use an external control line. The line is connected from the port (1/4" NPT) on the side of the body diaphragm flange (see port 5 in Fig. 5) to a pressure tap. The pressure tap should be located a minimum of 10 pipe diameters downstream of the regulator. It is recommended that the downstream pressure tap be located close to the point of use to minimize the adverse affect of variable line losses. A tubing outer diameter of 0.25 inch is adequate for short sensing lines (less than 4 feet). Use 3/8" tubing or 1/4" Sch 40 pipe for sensing lines of 5 to 50 feet.
- d. For condensable vapors (i.e. steam) slope the external sensing line downward 2 to 5 degrees to outlet piping to prevent water pockets, which allows the diaphragm chamber to always be self draining. The external sensing line may be sloped upward for liquids or gases.

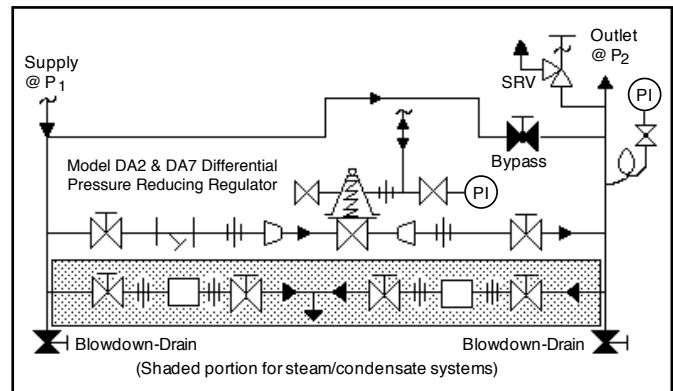
**⚠ CAUTION B**

**The proof test pressure must not exceed the diaphragm and body rating for the regulator.**

**⚠ CAUTION C**

**Installation of adequate overpressure protection is recommended to protect the regulator from overpressure and all downstream equipment from damage in the event of regulator failure.**

A hydrostatic or pneumatic proof test is allowable under the following conditions for the standard diaphragm construction: Uniformly pressurize the valve body inlet, valve body outlet, and loading chamber to the lesser of the Diaphragm Proof Rating or 1.5 times the Outlet Pressure Rating shown on the nameplate. For example, a 1" DA2 with Cast Iron Body and Spring Chamber, Neoprene Diaphragm (BC) has an Outlet Pressure Rating of 400 psig CWP. The lesser pressure of 1.5X 400 psig = 600 psig and the BC diaphragm proof rating of 750 psig is **600 psig**. Therefore, uniformly pressurizing the DA2 to 600 psig is allowable.



**Recommended Piping Schematic for Differential Pressure Reducing Station**

**TABLE 1 – DIAPHRAGM PROOF RATING IN PSIG (BARG)**

Diaphragm Material	Body Sizes – inch (mm)			
	1/2" - 2" (DN15 - 50)		2-1/2" - 4" (DN65 - 100)	
	Standard Diaphragm Construction	OPT-81 Full Diaphragm Support	Standard Diaphragm Construction	OPT-81 Full Diaphragm Support
BC, EPR	750 (51.7)	1200 (82.7)	450 (31.0)	800 (55.2)
HK, NBR, HK+TFE	300 (20.7)	1200 (82.7)	225 (15.5)	600 (41.4)
FK	500 (34.5)	1200 (82.7)	225 (15.5)	600 (41.4)
Elastomeric TFE	125 (8.6)	125 (8.6)	125 (8.6)	125 (8.6)
17-7 PH SST	500 (34.5)	1500 (103)	N/A	N/A
Be-Cu	300 (20.7)	750 (51.7)	N/A	N/A
302 SST	350 (24.1)	800 (55.2)	N/A	N/A
Inconel 718	500 (34.5)	1500 (103)	N/A	N/A

## SECTION IV

### IV. PRINCIPLE OF OPERATION

1. Valve plug movements modulate the flow across the valve seat to maintain the outlet pressure ( $P_2$ ) equal to the sum of the differential pressure ( $\Delta P_{DIFF}$ ) and the loading pressure ( $P_{Load}$ ). The outlet pressure acting on the underside of the diaphragm tends to close the valve plug against the valve seat. The outlet pressure acting on the topside of the diaphragm tends to lift the valve plug off the valve seat. The positive differential setting of the range spring for the DA2 tends to lift the valve plug off the valve seat. The negative differential setting of the range spring for the DA7 tends to pull the valve plug against the valve seat. The outlet pressure tracks with changes to the loading pressure. Each one psi increase or decrease in the loading pressure produces a respective one psi increase or decrease in the outlet pressure.
2. For a DA2 & DA7 (single diaphragm) design, a complete diaphragm failure will cause the outlet process fluid to mix with the loading fluid.

## SECTION V

### V. STARTUP

1. Start with the block valves closed.
2. Relax the range spring by turning the adjusting screw CCW for the DA2 (viewed from above) and CW for the DA7; a minimum of three (3) full revolutions. This reduces the  $\Delta P_{DIFF}$  (differential) pressure set point.
3. If it is a "hot" piping system, and equipped with a bypass valve, partially open the bypass valve to preheat the system piping and to allow slow expansion of the piping. Check for proper steam trap operation if installed. Closely monitor outlet (downstream) pressure via gauge to ensure not over-pressurizing. **NOTE:** If no bypass valve is installed, extra caution should be used in starting up a cold system; (i.e. do everything slowly).
4. Crack open the outlet (downstream) block valve.
5. Slowly open the inlet (upstream) block valve to about 25% open, observing the outlet (downstream) pressure gauge. Determine if the regulator is flowing. If not, slowly rotate the DA2 regulator adjusting screw CW (viewed from above) until flow begins. To begin the flow through a DA7, the user should slowly pressurize the spring chamber until flow begins. Slightly open the bleeder valve to vent any air as the spring chamber is filling with a liquid loading fluid.
6. Continue to slowly open the inlet (upstream) block valve until fully open.
7. Continue to slowly open the outlet (downstream) block valve, especially when the downstream piping system is not pressurized. If the outlet (downstream) pressure exceeds the desired pressure, close the inlet block valve and go to Step 2. Close bypass valve approximately 25%, and repeat procedure.
8. When flow is established steady enough that the outlet (downstream) block valve is fully open, begin to slowly close the bypass valve if installed.
9. Set the DA2 regulator set point ( $\Delta P_{DIFF}$ ) by turning the adjusting screw clockwise (CW) to increase outlet pressure or CCW to reduce outlet pressure. The outlet ( $P_2$ ) pressure under these conditions will approximate the desired differential pressure when loaded with  $P_{Load}$  for the DA2. Turn the adjusting screw of the DA7 CCW to increase the negative differential setting (i.e. CCW to change -10 psid to -20 psid) and CW to decrease the setting. The negative differential setting is the difference between the loading pressure ( $P_{Load}$ ) and the outlet pressure ( $P_2$ ).
10. Pressurize the source of loading ( $P_{Load}$ ) pressure and allow to fill the spring chamber cavity. Slightly open the bleeder valve to vent any air as the spring chamber is filling with a liquid loading fluid.
11. Develop system flow and pressure and readjust setpoint as required to obtain desired response. Performance should be analyzed at minimum and maximum flow levels.
12. Install closing cap where applicable. The standard regulator relies on a double o-ring rotary seal (item 34) around the non-rising adjusting screw.



#### CAUTION D

**Do not walk away and leave a bypassed regulator unattended!**

## SECTION VI

### VI. SHUTDOWN

**CAUTION E**

**Loading Pressure should be lowered as described in Section III, paragraph 9 before shutting down the system pressure.**

1. To prevent force imbalances and possible diaphragm failure of the standard diaphragm construction, the loading pressure ( $P_{Load}$ ) should be lowered until the loading pressure ( $P_{Load}$ ) is less than 50% of the diaphragm proof rating for

the standard construction. System sequencing must ensure this occurs.

2. It is recommended that manual operation not be attempted by a bypass valve during a shutdown.
3. When the outlet pressure ( $P_2$ ) has been lowered to 5 - 10 psig, the inlet (upstream) block valve may be closed. The inlet pressure ( $P_1$ ) should then decay to zero psig before the outlet (downstream) block valve is closed.

## SECTION VII

### VII. MAINTENANCE

#### A. General:

1. The regulator may be serviced without removing the regulator from pipeline. The regulator is designed with quick-change trim to simplify maintenance.
2. Record the nameplate information to requisition spare parts for the regulator. The information should include: Size, KM Product Code and Serial Number.
3. Refer to Section VIII for recommended spare parts. Only use original equipment parts supplied by Cashco/KM for rebuilding or repairing regulators.
4. Owner should refer to owner's procedures for removal, handling, cleaning and disposal of nonreuseable parts, i.e. gaskets, etc.  
**NOTE:** On regulators originally supplied as Special Cleaning Option-55, -56, or -57, maintenance must include a level of cleanliness equal to Cashco cleaning standards of #S-1134, #S-1542, and #S-1589 respectively. Contact factory for details.
5. The Inner Trim is removed and replaced in the body ( 23) as an assemblage of parts. The Inner Trim Assembly, hereinafter called **ITA**, consists of the following parts depending on what dynamic sealing system the regulator is using:

Item No.	Dynamic Seal Type	Part Description
13	All	Guide Bearing/Piston
14	All	Static Stem Seal †
14.1	All	Upper Static Stem Seal †
14.2	All	Middle Static Stem Seal †
14.3	All	Lower Static Stem Seal †
15	All	Cage O-ring Seal
16	CW,PW	Wiper
17.1	CW,PW	Wiper Washer
17.2	OR,CP,PR	Camber Adjusting Washer *
17.3	UC	Seal Retainer
19	All	Cage
20	All	Valve Plug
21	All	Seat Ring
27	All	Dynamic Side Seal
27.1	CP,CW	TFE Cap Seal
27.2	CP, CW	O-ring Energizer
27.3	UC	U-Cup Seal w/Metal Energizer
27.4	OR	O-Ring Seal
27.5	PR,PW	Piston Ring Seal w/Metal Energizer

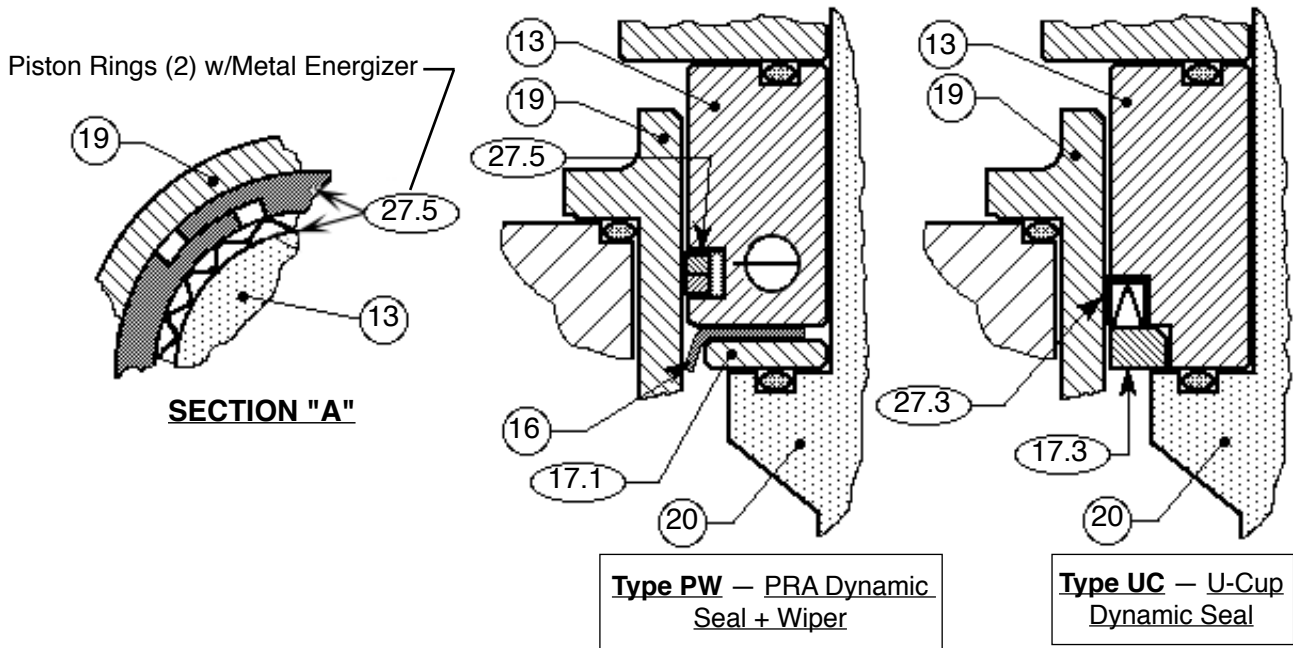
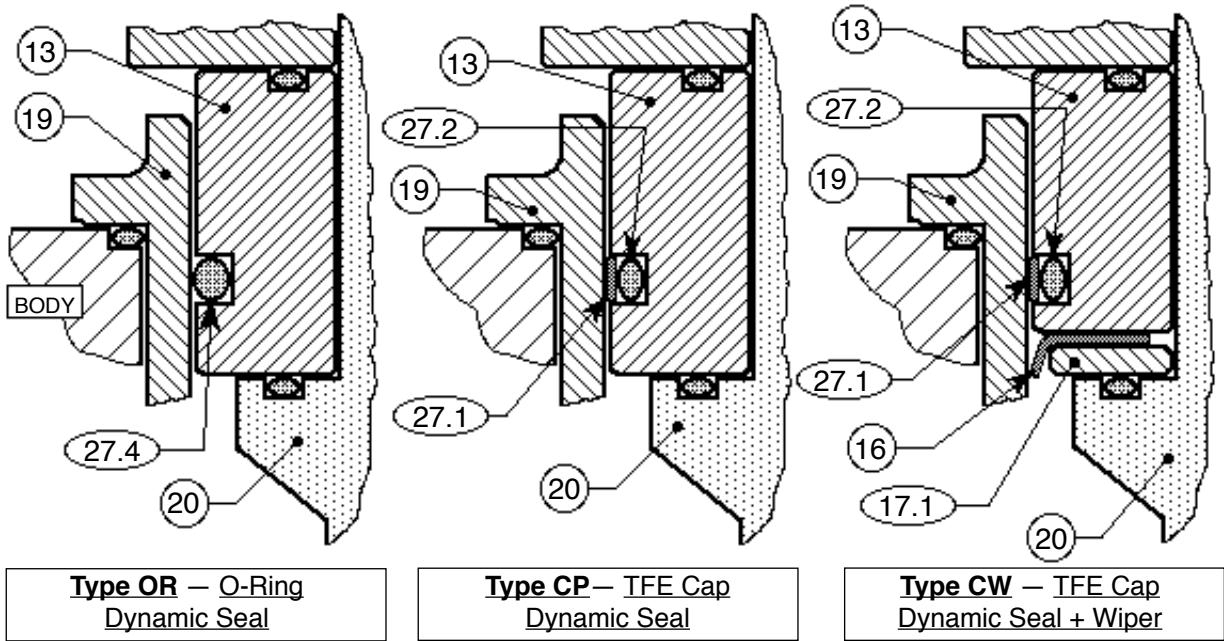
\* Metal Diaphragm Only.  
 † Comp. Diaphragm Only.

A detailed view of the dynamic side seal parts is shown in Figure 1 on the next page.

**WARNING 1**

**SYSTEM UNDER PRESSURE. Prior to performing any maintenance, isolate the regulator from the system and relieve all pressure. Failure to do so could result in personal injury.\***

\* Includes external sensing connection if applicable.



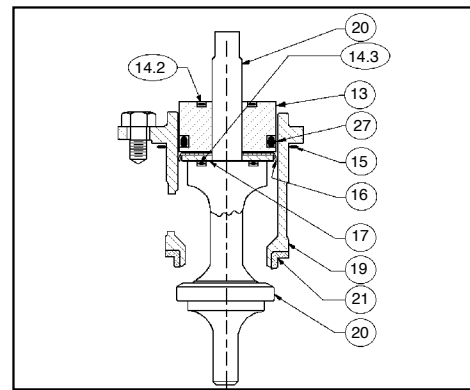
**Figure 1: Dynamic Side Seals**

## B. Main Valve Disassembly:

1. Shut down the system in accordance with Section VI.
2. Disconnect the external sensing line, if installed.
3. The quick change trim allows for the disassembly of the regulator while installed in the pipeline. Alternatively the maintenance can be done in a shop area. **NOTE:** It is easier to repair the regulator when mounted upright in a horizontal pipe run compared to a vertical pipe run or a regulator mounted with spring facing down. The description hereafter will assume shop disassembly.
4. Remove regulator body (23) from pipeline. Place the regulator in a vise with the spring chamber (4) upwards.
5. Relax range spring (6) forces by turning adjusting screw (1) CCW for DA2 (viewed from above) until spring relaxes. Turn the adjusting screw CW for the DA7 to relax the extension load of the spring assembly (item 6). The easiest way to check this, is to carefully loosen the locknut (item 2). If the adjusting screw (item 1) sinks into the chamber as the locknuts are loosened, then the spring assembly is still in extension. Turn the adjusting screw CW to remove the extension. Fully remove the locknuts.
6. Loosen the diaphragm flange bolts (11) and nuts (12) uniformly.
7. Place match marks on body (23) and spring chamber (4) flanges. Remove the spring chamber (4).
8. Remove spring follower (5) and range spring (6.1) on DA2. Unthread the range spring assembly (6.2) from the valve plug on DA7.
9. For composition diaphragm construction, hold the milled "flats" on top of the valve plug (20) stationary with appropriate socket wrench. Loosen and remove the diaphragm lock nut (7). **NOTE:** Metal diaphragm constructions do NOT have a diaphragm lock nut (7).
10. Remove upper diaphragm pressure plate (8).
11. Remove diaphragm(s) (9, 9.1, 9.2, 9.9) and o-ring upper stem seal (14.1). Examine diaphragm(s) to determine whether failed;

determine if operating conditions are exceeding pressure, pressure drop or temperature limits.

12. For composition diaphragm construction, remove lower diaphragm pusher plate (10).
13. Evenly loosen the three cage cap screws (18) in single revolution increments. If the regulator contains a lower piston spring (22), the ITA should rise as the cage cap screws (18) are evenly backed out. A downwards holding force should be applied to the top of the piston-guide bearing (13) to prevent the ITA from popping up as the last threads of the cage cap screws (18) are backed out.
14. Remove the ITA by pulling up on the valve plug (20). Set ITA aside.
15. Remove the lower piston spring (22), as applicable, from within the body (23). **NOTE:** Composition diaphragm constructions do not normally include a lower piston spring (22); all metal diaphragm constructions MUST include a lower piston spring (22).
16. Remove o-ring cage seal (15).
17. Remove body (23) from vise. Clean all reusable metal parts according to owner's procedures. (See Article VII.A.4. comments concerning cleaning for oxygen service.)



**Figure 2:** Assembled ITA,  
Composition Diaphragm Construction

## C. Disassembly of the ITA:

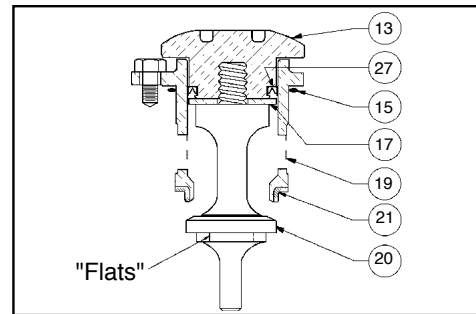
1. Removal of piston-guide bearing (13).
  - a. For a regulator with a composition diaphragm(s) (see figure 2); pull the valve plug (20) downwards and out the piston-guide bearing (13) and out of the lower end of the cage (19). Remove the piston-guide bearing (13) from the upper end of the cage (19).
  - b. For a regulator with a metal diaphragm(s)

(see figure 3); hold the lower part of the valve plug (20) in a bench vise, grasping the milled flats directly under the seat disc section of the plug (20). **DO NOT** clamp the machined lower spindle area of the plug (20) in the vise. The lower spindle area must slide smoothly in the lower guide bushing (24), therefore it cannot be marred. Loosen the piston-guide bearing (13) by turning CCW. A double-posted spanner wrench should be purchased to allow for easy loosening and correct reassembly (see Double-Posted Spanner Wrench Fitting Chart in Section IX). Remove the valve plug from the vise and complete the unthreading of the valve plug from the piston-guide bearing. Remove the valve plug from the lower end of the cage (19) and remove the piston-guide bearing from the upper end of the cage.

2. Examine the components (27.1, 27.2, 27.3, 27.4, 27.5) of the dynamic side seal (27) mechanism to determine if significant leakage was occurring. If the dynamic side seal (27) shows signs of significant leakage, determine if operating conditions are exceeding pressure, pressure drop, or temperature limits.

Remove dynamic side seal (27) components. Special care should be taken when using "tools" to remove the components to ensure that no scratches are imparted to any portion of the piston-guide bearing (13) groove.

3. Remove wiper seal (16), if supplied, from within cage (19).
4. Remove wiper washer (17.1), camber adjusting washer (17.2), or seal retainer (17.3), if supplied, from within cage (19).
5. Remove o-ring lower stem seal (14.3) from plug (20).
6. Remove seat ring (21); examine for signs of leakage. If seat ring (21) shows signs of significant leakage, determine if operating conditions of pressure, pressure drop, or temperature are exceeding limits.
7. Clean all reusable metal parts according to owner's procedures. **NOTE:** On regulators originally supplied as Special Cleaning Option-55, -56, or -57, maintenance must include a level of cleanliness equal to Cashco cleaning standards of #S-1134, #S-1542, #S-1589 respectively. Contact factory for details.



**Figure 3:** Assembled ITA,  
Metal Diaphragm Construction

#### D. Inspection of Parts:

1. After inspection remove from the work area and discard the old "soft goods" parts (i.e. o-rings, diaphragms, seals, gaskets, etc.) after inspection. These parts **MUST** be replaced with factory supplied new parts.
2. Inspect the metal parts that will be reused. The parts should be free of surface contaminants, burrs, oxides, and scale. Rework and clean the parts as necessary. Surface conditions that affect the regulator performance are stated below; replace parts that can not be reworked or cleaned.
3. QC Requirements:
  - a. Valve plug (20);
    1. 16 rms finish on its seating surface for tight shutoff.
    2. No major defects on bottom guide spindle.
  - b. Cage (19);
    1. 16 rms finish on cylinder bore. No "ledges" formed due to wear from moving dynamic side seal (27) or wiper seal (16).
  - c. Lower guide bushing (24) (non-replaceable on 1/2" - 2" sizes):
    1. 16 rms finish on bore.
    2. Max 0.015 inch (0.38 mm) clearance between valve plug (20) spindle and lower guide bushing (24).
  - d. Internal sensing drilled plug (32);
    1. Ensure that bore is minimum 0.125 inch (3.20 mm). Clean or drill out as required.
4. Staging Material for Reassembly.
  - a. Inspect and clean parts, as necessary, from the spare parts kit. (See Article VII.A.4. comments concerning cleaning for oxygen service.)
  - b. Lay out all the regulator parts and check against the bill of material.

## E. Reassembly of the ITA:

1. When replacing the wiper seal (16), the wiper seal (16) should be “performed” from the factory. It will, however, require reforming. Reform the wiper seal (16) by pressing the temporary assembly parts into the cage (19) backwards as shown in Figure 4 (only applicable to composition diaphragm design). The wiper seal (16) is best left in this position overnight, but a minimum of 30 minutes prior to reassembly. Soaking in a bucket of hot water will speed up the reforming process.

2. After reforming the wiper seal, remove parts (13, 16, 17) from cage (19) and disassemble the temporary assembly of Step 1. above.

3. Installation of dynamic side seal (27) (See Figure 1):

a. Type OR:

1. Stretch o-ring seal (27.4) over lower circumference of piston-guide bearing (13), taking care not to “cut” o-ring seal (27.4). Using thumbs, work the o-ring seal (27.4) up and into the groove of the piston-guide bearing (13). **NOTE:** A very slight amount of fluid and elastomer compatible o-ring lubricant is recommended as an installation aid.

2. For metal diaphragm construction, insert camber adjusting washer (17.2) into cage (19) and allow to rest in the bottom of the cage (19).

3. Position piston-guide bearing (13) over upper end of cage (19) properly oriented. Using thumbs, evenly press piston-guide bearing (13) into the cage (19), ensuring not to “cut” o-ring seal (27.4). Continue pressing piston-guide bearing (13) until in approximate final position.

b. Type CP:

1. Stretch o-ring energizer/seal (27.2) over lower circumference of piston-guide bearing (13), taking care not to “cut” o-ring energizer/seal (27.4). Using thumbs, work the o-ring energizer/seal (27.4) up and into the groove of the piston-guide bearing (13). **NOTE:** A very slight amount of fluid and elastomer compatible o-ring lubricant is recommended as an installation aid.

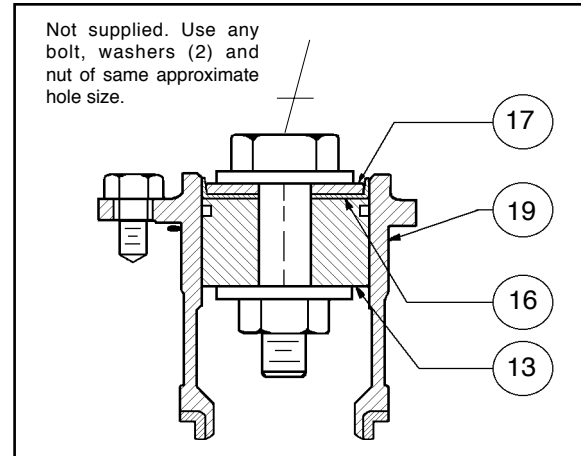


Figure 4

2. For metal diaphragm construction, insert camber adjusting washer (17.2) into cage (19) and allow to rest in the bottom of the cage (19).

3. Position TFE cap seal (27.1) ring with rectangular cross-section at end of piston-guide bearing (13). Stretch cap seal (27.1) over lower end of piston-guide bearing (13) using thumbs to work the cap seal (27.1) onto the piston-guide bearing (13). **DO NOT USE A TOOL FOR THIS STEP.** Continue pressing cap seal (27.1) upwards towards the groove until the cap seal (27.1) “snaps” into the groove of the piston-guide bearing (13).

4. Position piston-guide bearing (13) over and into upper end of cage (19) until the cap seal (27.1) edge touches the upper lip of the cage (19). While gently applying force to press the piston-guide bearing (13) into the cage (19), simultaneously use fingers to lightly press the cap seal (27.1) inwards into the groove of the piston-guide bearing (13) until the cap seal (27.1) “slips into” the cage (19). **DO NOT USE TOOLS, LUBRICANT, OR HEAVY FORCE TO ENGAGE THE CAP SEAL (27.1) INTO THE CAGE (19).**



c. Type CW:

1. Stretch o-ring energizer/seal (27.2) over lower circumference of piston-guide bearing (13), taking care not to “cut” o-ring energizer/seal (27.4). Using thumbs, work the o-ring energizer/seal (27.4) up and into the groove of the piston-guide bearing (13). **NOTE:** A very slight amount of fluid and elastomer compatible o-ring lubricant is recommended as an installation aid.
2. Place wiper washer (17.1) into cage (19). Allow wiper washer (17.1) to rest on bottom of cage (19). Insert wiper seal (16) into cage (19) at an approximate 45° angled approach. The turned-down lip of wiper seal (16) entering cage (19) first. Rotate wiper seal (16) and wiper washer (17.1) to a level position approximately half way down into cage (19). The serrated face of the wiper washer (17.1) must contact the lower face of the wiper seal (16) when the valve plug (20) is inserted into the cage (19).
3. Position TFE cap seal (27.1) ring with rectangular cross-section at end of piston-guide bearing (13). Stretch cap seal (27.1) over lower end of piston-guide bearing (13) using thumbs to work the cap seal (27.1) onto the piston-guide bearing (13). **DONOT USE A TOOL FOR THIS STEP.** Continue pressing cap seal (27.1) upwards towards the groove until the cap seal (27.1) “snaps” into the groove of the piston-guide bearing (13).
4. Position piston-guide bearing (13) over and into upper end of cage (19) until the cap seal (27.1) edge touches the upper lip of the cage (19). While gently applying force to press the piston-guide bushing (13) into the cage (19), simultaneously use fingers to lightly press the cap seal (27.1) inwards into the groove of the piston-guide bearing (13) until the cap seal (27.1) “slips into” the cage (19). **DO NOT USE TOOLS, LUBRICANT, OR HEAVY FORCE TO ENGAGE THE CAP SEAL (27.1) INTO THE CAGE (19).**

d. Type PW:

1. Place wiper washer (17.1) into cage

(19). Allow wiper washer (17.1) to rest on bottom of cage (19). Insert wiper seal (16) into cage (19) at an approximate 45° angled approach. The turned-down lip of wiper seal (16) entering cage (19) first. Rotate wiper seal (16) and wiper washer (17.1) to a level position approximately half way down into cage (19). The serrated face of the wiper washer (17.1) must contact the lower face of the wiper seal (16) when the valve plug (20) is inserted into the cage (19).

2. **NOTE:** A piston ring assembly (27.5) consists of one metal corrugated energizer and two piston ring seals. Wrap corrugated metal piston ring energizer into the groove of piston-guide bearing (13).
3. Spread a piston ring seal and slide over lower circumference of piston-guide bearing (13). Using thumbs and fingers, work the piston ring seal into the groove of the piston-guide bearing (13). Repeat this procedure with a second piston ring seal. Orient the Z-cuts in the piston ring seals 180 degrees apart to minimize leakage by the piston ring assembly.
4. Position piston-guide bearing (13) over and into upper end of cage (19) until the lower piston ring seal touches the upper lip of the cage (19). While gently applying force to press the piston-guide bearing (13) into the cage (19), simultaneously use fingers to lightly circumferentially press the piston ring assembly (27.5) inwards into the piston-guide bearing (13) groove until the piston ring assembly (27.5) “slips into” the cage (19).

e. Type UC:

1. Insert seal retainer (17.3) into top of cage and allow to rest in bottom of the cage.
2. Position u-cup seal (27.3) over lower circumference of piston-guide bearing (13). Ensure that the u-cup seal (27.3) is oriented with the center-open-downwards as shown in Figure 1. The u-cup seal (27.3) depends upon the P1-Inlet Pressure to activate the seal for proper sealing action.

3. Position piston-guide bearing (13) over and into upper end of cage (19) until the cap seal (27.1) edge touches the upper lip of the cage (19). While gently applying force to press the piston-guide bearing (13) into the cage (19), simultaneously use fingers to lightly press the u-cup seal (27.3) inwards into the groove of the piston-guide bearing (13) until the u-cup seal (27.3) “slips into” the cage (19). **DO NOT USE TOOLS, LUBRICANT, OR HEAVY FORCE TO ENGAGE THE U-CUP SEAL (27.3) INTO THE CAGE (19).**
4. Place properly oriented seat ring (21) onto its shoulder at the lower end of cage (19).
5. Composition Diaphragm Designs.
  - a. Place new o-ring lower stem seal (14.3) into groove of valve plug (20).
  - b. Insert valve plug (20) upwards through lower end of cage (19) and through the center hole in piston-guide bearing (13), also capturing camber adjusting washer (17.2), wiper washer (17.1) and wiper seal (16), if supplied. Hold plug (20) and cage (19) together.
  - c. This completes ITA reassembly.
6. Metal Diaphragm Designs.
  - a. Insert valve plug (20) upwards through lower end of cage (19) and through the center hole of camber adjusting washer (17.2) or wiper washer (17.1) and wiper seal (16).
  - b. Engage valve plug (20) with piston-guide bearing (13) threads and tighten manually as far as possible.
  - c. Place ITA into a vise and grasp at a hub location on the valve plug (20) that is not in the “spindle” zone. (See Figure 3.)
  - d. Using a special double-posted spanner wrench fitting (to order see NOTE in Section IX, Parts Ordering Information), tighten the piston-guide bearing (13) to the valve plug (20) with the following torque values. Do NOT allow valve plug (20) to rotate against seat ring (21) during tightening.

Recommended Torque values are:			
Body Size in (mm)		Torque ft-lbs (N-m)	
1/2" - 1"	(DN15-25)	40-50	(55-70)
1 1/4" - 2"	(DN32-50)	60-80	(80-110)

- e. This completes ITA reassembly.

## F. Main Reassembly:

1. Place body (23) in a vise.
2. Reinstall internal sensing drilled plug (32) with compatible thread sealant.
3. Insert the lower piston spring (22) into the body (23), if supplied.
4. Fit the o-ring cage seal (15) into its body (23) groove.
5. With the ITA held manually in the closed position, insert ITA into body (23).
6. Properly align all three cage bolt (18) holes as there is only one circumferential location possible for this alignment. If a lower piston spring (22) is used, apply downward force to the top of the cage (19) until the ITA is lowered sufficiently to engage the cage bolts (18) into the body (23). Engage all of the cage bolts (18), then evenly screw in the cage bolts in one-half revolution increments to pull down the ITA, taking care **NOT TO “COCK” THE ITA IN THE BODY.** Torque the cage bolts (18) to 13-15 ft-lbs (18-20 N-m).
7. Composition Diaphragm Designs:
  - a. For the following steps b.–h., the upper end of valve plug (20) **MUST** be manually held up if unit is not supplied with lower piston spring (22).
  - b. Place new o-ring middle stem seal (14.2) into groove of piston-guide bearing (13) upper surface.
  - c. Position lower diaphragm pusher plate (10) over upper end of valve plug (20) with tongue and groove “groove” on upper side.
  - d. Place new o-ring upper stem seal (14.1) into groove on lower diaphragm pusher plate (10).
  - e. Place diaphragm(s) (9) over end of valve plug (20). **NOTE:** For multiple diaphragms (9) that include TFE material, the TFE should be on wetted side; for 6-ply TFE elastomer diaphragm (9), stackup is TFE-TFE-HK-HK-TFE-TFE, beginning with lower wetted diaphragm (9) first.
  - f. Place upper diaphragm pressure plate (8) over upper end of valve plug (20) with tongue and groove “ridge” on lower side.
  - g. Place anti-seize lubricant on valve plug (20) threaded end. Engage diaphragm lock nut (7) with upper end of valve stem (20) as far as possible manually.

- h. Place a wrench on diaphragm lock nut (7) and a torque wrench on the upper end of valve plug (20). Hold torque wrench stationary and rotate diaphragm lock nut (7) to the following torque values:

Body Size		Torque	
in	(mm)	ft-lbs	(N-m)
1/2" - 1"	(DN15-25)	60-70	(81-95)
1 1/4" - 2"	(DN32-50)	120-130	(163-176)
2 1/2" - 4"	(DN65-100)	180-200	(244-271)

DO NOT allow valve plug (20) to rotate against seat ring (21) during tightening.

- i. This completes ITA reassembly.
8. Units with V-TFE & CTFE seat ring (21): Due to the relative "hardness" of the V-TFE & CTFE material, to obtain the best possible shutoff it is necessary to "coin" the V-TFE & CTFE with a permanent indentation.
- Close-off the outlet connection.
  - The level of seat leakage can be quantified at the internal sensing drilled plug (32) for internal sensing units. For external sensing units, it will be necessary to remove the internal sensing plug (33).
  - Pressurize the valve's inlet with gas or air to 50 - 150 psig (3.5 - 10 Barg).
  - Using a soft-headed mallet (rubber, leather), sharply rap the top end of the plug (20) for composition diaphragm designs, or the piston-guide bearing (13) for metal diaphragm designs. (**NOTE**: Gas will escape as the plug (20) opens at the seat ring (21). Allow sufficient time for leakage pressure on outlet to bleed-off.) The hammer rap should be strong enough to "bounce" the plug (20) into the seat ring (21), leaving the "coined" indentation. Check for leakage at the internal sensing port with a leak detection fluid. One bubble per second is typical of Class IV shut off.
  - Repeat d. a minimum of 2 times until the best possible seat leakage is obtained.
  - After "coining" completed, remove gas pressure source, remove outlet closure, and reinstall plug (33) if removed.
9. Metal Diaphragm Designs:
- Install new diaphragm gasket (37) onto body (23) diaphragm flange.
  - Position diaphragm(s) (9) onto body's (23) diaphragm flange.
  - Position upper diaphragm pressure plate (8) onto center top of diaphragm(s) (9) with counterbore upwards.

- Lubricate and install o-rings (34) into grooves on the adjusting screw (1).
- Assembly of range spring and spring chamber for DA2:
  - Lubricate the threads of adjusting screw (1) then thread into the spring follower (5).  
The spring follower should be threaded up adjusting the screw to within 3/8" of the top threads (see sectional drawing, figure 5).
  - Insert adjusting screw-spring follower into spring chamber (4). **NOTE**: Milled slots in spring follower must align with ribs in the bore of the spring chamber. The top of the adjusting screw must fit in the center hole of spring chamber. A light rap with a wooden handle of a hammer may be needed to fully install the adjusting screw into the spring chamber.
  - Aligning match marks and bolt holes, place spring chamber (4) over range spring (6.1). If the spring chamber flange reaches the body flange without a gap, turn adjusting screw (1) CW 2-3 turns. Repeat this procedure until the flanges are approximately 1/8" apart. Be sure that range spring is properly seated into counterbore on spring follower. **NOTE**: For metal diaphragm construction, if flanges do not come together equally, the upper diaphragm pressure plate (8) may be off-center. Remove spring chamber (4) and reposition upper diaphragm pressure plate (8) until the spring chamber (4) comes down evenly on all sides.
- Assembly of range spring assembly and spring chamber for DA7:
  - Lubricate the threads of adjusting screw (1), then thread into the range spring assembly (6.2). The adjusting screw should be threaded sufficiently into the range spring assembly to allow easy fitting of the spring chamber (see sectional drawing, figure 6).
  - Thread the lower end of the range spring assembly to the top of the valve plug. At least three good threads of engagement are required between the range spring assembly and the valve plug. Back off range spring assembly a fraction of the turn to align the milled slots perpendicular to the center line of the valve body. The slots should now be ready to accept the internal ribs of the spring chamber.
  - Aligning match marks and bolt holes place spring chamber (4) over range

spring assembly (6.2). If the spring chamber flange reaches the body flange without the adjusting screw passing through the center hole of the spring chamber, then remove the chamber. Holding the range spring assembly stationary, turn the adjusting screw CW 2-3 turns or as required so the top of the screw will pass through center holes of the spring chamber. After the top of the adjusting screw passes through the center hole of the spring chamber, continue to turn the adjusting screw CW until the adjusting screw is fully fitted into the spring chamber. **DO NOT** allow the spring chamber to rotate or the range spring assembly may disengage from the valve plug.

- d. Fit the locknut (2) to the top of the adjusting screw. **DO NOT** over tighten the first locknut. The adjusting screw should turn freely in the spring chamber. Lock the second locknut against the first locknut. Again, check that the adjusting screw turns freely.

- 13. Reinstall all flange bolts (11) and nuts (12) with nameplate (99) located under one bolt head. Hand-tighten nuts (12).

**NOTE:** If a six-ply diaphragm is being used, it is important that the diaphragm (9) is “pre-formed” – allow formation of a diaphragm (9) convolution. Starting with the body bolts and nuts (11,12) hand tightened, “preforming” can be accomplished by any one of the following techniques:

- a. Relax range spring fully by rotating adjusting screw CCW.
- b. Apply 30 psig (2.1 Barg) pressure to the valve outlet.

OR

Block the valve outlet and apply 30 psig (2.1 Barg) under the diaphragm through the 1/4" NPT (plugged) external pressure sensing connection on the valve diaphragm flange.

- c. Leave pressure on through tightening of bolting (11,12).

- 14. Evenly tighten the body bolting (11,12) in an alternating cross pattern in one revolution increments to the following torque value:

Body Size		Torque	
in	(mm)	ft-lb	(N-m)
1/2" - 2"	(DN15-50)	30-35	(41-47)
2 1/2" - 4"	(DN65-100)	45-50	(61-69)

If supplied, remove pressure of previous Step 14.

**G. Units with Supported Diaphragm Designs:**

- 1. A supported diaphragm (9) construction is designated as Opt-81.
- 2. For a Model DA2/7 the only “special” part to be supplied is the support plate (35) fitted into a counter bore cut into the body (23).

**H. Converting Internal/External Sensing:**

- 1. Disassemble the regulator and remove the diaphragm(s) (9) according to Steps 1-12 in Part B – Main Regulator Disassembly.
- 2. To convert from internal to external sensing, remove the drilled pipe plug (32) and install a solid pipe plug. Reverse this step for converting from external to internal sensing.
- 3. Reassemble the regulator according to Part F – Main Regulator Reassembly.

**I. Pressure Testing:**

- 1. Pressure Containment Test (External Leak Test.).
  - a. See Section III, last paragraph and Table 1 for restrictions.
  - b. Spray leak detection solution over the bolting, diaphragm edge, body, spring chamber and all other pressure boundary areas, during external leak test.
- 2. Inboard Leakage Test.
  - a. Release all range spring force by turning CCW for DA2 or CW for DA7 adjusting screw.
  - b. Pressurize inlet to 50 psig (3.5 Barg) with air, GN<sub>2</sub>.
  - c. Tube outlet to a beaker of water to observe number of escaping gas bubbles.
- 3. Excessive leakage will require disassembly, examination of sealing elements, correction of problem, reassembly and retesting. Leakage path may be via plug/seat or dynamic side seal. Before disassembling the regulator check the DAG-TB Table DAG-10 to determine the acceptable inboard leak rates of the seat and dynamic seal combination of the regulator.

## SECTION VIII

### VIII. TROUBLE SHOOTING GUIDE

When trouble shooting this regulator there are many possibilities as to what may be causing problems. Many times, the regulator itself is not defective, but one or more of the accessories may be. Sometimes the process may be causing difficulties.

The key to efficient trouble shooting is information and communication. The customer should try to be as precise as possible in their explanation of the problem, as well as their understanding of the application and operating conditions.

It is imperative the following information be provided by the customer:

- Fluid (with fluid properties)
- Range of flow rate
- Range of inlet pressure
- Range of outlet pressure
- Range of fluid temperature
- Range of ambient temperature

Pressure readings should be taken at every location that pressure plays a role - i.e., regulator inlet (as close as possible to inlet port), regulator outlet (as close as possible to outlet port), etc.

Below are some of the more common complaints along with possible causes and remedies.

#### 1. Erratic regulation, instability or hunting.

Possible Causes	Remedies
A. Sticking of internal parts	A. Remove internals, clean and if necessary, replace.
B. Load changes are too quick for system	B. Convert to external sensing (if necessary) and install an orifice or needle valve in external sensing line.
C. Oversized regulator	C. Check actual flow conditions; resize regulator for minimum and maximum flow; if necessary, replace with smaller regulator.
D. Unstable loading pressure.	D1. Stabilize loading pressure; i.e. pump, control valve, etc. D2. Air in loading piping. Vent spring chamber.

#### 2. Erratic regulation, instability or hunting (liquid service).

Possible Causes	Remedies
A. Air trapped under diaphragm.	A. Install valve on external sensing port and bleed off air. (Install regulator upside down to help prevent reoccurrence.)

#### 3. Downstream pressure will not reach desired setting.

Possible Causes	Remedies
A. Supply pressure is down (conformation pressure gauge).	A. Increase supply pressure.
B. Undersized regulator.	B. Check actual flow conditions; resize regulator for minimum and maximum flow; if necessary, replace with larger regulator.

**4. Diaphragm continually breaks (steam service regulators).**

Possible Causes	Remedies
A. Stem seals (14) which protect fluorocarbon elastomer in diaphragm assembly may have deteriorated.	A. Replace with new stem seals (14).
B. Diaphragm nut (7) may not be torqued to proper value.	B. Confirm torque value in accordance with Section VII, paragraph F-7.
C. Diaphragm too stiff causing it to crack in service.	C. Follow proper preforming and air evacuation techniques during diaphragm installation in accordance with Section VII, paragraph F-13.

**5. Diaphragm continually breaks (all regulators).**

Possible Causes	Remedies
A. Differential pressure across diaphragm may have exceeded limits. (See Table 1)	A. Be aware of limits as well as where the various pressures are acting. Install pressure safety equipment as necessary.

**6. Leakage at diaphragm flange.**

Possible Causes	Remedies
A. Body bolts not torqued properly.	A. Torque to proper value (see Section VII, paragraph F-14).
B. Pressures at diaphragm may be too high for regulator design.	B. Consult factory.

**7. Leakage across seat.**

Possible Causes	Remedies
A. Contamination (debris) in regulator.	A1. Remove internals, clean and if necessary, replace sealing and seating elements.* A2. "Coin" seat if V-TFE or CTFE seat material.
B. Oversized regulator; valve plug operates directly next to seat.	B. Check actual flow conditions; resize regulator for minimum and maximum flow; if necessary, replace with smaller regulator.
* Excess seat leakage may be diagnosed when a failure of the dynamic side seal has occurred. Inspect <u>both</u> potential internal leak paths.	

## SECTION IX

### IX. PARTS ORDERING INFORMATION

There are three methods to obtain parts ordering information/numbers. These methods are listed below, in order of ease of entering. The least expensive method is to utilize parts in kits where possible.

**NOTE:** In addition to ordering repair parts, it is recommended that a special double-posted spanner wrench fitting be ordered for use in the maintenance of the ITA. See the following table for correct size:

Double-Posted Spanner Wrench Fitting	
Body Size	Cashco P/N
1/2", 3/4", 1" (DN15, 20, 25)	112-A4-6-P0459-00
1-1/4", 1-1/2", 2" (DN32, 40, 50)	112-A4-6-P0459-01

#### **METHOD A - USE OF PRODUCT CODE.**

Step 1. If available, obtain the 18 character product code number from:

- a. The Bill of Materials sheet attached herein.
- b. The metal tag attached to the regulator.

□ □ □ - □ □ □ 7 - □ □ □ □ □ □ □ □ □ □

**NOTE:** Some regulators may not have the product code located on the metal tag.

Step 2. Identify which kits or parts are desired from the following:

- a. The Bill of Materials sheet attached herein, or refer to the cross-sectional drawings.
- b. Standard maintenance parts for a basic regulator (no options) are included in the Parts Kit Number table on Page 7. Kit "A" contains seal(s), diaphragm(s) and gasket(s). Kit "B" contains trim replacement parts plus seal(s), diaphragm(s) and gasket(s).

Step 3. Contact your local KM Sales Representative and specify the product code number along with a description of any parts not included in the kits. Costs of required parts (and kits) can be given by the Sales Representative.

#### **METHOD B - NO PRODUCT CODE AVAILABLE - DISASSEMBLED REGULATOR.**

Step 1. Determine all available information from regulator's metal tag.

- a. Serial number (5-digit).
- b. Regulator "Type" or "Model" number.
- c. Size (may have to observe body tap).
- d. Spring range.
- e. Trim designation number (if available).

Step 2. Determine construction of trim.

- a. What is fluid?
- b. Metal or composition (soft) seat?
- c. Is 316 needed over standard 17-4 PH SST?
- d. What material are the diaphragms?
- e. What material are the gaskets/seals? (Record color; TFE is white.)
- f. What material is the seat?

Step 3. With the information from Steps 1 and 2 above, contact your local KM Sales Representative for the proper identification numbers to use, and the parts costs.

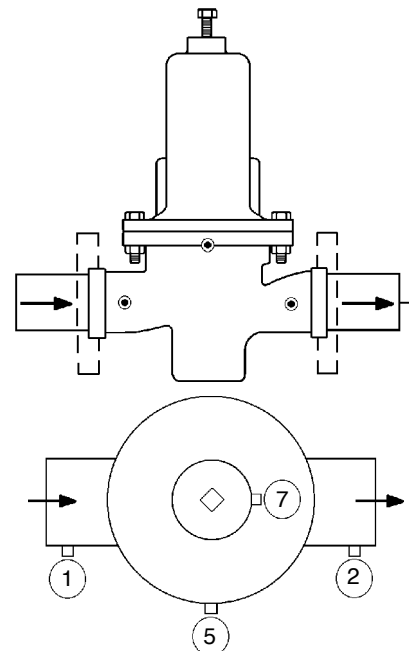
#### **METHOD C - NO PRODUCT CODE AVAILABLE - ASSEMBLED REGULATOR IN SERVICE.**

Step 1. Determine all available information from metal tag using Step 1, Method B.

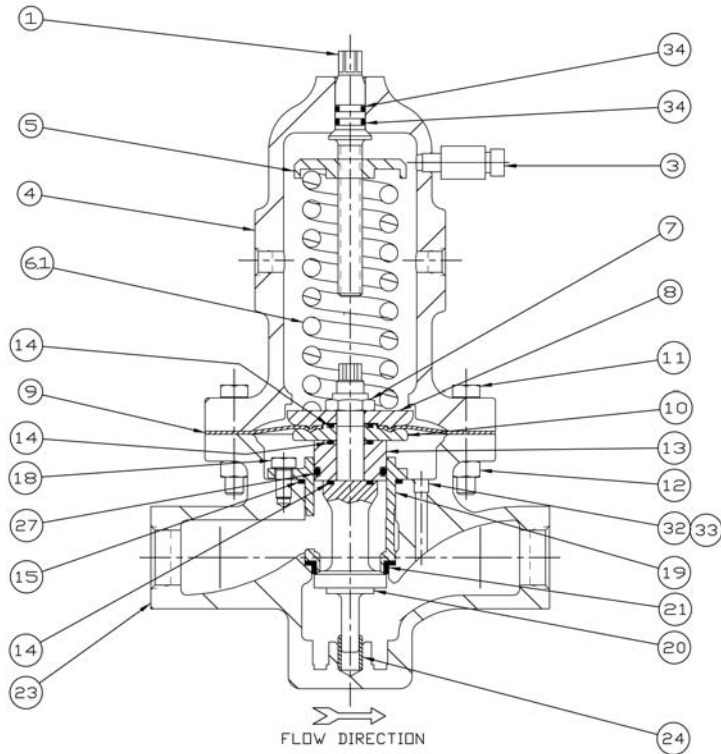
Step 2. Contact your local KM Sales Rep with the above information.

Step 3. Sales Representative will contact the factory to determine the original internal construction. Factory will relay information to the Sales Representative.

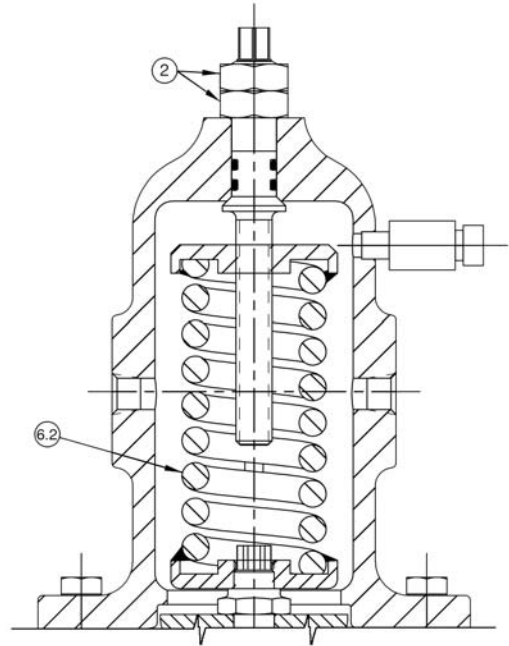
Step 4. Await the Sales Representative's return contact with the proper part numbers and cost.



**Figure 5: Location of Auxiliary Ports**



**Figure 5**  
**Model DA2 - Composition Diaphragm**  
**(w/Item 27.4 O-ring Seal)**



**Figure 6**  
**Model DA7 - Spring Chamber**

Item No.	Description	Item No.	Description
1	Adjusting Screw	17.1	Wiper Washer
2 ‡	Adjusting Screw Lock Nut	18	Cage Cap Screws
4	Spring Chamber	19	Cage
5 †	Spring Follower (Button)	20	Valve Plug
6	Range Spring	21	Seat Ring
6.1	Range Spring for DA2	22	Lower Piston Spring (if supplied)
6.2	Range Spring assembly for DA7	23	Body
7 **	Diaphragm Lock Nut	24	Lower Guide Bushing
8	Upper Diaphragm Pressure Plate	26	Tap Plug (Not Shown)
9	Diaphragm	27 *	Dynamic Side Seal
9.1 **	Diaphragm (Material #1)	27.1	TFE Cap Seal
9.2 **	Diaphragm (Material #2)	27.2	O-ring Energizer/Seal
9.9 **	Diaphragm TFE Cover	27.3	U-cup with Metal Energizer
10 **	Lower Diaphragm Pusher Plate	27.4	O-ring Seal
11	Flange Bolts	27.5	Piston Ring Seal w/Metal Energizer
12	Flange Bolt Nuts	32	Internal Sensing Drilled Plug (Internal Sensing Only)
13	Piston-Guide Bearing	33	Internal Sensing Plug (External Sensing Only)
14	Stem Seals	34	Adjusting Screw O-ring
14.1	Upper Stem Seal	35	Support Plate (Not Shown)
14.2	Middle Stem Seal		
14.3	Lower Stem Seal		
15	Cage Seal		
16	Wiper Seal		

\* Reference Figure 1 for details of Item #27 - Dynamic Side Seal.

\*\* Not utilized on metal diaphragm construction.

‡ Not utilized on DA2.

† Not utilized on DA7.