



ISO Registered Company

MODEL CA4/SA4

CA4 and SA4 - ULTRA HIGH PURITY, PRESSURE LOADED PRESSURE REDUCING REGULATORS

SECTION I

I. DESCRIPTION AND SCOPE

Models CA4/SA4 are pressure reducing regulators used to control downstream (outlet or P2) pressure. Sizes are 3/4" (DN20), 1" (DN25), 1-1/2" (DN40), and 2" (DN50). With proper trim utilization, the unit is suitable for liquid or gaseous service. **(NOTE: This product was formerly identified as a Model C4 or S4; a Model CA4/SA4 and C4/S4 are one and the same product.)**

SECTION II

II. REFERENCES

Refer to Technical Bulletin CA4/SA4-TB for technical specifications of a Model CA4/SA4 regulator.

ABBREVIATIONS

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

SECTION III

CAUTION

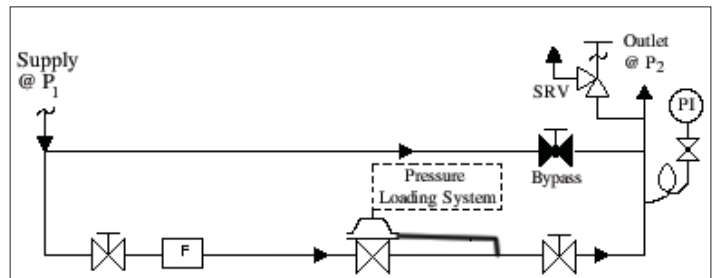
Installation of adequate overpressure protection is recommended to protect the regulator and all downstream equipment from damage in the event of regulator failure.

CAUTION

DO NOT HYDROSTATIC TEST THROUGH AN INSTALLED UNIT; ISOLATE REGULATOR FROM TEST. The "Outlet" rating as printed on the nameplate is the recommended "upper operating limit" for the sensing diaphragm. Higher pressures could cause internal damage. In addition, note on the nameplate that the Inlet and Outlet pressure and temperature ratings are at different levels.

III. INSTALLATION

1. Install per direction of flow arrow indicated on body, or "IN" and "OUT" markings.
2. Regulator may be rotated around pipe axis 360 degrees. For ease of maintenance, the recommended orientation is with the loading chamber (4) upwards.
3. Provide space below, above, and around regulator for removal of parts during maintenance.
4. Install block valves and pressure gauges to provide means for adjustment, operation, bypass, or removal of the regulator. A UHP filter is recommended before inlet to remove typical pipeline debris from entering valve and damaging internal "soft goods", primarily the dynamic seal and valve seat.



Recommended Piping Schematic for Pressure Reducing Station

SECTION IV

IV. PRINCIPLE OF OPERATION

1. When a loading pressure – P_{Load} – is applied to the top side of a diaphragm, the outlet controlled pressure – P_2 – will balance at approximately .90 – .98 of the loading pressure - P_L . (**NOTE:** *Fluctuations in P_1 – Inlet Pressure will cause a deviation in P_2 – Outlet Pressure due to inverse sympathetic ratio effect.*) See Section VIII.
2. Movement occurs as pressure variations register on the diaphragm. The registering pressure is the outlet, P_2 , or downstream pressure. The loading

pressure fluid opposes diaphragm movement. As outlet pressure drops, the loading pressure pushes the diaphragm down, opening the port; as outlet pressure increases, the diaphragm pushes up and the port opening closes.

3. A diaphragm failure will tend to cause the regulator to fall below setpoint. A loss of loading pressure while inlet pressure is imposed will cause the regulator to fail close. A complete diaphragm failure will cause the inlet process fluid to mix with the loading fluid.

SECTION V

V. STARTUP

- 1 Start with the block valves closed.
2. Adjust the loading system pressure control device so that main regulator is trying to be controlled at 0 psig pressure.
3. If it is a “hot” piping system, and equipped with a bypass valve, slowly open the bypass valve to preheat the system piping and to allow slow expansion of the piping. 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.*



CAUTION

Do not walk away and leave a bypassed regulator unattended!

4. Crack open the outlet (downstream) block valve to approximately 10% full open.
5. Slowly open the inlet (upstream) block valve to about 25% open, observing the outlet (downstream) pressure gauge. Determine if the regula-

tor is flowing. If not, slowly increase the loading pressure into the cover dome until flow begins.

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 isn't 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. Develop system flow to a level near its expected normal rate, and reset the regulator set point by increasing the loading pressure to increase outlet pressure, or decreasing the loading pressure to reduce outlet pressure.
10. Reduce system flow to a minimum level and observe pressure set point. Outlet pressure will rise from the set point of Step 9. The maximum rise in outlet pressure on decreasing flow should not exceed the stated upper limit of the range spring by greater than 10%. If it does, consult factory.

SECTION VI

VI. SHUTDOWN

1. Shutoff auxiliary loading pressure source. Close inlet block valve.
2. Allow sufficient time for the line pressure downstream of the inlet block valve to bleed down.

3. Shutoff the outlet block valve.
4. Relieve the trapped upstream and downstream pressure and loading pressure.

5. The regulator may now be disassembled for inspection and preventative maintenance while in-line.

SECTION VII

VII. MAINTENANCE

A. General:

WARNING

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.

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, Product Code, and Serial Number.
3. Refer to Section IX for recommended spare parts. Only use original equipment parts supplied by Cashco for rebuilding or repairing regulators.
4. Owner should refer to owner's procedures for removal, handling, cleaning and disposal of nonreusable parts, i.e. seals, etc.
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:

| Item No. | Dynamic Seal Type | Part Description |
|----------|-------------------|------------------------------|
| 13 | All | Piston-Guide Bearing |
| 15 | All | Cage O-ring Seal |
| 16 | UC | Shim |
| 19 | All | Cage |
| 20 | All | Valve Plug |
| 21 | All | Seat Ring |
| 27 | All | Dynamic Side Seal |
| 27.1 | CP | Cap Seal |
| 27.2 | CP | O-ring Energizer/Seal |
| 27.3 | UC | U-Cup Seal w/Metal Energizer |

6. A detailed view of the dynamic side seal parts is shown in Figure 1; an assembled ITA in Figure 2; and a cross-sectional drawing of the entire regulator is shown in Figure 3.

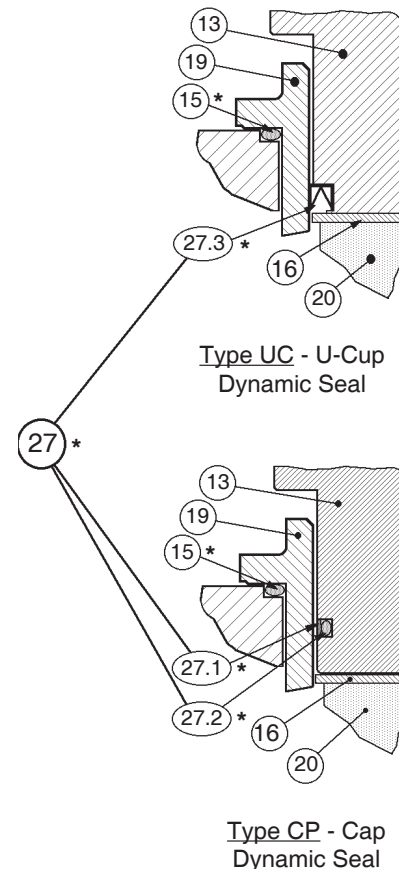


Figure 1: Dynamic Side Seals

B. Main Regulator Disassembly:

1. Shut down system in accordance Section VI.
2. Disconnect loading pressure supply line from loading chamber. Loosen the diaphragm flange bolts (12) and nuts (11) uniformly. Remove all bolting and nuts.
3. Place matchmarks on body (23) and loading chamber (4) flanges. Remove the loading chamber by lifting vertically. **NOTE: Seal (28) may fall out of loading chamber recess.**
4. Remove diaphragm(s) (9) and examine to determine if failed. If diaphragms failed, determine if operating conditions are exceeding designed pressure or temperature limits.
5. Evenly loosen the three cage cap screws (18)

in single revolution increments. The regulator contains a lower return spring (22); the ITA should rise as the cage cap screws (18) are backed out evenly. A downward 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 disengaged. Remove washers (17).

6. Remove the ITA by pulling up on the piston-guide bearing (13). Set ITA aside.
7. Remove the lower return spring (22) from within the body (23).
8. Remove the cage o-ring seal (15).
9. Remove metal C-ring seal (28) from body (23) diaphragm flange groove.
10. Clean all metal parts to be reused according to owner's procedures. **NOTE:** *Regulators are originally supplied with a level of cleanliness equal to Cashco cleaning standard #S-1662. Contact factory for details.*

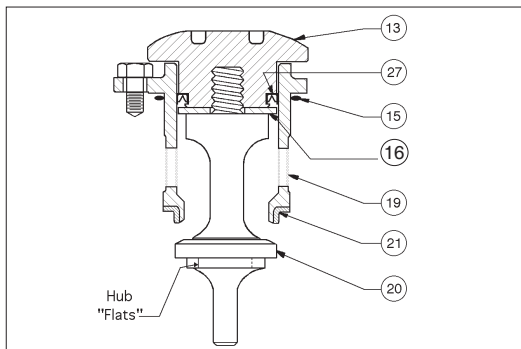


Figure 2: Assembled ITA, with "UC" Dynamic Side Seal

C. Disassembly of the ITA:

1. To Disassemble the ITA (See Figure 2):
 - a. Hold the lower part of the valve plug (20) in a bench vise; grasp in "smooth jaws" directly under plug's (20) seating disc portion on hub "flats" provided. **Do not hold on the machined surface in the plug's (20) spindle area.**
 - b. Using a special double-posted spanner wrench fitting, (to order see NOTE in Section IX Parts Ordering Information), turn the piston-guide bearing (13) CCW to loosen. The piston-guide bearing (13) may be removed by hand after loosening.
 - c. Remove ITA from vise. Pull the valve plug (20) down and out through the cage's (19) bottom opening.

- d. Examine the components (27.1, 27.2, 27.3) of the dynamic side seal (27) mechanism to determine if significant leakage was occurring. If the dynamic side seal shows signs of significant leakage, determine if operating conditions are exceeding pressure, pressure drop, or temperature limits.
- e. Remove dynamic side seal (27) components and discard. Special care should be taken when using "tools" to remove the components to ensure that no scratches are made to any portion of the piston-guide bearing (13) groove.
- f. Remove the shim (16) from within the cage (19).
- g. Remove seat ring (21); examine for signs of leakage. If seat ring shows signs of significant leakage, determine if operating conditions - pressure, pressure drop, or temperature exceed design limits.

2. Clean all metal parts to be reused according to owner's procedures. **NOTE:** *Regulators are originally supplied with a level of cleanliness equal to Cashco cleaning standard #S-1662. Contact factory for details.*

D. Inspection of Parts:

1. Remove and discard the following parts: o-ring (15), diaphragm(s) (9), seals (27, 28), and seat ring (21). 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.
 1. 16 rms finish on its seating surface for tight shutoff.
 2. No major defects on bottom guide spindle.
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 plug (20).

E. Reassembly of the ITA:

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

- a. 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 (27.2). Using thumbs, work the o-ring energizer/seal into the groove of the piston-guide bearing.

NOTE: Use NO lubricants!

2. Position 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 using thumbs to work the cap seal onto the piston-guide bearing. **DO NOT USE A TOOL FOR THIS STEP.** Continue pressing cap seal (27.1) upwards towards the groove until the cap seal "snaps" into the groove of the piston-guide bearing.
3. Insert shim (16) into cage (19) and allow to rest inside the cage (19).
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. 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 until the cap seal (27.1) "slips into" the cage (19). **DO NOT** use tools or lubricant to engage the cap seal (27.1) into the cage (19). **DO NOT** press downward on piston-guide bearing (13) too hard or fast - the cap seal (27.1) may slide out of its groove and become damaged.

- b. Type UC:

1. Position u-cup seal (27.3) over lower circumference of piston-guide bearing (13). Ensure the u-cup seal (27.3) is oriented with the center-open-downwards as shown in Figure 1, as the u-cup seal (27.3) depends upon the P1-Inlet pressure to activate proper sealing action.
2. Insert shim (16) into cage (19) and allow to rest inside the cage (19).
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. Gently apply downward force to press the piston-guide bearing (13) into the cage (19). **DO NOT** use tools, lubricant, or heavy force to engage the u-cup seal (27.3) into the cage (19).

2. Place properly oriented seat ring (21) onto its shoulder at the lower end of cage (19).
3. Completion of ITA Reassembly.
 - a. Insert valve plug (20) upwards through lower end of cage (19) and through the center hole of shim (16).
 - b. Engage valve plug (20) with piston-guide bearing (13) threads and finger tighten.
 - c. Place ITA into a vise with smooth jaws and grasp at hub "flats" location on the valve plug (20) that is not in the "spindle" zone. (See Figure 2.)
 - 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 30 - 50 ft-lbs (41-69 Nm). Do **NOT** allow valve plug (20) to rotate against seat ring (21) during tightening.
 - e. This completes ITA reassembly.

F. Main Regulator Reassembly:

1. Insert the return spring (22) into the body (23).
2. Fit cage O-ring seal (15) into the body (23) groove.
3. With the ITA held manually in the closed position, insert ITA and cage (19) into body (23).
4. Properly align all three cage bolt (18) holes as there is only one proper alignment possible. Apply a downward force to the top of the cage (19) until the ITA is lowered sufficiently to engage the cage bolts (18) with washers (17) into the body (23). Engage all of the cage bolts (18), then tighten the cage bolts in alternating one-half revolution increments to pull down the ITA evenly. **ENSURE THE ITA DOES NOT BECOME WEDGED AS IT IS SLID INTO THE BODY.** Tighten the cage bolts (18) to a torque value of 13-15 Ft-lbs (17.5-20.5 Nm).

5. Units with CTFE or VTFE seat ring (21): Due to the relative "hardness" of the CTFE and VTFE material, to obtain the best possible shutoff it is necessary to generate a "coined" seating chamfer.
6. To coin the seat ring:
 - a. Close-off the outlet connection.
 - b. The level of seat leakage can be quantified at the internal sensing passage.
 - c. Pressurize the regulator's inlet with 50–100 psig (3.5–6.9 Barg) of UHP grade GN2.
 - d. Place a thin, flexible membrane that more than covers the diaphragm flange cavity of the body (23).
 - e. Using a soft-headed mallet (rubber, leather), sharply rap the thin membrane over the top, center end of the piston-guide bearing (13). **(Note: Gas will escape as the plug (20) is momentarily forced off the seat ring (21). Allow sufficient time for leakage pressure on outlet side to bleed-off.)** The hammer rap should be strong enough to "bounce" the plug (20) into the seat ring (21), leaving a "coined" seating chamfer. Repeat a minimum of 2 times. Check after each rap to see if required shut off is obtained.
 - f. After "coining" is complete, remove UHP grade GN2 pressure source, membrane and open outlet.
7. To Install Diaphragm(s):
 - a. Install a new metal C-ring seal (28) into the body (23) diaphragm flange groove.
 - b. Center diaphragm(s) (9) onto body's (23) diaphragm flange.
8. Aligning matchmarks and bolt holes, place loading chamber (4) on body (23).
9. Install all flange bolts (12) and nuts (11) with nameplate (99) located under one bolt head. Hand-tighten nuts (11).
10. Evenly tighten body bolting (11,12) using an alternating cross pattern in one revolution increments. Tighten to the following torque value: All body sizes: 30-35 Ft-lbs (41-47 Nm).

G. Pressure Testing:

1. If a high static pressure test is performed, pressure must be applied to all three, the loading chamber, the inlet and the outlet of body at the same level.

DO NOT HIGH STATIC PRESSURE TEST THE BODY WITHOUT LOADING CHAMBER PRESSURIZED. NOT ADHERING WILL DO PHYSICAL DAMAGE TO INTERNALS THAT COULD RENDER THE UNIT INOPERABLE.

2. Seat Leakage Test.
 - a. Release all loading pressure from loading chamber.
 - b. Pressurize inlet to 50 psig (3.5 Barg) with UHP grade GN2.
 - c. Tube outlet to a beaker of water to observe number of escaping gas bubbles. A steady flow of gas bubbles (e.g., 20 bubbles / minute or greater) is excessive leakage.
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. **NOTE: Regulators are not tight shutoff devices. Even if pressure builds up beyond set point, a regulator may or may not develop bubble tight shutoff.**

NOTE: If disassembly and re-testing is required, the metal C-ring seal (28) MUST be replaced for each disassembly/reassembly.

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. Oversized regulator | B. Check actual flow conditions; resize regulator for minimum and maximum flow; if necessary, replace with smaller regulator. |

2. Downstream pressure will not reach desired setting.

| Possible Causes | Remedies |
|---|--|
| A. Supply pressure is down (confirm on 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. |

3. Diaphragm continually breaks.

| Possible Causes | Remedies |
|---|---|
| A. Differential pressure across diaphragm may have exceeded limits. (See Table 1 in Tech Bulletin). | A. Be aware of limits as well as where the various pressures are acting. Install pressure safety equipment as necessary. Pressure limit for outlet is <u>lower</u> than the limit of the inlet. |

4. Leakage at diaphragm flange.

| Possible Causes | Remedies |
|---|--|
| A. Body bolts not torqued properly. | A1. Torque to proper value (see Section VII, F.13). A2. Failed C-ring seal. Replace seal. |
| B. Pressures at diaphragm may be too high for regulator design. | B. Consult factory. |

5. Leakage across seat.

| Possible Causes | Remedies |
|--|--|
| A. Contamination (debris) in regulator. | A1. Remove internals, clean and if necessary, replace sealing seating elements. * A2. Install UHP filter at inlet. |
| B. Oversized regulator; 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 both potential internal leak paths. | |
| C. Failure due to wear. | C1. Replace seat. C2. Replace all internal trim due wear. |
| D. Improper installation. | D1. Failure to "coin" CTFE or VTFE seat; disassemble and "coin". D2. Improper re-assembly. Disassemble and re-assemble per instructions within IOM. |

SECTION IX

IX. ORDERING INFORMATION

NEW REPLACEMENT UNIT VS PARTS "KIT" FOR FIELD RE

To obtain a quotation or place an order, please retrieve the Serial Number and Product Code that was stamped on the metal name plate and attached to the unit. This information can also be found on the Bill of Material ("BOM"), a parts list that was provided when unit was originally shipped. (Serial Number typically 6 digits). Product Code typical format as follows: (last digit is alpha character that reflects revision level for the product).

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NEW REPLACEMENT UNIT:

Contact your local Cashco, Inc., Sales Representative with the Serial Number and Product code. With this information they can provide a quotation for a new unit including a complete description, price and availability.

PARTS "KIT" for FIELD REPAIR:

Contact your local Cashco, Inc., Sales Representative with the Serial Number and Product code. Identify the parts and the quantity required to repair the unit from the "BOM" sheet that was provided when unit was originally shipped.

NOTE: *Those part numbers that have a quantity indicated under "Spare Parts" in column "A" reflect minimum parts required for inspection and rebuild, - "Soft Goods Kit". Those in column "B" include minimum trim replacement parts needed plus those "Soft Goods" parts from column "A".*

If the "BOM" is not available, refer to the cross-sectional drawings included in this manual for part identification and selection.

A Local Sales Representative will provide quotation for appropriate Kit Number, Price and Availability.

CAUTION

Do not attempt to alter the original construction of any unit without assistance and approval from the factory. All purposed changes will require a new name plate with appropriate ratings and new product code to accommodate the recommended part(s) changes.

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.

| Double-Posted Spanner Wrench Fitting | |
|--------------------------------------|-------------------|
| Body Size | Part Number |
| All | A96-75-9-P0459-00 |

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NOTES

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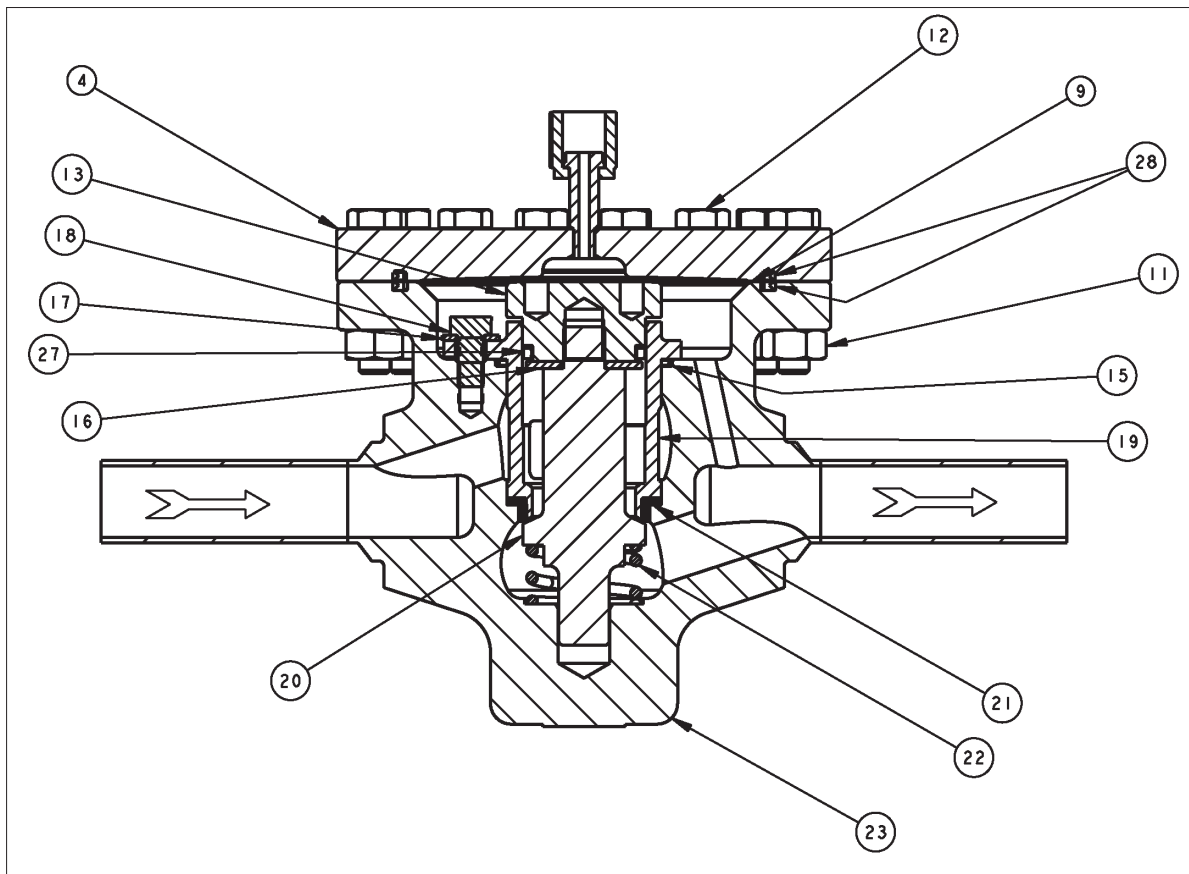


Figure 3:
Model CA4/SA4

| <u>Item No.</u> | <u>Description</u> | <u>Item No.</u> | <u>Description</u> |
|-----------------|----------------------|-----------------|-------------------------------|
| 4 | Loading Chamber | 23 | Body |
| 9 * | Diaphragm | 27 * | Dynamic Side Seal |
| 11 | Flange Bolt Nuts | 27.1 * | Cap Seal |
| 12 | Flange Bolt | 27.2 * | O-ring Energizer |
| 13 † | Piston-Guide Bearing | 27.3 * | U-Cup Seal w/ Metal Energizer |
| 15 * | Cage O-ring Seal | 28 * | Diaphragm Seal |
| 16 | Shim | | |
| 17 | Cage Washer | | |
| 18 | Cage Cap Screw | | |
| 19 | Cage | | |
| 20 | Valve Plug | | |
| 21 * | Seat Ring | | |
| 22 | Return Spring | | |

* Recommended Repair Parts
 † It is recommended that a special double-posted spanner wrench fitting be ordered for use in the maintenance of the ITA. To order, see NOTE in Section IX, Parts Ordering Information.

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