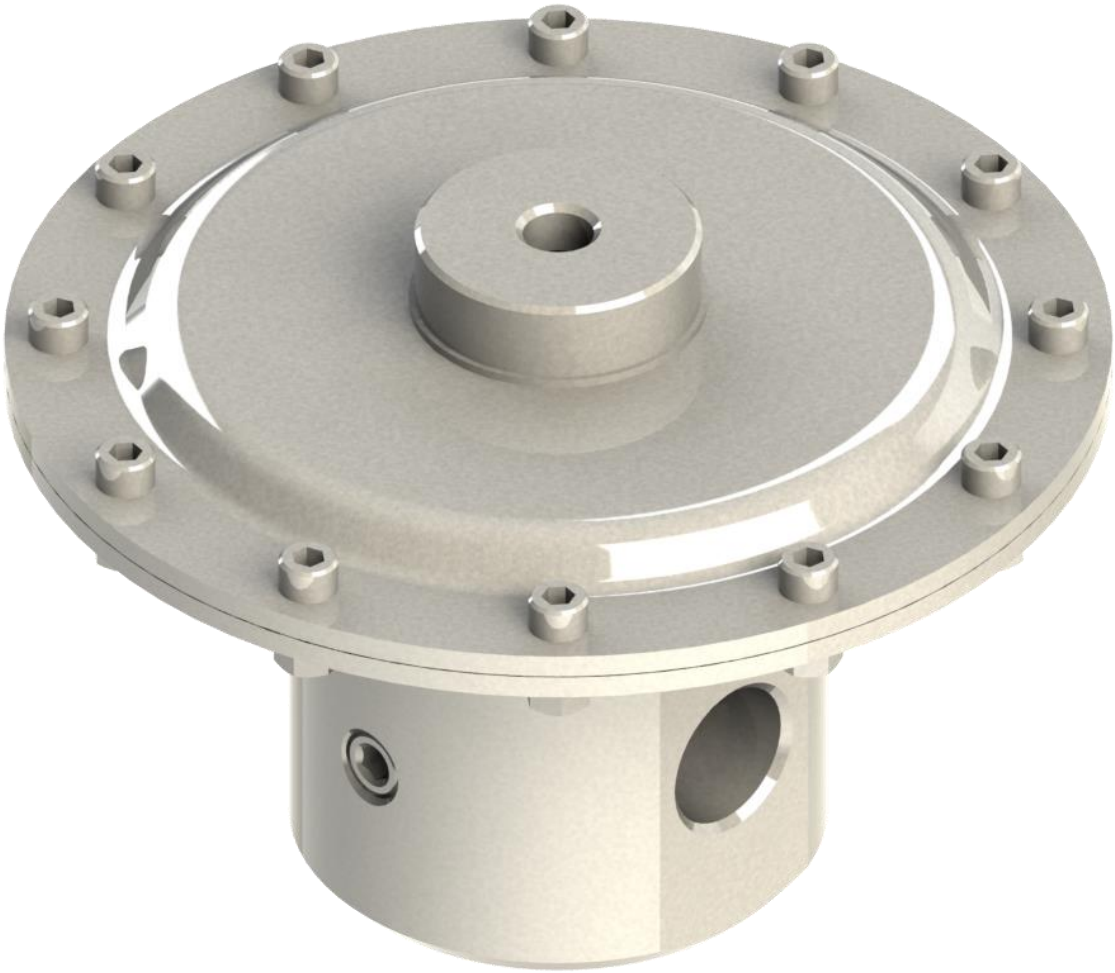
RA4/6/8 Pressure-Reducing Ratio Regulator
User Manual



Read the complete manual before installing and using the regulator.

Safe Product Selection

When selecting a product, the total system design must be considered to ensure safe, trouble-free performance. Function, material compatibility, adequate ratings, proper installation, operation, and maintenance are the responsibilities of the system designer and user.

WARNING

- Users must be trained and equipped for the handling, use, and servicing of pressure products and systems.
- Users must contact their gas or liquid supplier for specific safety precautions and instructions.
- Gaseous media should be free of excessive moisture to prevent icing at high flow.
- Always wear the appropriate protective clothing, including safety glasses, gloves, etc., if required.
- Follow the applicable safety and maintenance procedures.
- Obey specific local regulations.
- Do not exceed the maximum inlet and outlet pressure rating of the product or its accessories.
- Operate within the temperature limits and any other conditions specified for the product.
- Do not drop or damage the product in any other way. This may negatively affect the performance of the product which can cause the product to malfunction.
- Venting fluids and gases can be dangerous. Vent to a safe environment away from people. Ensure adequate ventilation.

Contents

Introduction

Overview

- The RA series are pneumatic-loaded pressure-reducing ratio regulators designed for the regulation of high pressure, gases and liquids.
- For pressure and temperature rating information refer to the *Pressure Regulators, RHPS Series* catalog, MS-02-430. Note that seat seal material selection can limit the regulator operational pressure at elevated temperatures.

WARNING
Check that system pressures and temperatures do not exceed those stated on the regulator as this could result in product failure.

Standard Features

- Bolted construction
- Stainless steel as standard
- Fully serviceable
- Diaphragm controlled
- Piston sensing
- Balanced poppet
- Self-venting

Additional Options

The regulator is available with the following options:

Gauge connections

WARNING
The self-venting feature is for venting off excessive outlet pressure under zero flow conditions. It is not intended to be used as a safety relief valve.

Oxygen Service

- For more information about hazards and risks of oxygen enriched systems see the *Swagelok Oxygen System Safety* technical report (MS-06-13).
- Cleaning and packaging to ensure compliance with product cleanliness requirements stated in ASTM G93 Level C is available. Refer to the *Pressure Regulators, RHPS Series*, catalog, MS-02-430, for additional information.

Installation

CAUTION
Do not use the regulator as a shutoff device. A level of leakage across the regulator seat can occur during normal operation.

Points of Attention Before Installation

This regulator can be equipped with a variety of different options. Before installing the regulator you should fully understand the functions of the supplied options and the suitability of your particular regulator for the intended application.

- The preferred mounting position of the regulator is horizontal with the dome facing upwards per Fig 1. Alternative mounting positions may increase the risk of component wear.
- It may be necessary to remove the regulator from the system during maintenance or service. Ensure that this is possible.
- The regulator is suitable for gases and liquids. Ensure compatibility between the regulator's materials of construction and the system media.
- Swagelok recommends connecting a vent line to the self-vent port when the process media is hazardous or toxic.

Installation

- Verify that the regulator, the connections, and its accessories are undamaged.
- Verify that the regulator and its accessories are suitable for the system operating pressure and temperature and have suitable connections.
- At the time of delivery any gauge ports may be plugged with blind fittings. Remove these and connect gauges if desired.
- If inlet/outlet fittings are being used, assemble them to the regulator, per the manufacturer's instructions, prior to installing the regulator in the system.

CAUTION
Ensure all upstream tubing/pipework is clean and free from debris. Any swarf, lint, wire, etc. may damage the regulator, resulting in a seat leak.

- Verify the flow direction of the system and mount the regulator accordingly.
- Securely make the appropriate connections to the regulator in accordance with the procedures recommended by the connection manufacturer.
- Ensure that the tubing/pipework and the regulator are adequately supported and that there is no stress on the connections.
- Upstream and downstream shutoff valves should be installed in the system to facilitate servicing, maintenance, and troubleshooting of the regulator.

CAUTION
Do not plug the vent port. Vented pressure would become trapped and could be released upon disassembly. The port must be open to atmosphere either directly or via a vent line.

Dome Pressure Control

The dome pressure of the regulator controls the outlet pressure. There are several methods available for supplying and controlling the dome pressure.

- **External dome control**. In this setup the dome pressure is supplied from an independent source, such as a cylinder or main supply (Fig 1). The best performance will be achieved by allowing a small flow to continuously pass through the pilot regulator.
- **Electronic control.** In this setup an electronic pilot regulator, fed from an independent source, is used in conjunction with a pressure transducer to directly control the dome pressure (Fig 2).

NOTICE

The outlet pressure of the regulator is sensitive to changes in the dome pressure. Every change to the dome pressure will result in an outlet pressure change equal to the dome pressure change, multiplied by the ratio of the regulator. For example; with a 1:70 ratio regulator a rise of 14.5 psig (1 bar) of the dome pressure will result in a rise of 1015 psig (70 bar) of the outlet pressure.

External Dome Control Schematic

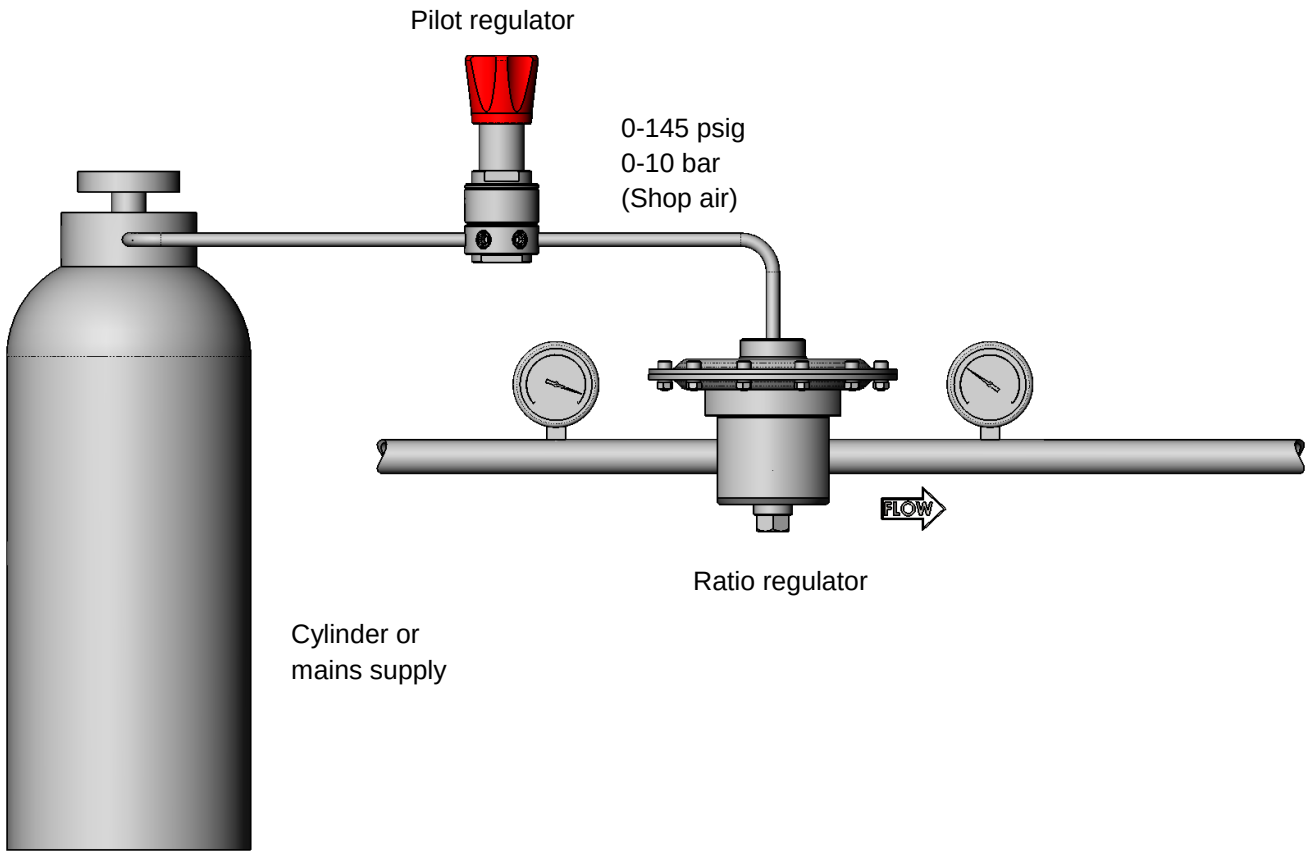


Fig 1

Electronic Control Schematic

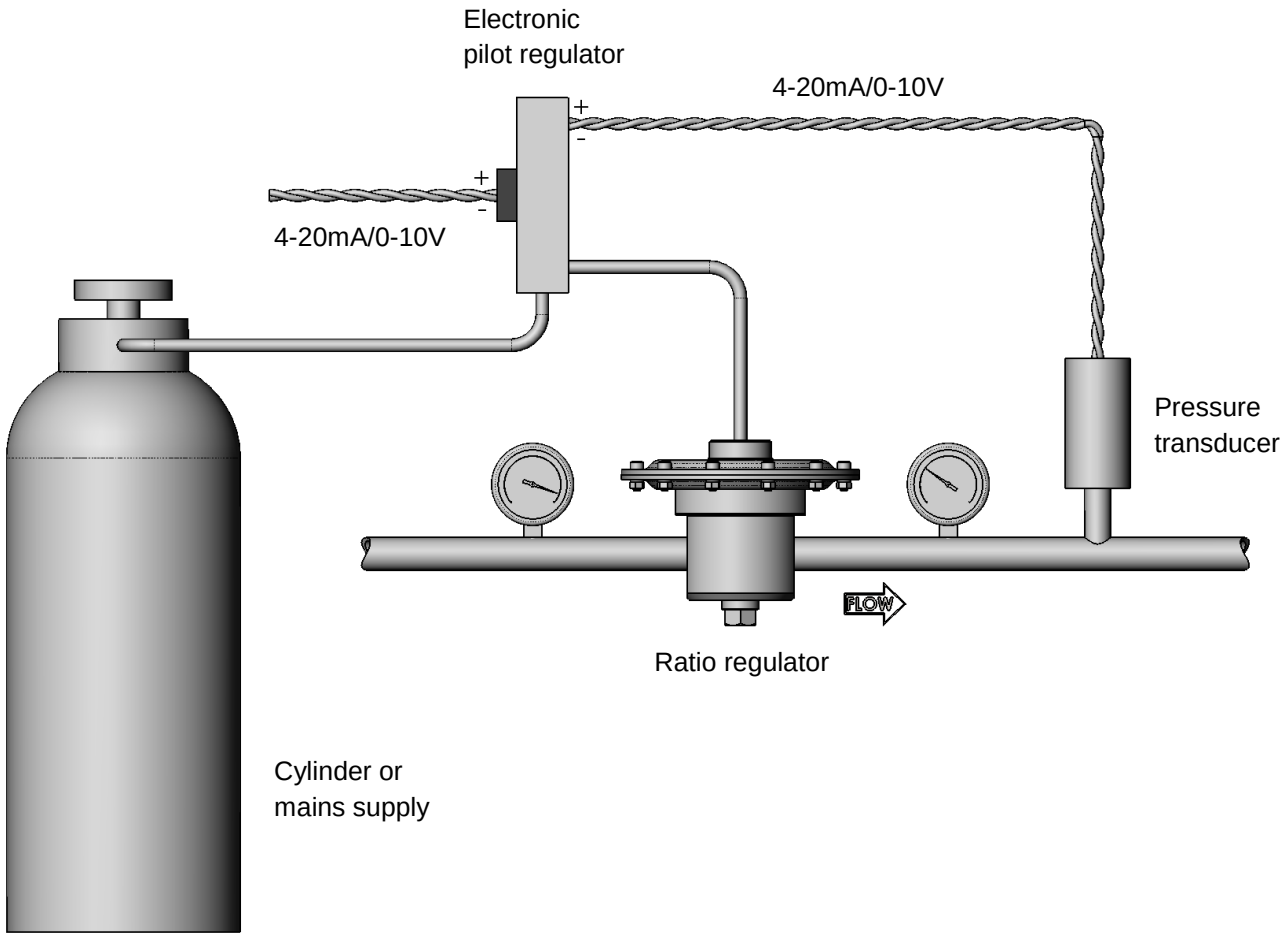


Fig 2

Operation

Required Tools for Operation

No tools are required for changing the set pressure on a standard regulator.

Points of Attention Before Operation

CAUTION
The product can be hot or cold, depending on the environmental temperature and the process media temperature. Take the necessary precautions before operating or touching the product.

- Stopping flow through the regulator by closing a downstream shutoff valve may result in a rise in outlet pressure above the set pressure. This is usually referred to as "**lock-up**". This phenomenon does not indicate a problem with the regulator.
- A decrease of the flow rate may result in a rise of the outlet pressure. An increase of the flow rate may result in a fall of the outlet pressure. This is usually referred to as "**droop**". This phenomenon does not indicate a problem with the regulator.
- A decrease of the inlet pressure may result in a rise of the outlet pressure. An increase of the inlet pressure may result in a fall of the outlet pressure. This is usually referred to as "**inlet dependency**" or "**Supply Pressure Effect (SPE)**". This phenomenon does not indicate a problem with the regulator.

Adjusting the Set Pressure

- The set pressure is the desired outlet pressure of the regulator.
- To set the regulator, ensure that the supply pressure is greater than the required set pressure but does not exceed the maximum rating of the regulator.
- Excess outlet pressure will self vent through the port in the side of the regulator.

1. Ensure there is zero pressure in the dome.
2. Steadily open the supply valve to allow inlet pressure to the regulator.
3. The set pressure is controlled by altering the dome pressure. Increasing the dome pressure raises the set pressure while decreasing the dome pressure lowers the set pressure.

NOTICE
The outlet pressure of the regulator is sensitive to changes in the dome pressure. Every change to the dome pressure will result in an outlet pressure change equal to the dome pressure change, multiplied by the ratio of the regulator. For example; with a 1:70 ratio regulator a rise of 14.5 psig (1 bar) of the dome pressure will result in a rise of 1015 psig (70 bar) of the outlet pressure.

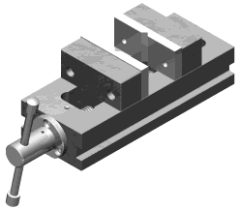
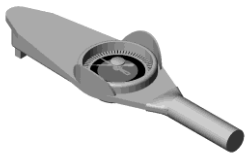
4. To obtain the most accurate set pressure, final adjustment must be made while **increasing** the set pressure. If the desired outlet pressure is exceeded, reduce the pressure below this value then increase up to it.
5. Fully open any downstream valve to allow full flow during operation.
6. Once under flow conditions make any final set pressure adjustments per steps 3 and 4 if required.

Maintenance

WARNING
Incorrect or improper repair or servicing of this product can cause serious personal injury and property damage.

- All repairs, servicing, and testing of this product must be performed by competent personnel.
- Following any maintenance of the regulator, it is recommended that the product be tested for operation and leakage.
- The product should be checked periodically for proper and safe operation. It is the user's sole responsibility to determine the frequency of maintenance based on the application.
- To reduce maintenance related system downtime to a minimum, either during commissioning or normal operation, Swagelok recommends having maintenance kits readily available on site. The need for maintenance kits is particularly important during the commissioning phase of a system installation due to residual assembly debris remaining in the system. Such debris can cause a seat leak in the regulator, resulting in components needing to be replaced.

Required Tools for Maintenance

Smooth-jawed vise		Calibrated torque wrench up to 52 lbf·ft (70 N·m)	
24 mm socket		Lubricant (included in kit) WL-8① Krytox® 240 AC②	
10 mm open-ended wrench		Liquid leak detector	
5 mm hex drive 6 mm hex drive			

① Standard cleaned assemblies

② ASTM G93 or SC11 cleaned assemblies

Table 1

Points of Attention Before Removal from the System

- Swagelok recommends removing the regulator from the system for servicing and maintenance.
- Follow all local system safety and maintenance procedures when removing the regulator.

WARNING

Before removing a regulator from the system, to avoid personal injury, you must:

- **Depressurize the system and dome.**
- **Purge the system to remove any residual system media left in the regulator.**
- **Always vent to a safe environment away from people and ensure there is adequate ventilation.**

CAUTION

Check if the process media is hazardous or toxic. If required, take the necessary safety precautions to ensure a safe workspace and your personal safety.

CAUTION

The product can be hot or cold, depending on the environmental temperature and the process media temperature. Take the necessary precautions before operating or touching the product.

Removal from the System

1. Isolate the regulator from all pressure sources by closing all appropriate upstream valves in the system.
2. With the pilot regulator set, open all appropriate downstream valves to allow pressure to vent from the regulator.

WARNING

Ensure all pressure on the inlet, outlet and dome has been fully vented. The accidental release of residual trapped pressure can cause serious personal injury.

3. Ensure that any external dome feed or vent line connection is disconnected.
4. Disconnect and remove the regulator from the system.

Assembly Reference Data

Item	Component Name	Kit Type(s)	Torque lbf·ft (N·m)	Recommended Lubrication (included in kit per Table 1)
1	Body plug	C1, C2	37 (50)	Lubricate threads
2	Body plug backup ring	B1, B2, C1, C2		
3	Body plug O-ring	B1, B2, C1, C2		
4	Poppet spring	C1, C5		
5	Poppet backup ring	A1, B1, B2, C1		
6	Poppet O-ring	A1, B1, B2, C1		Lubricate
7	Poppet	A1, B1, C1		
8	Seat	A1, A2, B1, C1		
9	Seat O-ring	A1, A2, B1, B2, C1		
10	Body	N/A		
11	Piston plate O-ring	B1, B2, C1, C3		
12	Relief seat	A1, A2, B1, B2, C1		
13	Piston	C1, C3		
14	Piston O-ring	B1, B2, C1, C3		Lubricate
15	Piston backup ring	B1, B2, C1, C3		
16	Nut	E1		
17	Washer	E1		
18	Piston plate	C1, C3		
19	Washer	N/A		
20	Cap screw	N/A	18 (25)	Lubricate threads
21	Diaphragm plate	C1		
22	Diaphragm support	B1, B2, C1, C3		
23	Diaphragm	B1, B2, C1, C3		
24	Dome	N/A		
25	Cap screw	E1	11 (15)	Lubricate threads
26	Relief seat O-ring	A1, A2, B1, B2, C1		
27	BSP blind plug O-Ring	B1, B2, C1		
28	Blind plug	N/A	NPT: 15 (20)	Wrap threads in 2 layers of PTFE tape. Lubricate tape.
			BSP: 26 (35)	Lubricate threads

Table 2

For more information on RHPS series maintenance kits, refer to the *Pressure Regulators, RHPS Series*, catalog, MS-02-430.

RA4/6/8 Series, Exploded View

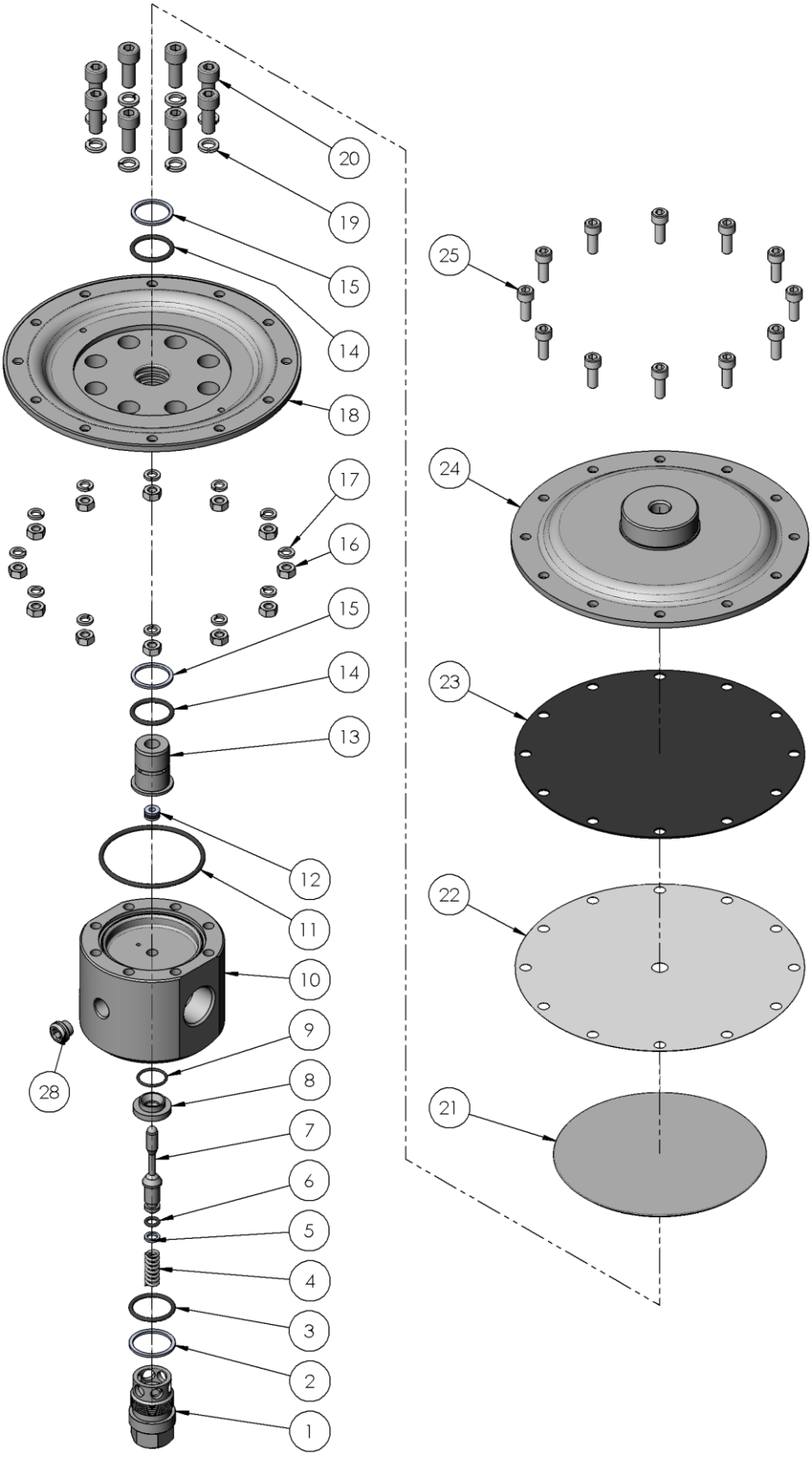


Fig 3

RA4/6/8 Series, Section View

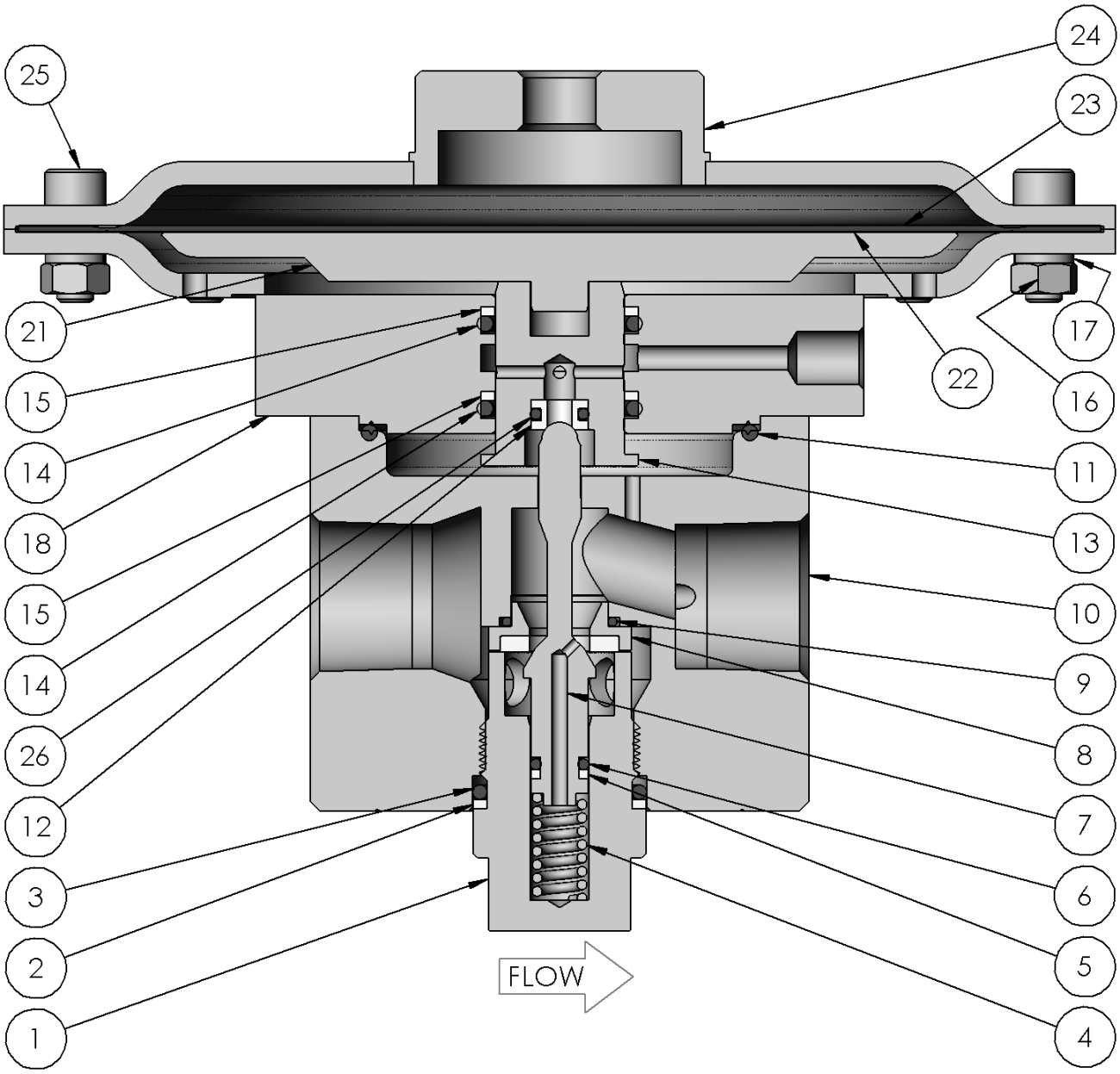


Fig 4

Disassembly

- The following instructions describe how to fully disassemble the regulator for the purposes of maintenance and repair.
- Note that not all components listed appear in all regulator configurations.
- Only disassemble the regulator as far as is required to replace the components supplied in the maintenance kit.
- Discard all components being replaced.

1. Remove the body plug (1), poppet spring (4), poppet (7), and seat (8).
2. Remove the O-ring (3) and, if present, backup ring (2) from the body plug (1).
3. Remove the O-ring (6) and backup ring (5) from the poppet (7).
4. Remove the O-ring (9) from the seat (8).
5. Remove the cap screws (25) to remove the dome (24), diaphragm (23), diaphragm support (22), and diaphragm plate (21).
6. Remove the cap screws (20) to remove the piston plate (18).
7. Remove the piston (13), piston O-rings (14), and piston backup rings (15) from the piston plate (18).
8. Remove the relief seat (12) from the piston (13).

Points of Attention Before Reassembly

- Visually inspect all components for abnormal wear or damage. Replace components in case of doubt.
- All parts must remain clean and undamaged before starting assembly.
- Maintenance kit components will be supplied preassembled where practicable to aid reassembly.
- Swagelok recommends replacing all O-rings removed during disassembly.
- Swagelok recommends that dynamic O-rings should be lightly lubricated per Table 2.

NOTICE

All threaded components must be lightly lubricated per Table 2 before reassembly to avoid galling of threads.

Reassembly

1. Secure the body (10) in a vise.
2. Fit the body plug O-ring (3) and, if present, body plug backup ring (2) onto the body plug (1). Ensure their orientation is correct per Fig 4.
3. Fit the seat O-ring (9) onto the seat (8).
4. Insert the seat (8) into the body (10). The poppet valve (7) can be used as an insertion tool if required. Take care not to damage the seat (8) and poppet (7) if doing this.
5. Fit the O-ring (6) and backup ring (5) onto the poppet (7). Ensure their orientation is correct per Fig 4.
6. Lightly lubricate the poppet O-ring (6) then stack the poppet (7) and poppet spring (4) through the seat (8).
7. Lightly lubricate the body plug (1) threads and assemble over the spring (4) into the body (10). Torque to 37 lbf·ft (50 N·m) while ensuring the body plug O-ring (3) is not pinched.
8. Fit the relief seat O-ring (26) over the relief seat (12) then insert the seat into the piston (13). Ensure the chamfered edge of the seat is facing out.
9. Insert the piston O-rings (14) and backup rings (15) into the piston plate (18). Ensure their orientation is correct per Fig 4.
10. Lightly lubricate the piston O-rings (14) then insert the piston (13) into the piston plate (18).
11. Place the piston plate O-ring (11) into the body (10) then fit the piston plate assembly, aligning the vent port as desired.
12. Lubricate the threads of the cap screws (20). Secure the piston plate (18) to the body (10) with the cap screws (26) and washers (25). Torque to 18 lbf·ft (25 N·m).
13. Place the diaphragm plate (21) on to the piston (13).
14. Place the diaphragm support (22) then the diaphragm (23) onto the diaphragm plate (21).
15. Lubricate the threads of the cap screws (25). Fit the dome (24) onto the diaphragm (23) and secure with the cap screws (25), washers (17), and nuts (16). Torque to 11 lbf·ft (15 N·m).

Testing

Swagelok recommends that the regulator be tested for seat and shell leakage to atmosphere. A well performing regulator will not show any indication of leaking. If any evidence of a leak is identified this must be rectified. Any damaged components must be replaced.

Seat Leak Test

1. Ensure there is sufficient supply pressure to the regulator to be able to perform the tests.
2. Ensure that there is zero pressure in the dome.
3. Maintain an inlet pressure of approximately 14.5 psig (1 bar) on the regulator and close the downstream shutoff valve.
4. Monitor the outlet pressure. An increase in pressure over time indicates a seat leak.
5. Repeat the procedure with the highest inlet pressure applicable for the regulator and system.

Shell Leak Test

1. Maintain an inlet pressure of approximately 29 psig (2 bar) on the regulator and close the downstream shutoff valve.
2. Increase the outlet pressure to approximately 14.5 psig (1 bar).
3. Using liquid leak detector, check for bubbles at the dome to piston plate interface, piston plate to body interface body plug to body interface and the self-vent port.
4. Repeat the procedure with the highest inlet and outlet pressure applicable for the regulator and system.

Troubleshooting

Symptom	Cause	Remedy
The outlet pressure creeps up, without adjusting dome pressure.	A damaged poppet and/or seat.	Replace the poppet and/or seat.
Leakage around the body plug.	A damaged O-ring.	Replace the O-ring.
Leakage around the piston plate.	A damaged O-ring.	Replace the O-ring.
Leakage between the piston plate and the dome.	A damaged diaphragm.	Replace the diaphragm.
	Insufficient torque on the cap screws.	Tighten the cap screws per Table 2.
Controlled pressure drops off sharply even when the flow is within regulator capabilities.	The system filter element is clogged.	Replace the system filter.
The required outlet pressure cannot be reached.	The inlet pressure to the regulator is not high enough.	Ensure that the inlet pressure to the regulator is equal to or greater than the desired set pressure.
The outlet pressure rises too much when going from a dynamic to a static situation.	There is too much flow in the dynamic situation.	A larger regulator or parallel regulator is required. Review application flow capacity and contact your local authorized sales and service center.
The outlet pressure has changed without adjusting the dome pressure.	Changes to the inlet pressure may result in changes to the outlet pressure.	Maintain a constant inlet pressure to the regulator. See “**Points of Attention Before Operation**” about **dependency**.
	Changes to the flow may result in changes to the outlet pressure.	Maintain a constant flow through the regulator. See “**Points of Attention Before Operation**” about **droop**.

Table 3

Warranty Information

Swagelok products are backed by The Swagelok Limited Lifetime Warranty.
For a copy, visit swagelok.com or contact your authorized Swagelok representative.

July 2018, RevB
MS-CRD-0177