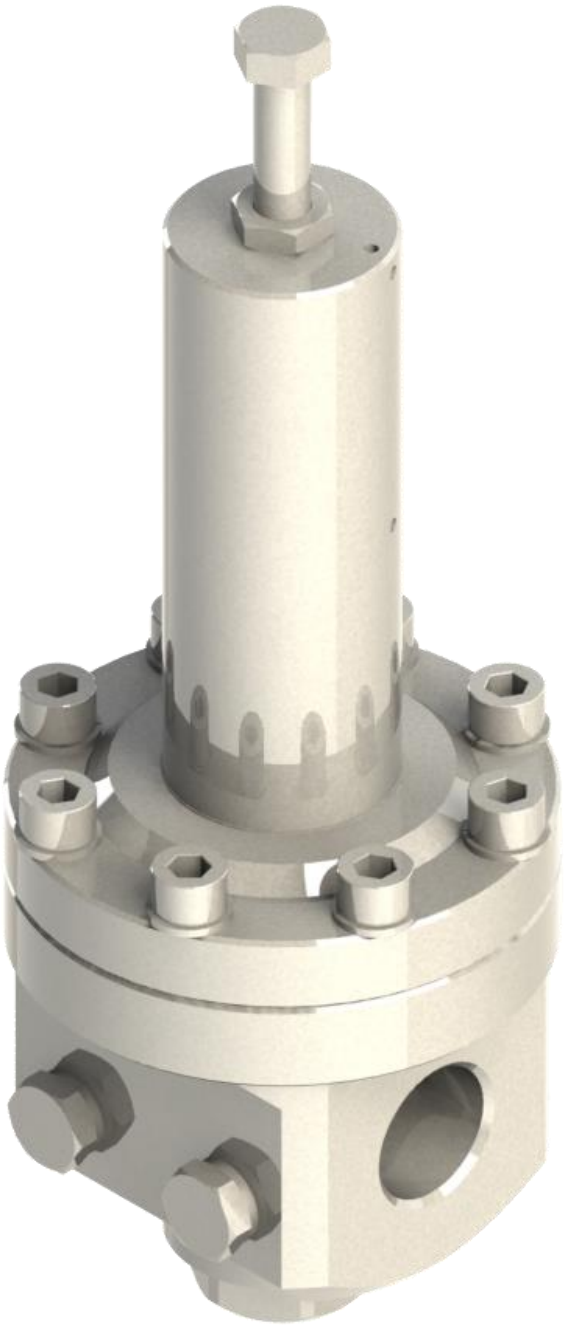
# BS(H)10/15 Back-Pressure Regulator User Manual



**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 BS(H)10 and BS(H)15 series are spring loaded back pressure regulators designed for the regulation of high pressure, high flow gases, and liquids.
- For pressure and temperature rating information refer to the *Pressure Regulators, RHPS Series* catalog, MS-02-430.

**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 or piston sensing
- Balanced poppet①

## Additional Options

The regulator is available with the following options:

Anti-tamper

## 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.

① BSH10 control ranges 5-8 and BSH15 series only

# 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 and connections. 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 spring housing facing upwards per Fig 2. 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.

## Installation

- Verify that the regulator, its connections, and any accessories are undamaged.
- Verify that the regulator and any 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.

# Operation

## Required Tools for Operation

- A 19 mm open-ended wrench is required for changing the set pressure on a standard regulator.
- A 19 mm and 32 mm open-ended wrench are required for anti-tamper regulators.

## 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.**

- Once the regulator closes, after being open to flow, the inlet pressure may fall a little under the set pressure. This is usually referred to as **"reseat pressure"**. This phenomenon does not indicate a problem with the regulator.
- An increase in the flow may result in a rise of the set pressure. A decrease in the flow may result in a fall of the set pressure. This is usually referred to as **"accumulation".** This phenomenon does not indicate a problem with the regulator.
- An increase of the outlet pressure may result in a fall of the set pressure. A decrease of the outlet pressure may result in a rise of the set pressure. This is usually referred to as **"dependency"**. This phenomenon does not indicate a problem with the regulator.

## Adjusting the Set Pressure

- The set pressure is the desired upstream 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.
- The regulator must be able to flow in order to adjust the set pressure.

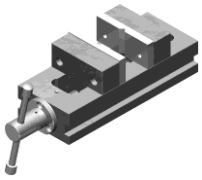
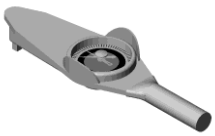
1. Open any downstream valve.
2. To operate the regulator, turn the adjusting screw clockwise to increase the set pressure. Turn the adjusting screw counterclockwise to reduce the set pressure.
3. Partially open the supply valve to allow the regulator to sense the inlet pressure with minimal flow.
4. Close the supply valve and verify the set pressure by measuring the regulator inlet pressure.
5. Make adjustments to the set pressure as required and repeat steps 3 and 4
6. To obtain the most accurate set pressure, final adjustment must be made while **increasing** the set pressure. If the desired set pressure is exceeded, reduce the pressure below this value then increase up to it.
7. Once the regulator is set, the supply pressure can be adjusted to its normal working value.
8. Open the supply valve fully to allow full flow during operation.
9. When in operation make any final set pressure adjustments 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 |  | Seat insertion tool:<br>RHPS-10-SEAT-TOOL<br>RHPS-15-SEAT-TOOL |  |
| 36 mm socket<br>17 mm socket① |  | Calibrated torque wrench up to 52 lbf·ft (70 N·m) |  |
| 30 mm crows foot② |  | Lubricant (included in kit):<br>WL-8③<br>Krytox® 240 AC④ |  |
| 8mm hex drive |  | Liquid leak detector |  |
| C-ring pliers |  | | |

① Diaphragm and BS(H)15 control range 5 regulators only
② Piston regulators only
③ Standard cleaned assemblies
④ 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.**
- **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 regulator set to the open position (i.e. adjusting screw backed off fully counterclockwise) , open all appropriate downstream valves to allow pressure to vent from the regulator.

**WARNING**

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

3. 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 O-ring | B1, B2, C1, C2 | | |
| 3 | Seat | A1, B1, C1 | BS(H)10: 7 (10)<br>BS(H)15: 11 (15) | Lubricate threads |
| 4 | Seat O-ring | A1, B1, B2, C1 | | |
| 5 | Body | N/A | | |
| 6 | Poppet O-ring | A1①, A2①, B1, B2, C1, C2② | | Lubricate |
| 7 | Poppet backup ring | A1①, A2①, B1, C1 | | |
| 8 | Poppet | A1, A2, B1, C1 | | Lubricate threads |
| 9 | Body plate | C1 | | |
| 10 | Retaining ring | C1 | | |
| 11 | Clamp plate | C1 | | |
| 12 | Diaphragm | C1, C3 | | |
| 13 | Clamp plate O-ring | B1, B2, C1 | | |
| 14 | Bottom spring guide | C1 | | |
| 15 | Poppet washer | C1 | | |
| 16 | Poppet nut | C1 | 9 (12) | |
| 17 | Piston | C1, C3 | | |
| 18 | Piston plate O-ring | B1, B2, C1, C3 | | |
| 19 | Piston O-ring | B1, B2, C1, C3 | | Lubricate |
| 20 | Piston plate | C1, C3 | | |
| 21 | Piston screw | C1 | 11 (15) | Lubricate threads |
| 22 | Overtravel spring | C1, C5 | | |
| 23 | Piston backup ring | B1, B2, C1, C3 | | |
| 24 | Set spring | C1, C4 | | |
| 25 | Upper spring guide | C1 | | Lubricate central recess |
| 26 | Ball | C1 | | Lubricate |
| 27 | Spring housing | N/A | | |
| 28 | Washer | E1 | | |
| 29 | Cap screw | E1 | 22 (30) | Lubricate threads |
| 30 | Set screw nut | D1 | | |
| 31 | Adjusting screw | D1 | | Lubricate threads |
| 32 | Anti-tamper cover O-ring | D1 | | |
| 33 | Anti-tamper cover | D1 | | Lubricate threads |
| 34 | Blind Plug | N/A | NPT: 15 (20) | Wrap threads in 2 layers of PTFE tape. Lubricate tape. |
| | | | BSP: 26 (35) | Lubricate threads |
| 35 | BSP blind plug O-ring | B1, B2, C1 | | |

① BS(H)10 series only

② BS(H)15 series only

Table 2

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

**BS(H) Series Exploded View**

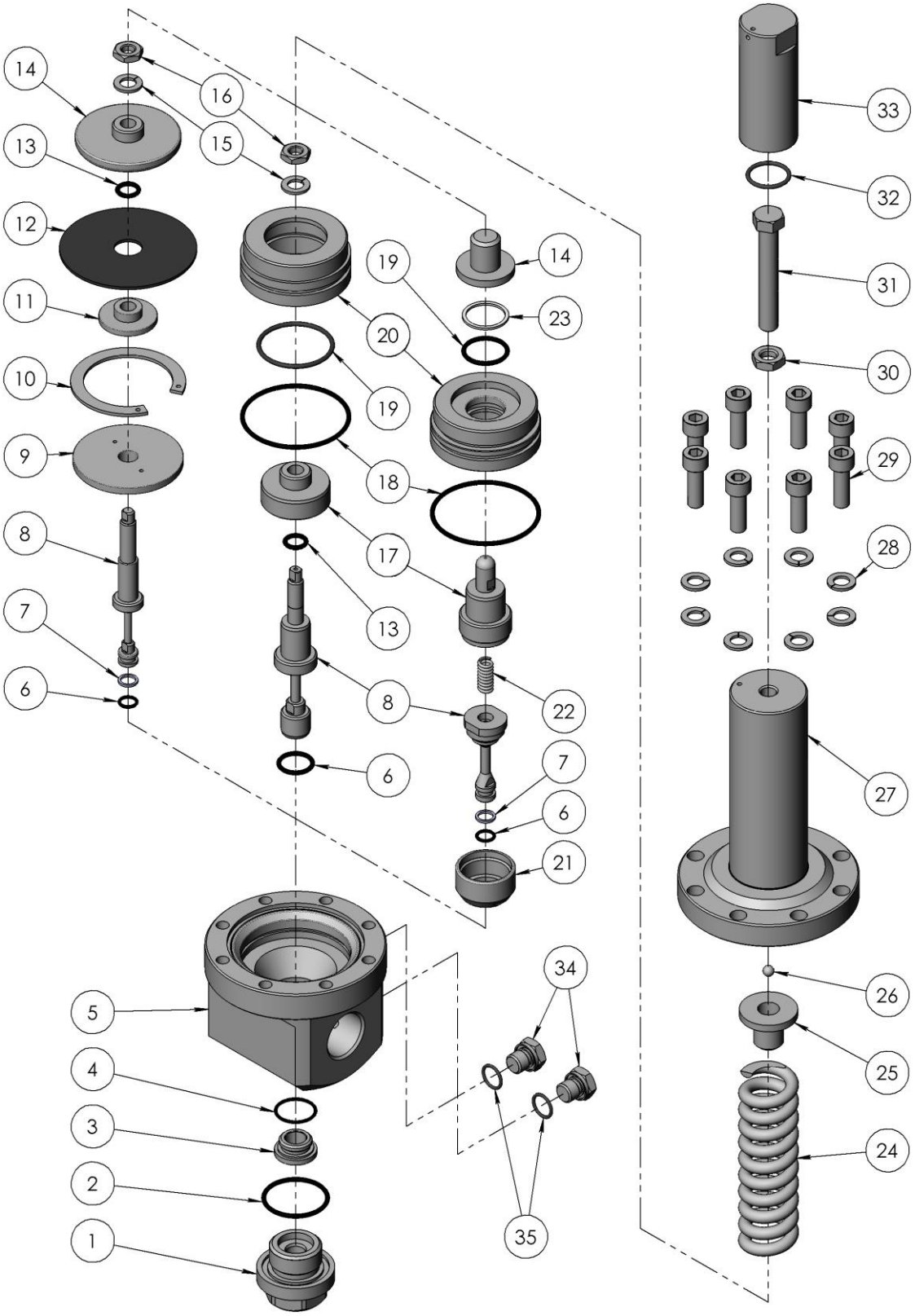



Fig 1

**BS(H)10 Series, Diaphragm Sensing, Section View**

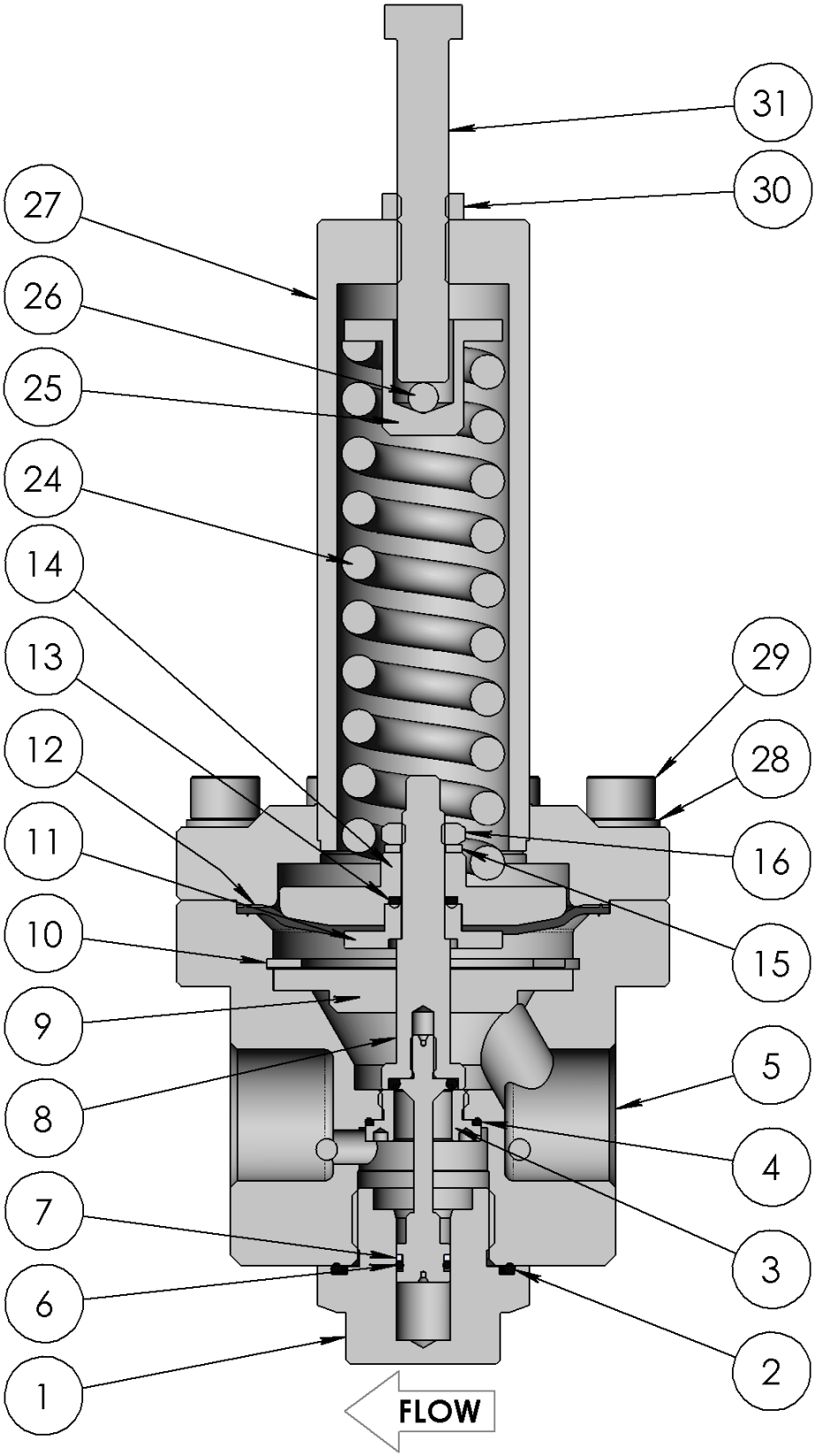



Fig 2

**BS(H)10 Series, Piston Sensing with Anti-Tamper, Section View**

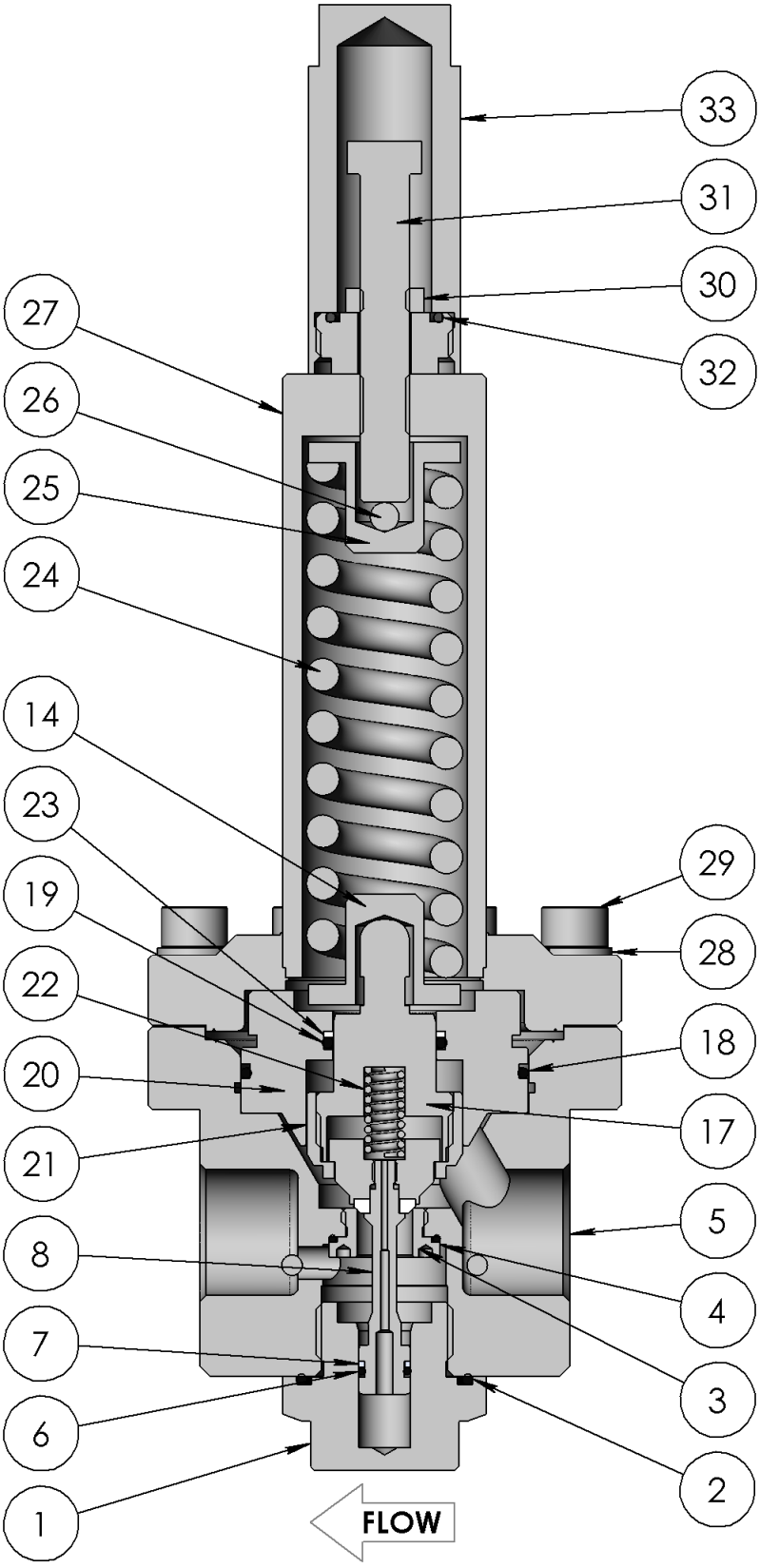



Fig 3

**BS(H)15 Series, Diaphragm Sensing, Section View**

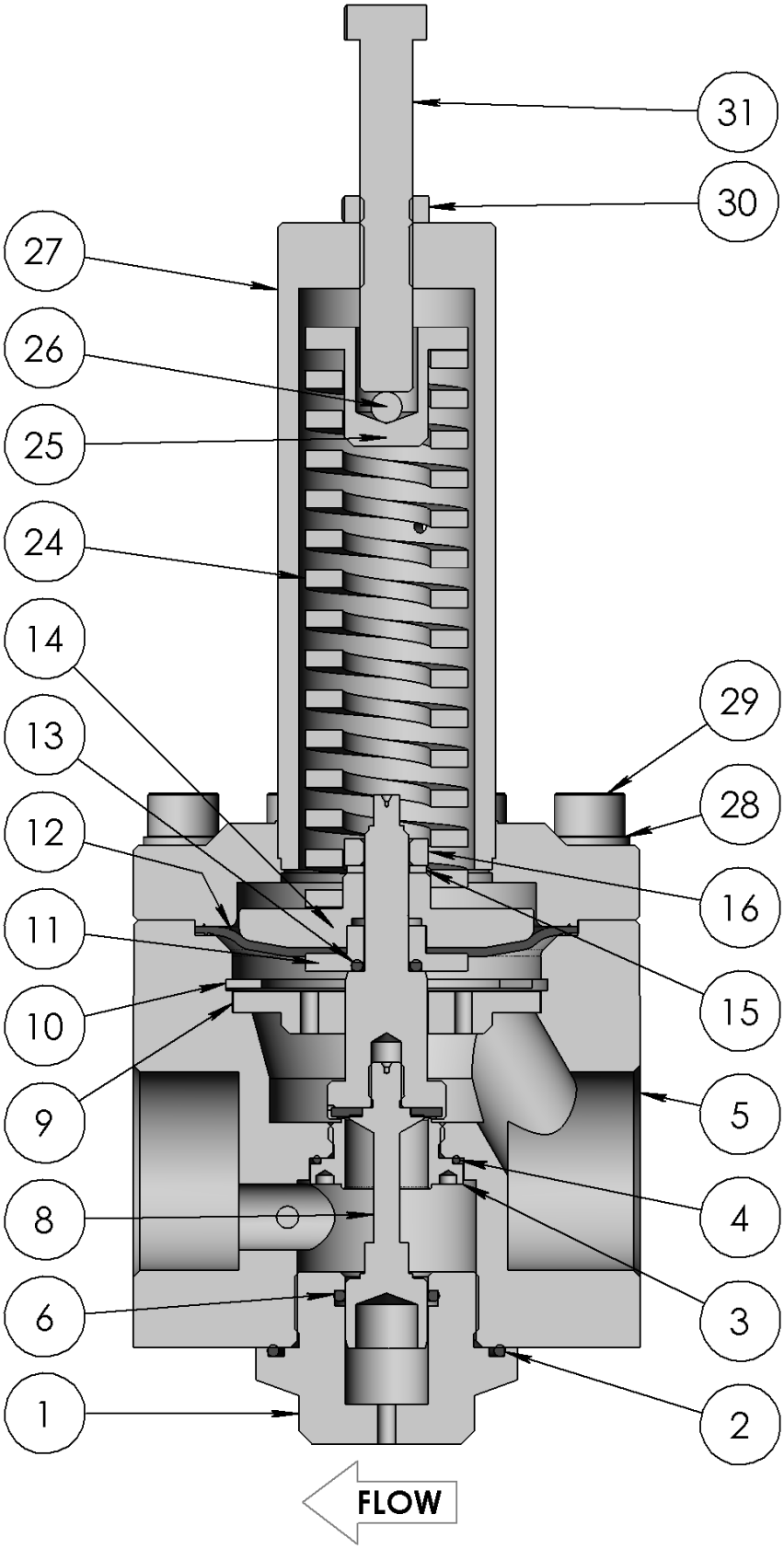



Fig 4

**BS(H)15 Series, Piston Configuration; Control Range 5**

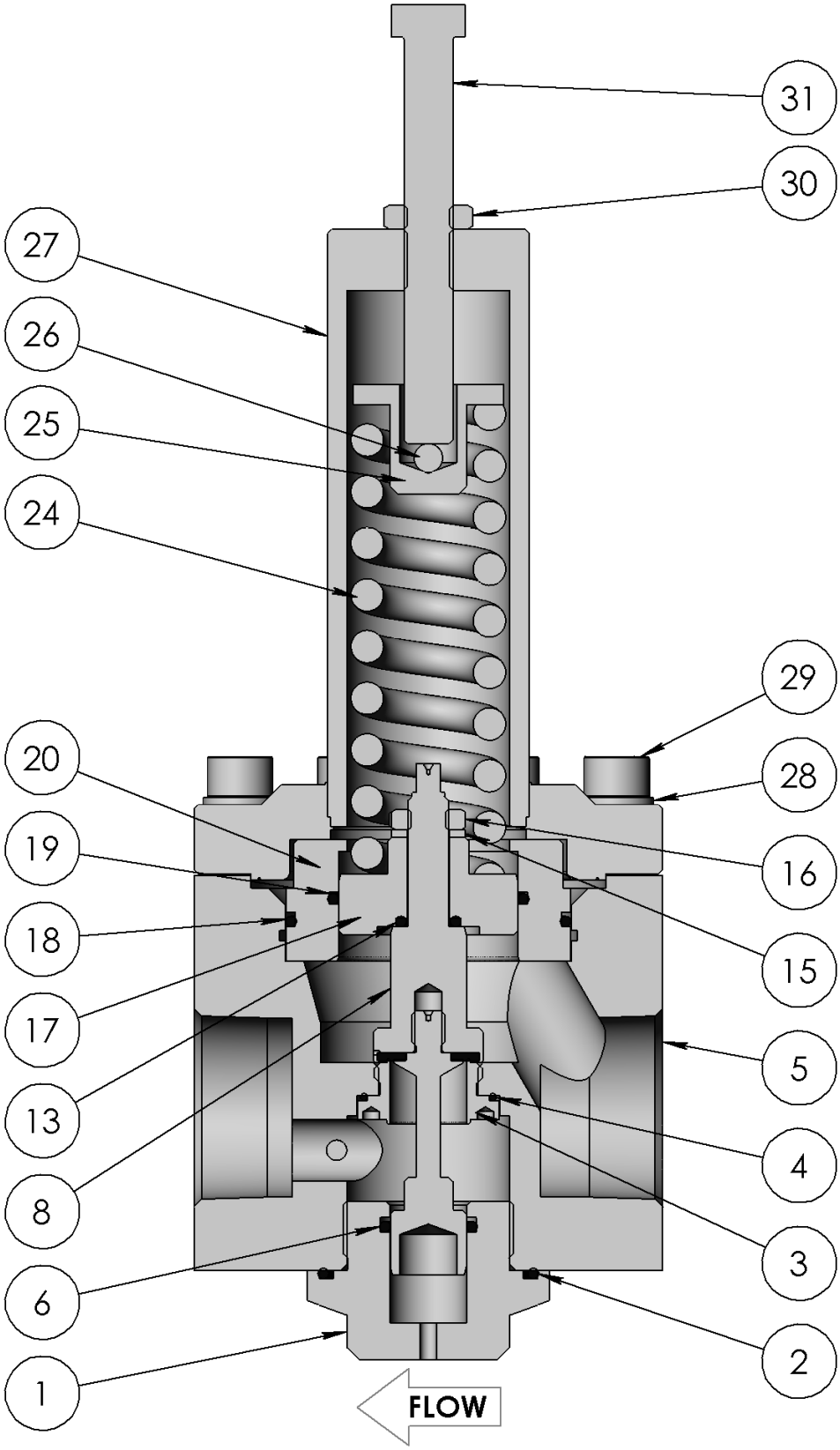



Fig 5

## 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. Ensure the adjusting screw (31) is backed out and not acting on the set spring (24).
2. Loosen the cap screws (29) and remove the spring housing (27).
3. Remove the upper spring guide (25) including the ball (26) and the set spring (24).

4a. For a diaphragm sensor, remove the poppet nut (16) and washer (15) from the sensing assembly and remove the bottom spring guide (14), clamp plate O-ring (13), diaphragm (12), and clamp plate (11). Remove the retaining ring (10) from the body then remove the body plate (9) and poppet (8).

4b. For a piston sensor with a piston screw (21) refer to Fig 3. Remove the sensing assembly from the body (5). Remove the piston (17) from the piston plate (20) then remove the piston screw (21) from the piston (17) to release the poppet (8) and overtravel spring (22).

4c. For a piston sensor with a poppet nut (16) refer to Fig 5. Remove the sensing assembly from the body (5). Remove the piston (17) from the piston plate (20) then remove the poppet nut (16) and washer (15) to release the poppet (8) and O-ring (13).

5. If present, remove the O-ring (6) and backup ring (7) from the poppet (8).
6. Remove the piston O-ring (19), piston plate O-ring (18) and, if present, piston backup ring (23) from the piston plate (20).
7. Remove the body plug (1).
8. Remove the body plug O-ring (2) and, if present, poppet O-ring (6) from the body plug (1).
9. Remove the seat (3) and seat O-ring (4) using the seat insertion tool.

## 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

### BS(H)10 Series: Diaphragm Sensing

1. Fit the seat O-ring (4) onto the seat (3).
2. Lightly lubricate the seat threads (3) and insert into the body (5) using the seat insertion tool.
3. Torque the seat to 7 lbf·ft (10 N·m).
4. Fit the body plug O-ring (2) onto the body plug (1) and lightly lubricate the body plug threads (1).
5. Screw the body plug (1) into the body (5) and torque to 37 lbf·ft (50 N·m).
6. Fit the O-ring (6) and backup ring (7) onto the poppet (8). Ensure they are oriented correctly per Fig 2. Lightly lubricate the poppet O-ring (6).
7. Insert the poppet (8) through the seat (3) and into the body plug (1).
8. Insert the body plate (9) into the body (5) over the poppet (8) and secure with the retaining ring (10).
9. Assemble the clamp plate (11), diaphragm (12), clamp plate O-ring (13), and bottom spring guide (14) onto the poppet (8) per Fig 2.
10. Lightly lubricate the poppet threads (8).
11. Fit the washer (15) and nut (16) onto the poppet (8) and toque to 9 lbf·ft (12 N·m).
12. Fit the ball (26) into the upper spring guide (25) and retain in place with a liberal amount of lubricant.
13. Stack the set spring (24) and upper spring guide (25) onto the bottom spring guide (14).
14. Lightly lubricate the cap screws (29). Fit the spring housing (27) over the spring (24) and secure with the cap screws (29) and washers (28). Torque the cap screws (29) to 30 lbf·ft (40 N·m).
15. Lightly lubricate the adjusting screw (31) then assemble the lock nut (30) on to it.
16. Insert the adjusting screw (31) into the spring housing (27).

### BS(H)10 Series: Piston Sensing

1. Follow steps 1 through 6 of the BS(H)10 series diaphragm sensing reassembly procedure.
2. Lightly lubricate the piston threads (17).
3. Insert the poppet (8) through the piston screw (21).
4. Place the overtravel spring (22) onto the poppet (8).
5. Screw the piston screw (21) onto the piston (17). Torque to 11 lbf·ft (15 N·m).
6. Fit the piston plate O-ring (18), piston O-ring (19) and, if present, piston backup ring (23) onto the piston plate (20). Ensure they are oriented correctly per Fig 3.
7. Lightly lubricate the piston O-ring (19) then insert the piston (17) into the piston plate (20).
8. Lightly lubricate the poppet O-ring (6) then insert the sensing assembly into the body (5). The poppet (8) is inserted through the seat (3) and into the body plug (1).
9. Place the bottom spring guide (14) onto the piston (17).
10. Follow steps 12 through 16 of the BS(H)10 series diaphragm sensing reassembly procedure.

**BS(H)15 Series: Diaphragm Sensing**

1. Follow steps 1 and 2 of the BS(H)10 series diaphragm sensing reassembly procedure.
2. Torque the seat to 11 lbf·ft (15 N·m).
3. Follow step 4 of the BS(H)10 series diaphragm sensing reassembly procedure.
4. Fit the poppet O-ring (6) into the body plug (1) and lightly lubricate it.
5. Follow steps 5, 7 and 8 of the BS(H)10 series diaphragm sensing reassembly procedure.
6. Assemble the clamp plate (11), diaphragm (12), clamp plate O-ring (13), and bottom spring guide (14) onto the poppet (8) per Fig 4.
7. Follow steps 10 through 16 of the BS(H)10 series diaphragm sensing reassembly procedure.

**BS(H)15 Series: Piston Sensing, Control Range 5**

1. Follow steps 1 and 2 of the BS(H)10 series diaphragm sensing reassembly procedure.
2. Torque the seat to 11 lbf·ft (15 N·m).
3. Follow step 4 of the BS(H)10 series diaphragm sensing reassembly procedure.
4. Fit the poppet O-ring (6) into the body plug (1) and lightly lubricate it.
5. Follow step 5 of the BS(H)10 series diaphragm sensing reassembly procedure.
6. Fit the O-ring (13) and piston (17) onto the poppet (8) per Fig 5.
7. Lightly lubricate the poppet threads (8).
8. Fit the washer (15) and nut (16) onto the poppet (8) and toque to 9 lbf·ft (12 N·m).
9. Fit the piston plate O-ring (18) and piston O-ring (19) onto the piston plate (20).
10. Lightly lubricate the piston O-ring (19) then insert the piston (17) into the piston plate (20).
11. Insert the sensing assembly into the body (5). The poppet (8) is inserted through the seat (3) and into the body plug (1).
12. Follow steps 12 through 16 of the BS(H)10 series diaphragm sensing reassembly procedure.

**BS(H)15 Series: Piston Sensing, Control Ranges 6-8**

1. Follow steps 1 and 2 of the BS(H)10 series diaphragm sensing reassembly procedure.
2. Torque the seat to 11 lbf·ft (15 N·m).
3. Follow step 4 of the BS(H)10 series diaphragm sensing reassembly procedure.
4. Fit the poppet O-ring (6) into the body plug (1) and lightly lubricate it.
5. Follow step 5 of the BS(H)10 series diaphragm sensing reassembly procedure.
6. Lightly lubricate the piston threads (17).
7. Insert the poppet (8) through the piston screw (21).
8. Place the overtravel spring (22) onto the poppet (8).
9. Screw the piston screw (21) onto the piston (17). Torque to 11 lbf·ft (15 N·m).
10. Fit the piston plate O-ring (18), piston O-ring (19) and, if present, piston backup ring (23) onto the piston plate (20). Ensure they are oriented correctly per Fig 3.
11. Lightly lubricate the piston O-ring (19) then insert the piston (17) into the piston plate (20).
12. Insert the sensing assembly into the body (5). The poppet (8) is inserted through the seat (3) and into the body plug (1).
13. Place the bottom spring guide (14) onto the piston (17).
14. Follow steps 12 through 16 of the BS(H)10 series diaphragm sensing reassembly procedure.

# 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 any downstream shutoff valves are open.
3. Set the regulator to 14.5 psig (1 bar) then close the supply shutoff valve.
4. Monitor the inlet pressure and/or use liquid leak detector on the outlet port. A drop in inlet pressure over time or bubbles in the leak detector indicates a seat leak.
5. Repeat the procedure with the highest set pressure suitable for the regulator and system.

## Shell Leak Test

1. Set the regulator to the open position (i.e. ensure the adjusting screw is fully backed off counterclockwise).
2. Close the downstream shutoff valve.
3. Maintain an inlet pressure of approximately 14.5 psig (1 bar) on the regulator. Measure the outlet pressure to ensure this also reads the same value.
4. Using liquid leak detector, check for bubbles at the spring housing to body interface, body plug to body interface and the spring housing weep hole.
5. Repeat the procedure with the highest inlet and outlet pressure applicable for the regulator and system.

# Troubleshooting

| Symptom | Cause | Remedy |
|---|---|---|
| Constant leakage from the outlet before the set pressure is reached. | A damaged seat and/or poppet. | Replace the seat and/or poppet. |
| Leakage around the body plug. | A damaged O-ring. | Replace the O-ring. |
| Leakage between the body and the spring housing. | A damaged diaphragm or O-ring. | Replace the diaphragm or O-ring. |
| | Insufficient torque on the cap screws. | Tighten the cap screws per Table 2. |
| The required set 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 inlet 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.<br>Review application flow capacity and contact your local authorized sales and service center. |
| The regulator will not relieve at the set point. | The poppet is sticking. | Replace the poppet. |
| | The set point has been accidentally altered. | Readjust the set point. |
| The set pressure has changed without adjusting the knob. | Changes to the outlet pressure may result in changes to the set pressure. | Maintain a constant outlet pressure on the regulator. See “**Points of Attention Before Operation**” about **dependency**. |
| | Changes to the flow may result in changes to the set pressure. | Maintain a constant flow through the regulator. See “**Points of Attention Before Operation**” about **accumulation.** |

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-0158