



ANDERSON GREENWOOD SERIES 9300 PILOT OPERATED SAFETY RELIEF VALVES INSTALLATION AND MAINTENANCE INSTRUCTIONS

Before installation these instructions must be fully read and understood

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Installation and Maintenance Instructions for Anderson Greenwood Series 9300 Pilot Operated Safety Relief Valves (POSRV). The intent of these instructions is to acquaint the user with the storage, installation and operation of this product. Please read these instructions carefully before installation.

SAFETY PRECAUTIONS

When the safety valve is under pressure never place any part of your body near the outlet/exhaust of the valve.

The valve outlet and any separate drains should be piped or vented to a safe location.

Always wear proper safety gear to protect hands, head, eyes, ears, etc. anytime you are near pressurized valves.

Never attempt to remove the safety valve from a system that is pressurized.

Never make adjustments to or perform maintenance on the safety valve while in service unless the valve is isolated from the system pressure. If not properly isolated from the system pressure, the safety valve may inadvertently open resulting in serious injury.

Remove the safety valve prior to performing any pressure testing of the system.

The safety of lives and property often depends on the proper operation of the safety valve. The valve must be maintained according to appropriate instructions and must be periodically tested and reconditioned to ensure correct function.

WARNING

The protection and safety of equipment, property and personnel depends on the proper operation of the safety valves described in this manual.

All Emerson safety valves should be kept in proper working condition in accordance with the manufacturer's written instructions. Periodic testing and maintenance by the user of this equipment is essential for reliable and safe valve operation.

All installation, maintenance, adjustment, repair and testing performed on safety valves should be done by qualified technicians having the necessary skills and training adequate to perform such work. All applicable Codes and Standards, governing regulations and authorities should be adhered to when performing safety valve repair. No repair, assembly, adjustment or testing performed by other than Emerson or its authorized assemblers and representatives shall be covered by the warranty extended by Emerson to its customers. The user should use only original, factory supplied OEM parts in any maintenance or repair activity involving this product.

This Maintenance Manual is provided as a general guide for the repair and maintenance of the safety valves described herein. It is not possible to describe all configurations or variations with such equipment. The user is advised to contact Emerson or its authorized assemblers and representatives for assistance in situations that are not adequately covered or described in this manual.

Before removing a safety valve for maintenance, ensure that the system pressure has been fully depressurized. If an isolation block valve is used ensure that any trapped fluid between the block valve and the safety valve is safely vented.

Before disassembling the safety valve ensure that the valve has been decontaminated from any harmful gasses or fluids and that it is at a safe temperature range for handling. Fluids can be trapped in the dome space of pilot operated safety valves. Before installation, the Installation and Operational Safety Instructions should be fully read and understood. These Instructions may be requested from the factory or are available at www.valves.emerson.com.

STORAGE AND HANDLING

Pressure/vacuum relief valve performance may be adversely affected if the valve is stored for an extended period without proper protection. Rough handling and dirt may damage, deform, or cause misalignment of valve parts and may alter the pressure setting and adversely affect valve performance and seat tightness. It is recommended that the valve be stored in the original shipping container in a warehouse or at a minimum on a dry surface with a protective covering until installation. Inlet and outlet protectors should remain in place until the valve is ready to be installed in the system.

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INSTALLATION AND MAINTENANCE INSTRUCTIONS

1 INTRODUCTION

1.1 Description of valve

The Series 9300 employs the highly successful pressurized PTFE film seat, as well as protected FEP diaphragms. The design allows these valves to be used in the pilot operated pressure relief mode and simultaneously provide vacuum relief, either via weight loads of the internals, or with a specific pilot control of the vacuum opening. The Series 9300 was designed with a special studded inlet connection to reduce the inlet profile, and coupled with larger orifice areas, these valves provide flow capacities as much as 45% greater than the Series 90 valves. The Series 9300 is a full body valve to pipe away the discharge if required.

1.1.1 Pilot operated safety relief valve with non-flowing modulating pilot

- 9340P - Positive pressure relief valve
- 9340C - Positive and negative pressure relief valve
- 9304V - Negative pressure relief valve

Pilot operated valves use a pilot to control pressure over a large unbalanced member in the main valve, such as a diaphragm piston. The large overbalance means a much larger force on top of the seat compared to process forces pushing up on the seat. At set pressure, the pilot relieves the pressure quickly, permitting the main valve seat to open rapidly. All of the pilots have the same construction, except for the location of the connections to the main valve diaphragm actuators, or the connections for the pressure sense. For either the 9340P or the 9340C, the pilot controls only the positive pressure relief. The negative pressure relief is controlled by the weight of the parts that move in the main valve when it opens. In the 9304V, the pilot controls the negative pressure relief.

1.1.2 Pilot operated safety relief valve with flowing modulating or snap action pilot

- 9390P - Positive pressure relief valve
- 9390C - Positive and negative pressure relief valve
- 9309V - Negative pressure relief valve

Weighted-loaded and spring operated valves open as process forces overcome downward forces, with little flexibility to overcome problem applications. Anderson Greenwood pilot operated valves can be adjusted to open with a rapid 'snap' action or modulating action. Most applications are well served by the snap action mode, with full opening at set pressure and full reseating after a short blowdown. However, some systems might best be served by a proportional opening, whereby the valve opens just enough to satisfy small upsets and maintain constant system pressure, yet still have the capability to reach full capacity

within 10% overpressure. The 9390C and 9309V pilots have the same construction except for the location of the connections for the pressure sense. For either the 9390P or 9390C, the pilot controls only the positive pressure relief. In the 9309V, pressure relief is controlled by the weight of the parts that move in the main valve when it opens. The pilot controls the negative pressure relief on the negative pressure relief valve. The Anderson Greenwood 9390 Series can be set for a snap acting or modulating mode with a simple adjustment of the external blowdown screw. No part changes are necessary to change the operating mode.

1.2 Service applicability

Refrigerated or cryogenic storage tanks (accurate low-pressure protection), natural gas transmission and distribution, blanketed vessels in the petrochemical, food and electronics industries, ammonia, air blowers in the waste water treatment plants and marine (LNG and LPG).

1.3 Code applicability

The Series 9300 are designed to meet the requirements of ASME UV Code Stamp, NB certified capacity 15 psig and above, and API 2000.

1.4 Conversion

Valve conversions are defined as any change which affects critical parts and/or valve nameplate data, from that which was originally supplied by the manufacturer such as a change in set pressure. Conversions, when required by the owner/user, shall only be performed by the manufacturer, their appointed/authorized assembler or repair center in strict accordance with written instructions provided by the manufacturer. Communication with the manufacturer is critical when making any conversion to ensure the converted valve(s) provides the same safe, reliable performance as the original valve supplied by the manufacturer.

For conversion information on the Series 9300 Pressure Relief Valves:

www.valves.emerson.com

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1.5 SIZE/PRESSURE RANGES OF SERIES 9300 PRESSURE/VACUUM RELIEF VALVES

| Materials | AL, CS, SS |
|--------------------------------|--|
| Main valve soft goods | PTFE Diaphragm seat and seals |
| Pilot soft goods | Elastomer or all PTFE Soft goods |
| Set pressure range | 4" wc to 50 psig (9.9 mbarg to 3.45 barg) |
| Vacuum range | -1.73" wc to -14.7 psig (-4.3 mbarg to -1.01 barg) |
| Process temperature | -320°F to 200°F (-196°C to 93°C) |
| Size | 2" to 12" |
| Blowdown - (fixed or variable) | |

1.6 Basic pilot series for the 9300 main valve

1.6.1 Series 91 Pilot

The Series 91 was designed for specific applications where FEP diaphragms alone were not rugged enough and premium sealing was required for super cryogenic fluids. Series 91 design includes stainless steel (SS), and PTFE diaphragms which provide extraordinary performance for hard to hold cryogenic fluids.

1.6.2 Series 93 Pilot

The Series 93 is a pilot operated pressure relief valve designed with elastomer seats and seals, and construction materials in aluminum (AL), carbon steel (CS), and stainless steel (SS). These construction materials satisfy the majority of gas piping and chemical tank applications. The Series 93 pilot can be used on any Series 9000 valve except a combination 9000 larger than 6".

1.6.3 Series 93T Pilot

The Series 93T was an offshoot of the Series 93, designed specifically for cryogenic and chemical applications where an elastomer seal is not satisfactory.

1.6.4 Series 400B

The Series 400B is used with 8", 10", and 12" combination weight-loaded vacuum and pressure valves where quick relieving of dual chamber diaphragms is required to open the main valve.

2 MAIN VALVE

2.1 General main valve maintenance

Since the Series 9300 valve can be either a pressure only, vacuum only, or pressure/vacuum relieving device, it is built in a modular fashion. The standard single diaphragm unit will function on pressure and vacuum, however, opening under very low vacuum requires use of the auxiliary diaphragm chamber. The valve can also be repaired in a modular fashion. The seat can be replaced without complete disassembly of the diaphragm cases. Selective repair can be performed as required.

Prior to disassembly of the main valve or pilot, it is recommended to stamp or mark the location of the pilot, the orientation of the diaphragm cases, studs, and column supports to the main valve body.

This practice will ensure proper alignment and location of parts during reassembly.

To prevent mixing up parts it is recommended to repair the main valve and pilot in stages.

For this reason, the diaphragm, nozzle, and seat maintenance and/or replacement instructions are separate from the pilot instructions.

2.2 Main valve single chamber diaphragm disassembly (Refer to figure 1)

1. Remove the pilot (as a unit) and the tubing from the diaphragm case. Set them aside.
Note: match mark orientation of tubing and case assembly to the body. This will assist in reassembly.
2. Unscrew the case bolts (700/710) and remove the upper diaphragm case (210).
3. On valve sizes 2" through 4", remove the diaphragm assembly, lower case (280), shaft (320) and seat plate assembly from the main valve body (100).
4. On valve sizes 6" and larger, remove seat plate assembly from shaft (320) prior to removing diaphragm assembly, lower case (280), and shaft (320). To remove, spin diaphragm plate assembly counterclockwise while holding seat plate assembly stationary until shaft (320) is free of seat hub (420). The seat plate assembly should then rest on nozzle (460).
5. On valve sizes 6" and larger, remove diaphragm assembly and shaft (320) from lower case (280). Then remove lower case from the body (100).
6. On valve sizes 6" and larger, lift seat plate assembly from the body (100).

8. Holding the shaft (320) stationary, remove the jam nut (520) from the diaphragm assembly. Remove the diaphragms (170, 175, 950, 960), washers (580, 590, 600), gaskets (620), plates (150, 160), and lower case (280) (as a unit) from the shaft (320).

CAUTION

When removing seat plate assembly, be careful not to damage the nozzle (460).

7. Unscrew counterclockwise the seat plate assembly from the main shaft (320). This is normally a hand operation, however, a $\frac{3}{16}$ " (14.3 mm) wrenching flat is provided on the seat hub (420). The connecting thread will run free, then tighten, and run free again as it disengages from a locking helicoil (330) in the vertical shaft (320). This will allow the seat plate assembly, diaphragm assembly and lower case (280) to be separated.

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2.3 Main valve dual chamber diaphragm disassembly (refer to figure 2)

1. Remove the pilot and tubing from the auxiliary diaphragm case.
Note: match mark orientation of tubing and case assembly with the body. This will assist in reassembly.
2. Unscrew the upper auxiliary case bolts (700) and nuts (730), and remove the upper auxiliary diaphragm case (210B).
3. Install a 6" to 8" long braided wire through the hole at the top of the lift rod (250) to retain the lift rod (250). (See Figure 3, detail C)
4. Lift the auxiliary (160B, 170B, 290) and main diaphragm (150, 160A, 170A) assemblies to the full open position using the auxiliary vacuum plate (160B). The open dome port can be temporarily capped to hold the main diaphragm assembly open.
5. Remove nuts (530 and 520B) and PTFE O-ring (670). (See Figure 3, detail A).
6. The lift rod (250) is attached to the auxiliary plate bushing (240) with threads. Unscrew the lift rod (250) from the bushing (240) by turning the rod (250) clockwise until it drops down into the main valve shaft bore (320).
7. Remove the main diaphragm case bolts (700, 710). Remove the studs (810) from the body (100). Remove the lower auxiliary diaphragm case (280B) and the upper main diaphragm case (220) as a unit, which is assembled to the diaphragm case adapter (230). Allow the lift rod (250) to slip from the center hole and lift the lower auxiliary diaphragm case (280B), upper main diaphragm case (220), and adapter (230) upwards as one unit.

CAUTION

Be careful not to bend the lift rod (250) during case assembly removal.

8. On valve sizes 2" through 4", remove the diaphragm assembly (150, 160A, 170A), lower case (280), shaft (320) and seat plate assembly (910, 920) from the main valve body (100).
9. On valve sizes 6" and larger, remove seat plate assembly (910, 920) from shaft (320) prior to removing diaphragm assembly (150, 160A, 170A), lower case (280) and shaft (320). To remove, spin diaphragm plates (150, 160A, 170A) assembly counterclockwise while holding seat plate (910, 920) assembly stationary until shaft (320) is free of seat hub (420). The seat plate (910, 920) assembly should then rest on nozzle (460).

10. On valve sizes 6" and larger, remove diaphragm assembly (150, 160A, 170A) and shaft (320) from lower case (280A). Then remove lower (280A) case from the body (100).
11. On valve sizes 6" and larger, lift seat plate (910, 920) assembly from the body (100).

CAUTION

When removing seat plate assembly (910, 920), be careful not to damage the nozzle (460).

12. Unscrew counterclockwise the seat plate (910, 920) assembly from the main shaft (320). This is normally a hand operation, however, a $\frac{9}{16}$ " (14.3 mm) wrenching flat is provided on the seat hub (420). The connecting thread will run free, then tighten, and run free again as it disengages from a locking helicoil (330) in the vertical shaft (320). This will allow the seat plate assembly (910, 920), diaphragm (150, 160A, 170A) assembly and lower case (280A) to be separated.
13. Holding the shaft (320) stationary, remove the jam nut (520A) from the diaphragm (150, 160A, 170A) assembly. Remove the diaphragms (170A, 175A, 950, 960), washers (580, 590, 600), gaskets (620A), plates (150A, 160A), and lower case (280A) (as a unit) from the shaft (320). (See figure 3, detail C).

With the main valve disassembled, you are now ready to disassemble, inspect, and replace soft goods starting with the seat plate (910, 920) assembly.

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INSTALLATION AND MAINTENANCE INSTRUCTIONS

MAIN VALVE PARTS

| Item | Description |
|------|--|
| 100 | Body |
| 110 | Screw - nozzle retainer |
| 120 | Screw - seat (used with Item 130 seat plate assembly option 1) |
| 125 | Clamp band - seat (used in place of item 120 and 130 seat plate assembly option 2) |
| 130 | Nut, lock (used with item 120 seat plate assembly option 1) |
| 140 | Retainer seat |
| 150 | Plate - main pressure |
| 160 | Plate - main vacuum |
| 170 | Diaphragm - main |
| 175 | Diaphragm reinforcement (used on 2" and 3" low pressure only) |
| 210 | Case, upper diaphragm |
| 215 | Cap spacer (6" only, not used on dual chamber diaphragm) |
| 220 | Case, upper main (used on dual chamber diaphragm only) |
| 230 | Adapter (used on dual chamber diaphragm only) |
| 240 | Bushing (used on dual chamber diaphragm only) |
| 250 | Rod (used on dual chamber diaphragm only) |
| 260 | Bushing - rod (used on dual chamber diaphragm only) |
| 270 | Washer (used on dual chamber diaphragm only) |
| 280 | Case, lower diaphragm |
| 290 | Plate - aux pressure (used on dual chamber diaphragm only) |
| 300 | Washers (used under 700/710 on aluminum cases only) |
| 320 | Shaft - assembly (includes item 330 as part of assy) |
| 330 | Helicoil |
| 340 | Sleeve guide |
| 360 | Bushing split (not used on 2" and 3" or high pressure) |
| 420 | Hub seat |
| 430 | Spacer seat |
| 440 | Bushing seat |
| 450 | Nut - seat jam |
| 460 | Nozzle (assembly) |
| 500 | Bushing guide |
| 520 | Nut - jam |
| 530 | Nut (used on dual chamber diaphragm only) |
| 570 | Secondary seat (high pressure only) |
| 580 | Washer |
| 590 | Washer |
| 600 | Gasket - clamp plate |
| 610 | Seat - film |
| 620 | Gasket - case |
| 630 | Nozzle gasket |
| 640 | Spacer [O-ring/-018] |
| 660 | Gasket - adapter (used on dual chamber diaphragm only) |
| 670 | Seal - adapter (used on dual chamber diaphragm only) |
| 680 | Retaining - ring (used on dual chamber diaphragm only) |
| 690 | Seal - rod (used on dual chamber diaphragm only) |
| 700 | Cap bolt - hex |
| 710 | Cap bolt - eye (not shown used on 4" and above) |
| 730 | Nuts (used on dual chamber diaphragm only) |
| 810 | Stud |
| 820 | Nut |
| 840 | Stud - 2nd chamber support (used on dual chamber diaphragm only) |
| 850 | Nuts (used on dual chamber diaphragm only) |
| 890 | Screen - lower case |
| 900 | Screen - upper case (used on dual chamber diaphragm only) |
| 910 | Plate - seat |
| 920 | Plate - seat protector |
| 930 | Nameplate (not shown) |
| 940 | Rivets (not shown) |
| 950 | Diaphragm slipper outer |
| 960 | Diaphragm slipper inner |
| 970 | Washer seat (used prior to 1990) |

NOTE

Suffix A and B are used after Item #s to denote parts for main and auxiliary chambers in the dual chamber design.

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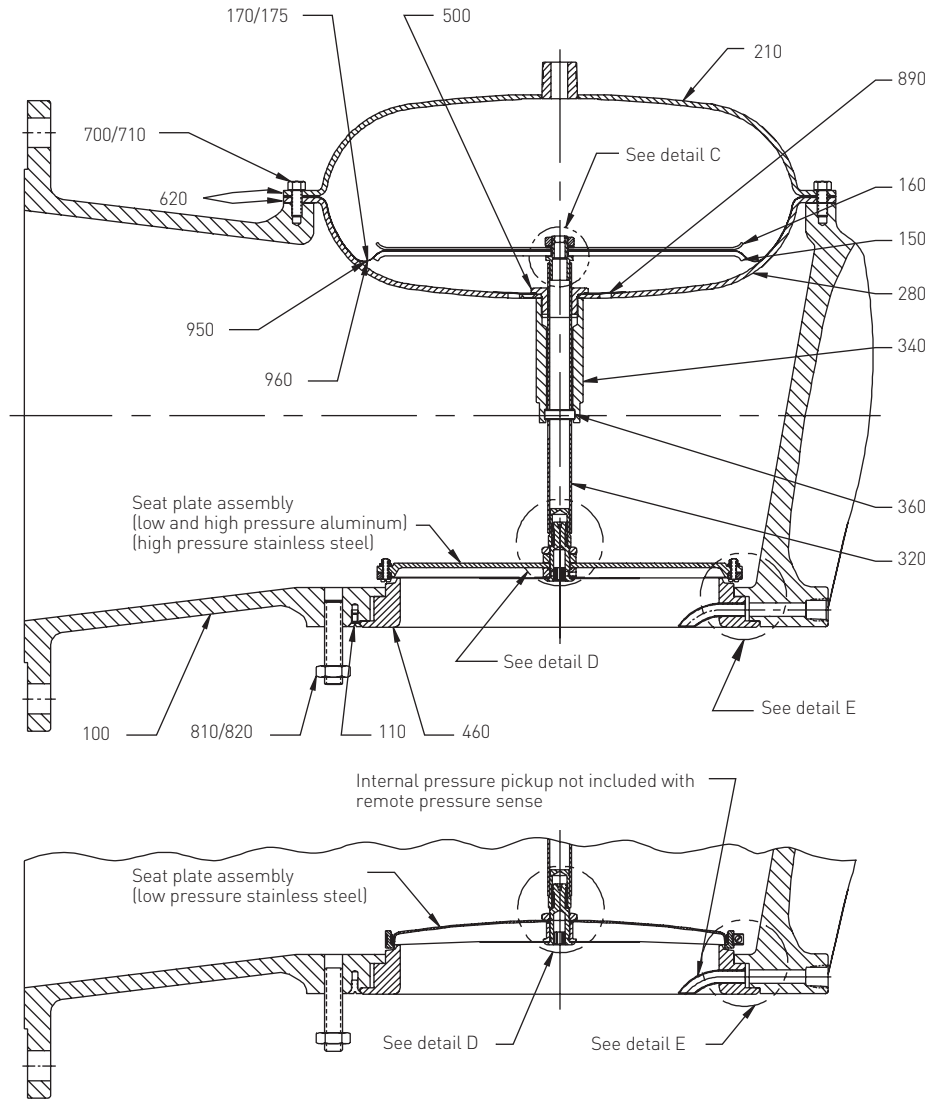


FIGURE 1
9390P Single chamber diaphragm assembly

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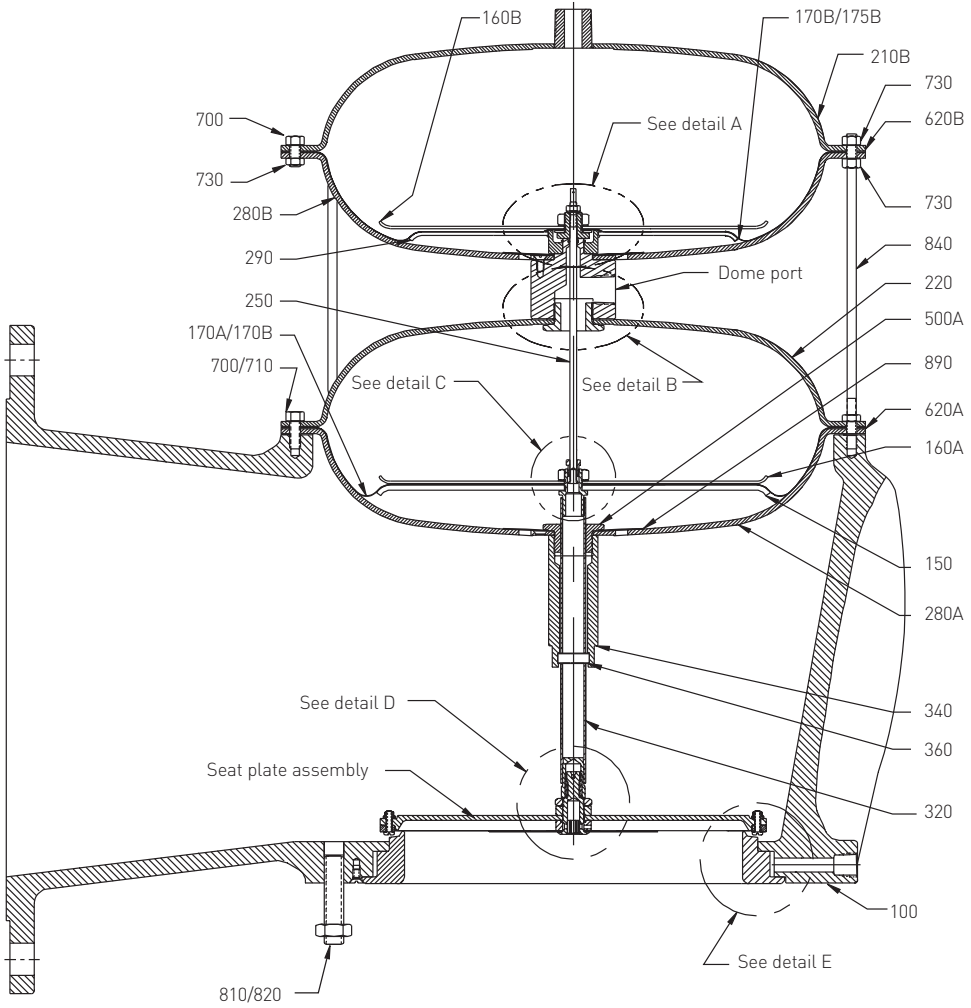


FIGURE 2
9390C Dual chamber diaphragm assembly
Remote pressure sense shown

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 INSTALLATION AND MAINTENANCE INSTRUCTIONS

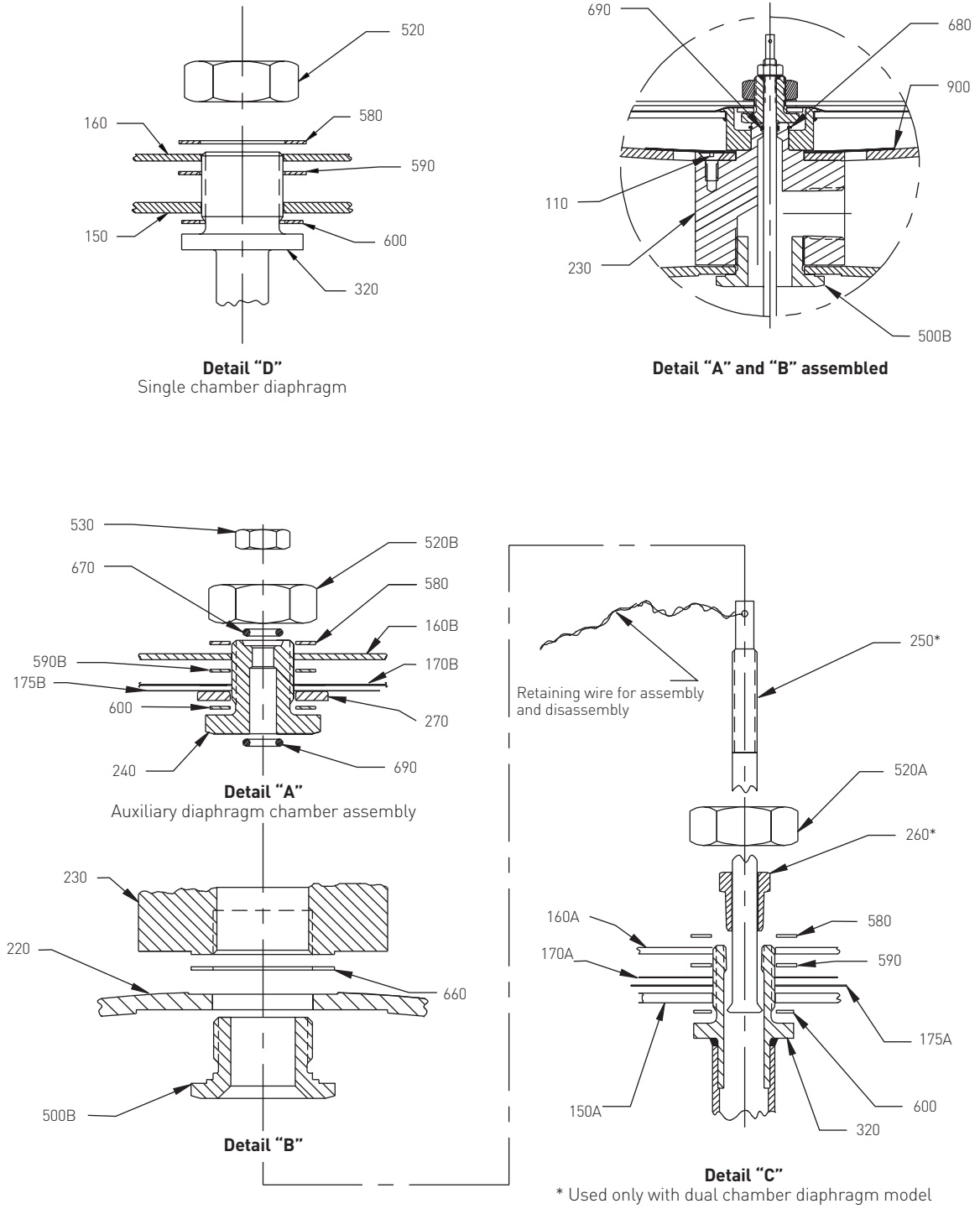


FIGURE 3

ANDERSON GREENWOOD SERIES 9300 PILOT OPERATED SAFETY RELIEF VALVES

INSTALLATION AND MAINTENANCE INSTRUCTIONS

2.4 Main valve seat disassembly and replacement (bolted) (refer to Figure 4, detail D, and Figure 5, detail E)

1. To assist in seat plate disassembly, partially thread the seat plate assembly into the fixture which consists of a 6" long hexagon bar with a 1/2" x 13 x 1" deep threaded hole in one end, and a 5/16" x 18 x 1" deep threaded hole in the other end.

Note: the 5/16" hole is for valves sizes 2" through 6" and the 1/2" hole is for 8" through 12".

2. With the seat plate assembly threaded into the fixture, secure the fixture into a vise and remove the seat screws (120) by holding the lock nut (130) and turning the screws (120) counterclockwise. Then remove the seat plate (910).
3. Holding the 5/16" wrench flat (located at the top end of the seat hub (420)) secure, loosen the seat plate jam nut (450) by turning it clockwise. Then remove the seat hub (420) from the fixture and disassemble the remaining parts of the seat plate assembly.
Note: secondary PTFE seat (570) used only in high pressure stainless steel options.
4. Inspect seat plate (910) radius for damage. Minor nicks and scratches may be removed by polishing radius with 320 grit or finer sand paper, maintaining seat shape.

WARNING

No lapping or machining of seat plate allowed.

5. Inspect threaded parts and sealing surfaces and if damaged replace. Otherwise, clean all metal parts with oil free solvent and dry with lint free towel.
6. The new seat film (610) is supplied as a square sheet of PTFE without holes for the screws. To install, secure the larger end of the seat hub with the 5/16" wrenching flat into a vise and install in this order: protector plate (920), PTFE seat film (610), seat bushing (430), spacer (640) (on outside of seat plate (910), on 6" size seat plates), seat plate (910) (radius side down) and jam nut (450). Then tighten by turning the jam nut (450) clockwise.
7. Remove the seat hub (420) from the vise and install it into the fixture. To complete the assembly, install the secondary seat (570) (high pressure stainless steel only) and then the seat retainer (140) (bevel side down) onto the seat film (610). Then using a scribe punch out a hole in the film starting with the four threaded indicator holes (only threaded holes in seat retainer (140)). Then install the 4 long retainer screws (120) through those holes and tighten in a criss cross pattern.

Note: lubricate retainer screws (120) with Fluorolube to reduce the chances of galling.

8. Punch out the remaining seat screw holes and install the screws (120) and nuts (130) and tighten.

CAUTION

Be careful not to puncture or scratch the seat (610) during this operation.

9. Trim off the excess film from the outside diameter of the seat plate (910) to complete the replacement process.

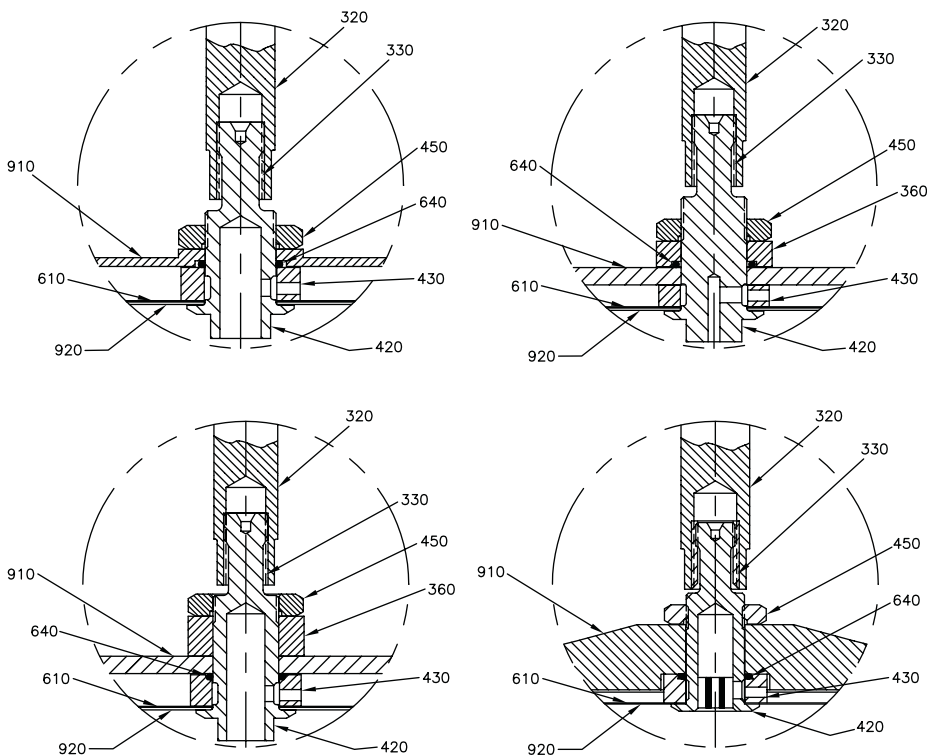


FIGURE 4, DETAIL D
Main valve seat plate hub assembly

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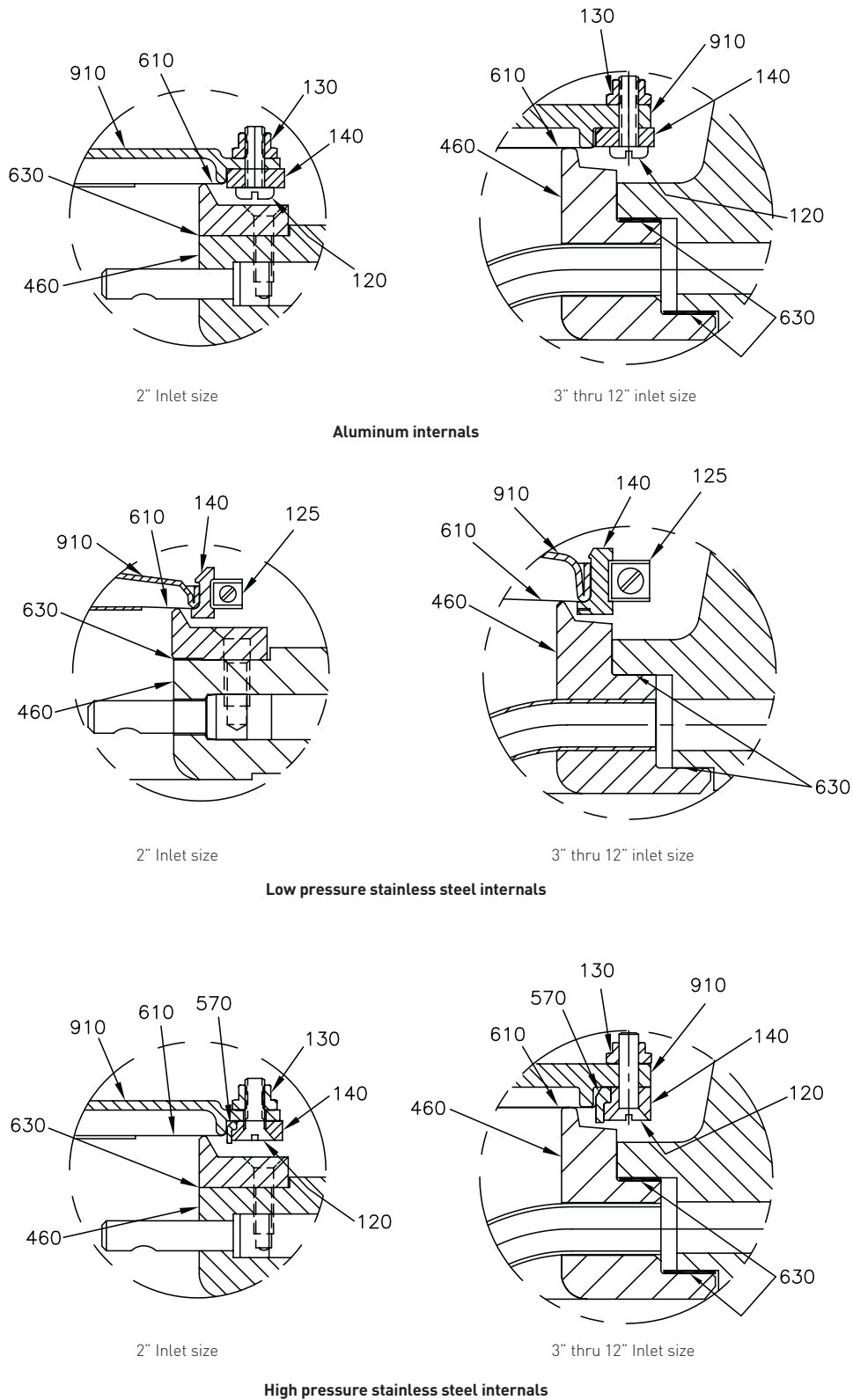


FIGURE 5, DETAIL E
 Main valve seat plate assembly (internal pressure sense shown)

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2.5 Main valve seat disassembly and replacement (banded) (Refer to Figure 4, detail D and Figure 5, detail E)

1. To assist in seat plate disassembly, partially thread the seat plate assembly into the fixture which consists of a 6" long hexagon bar with a 1/2" x 13 x 1" deep threaded hole in one end, and a 5/16" x 18 x 1" deep threaded hole in the other end.
Note: the 5/16" hole is for valves sizes 2" through 6" and the 1/2" hole is for 8" through 12".
2. With the seat plate assembly threaded into the fixture and secured in a vise, remove the band clamp (125). Then holding the 7/16" wrench flat on the seat hub (420) stationery remove the seat plate jam nut (450).
3. Remove the seat hub (420) from the fixture and disassemble the remaining parts from the seat plate assembly.
4. Inspect seat plate (910) radius for damage. Minor nicks and scratches may be removed by polishing radius with 320 grit or finer sand paper maintaining seat shape.

WARNING

No lapping or machining of seat plate allowed.

5. Inspect threaded parts and sealing surfaces and if damaged replace. Otherwise, clean all metal parts with oil free solvent and dry with lint free towel.
6. The new seat film (610) is pre-molded. To install, secure the wrenching flat of the seat hub (420) into a vise and install the protector plate (920), PTFE seat film (610) (radius side down), seat bushing (430), spacer (640), seat plate (910) (radius side up), and install the jam nut (450) HAND TIGHT.

CAUTION

Tightening the jam nut (450) prior to stretching the film (610) will cause ripples in the film. (See Figure 5, Detail E)

7. Remove the seat hub (420) from the vise and install it into the fixture. Then install the seat retainer (140) (beveled side down) onto the seat film (610), and then install the clamp band (125) and tighten.
8. Using a heat gun, apply heat to the seat film (610) in a circular motion approximately 2" to 3" above surface until all ripples and creases are gone. This usually takes less than 1 minute. Now tighten jam nut (450) wrench tight.
9. Trim excess film (610) from back side of seat plate (910) to complete reassembly process.

2.6 Diaphragm replacement

2.6.1 Single chamber diaphragm replacement (See Figure 3, detail D)

1. Secure the main valve shaft (320) wrenching surface in a soft jaw vise. Caution should be taken when securing aluminum shaft (320) to prevent destroying the part.
2. Remove jam nut (520) by turning it counterclockwise.
3. **Note:** mark plates as top (vacuum) and bottom (pressure) prior to disassembly. Remove the following parts in this order: washer (580), vacuum plate (160), washer (590), diaphragm (170), *slipper/reinforcement diaphragm (950,960/175) (see notes for configuration variances), pressure plate (150), and PTFE washer (600).
Note: on single chamber valves with high pressure stainless steel internals, an outer (950) and inner (960) diaphragm slipper is used to protect the diaphragm (170) from wear. The outer slipper (950) is between the diaphragm (170) and lower case (280). The inner slipper (960) is between the diaphragm (170) and the pressure plate (150).
Note: on 2" and 3" single and dual chamber valves with low pressure aluminum or low pressure stainless steel internals, use a reinforcement diaphragm (175) between the main diaphragm (170) and lower case (280). The reinforcement diaphragm (175) is recognized by a small offset hole at the center of the diaphragm.

CAUTION

Installing the reinforcement diaphragm (175) in the wrong location will cause damage to the diaphragm assembly.

4. Inspect plates (150, 160) for cracks, warpage. Clean all metal parts with oil free solvent, and dry with lint free towel.
5. Proceed with this step only on disassembly of main valve dual diaphragms. Inspect lift rod (250) straightness and ensure small diameter tip is not damaged. Also raise the lift rod (250) up and check the surface for damage.
6. Proceed with this step only on disassembly of main valve dual diaphragms. Install 6" to 8" of braided stiff wire through the hole at the top of the lift rod (250). This will aid in reassembly of auxiliary diaphragm.
7. Install new PTFE washer (600), pressure plate (150), *slipper/reinforcement diaphragm (950,960/175) (radius side down) (see notes for configuration variances), diaphragm (170), flat washer (590), vacuum plate (160), flat washer (580), and jam nut (520).

Note: on single chamber valves with high pressure stainless steel internals, an outer (950) and inner (960) diaphragm slipper is used to protect the diaphragm (170) from wear. The outer slipper (950) is between the diaphragm (170) and lower case (280). The inner slipper (960) is between the diaphragm (170) and the pressure plate (150).
Note: on 2" and 3" single and dual chamber valves with low pressure aluminum or low pressure stainless steel internals, use a reinforcement diaphragm (175) between the main diaphragm (170) and lower case (280). The reinforcement diaphragm (175) is recognized by a small offset hole at the center of the diaphragm.

CAUTION

Installing the reinforcement diaphragm (175) in the wrong location will cause damage to the diaphragm assembly.

8. Tighten jam nut (520), wrench tight.

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2.6.2 Dual chamber diaphragm replacement (See Figure 3, detail A, B, C)

1. Secure auxiliary diaphragm bushing (240) into soft jaw vise, and remove nut (530) and jam nut (520B) by turning it counterclockwise.
2. Remove washer (580), auxiliary plate (160B), washer (590A), reinforcement diaphragm (175), washer (270), and PTFE washer (600).
3. Inspect threads on bushing (240) and general condition of metal washers (270, 580, 590B) including sealing surface where PTFE washers (600) seat. Clean metal parts with oil free solvent, and dry with lint free towel.
4. Install PTFE washer (600), washer (smooth side up) (270), auxiliary diaphragm (radius side down) (170), washer (smooth side down) (590B), auxiliary plate (bevel side down) (160B), washer (580), jam nut (520B), and tighten by turning the jam nut (520B) clockwise.

CAUTION

When tightening jam nut be careful not to damage diaphragm.

Note: on 2" and 3" single and dual chamber valves with low pressure aluminum or low pressure stainless steel internals, use a reinforcement diaphragm (175B) between the main diaphragm (170B) and lower case (280B). The reinforcement diaphragm (175B) is recognized by a small offset hole at the center of the diaphragm. (See detail A)

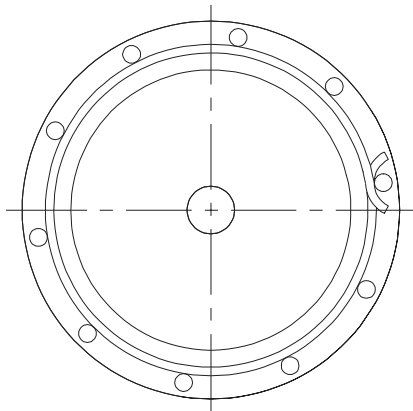
2.7 Main valve nozzle replacement

1. Remove nozzle retaining screws (110) and gently tap nozzle (460) with soft face mallet.
2. Inspect nozzle seating surface for nicks or scratches. If they cannot be removed with a crocus cloth or finer sandpaper, the nozzle (460) must be replaced.

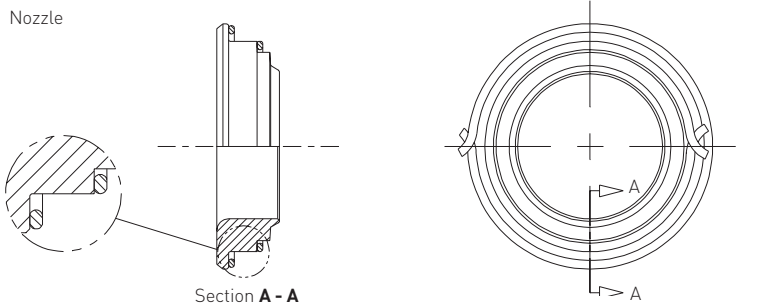
3. If the upper and lower nozzle gaskets (630) are to be replaced, install PTFE gasketing. (See Figure 6, Section A-A, the nozzle part only)
4. Reattach nozzle (460) and retaining screws (110).

1. The contact surfaces must be clean, free from grease, and dry.
2. Remove the protective strip on the adhesive tape.
3. Lightly press in place as shown below.

UPPER CASE(S) AND TOP OF BODY



Put tape just inside of bolt holes, overlapping ends at a bolt hole. Put tape on top case only. Put tape on top surface of body. Do not put on lower case of mating pair.



Place tape toward outer edge of each gasket ledge. Put overlaps on opposite sides. Use 1/8" tape on 3" and 4" nozzles. 3/16" tape on all cases and larger nozzles.

FIGURE 6
PTFE Tape gasket mounting instructions

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2.8 Reassembly of main valve single chamber diaphragm

1. Ensure nozzle (460) maintenance is complete and nozzle (460) is reinstalled.
2. Secure seat hub (420) into soft jaw vise.
3. Install lower case (280) on top of seat plate.
4. Lower shaft (320) and diaphragm assembly through center hole of case (280).
5. Holding shaft (320) stationary, screw the seat plate assembly (910, 920) onto the main valve shaft (320). The connecting thread will run free, tighten, and free again as it engages with the locking helicoil (330).

CAUTION

Do not tighten the seat hub against the shoulder of the shaft.

6. Apply PTFE gasketing (620) to top of the main valve body (100). [See Figure 6]
7. Lower seat plate (910, 920), shaft assembly, (320) and lower diaphragm case (280) into main valve body (100). Align bolt holes with diaphragm (170), case (280), and body (100).
8. Install PTFE gasket (620) material to upper case (280). [See Figure 6]
9. Reattach the upper diaphragm case (210) and seat plate assembly (910, 920) to the body (100).
10. Align match marks of case (210) with body (100), and install cap bolts (700, 710) and tighten in a crisscross pattern.
11. Reattach the pilot and tubing.

2.9 Reassembly of main valve dual chamber diaphragm

1. Ensure nozzle (460) maintenance is complete and nozzle (460) is reinstalled.
2. Secure seat hub (420) into soft jaw vise.
3. Install lower case (280A) on top of seat plate (910).
4. Lower shaft (320) and diaphragm assembly through center hole of case (280A).
5. Holding shaft (320) stationary, screw the seat plate assembly onto the main valve shaft (320). The connecting thread will run free, tighten, and free again as it engages with the locking helicoil (330).

CAUTION

Do not tighten the seat hub against the shoulder of the shaft.

6. Apply PTFE gasketing (620) to top of the main valve body (100). [See Figure 6]
7. Lower seat plate (910, 920), shaft assembly (320), and lower diaphragm case (280A) into main valve body (100). Align bolt hole with diaphragm (170A), case (280A), and body (100).
8. Replace the Seal Rod (690) in the upper end of the adapter bore (230) lubricating it with Dow Corning FS3451 or equivalent when the new one is installed. [See Figure 3, Detail A]

9. Install PTFE gasket material to upper main case (220) [See Figure 6] and lower auxiliary case assembly spool [see Figure 6].
10. Lubricate threads and shaft of lift rod (250) and lower spool assembly onto the main valve (100) while lifting rod wire through the center hole of the adapter (230).
11. Align match marks of case (220, 280A) with body (100), and install cap bolts (700, 710) and tighten in a crisscross pattern.
12. Lower auxiliary diaphragm assembly onto lower auxiliary case (280B) lifting rod wire through the center of diaphragm bushing (240). Holding the wire, spin diaphragm assembly 2 full turns clockwise.
13. Now bend the wire in half and spin the lift rod (250) counterclockwise approximately 20 turns. This is the starting position for setting the lift of the auxiliary diaphragm (170B).
14. To set lift position, position the edge of a ruler at the top edge of the auxiliary vacuum plate (160B) and lift the rod (250) up. Normal lift is $\frac{1}{8}$ " to $\frac{3}{16}$ ". To increase lift, spin rod (250) clockwise. To decrease lift, turn rod counterclockwise.
15. To lock setting insert PTFE seal rod O-ring (690) onto rod (250) and install jam nut (520B). To tighten, hold jam nut (520B) and lift rod (250) stationary and turn rod jam nut (530) clockwise until wrench tight.
Note: re-check Lift to ensure adjustment did not change during tightening.
16. Uncap the dome port and close the auxiliary and main diaphragm assemblies.
17. Apply PTFE Gasket (620B) to upper auxiliary diaphragm case. [See Figure 6] Replace the upper auxiliary diaphragm case (620B). Install case bolts (700) and nuts (730) and tighten.
18. Replace the pilot and tubing.

3 PILOT MAINTENANCE

3.1 Pilot disassembly for non-flowing modulating pilots (Series 400B) (Refer to Figures 7 and 8)

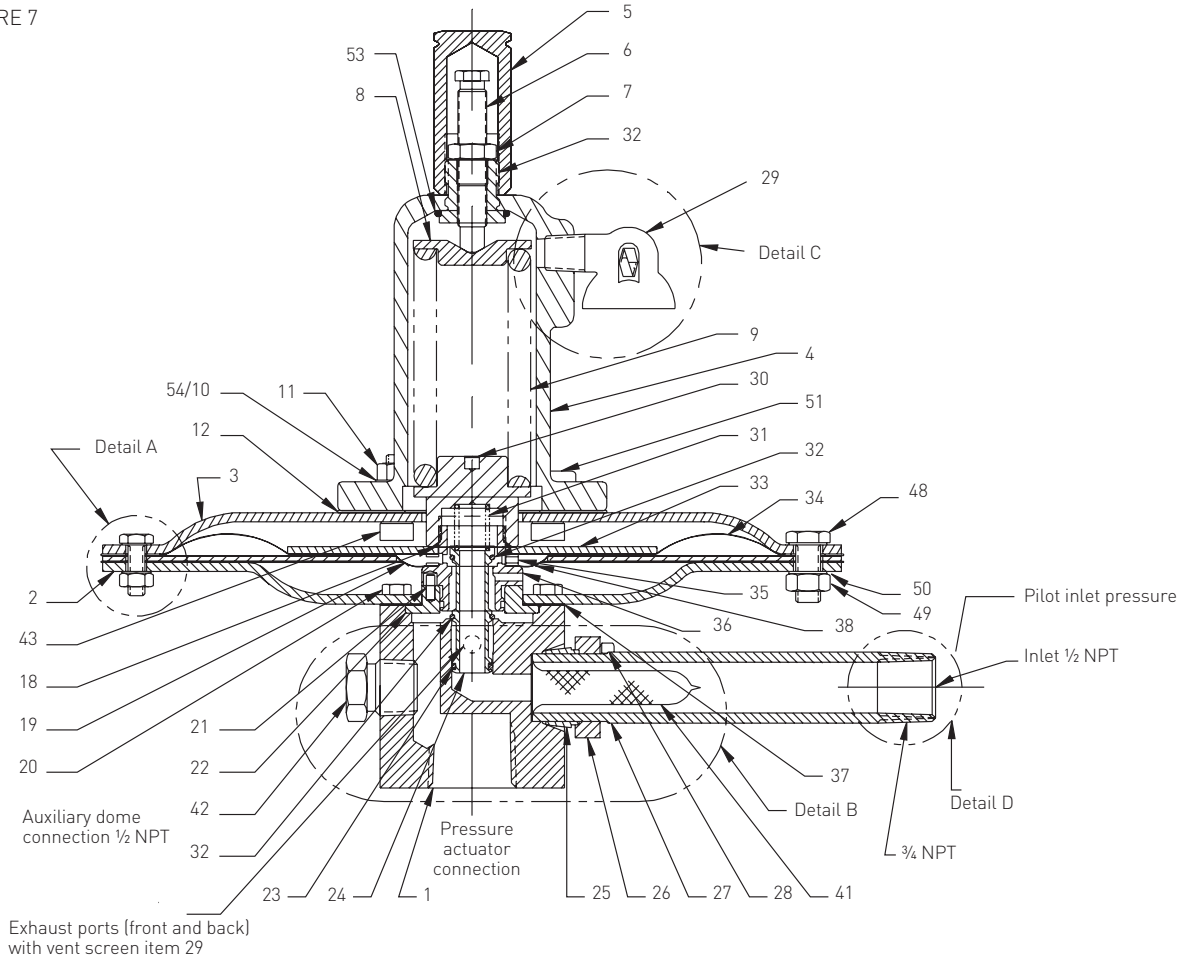
1. Remove bonnet cap (5), loosen adjustment screw lock nut (7), back out adjusting screw (6) to relieve spring (9) tension. Remove bonnet nuts (11), bonnet washers (10 and 53), bonnet assembly (4, 29, 51), bonnet gasket (12), spring washer (8), and spring (9).
2. Push down on spool retaining nut (30) with a Phillips screw driver engaging the spool anti-rotation pin (21), and remove nut (30) with a $\frac{1}{2}$ " open end wrench turning counterclockwise.
3. Remove spindle spring (31), case bolts (13 and 48), nuts (17 and 49), washers (16 and 50) and upper case (3). Remove the bonnet studs (43).
Note: internals are now accessible for removal.
4. Remove -014 O-ring (32), plate sense gasket (18), sense plate (33), sense diaphragm (34), gasket (15), ring lantern (35), diaphragm

- (19), feedback diaphragm (38), gasket (15), feedback diaphragm plate (14) and gasket (15).
5. Remove spool (36) and spindle (24) assembly.
6. Remove the lower spindle, -013 O-ring (23), outlet seat (22), -014 O-ring (32) from the spindle (24). Now the spindle (24) may be removed from the spool (36). Remove the top inlet seat O-ring from the spindle.
7. Remove the lower diaphragm case (2) from the body by removing the 4 inner case bolts (20).
8. Remove the inlet connector (27) and inlet screen (41) by removing the 2 bolts (28) on the side of the pilot body (1).
9. Clean all metal parts, and throw away all gaskets, diaphragms, and seals.
Note: pay particular attention to all port holes and polished areas.

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FIGURE 7

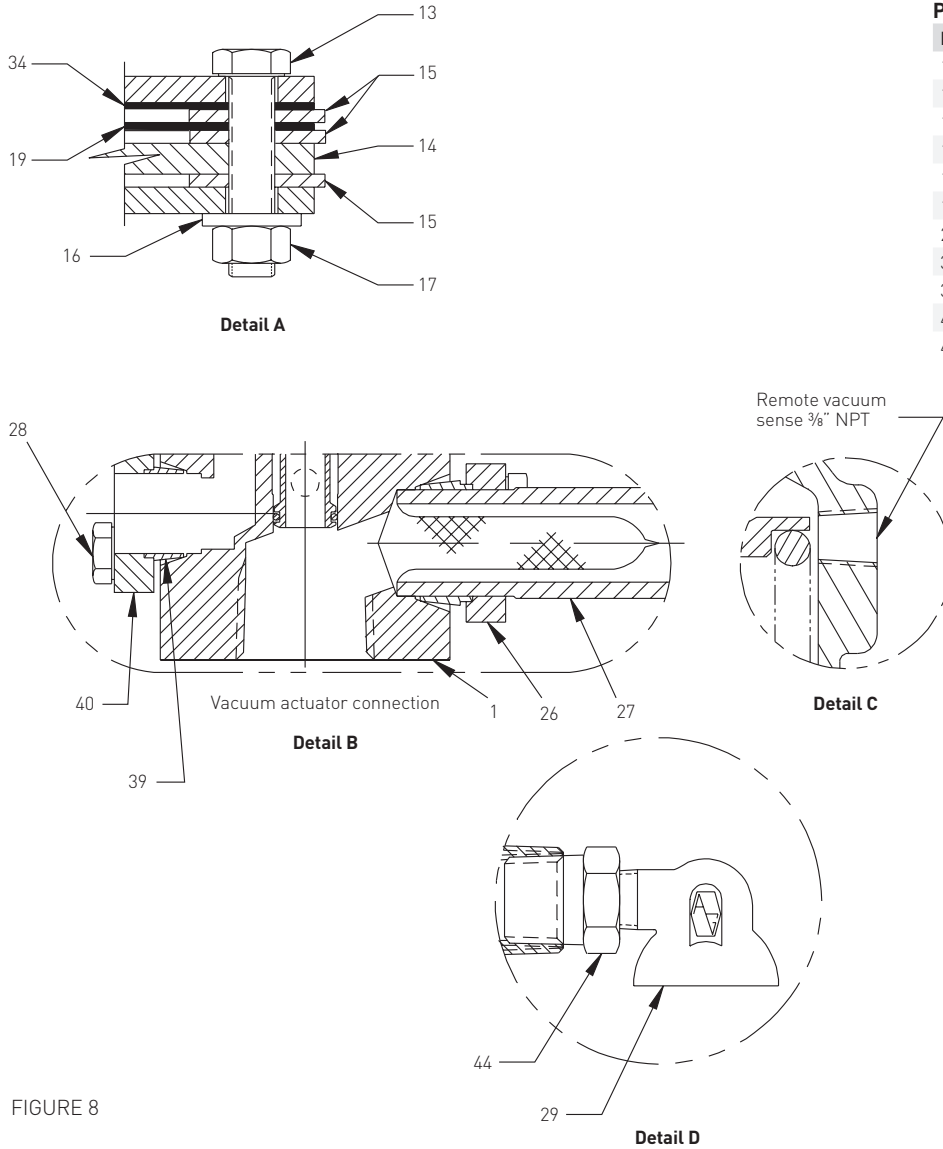


PARTS

| Item | Description | Item | Description | Item | Description |
|------|-----------------------------|------|-----------------------------|------|------------------------------|
| 1 | Body | 20 | Bolt | 35 | Ring - lantern |
| 2 | Case - diaphragm, lower | 21 | Pin - groove | 36 | Spool |
| 3 | Case - diaphragm, upper | 22 | Bushing - guide | 37 | Gasket - body |
| 4 | Bonnet assembly | 23 | O-ring [-013] | 38 | Slipper - feedback diaphragm |
| 5 | Cap - bonnet | 24 | Spindle | 41 | Screen - inlet |
| 6 | Screw - pressure adjustment | 25 | Ferrule - tubing | 42 | Plug - pipe |
| 7 | Nut - lock | 26 | Retainer - inlet connection | 43 | Stud - bonnet |
| 8 | Washer - spring | 27 | Connector - inlet | 48 | Case bolt |
| 9 | Spring | 28 | Bolt | 49 | Nut |
| 10 | Washer - plain | 30 | Nut - spool retainer | 50 | Washer |
| 11 | Nut | 31 | Spring - spindle | 51 | Plug |
| 12 | Gasket - bonnet | 32 | O-ring [-014] | 52 | Insert |
| 18 | O-ring [-022] | 33 | Plate - sense | 53 | O-ring |
| 19 | Diaphragm - feedback | 34 | Diaphragm - sense | 54 | Seal - thread |

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PARTS

| Item | Description |
|------|--------------------------|
| 13 | Bolt |
| 14 | Plate, diaphragm support |
| 15 | Gasket, diaphragm case |
| 16 | Washer, lock |
| 17 | Nut |
| 19 | Diaphragm, feedback |
| 29 | Vent |
| 34 | Diaphragm, sense |
| 39 | Ferrule, tubing |
| 40 | Retainer, dome tubing |
| 44 | Bushing |

FIGURE 8

3.2 Pilot assembly for non-flowing modulating pilots (Series 400B)

Assembly is done in the reverse order of disassembly.

- Lubricate all O-rings, sliding surfaces, screw threads and spring washer pivot points with Dow Corning No. 33 silicone grease or equivalent.
Note: for oxygen service valves use only lubricants suitable for this service, such as Krytox 240AC.
- The spindle O-ring and bearing surface should be lubricated with Dow Corning FS 3451 or equivalent.
Note: do not lubricate inlet or outlet seat O-rings
- Assemble the diaphragm lower case (2) to the body (1).
Note: for Pilots with Kalrez® O-rings, use two PTFE gaskets (37) between the lower diaphragm case (2) and the body (1).

- Assemble the inlet screen (41) to the inlet connector (26) and the inlet connector (26) to the body (1).
- Assemble the inlet seat (upper O-ring [-014]) (UPPER 32) and the spindle O-ring (23) to the spindle (24).
- Assemble the spindle (24) to the spool (36) and install the outlet seat (lower O-ring [-014]) (LOWER 32) to the spindle (24).

NOTE

Kalrez® is a registered trademark of DuPont Dow Elastomers.

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7. Install the spool (36) with spindle (24) in the body (1). Position the spool (36) to engage the anti-rotation groove pin (21).
8. Install a diaphragm case gasket (15) on the lower diaphragm case (2) and the feedback diaphragm support plate (14).
Note: install the support plate (14) with the rounded edge up towards the feedback diaphragm (38).
9. Install the following parts in the order listed on the spool (36):
 - a. Feedback diaphragm support plate (14)
 - b. Gasket (15)
 - c. Feedback diaphragm (38)
 - d. Diaphragm (19)
 - e. Lantern ring (35)
 - f. Gasket (15)
 - g. Sense diaphragm (34)
 - h. Sense plate (33)
Note: install the sense plate (33) with the round edge towards the sense diaphragm (34).
 - i. Install -022 O-ring (18) around the spindle. On the sense, add plenty of lubricant to the O-ring.
10. Install bonnet studs (43) thru upper diaphragm case (3). Install the upper diaphragm case (3), case bolts (13, 48), washers (16, 50), and nuts (17, 49).
11. Install the spindle spring (3) and spool retainer nut (30). Lube nut with Dow Corning 33 on bevel and use Fluorolube on the threads. Push down on the spool retainer nut (30) with a Phillips screw driver engaging the anti-rotation pin (21) and tighten the nut to 10 foot pounds using 1/2" open end wrench.
Note: do not over tighten, the diaphragms may be damaged.
12. Pretest pilot function by depressing spindle/diaphragm assembly stack downward. The spindle spring should return the stack assembly to the upward position. If it doesn't return to upward position, disassemble pilot and re-check assembly.
13. Install spring (9), spring washer (8), bonnet gasket (12) and bonnet (4) onto upper diaphragm case (3). Install bonnet washers (10,53) and nuts (11) and tighten.
14. Install pressure adjustment screw (6), lock nut (7) and cap (5).
This pilot is now ready for testing.

3.3 Pilot disassembly for flowing modulating or snap action pilots (Series 91, 93, and 93T) refer to Figures 9 thru 13

The pilot disassembly instructions and soft goods vary between pilot series. Pay particular attention to orientation of parts and materials. The 93T pilot has all PTFE soft goods including diaphragms, and its maximum set pressure is 15 psig. The 91 pilot has PTFE soft goods with stainless steel (SS), Hastelloy®, and PTFE diaphragms, and its set pressure ranges from 16 psig to 50 psig. The 93 pilot is different from

the 93T and 91 pilot in that it uses elastomer seat, seals and diaphragms.

1. Remove cap (760) and adjusting screw (790) and adjusting screw seal (720) for vacuum pilot. Remove bonnet bolts (770), seals (700) for vacuum pilot, bonnet (200), spring (840) and spring washer (820).
2. On Series 91 and 93T pilots, loosen boost tube fitting (310) on boost tube (320) at boost tube connector bolt (270). Refer to detail B. Remove boost tube connector nut (300), washer (290), lower boost tube seal (590), seal retainer (280). Let these three parts slide down boost tube. Remove boost tube connector bolt (270), upper boost tube seal (590) and seal retainer (280).
3. On Series 93 pilot, loosen boost tube fitting (310) on boost tube (320) at boost tube connector bolt (270). Refer to detail B. Remove boost tube connector nut (300), washer (290), lower boost tube seal (600) Let these three parts slide down boost tube. Remove boost tube connector bolt (270) and upper boost tube seal (590).
4. Remove case bolt nuts (260), washer (250) and bolts (240). Remove upper case (210).
5. On Series 91 and 93T pilot. Hold hex spacer (120) with a shortwell 3/4" socket that has the ratchet area bored out and inserting another socket into the bored out hole, loosen.
6. Remove parts in the following order: hex spacer (120), sense plate (150), upper gasket (650), sense diaphragm case gasket (650), spindle gasket (680), sense spacer (140), boost plate (160), spacer ring (230), diaphragm gasket (620), boost diaphragm gasket (680) (See Figure 12, detail A)
7. On Series 93 pilot. Hold hex spacer (120) with a shortwell 3/4" socket that has the ratchet area bored out and inserting another socket into the bored out hole, loosen.
8. Remove parts in the following order: hex spacer (120), sense plate (150), sense diaphragm (510), upper gasket (650), sense spacer (140), boost plate (160), spacer ring (230), diaphragm gasket (620), boost diaphragm gasket (510), boost spacer (130), check plate (560) and spindle seal (660). (See figure 12, detail A)
9. Remove boost tube (320) from body (100) and lower boost tube seal (590/600(93T)) from boost tube (320).
10. Remove spindle diaphragm (500) and gasket (690) for 93T pilot and spindle/disc assembly (550) from body (100).
11. Remove spindle diaphragm plate (170) and shim washer(s) (490) from spindle/seat assembly (550).
Note: shim washer(s) may not always be used in assembly (550).
12. Refer to detail A. For the 93T pilot seat assembly, remove the retainer ring (430) and seat retainer (420) from the spindle/disc assembly (550). Remove the seat (570).

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13. Remove blowdown bushing (390) and blowdown seal (630) from body (100).
Note: the blowdown screw retainer (380) is a loose fit on the blowdown adjustment screw (350). Be prepared to catch it when the bushing (390) is removed from the body (100).
 14. Loosen the blowdown screw locknut (370) and remove the blowdown adjusting screw (350) and seal (630) from the bushing (390).
 15. Remove the vent (800) from the body (100).
Note: it is not necessary to remove the filter screen (400) or nozzle (110) from the body (100).
 16. Clean all parts and replace all soft goods. The spindle/seat assembly (550) is factory assembled and must be replaced as a unit. If the nozzle (110) is nicked or scratched, it should be replaced. To remove it, use a deep socket.
- ### 3.4 Pilot assembly for flowing modulating or snap action pilots [Series 91, 93, and 93T]
1. On Series 93 and PTFE seat Series 91 and 93T pilots, if you removed the nozzle (110), reattach the nozzle (110) to the body (100), and replace the spindle seat assembly (550).
 2. If you removed the filter screen (400), reattach the filter screen (400), and reattach the vent (800) to the body (100).
 3. Reattach the blowdown seal (620), and blowdown adjusting screw (350) to the blowdown bushing (390), and tighten the blowdown nut (370).
Note: make sure the blowdown screw retainer (380) is on the blowdown adjustment screw (350).
 4. Attach the bushing seal (630) and the blowdown bushing (390) to the body (100).
 5. Place the shim washer(s) (490), if applicable, and spindle spacer (170) on the spindle seat assembly (550). Then place the spindle seat assembly (550) in the body (100).
 6. Lay a straight edge across the body (100) and check the gap between the straight edge and the spindle spacer (170). Add or remove shim(s) (490) as required to make the top of the spindle spacer (170) even with the top of the body (100).
 7. Align the small hole in the lower diaphragm case (220) with the hole in the spindle diaphragm (500). Then align the spindle diaphragm hole (500) with the hole in the body (100). Install the lower case (220), body bolts (340) and bolt seals (610) onto the body (100) and tighten together.
Note: on the 91 and 93T pilots, there are gaskets (690) on each side of the spindle diaphragm (500) and a diaphragm case plate (180) that must be installed onto the lower case (220) using the spiral pin (410).
 8. On Series 91 and 93T pilots, slide the hex nut (300), flat washer (290), seal retainer (280), and seal boost tube (590) on to the boost tube (320).
On Series 93 pilots, slide the hex nut (300), flat washer (290), and thread seal (600) on to the boost tube (320). Then attach the boost tube (320) to the body (100) with the connector (330).
 9. On Series 91 and 93T pilots, install parts in the following order: spindle seal (660), boost spacer (130), diaphragm case gasket (640), boost diaphragm (510/520), diaphragm case gasket (larger I. D. hole) (640), spacer ring (230), boost plate (160), sense spacer (140), diaphragm case gasket (640), sense diaphragm (510), diaphragm gasket (smaller I.D. hole)(640), sense gasket (670), sense plate (150), hex spacer (120), spring disc (830), lock washer (780) and jam nut (750).
Note: be sure to align large hole in diaphragm(s) (510/520) and gaskets (ALL 640) with the boost tube hole (270).
 10. On Series 93 pilot, install parts in the following order: spindle seal (660), check plate (rubber side down) (560), boost spacer (130), boost diaphragm (510), diaphragm gasket (650), spacer ring (230), boost plate (160), sense spacer (140), diaphragm gasket (650), sense diaphragm (510), sense plate (150), hex washer (120), spring disc (830), lock washer (780), and jam nut (750).
Note: be sure to align large hole in diaphragm(s) (510) and gaskets (ALL 650) with the boost tube (270) hole.
 11. To tighten spindle (550) and diaphragm assembly, hold ¾" socket tool onto hex washer (120) stationary, and tighten the jam nut (750).
 12. Install upper diaphragm case (210), case bolts (240), washers (250) and nuts (260), and tighten.
 13. Install the upper boost tube seal (590) (Series 93 pilot), PTFE seal (590) and seal retainer (280) (Series 91 and 93T pilot), and boost tube connector/bolt (270) into the large hole of the diaphragm cases (210, 220). Slide the lower boost tube seal (600) (Series 93 pilot), PTFE seal (590) and seal retainer (280) (Series 91 and 93T pilot), washer (290), nut (300), and boost tube connector nut (310/480) up the boost tube (320) attach to the boost tube connector/ bolt (270). Tighten boost tube fitting (310) on the boost tube (320) at the boost tube connector/bolt (270).
 14. Install the spring (840), spring washer (820), bonnet assembly (200), and bonnet bolts (770), adjusting screw (790), locknut (190), and cap (760).
Note: for the vacuum pilot remember to replace bonnet bolt (700), bonnet gasket (580) and adjusting screw seal (720).

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PILOT PARTS (FIGURES 9, 10, 11)

| Item | Description | Item | Description |
|------|--|------|--|
| 100 | Body | 490 | Washer - shim (for stack height only) |
| 110 | Nozzle | 500 | Diaphragm - spindle |
| 120 | Spacer - hex | 510 | Diaphragm - sense/boost |
| 130 | Spacer - boost | 520 | Diaphragm - sense (93T only) |
| 140 | Spacer sense | 550 | Spindle |
| 150 | Sense plate | 560 | Plate - check |
| 160 | Plate - boost | 570 | Seat |
| 170 | Spacer - spindle | 580 | Gasket - bonnet |
| 180 | Plate - diaphragm case (93T only) | 590 | Seal - boost tube |
| 190 | Pressure adjustment lock nut | 600 | Seal - thread |
| 200 | Bonnet assembly (items 450 - 710 part of assembly) | 610 | Seal - body bolt |
| 210 | Diaphragm case upper | 620 | Seal - blowdown |
| 220 | Diaphragm case lower | 630 | Seal - bushing |
| 230 | Ring - spacer | 640 | Gasket - case |
| 240 | Case - bolt | 650 | Gasket - diaphragm |
| 250 | Case washer - lock | 660 | Seal - spindle |
| 260 | Case nut - hex | 670 | Gasket - sense (93T only) |
| 270 | Connector - boost tube | 680 | Gasket - spindle (93T only) |
| 280 | Seal - retainer (93T only) | 690 | Gasket - spindle diaphragm used if item 500 is PTFE) |
| 290 | Washer - flat | 700 | Seal - bonnet bolt (93T only) |
| 300 | Nut - hex | 710 | Seal - bonnet insert (part of item 200 assembly vacuum only) |
| 310 | Nut - connector | 720 | Seal adjustment screw (93T only) |
| 320 | Tube - boost | 730 | Base - seat (93T only) |
| 330 | Connector - straight | 740 | Ball |
| 340 | Bolt - body | 750 | Nut - hex |
| 350 | Needle - blowdown adjustment | 760 | Cap |
| 370 | Blowdown nut | 770 | Bolt - bonnet |
| 380 | Blowdown retainer | 780 | Washer - lock |
| 390 | Blowdown bushing | 790 | Pressure adjustment screw |
| 400 | Screen filter | 800 | Vent - body (dependent on configuration of assembly) |
| 410 | Pin - spiral (93T only) | 810 | Vent - bonnet |
| 430 | Ring - retainer (93T only) | 820 | Washer - spring |
| 440 | Nut - swage (93T only) | 830 | Disc spring |
| 450 | Insert - bonnet (part of item 200 assembly) | 840 | Spring |
| 460 | Wire | 910 | Name plate (not shown) |
| 470 | Seal - 1/2" dia | 920 | Screw - drive (not shown) |
| 480 | Ferrule (not shown) | | |

ANDERSON GREENWOOD SERIES 9300 PILOT OPERATED SAFETY RELIEF VALVES
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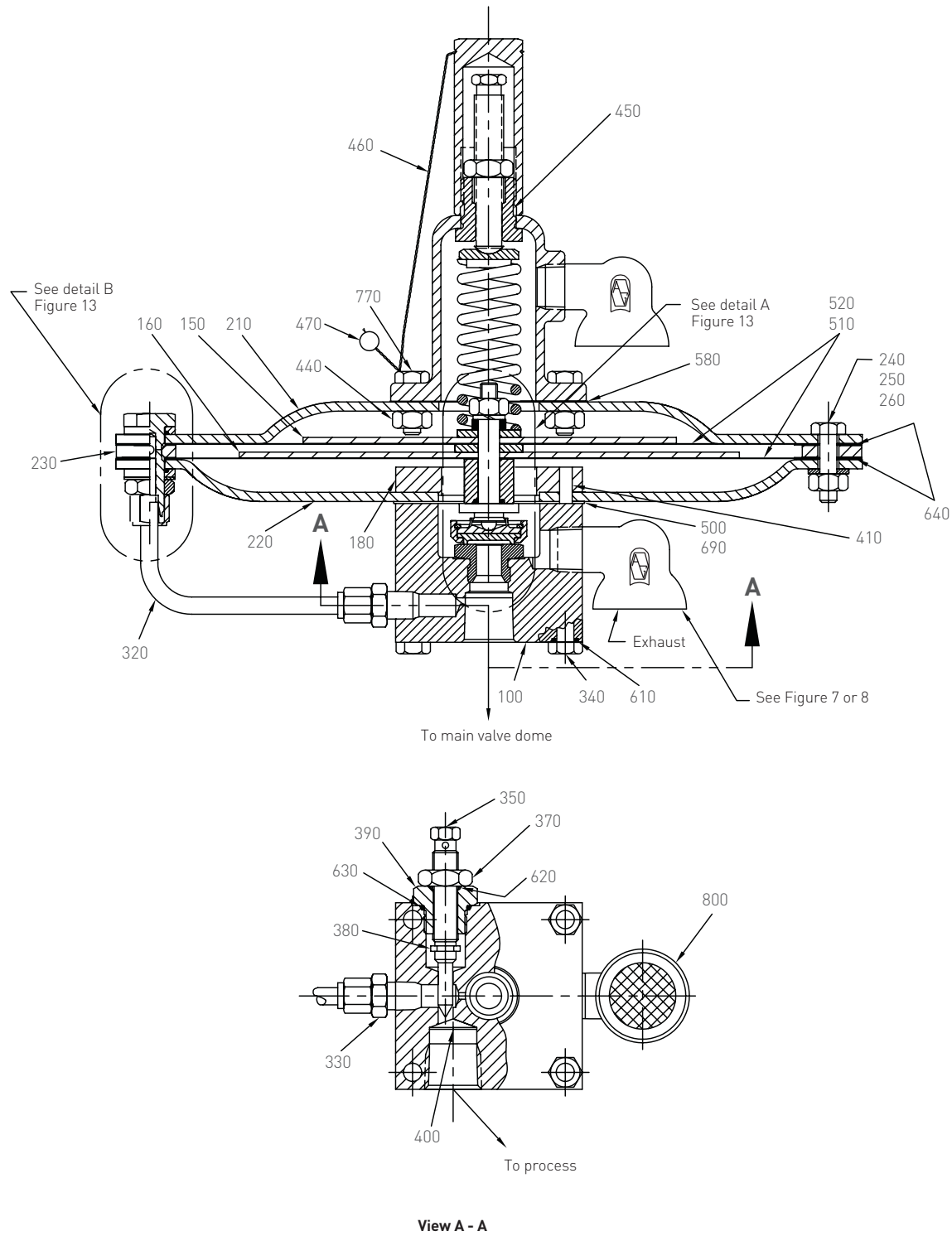


FIGURE 9
 Series 93 and 93T pressure pilot (below 15 psig)

ANDERSON GREENWOOD SERIES 9300 PILOT OPERATED SAFETY RELIEF VALVES

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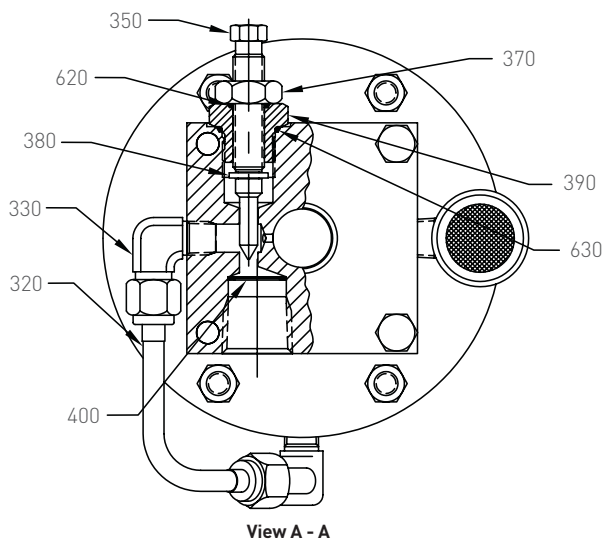
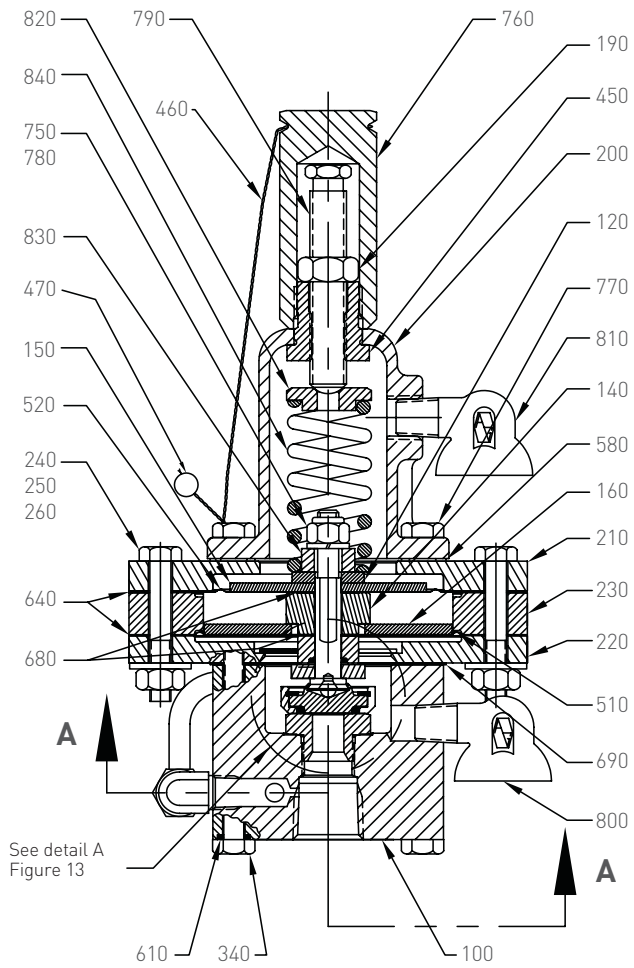


FIGURE 10
Series 91 and 93 pressure pilot (Above 15 psig)

ANDERSON GREENWOOD SERIES 9300 PILOT OPERATED SAFETY RELIEF VALVES
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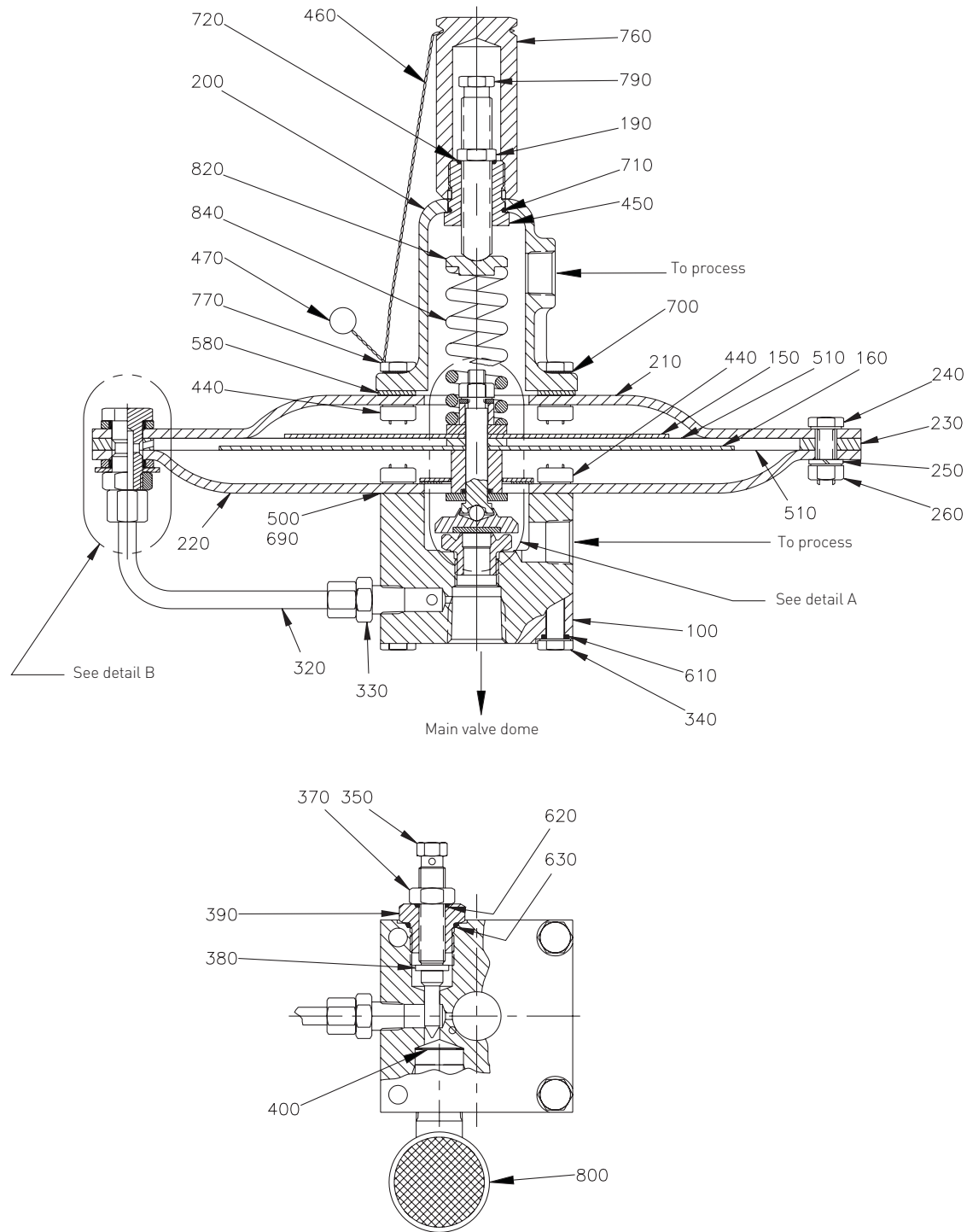


FIGURE 11
 Series 93 vacuum pilot

ANDERSON GREENWOOD SERIES 9300 PILOT OPERATED SAFETY RELIEF VALVES
 INSTALLATION AND MAINTENANCE INSTRUCTIONS

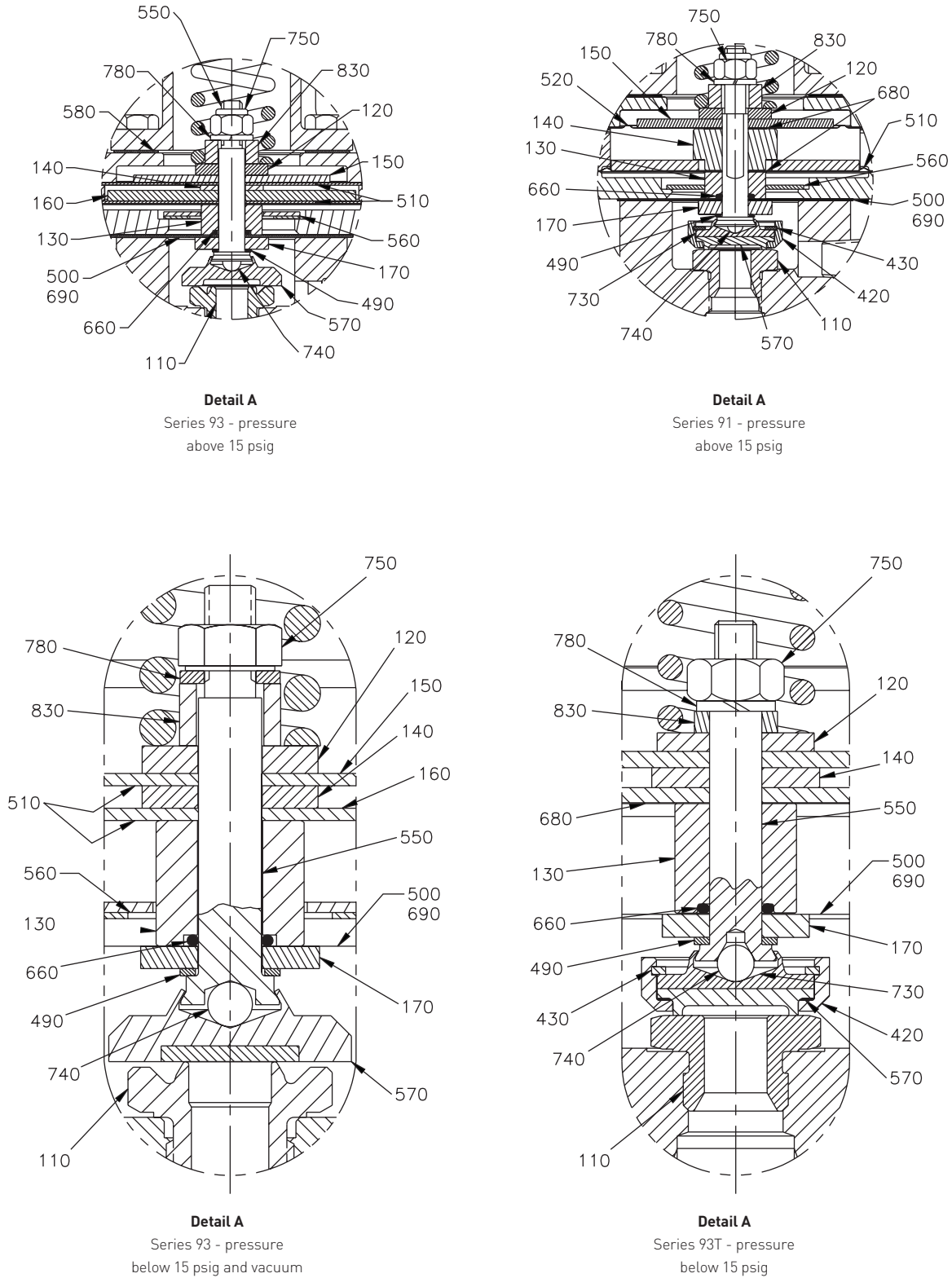


FIGURE 12

ANDERSON GREENWOOD SERIES 9300 PILOT OPERATED SAFETY RELIEF VALVES
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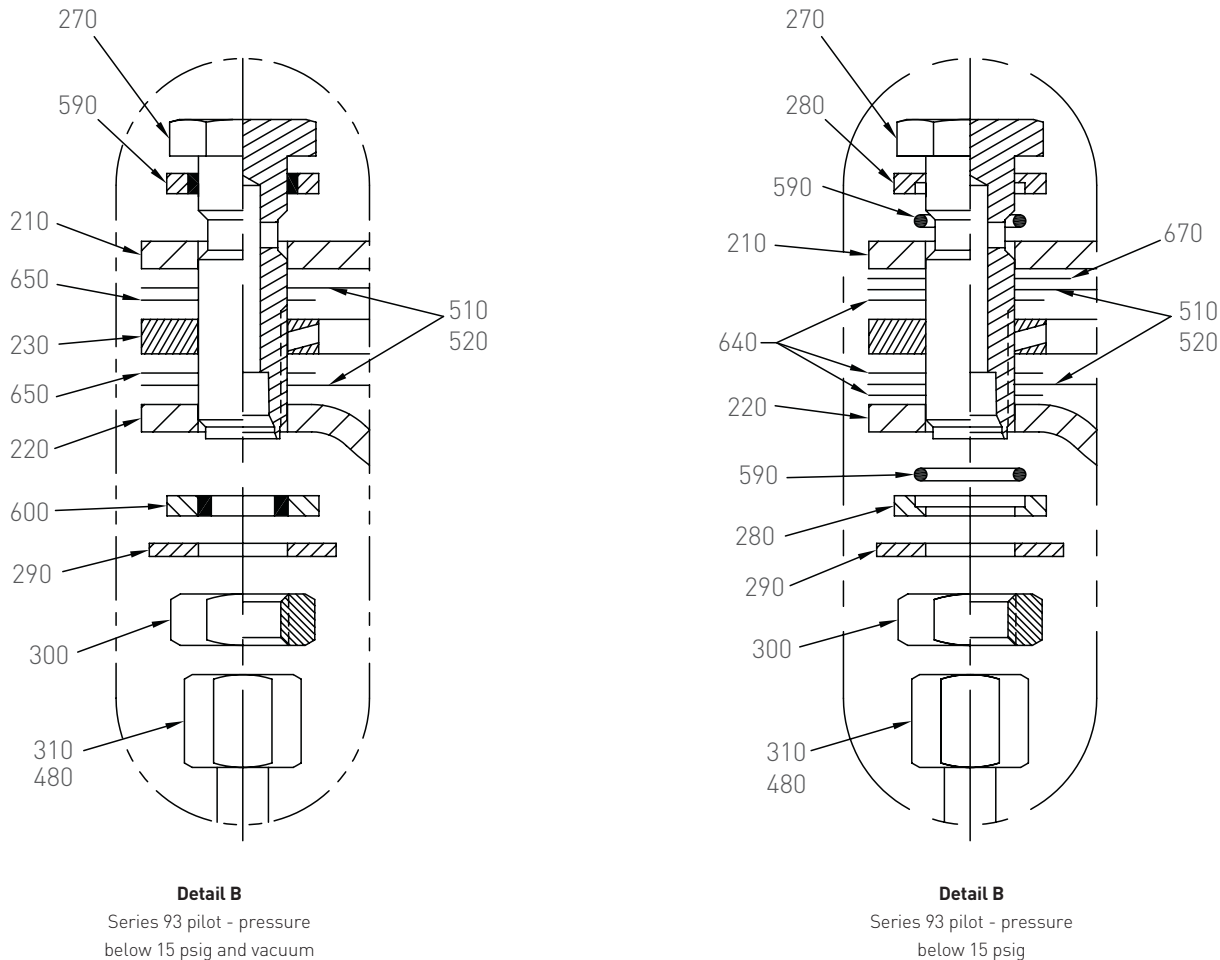


FIGURE 13

3.5 Pilot adjustment for non-flowing modulating pilots (Series 400B)

The pilot may be set separate from the main valve provided there is access to a pilot test system similar to the one shown in Figure 14.

3.5.1 Adjustment of set pressure

1. Install the pilot valve onto the pilot test system and attach gage sensing lines to the supply and dome connections.
2. Remove cap.
3. Screw the set pressure adjustment screw clockwise until it is screwed IN 80% to 90%.
4. Increase the supply pressure to nameplate setting and slowly back out the adjustment screw until flow through the pilot exhaust begins.
5. Continue to back the set pressure adjustment screw out until the dome pressure is 70% of the supply pressure. When the dome pressure reaches 70% of the supply pressure read the supply gage pressure. If it is below set pressure, you will need to tighten down on the pressure screw, or back off if you are high. Tighten the locknut once the desired set pressure is achieved.

Note: adjust the set pressure for $101\% \pm 1\%$ of the nameplate set pressure.

6. Cycle the pilot valve a minimum of 5 times to assure that the dome pressure reduction at set pressure is consistent. Increase the pressure very slowly in order to obtain an accurate reading of the cracking pressure and to expose any erratic performance.

Note: cracking pressure on vacuum pilots is that pressure at which the initial dome pressure change is noted.

7. Hold the pilot valve at set pressure to obtain the dome pressure reading.

Note: the first 6 steps should be completed before this step is undertaken. In modulating 400B pilots, the dome pressure decreases proportional to increase in inlet pressure. Full dome reduction (dome pressure) occurs $\leq 6\%$ over pressure.

8. Check the pilot exhaust for leakage when the pilot is in null position between crack and reseal.

Note: maximum leakage allowed is 60 bubbles per minute.

3.5.2 Reseat pressure

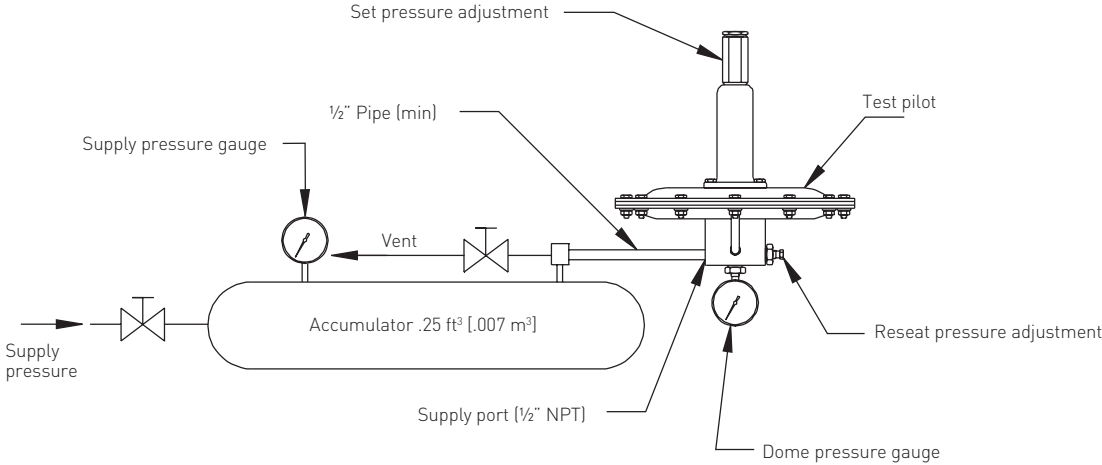
Reseat is defined as that supply pressure when the dome pressure is 75% of the supply pressure.

Note: blowdown adjustment is not required on Series 400B pilots.

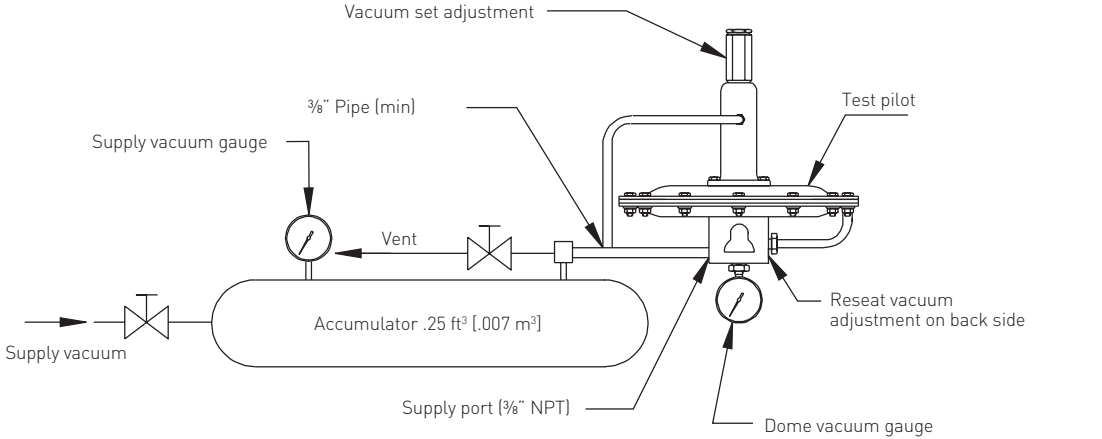
3.5.3 ADJUSTMENT TOLERANCES

| Pressure | Tolerance |
|-----------------|------------|
| Set pressure | $\pm 3\%$ |
| Crack pressure | 98% of set |
| Reseat pressure | 96% of set |

ANDERSON GREENWOOD SERIES 9300 PILOT OPERATED SAFETY RELIEF VALVES
INSTALLATION AND MAINTENANCE INSTRUCTIONS



Positive pressure pilot



Negative pressure pilot

FIGURE 14

ANDERSON GREENWOOD SERIES 9300 PILOT OPERATED SAFETY RELIEF VALVES

INSTALLATION AND MAINTENANCE INSTRUCTIONS

3.6 Pilot adjustment for flowing modulating or snap action pilots (Series 91, 93, and 93T pilots)

The pilot may be set separate from the main valve provided there is access to a pilot test system similar to the one shown in Figure 14.

3.6.1 Adjustment of set pressure

1. Install the pilot valve onto the pilot test system, and attach gage sensing lines to the supply and dome connections.
2. Remove the cap.
3. Screw the set pressure adjustment screw clockwise until it is screwed in 80% to 90%.
4. Increase the supply pressure to nameplate setting and slowly back out the set pressure adjustment screw until flow through the pilot exhaust begins.
5. Continue to back the set pressure adjustment screw out until the dome pressure is 70% of the supply pressure. When the dome pressure reaches 70% of the supply pressure read the supply gage pressure. If it is below set pressure, you will need to tighten down on the pressure screw, or back off it if you are high. Tighten the locknut once the desired set pressure is achieved.

Note: set pressure on a vacuum pilot is evidenced by a rapid change of the dome pressure (0 gage) to the supply pressure. A slow ramp speed is recommended on low set valves in order to obtain true reading of set pressure.
6. Check the pilot exhaust vent for leakage. The pilot shall be bubble tight up to crack pressure shown in 3.6.3. Also, check upper pilot vent for leakage. There should be 0 leakage from the upper vent.

3.6.2 Reseat pressure

1. Turn the blowdown adjusting screw clockwise to decrease the reseat pressure or counterclockwise to increase the reseat pressure.
2. A small interaction between set pressure and reseat pressure adjustments will occur; therefore, it may be necessary to readjust the set pressure after setting reseat pressure.

Note: if the blowdown adjusting screw has been removed or turned to either extreme, positioning it midway will aid in obtaining the correct reseat pressure. There are approximately 7 to 8 turns to obtain full travel of the adjustment. Midway from either end should produce a blowdown for snap action. For modulating pilot action, back the adjustment screw out counterclockwise.

3. Cycle the pilot valve a minimum of 5 times to assure that dome pressure reduction at set pressure is consistent. Increase the pressure very slowly in order to obtain an accurate reading of the cracking pressure and to expose any erratic performance.

Note: cracking pressure on vacuum pilots is that pressure at which the initial dome pressure change is noted.

4. Hold the pilot valve at set pressure to obtain the dome pressure reading. For modulating pilots, dome pressure shall be read with the inlet at 105% of set pressure.

Note: the first 4 steps should be completed before this step is undertaken. On snap action pilots, the dome pressure decreases rapidly with a "snap" to 15% ± 10% of set pressure. On modulating action pilots (Series 90), the dome pressure decreases slowly to 30% ± 5% of set pressure and recovers to 60% ± 10% of set pressure at set pressure.
5. After desired pilot action is set, verify pilot seat tightness. This is accomplished by checking the pilot exhaust vent for leakage. The pilot should be bubble tight up to crack pressure as shown in 3.6.3. Be aware of crack pressure changes between set pressure ranges.

3.6.3 ADJUSTMENT TOLERANCES

| Pilot action | Set press. | Set press. tolerances | Crack press. % set | Reseat press. % set |
|-------------------|------------------------|-----------------------|--------------------|---------------------|
| Snap | 4" WC to 7" WC | ± .2" WC | 75% | 90% ± 1 |
| Snap | 7" WC to 1.0 psig | ± 3% | 90% | 90% ± 1 |
| Snap | Above 1 psig | ± 3% | 95% | 92% ± 1 |
| Snap | -4" WC to -7" WC | ± .2" WC | 75% | 90% ± 1 |
| Snap | -7" WC to -1.0 psig | ± 3% | 90% | 90% ± 1 |
| Snap | -1 PSI to -14.7 psig | ± 3% | 95% | 92% ± 1 |
| Modulating action | 4" WC to 7" WC | ± .2" WC | 75% | 100% |
| Modulating action | 7" WC to 1.0 psig | ± 3% | 90% | 100% |
| Modulating action | Above 1.0 psig | ± 3% | 95% | 100% |
| Modulating action | -4" WC to -7" WC | ± .2" WC | 75% | 100% |
| Modulating action | -7" WC to -1.0 psig | ± 3% | 90% | 100% |
| Modulating action | -1.0 PSI to -14.7 psig | ± 3% | 95% | 100% |

4 FUNCTIONAL TESTING OF COMPLETE ASSEMBLY OF MAIN VALVE AND PILOT

4.1 General

Assemble the pilot to the main valve, and install remaining tubing and accessories. The complete valve assembly should be leak tested for internal and external leaks using a pressure equal to 30% and 90% of set.

4.1.1 Leakage check - pressure relief valves

Apply pressure to the inlet equal to 30% of the set pressure. Check for leakage at the main valve seat, no visible leakage shall occur. Hold time is 1 minute.

Increase the inlet pressure to 90% of the set pressure. Check for leakage at the cap seal, casting, pilot support pipe and supply tube and other applicable connections using leak test solution and at the main valve seat. No visible leakage shall occur for a hold time of 1 minute.

4.1.2 Leakage check - vacuum relief valves

Valves equipped with vacuum pilots shall be leak tested per 4.1.1 on positive pressure with the set pressure equal to the reciprocal of the vacuum set pressure. Valves with weighted diaphragms shall be tested for leakage at 50% of their weighted set.

4.1.3 Back flow preventers and/or field test

The use of some field test connection or back flow preventers necessitates the use of check valves. These valves shall be installed per the applicable assembly drawings and in the free flow direction shall open at less than .5" W.C. The check valves may be tested for forward flow either before or after assembly at the shops option. The output check valve of back flow preventers shall be checked for zero leakage per 4.1.1 paragraph 2.

4.2 Leakage check - pressure relief valves pressure pilot (Series 400B pilot)

1. Connect gas bottle as shown in Figure 15.
2. Close valve "C".
3. Open block valve "B" to supply regulator.
Note: regulator pressure should be set at 0.
4. Connect bubble tester bottle to pilot exhaust vent and block the second pilot vent if the pilot is equipped with one.
5. Increase pressure at field test port to slightly above tank pressure by slowly increasing regulated pressure.
6. Open field test valve "A" and slowly increase regulator pressure until bubbles are seen in the bottle. That pressure will be within 3% of the set pressure.
7. To remove the test set-up, close valves "A" and "B" and open valve "C".

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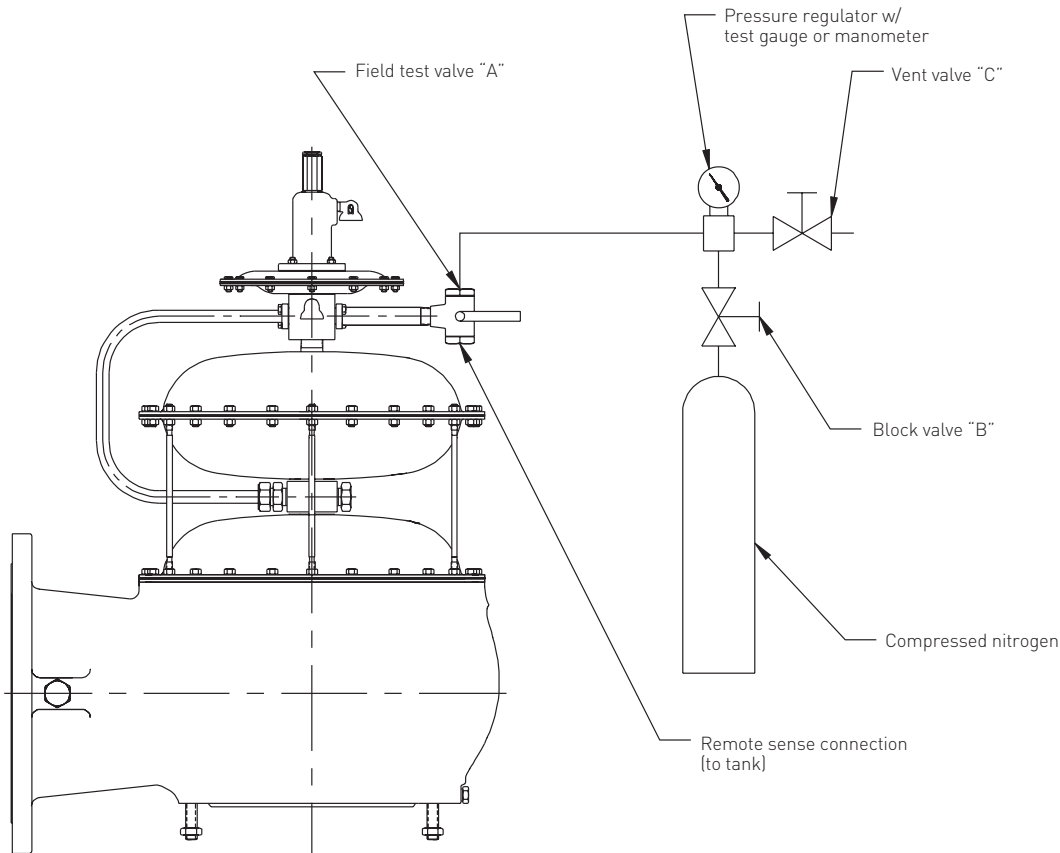


FIGURE 15

4.3 Field test instructions for flowing modulating or snap action pilots

4.3.1 General

An optional field test accessory is available for checking the positive set pressure without removing the valve from service. The field test accessory consists of a 3-way ball valve to allow the pilot to sense pressure from either the process or from the test gas source.

A standard bottle of nitrogen equipped with a pressure regulator, block valve, pressure gage, and convenient length of high pressure flexible hose is recommended for testing. A set up similar to that shown in Figure 13 should be used. Such a test kit is available from Anderson Greenwood under the part number 04.4812.001 plus additional dash numbers for the pressure gages required.

4.3.2 Field test procedure for flowing modulating or snap action pilots

1. Connect the gas bottle as shown in Figure 16.
2. Close vent valve "C".
3. Open block valve "B" to supply regulator.
Note: regulator pressure should be set at 0.
4. Connect bubble tester bottle to pilot exhaust vent.

5. Increase pressure at field test port to slightly above tank pressure by slowly increasing regulated pressure.
6. Open field test valve "A" and slowly increase regulator pressure until bubbles are seen in the bottle. That pressure will be within 10% of the set pressure.
Note: for pilots adjusted for snap action, the main valve seat will open at set pressure if the tank pressure is present. If it is not, a sudden increase in pilot exhaust flow will be observed at set pressure.
7. To remove the test set-up, close valves "A" and "B" and open valve "C".

ANDERSON GREENWOOD SERIES 9300 PILOT OPERATED SAFETY RELIEF VALVES

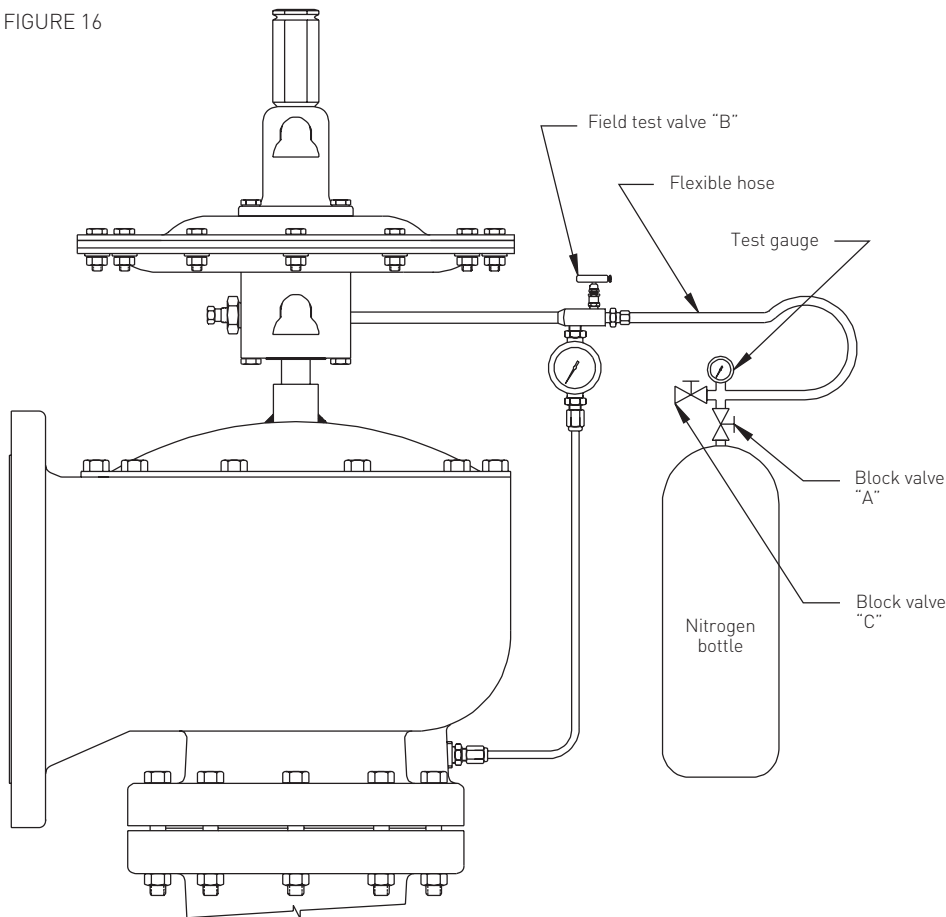
INSTALLATION AND MAINTENANCE INSTRUCTIONS

5 STORAGE AND HANDLING

Because cleanliness is essential to the satisfactory operation and tightness of a Series 9000 pilot operated relief valve, precautions should be taken to keep out all foreign particles and materials. Valves should be closed off properly at both the valve inlet and outlet. Particular care should be taken to keep the valve inlet absolutely clean. Valves should preferably be stored indoors with the original factory installed protective measures left in place. This includes all desiccants, flange protectors, and factory seals.

Valves should be placed on wooden pallets or other blocking materials to keep them off the floor or in a location where dirt and other forms of contamination are kept to a minimum. Valves should not be thrown in a pile or laid on the bare ground waiting for installation.

FIGURE 16



ANDERSON GREENWOOD SERIES 9300 PILOT OPERATED SAFETY RELIEF VALVES

INSTALLATION AND MAINTENANCE INSTRUCTIONS

6 TROUBLE SHOOTING

| Problem | Possible cause | Resolution |
|--------------------------------|---|--|
| 1. Valve opens below set | 1. Improper installation of sense line 2. Plugged sense line 3. Improper gauge accuracy and/or location | 1. Verify if sense line is installed properly 2. Check sense line, inlet screen, and dipper tube for cleanliness 3. Verify gauge accuracy for valve being tested and ensure location is at valve being tested |
| 2. Pilot leaks from upper vent | 1. Sense diaphragm failure 2. Spindle lock nut loose | 1. Replace diaphragm 2. Tighten spindle lock nut |
| 3. Pilot leaks from lower vent | 1. Pilot seat leakage 2. Nozzle over tightened | 1. On the 93 pilot, replace spindle disc assembly. On the 93T and 91 pilots, replace seat. Inspect nozzle and relap if necessary 2. Tighten nozzle per assembly instructions |
| 4. Main valve leaks | 1. Seat film damaged 2. Nozzle damaged 3. Nozzle seal damaged, missing, or out of place 4. Seat plate assembly is loose 5. Operating too close to set pressure (above 96%) 6. Main valve diaphragm failure 7. Diaphragm assembly loose 8. Seat plate not fully threaded on hub | 1. Replace seat film 2. Inspect nozzle and relap if necessary 3. Position nozzle seal per assembly instructions 4. Tighten seat plate assembly 5. Lower operating pressure 6. Replace diaphragm 7. Tighten diaphragm assembly 8. Install seat per assembly instructions |

7 MAIN VALVE SPARE PARTS AND REPAIR KITS

Soft goods repair kits contain all the diaphragms, seals, and seats to a repair valve. To order a kit, specify the base number and select the last three digits from the following tables.

To ensure the purchase of the correct repair kit, the order should specify the valve model and serial number. For chloride rich environments, the bolts in the main valve and pilot exposed to the environment should be replaced during routine maintenance or at least every 5 years.

7.1 - SERIES 9300 MAIN VALVE SINGLE CHAMBER DIAPHRAGM REPAIR KIT (06.0235.XXX)

| Kit type | Internals | Materials | 2" | 3" | 4" | 6" | 8" | 10" | 12" |
|------------|------------------|-----------|-----|-----|-----|-----|-----|-----|-----|
| Soft goods | Aluminum | PTFE | 319 | 321 | 323 | 526 | 327 | 329 | 331 |
| Soft goods | SST-LP | PTFE | 496 | 498 | 500 | 527 | 504 | 506 | 508 |
| Soft goods | SST-HP | PTFE | 356 | 360 | 364 | 528 | 372 | 376 | 380 |
| Bolt | Aluminum | SST | 332 | 333 | 334 | 335 | 336 | 337 | 338 |
| Bolt | SST-LP | SST | 339 | 340 | 341 | 342 | 343 | 344 | 345 |
| Bolt | SST-HP <15 psig | SST | 346 | 347 | 348 | 570 | 350 | 351 | 352 |
| Bolt | SST-HP ≥15 psig | SST | 346 | 347 | 348 | 349 | 350 | 351 | 352 |
| Bolt | SST Marine | SST | 624 | 625 | 626 | 627 | 628 | 629 | 630 |
| Bolt | SST Marine certs | SST | - | - | - | 631 | 632 | 633 | 634 |

7.2 - SERIES 9300 MAIN VALVE DUAL CHAMBER DIAPHRAGM REPAIR KIT (06.0235.XXX)

| Kit type | Internals | Materials | 2" | 3" | 4" | 6" | 8" | 10" | 12" |
|------------|-----------|--------------|-----|-----|-----|-----|-----|-----|-----|
| Soft goods | Aluminum | PTFE/Kalrez® | 382 | 384 | 386 | 388 | 390 | 392 | 394 |
| Soft goods | SST | PTFE/Kalrez® | 545 | 547 | 549 | 551 | 553 | 555 | 557 |
| Bolt | Aluminum | SST | 395 | 396 | 397 | 398 | 399 | 400 | 401 |
| Bolt | SST | SST | 402 | 403 | 404 | 405 | 406 | 407 | 408 |

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INSTALLATION AND MAINTENANCE INSTRUCTIONS

8 PILOT SPARE PARTS AND REPAIR KITS

8.1 - 91 PILOT REPAIR KIT (04.4744.XXX)

| Pilot type | Pressure | Kit type | Material | Pressure |
|------------|--------------|------------|----------------|----------|
| 91 Pilot | 15 - 50 psig | Soft goods | PTFE/Stainless | 003 |

8.2 - 93 PILOT REPAIR KIT (06.0235.XXX)

| Pilot Series | Pressure | Kit type | Material | Pressure | Vacuum |
|-----------------|------------------|------------|--------------------|----------|--------|
| 93 Pilot | 4"WC - 14.9 psig | Soft goods | NBR | 133 | 152 |
| 93 Pilot | 4"WC - 14.9 psig | Soft goods | FKM | 134 | 153 |
| 93 Pilot | 4"WC - 14.9 psig | Soft goods | EPR | 135 | 154 |
| 93 Pilot | 4"WC - 14.9 psig | Soft goods | NBR ⁽¹⁾ | 136 | 155 |
| 93 Pilot | 4"WC - 14.9 psig | Soft goods | FKM ⁽¹⁾ | 137 | 156 |
| 93 Pilot | 4"WC - 14.9 psig | Soft goods | EPR ⁽¹⁾ | 138 | 157 |
| 93 Pilot | 4"WC - 14.9 psig | Bolt | SST | 287 | 287 |
| 93 Pilot marine | 4"WC - 14.9 psig | Bolt | SST | 702 | 702 |
| 93 Pilot | 15 - 50 psig* | Soft goods | NBR | 141 | - |
| 93 Pilot | 15 - 50 psig* | Soft goods | FKM | 142 | - |
| 93 Pilot | 15 - 50 psig* | Soft goods | EPR | 143 | - |
| 93 Pilot | 15 - 50 psig* | Bolt | SST | 416 | - |

1. PTFE diaphragm

* (3 - 50 psig marine)

8.3 - 93T PILOT REPAIR KIT (06.0235.XXX)

| Pilot Series | Pressure | Kit type | Material | Pressure | Vacuum |
|------------------|----------------|------------|----------|----------|--------|
| 93T Pilot | 4"WC - 15 psig | Soft goods | PTFE | 139 | 158 |
| 93T Pilot | 4"WC - 15 psig | Bolt | SST | 288 | 288 |
| 93T Pilot marine | 4"WC - 15 psig | Bolt | SST | 701 | 701 |

8.4 - 400A/B PILOT REPAIR KIT (06.0235.XXX)

| Pilot Series | Pressure | Kit type | Material | Pressure | Vacuum |
|--------------|-------------------|------------|------------------------------------|----------|--------|
| 400A/B Pilot | 4"WC - 10"WC | Soft goods | NBR ⁽¹⁾ | 127 | 149 |
| 400A/B Pilot | 4"WC - 10"WC | Soft goods | FKM ⁽¹⁾ | 128 | 150 |
| 400A/B Pilot | 4"WC - 10"WC | Soft goods | EPR ⁽¹⁾ | 129 | 151 |
| 400A/B Pilot | 4"WC - 10"WC | Soft goods | Kalrez ⁽¹⁾ | 455 | 456 |
| 400A/B Pilot | >10" WC - 15 psig | Soft goods | NBR ⁽¹⁾ | 558 | 562 |
| 400A/B Pilot | >10" WC - 15 psig | Soft goods | FKM ⁽¹⁾ | 559 | 563 |
| 400A/B Pilot | >10" WC - 15 psig | Soft goods | EPR ⁽¹⁾ | 560 | 564 |
| 400A/B Pilot | >10" WC - 15 psig | Soft goods | Kalrez [®] ⁽¹⁾ | 561 | 565 |
| 400A/B Pilot | 4" WC - 15 psig | Bolt | SST | 409 | 409 |

1. PTFE diaphragm

8.5 - 400A PILOT REPAIR KIT (06.0235.000)

| Pilot Series | Pressure | Kit type | Material | Pressure | Vacuum |
|--------------|--------------|------------|------------------------------------|----------|--------|
| 400A Pilot | 15 - 50 psig | Soft goods | NBR ⁽¹⁾ | 458 | - |
| 400A Pilot | 15 - 50 psig | Soft goods | FKM ⁽¹⁾ | 459 | - |
| 400A Pilot | 15 - 50 psig | Soft goods | EPR ⁽¹⁾ | 460 | - |
| 400A Pilot | 15 - 50 psig | Soft goods | Kalrez [®] ⁽¹⁾ | 461 | - |
| 400A Pilot | 15 - 50 psig | Bolt | SST | 462 | - |

1. PTFE diaphragm

NOTES

Kalrez[®] is a registered trademark of DuPont Dow Elastomers

ANDERSON GREENWOOD SERIES 9300 PILOT OPERATED SAFETY RELIEF VALVES

INSTALLATION AND MAINTENANCE INSTRUCTIONS

9 ACCESSORIES, OPTIONS AND ACCESSORY REPAIR KIT

9.1 Accessories

- Field test connection
 - In-service verification of set pressure.
 - Simplifies the periodic testing of pressure relief valves.
- Backflow preventer
 - Prevents accidental reverse flow through pressure relief valve.

9.2 Options

- Manual unloader
 - Permits the pressure relief valve to be opened at pressures below the nameplate setting.
 - Acts as manual override to normal pressure setting, but has no effect on the sealed pressure setting.
- Remote unloader
 - Permits the pressure relief valve to be remotely opened to depressurize the system.
- Pilot exhaust tubed to main valve outlet (PEMVO)
 - Eliminates any local venting of fluid media from pilot.
- Remote pressure sense connection
 - Pressure relief valve will respond to actual system pressure conditions.
 - Eliminates undesirable cycling due to excessive inlet pressure losses.
 - Improves safety under adverse operating conditions.

9.3 - ACCESSORY REPAIR KIT (06.0235.XXX)

| Accessory | Kit type | Material | Dash number |
|---------------|------------|----------|-------------|
| Shuttle check | Soft goods | PTFE | 140 |
| Shuttle check | Bolt | SST | 410 |
| Diaphragm | Soft goods | PTFE | 144 |
| Diaphragm | Bolt | SST | 414 |
| Ball check | Soft goods | NBR | 145 |
| Ball check | Soft goods | FKM | 146 |
| Ball check | Soft goods | EPR | 147 |
| Ball check | Soft goods | Kalrez® | 148 |

10 LUBRICANT AND SEALANTS FOR SERIES 9300

(Only include lubricants referenced in the manual)

10.1 - LUBRICANTS USED ON PILOT PARTS

| Pilot parts | Description | Lubricant ⁽¹⁾ |
|---|---|--|
| Pressure adjustment, screw and locknut | Threads | Dow corning 33, #05.1500.012 |
| Diaphragm and gaskets (91 and 93T pilots) | Seal surfaces between cases and spacer ring | Slick stuff, #05.1500.015 |
| Stainless steel case, bolts and nuts | Threads | Fluorolube LG 160, #05.1500.023 |
| Carbon steel case bolts | Threads | Dow corning 33, #05.1500.012 |
| Stainless to aluminum or aluminum parts | Threads | Dow corning 33, #05.1500.012 |
| Sliding seals | PTFE or elastomer | Dow corning 33, #05.1500.012 |
| Pipe fittings and vents | Threads | PTFE Tape and dow corning 33, #05.1500.012 |

- For oxygen service use Krytoc 240AC

10.2 - LUBRICANTS AND SEALANTS USED ON MAIN VALVE PARTS

| Main valve parts | Description | Lubricant ⁽¹⁾ | Sealant |
|---|---|--|---------|
| Carbon steel bolts, screws and nuts, fittings | Threads | Dow corning 33, #05.1500.012 | - |
| Stainless on stainless bolts, screws, nuts and fittings | Threads | Fluorolube LG 160, #05.1500.023 | - |
| Diaphragms and gaskets (91 and 93T) | Seal surfaces between diaphragm and cases | Slick Stuff #4, #05.1500.015 | - |
| Seat hub and jam nut | Threads | - | Loctite |
| Shaft assembly and diaphragm Assembly jam nut | Threads | - | Loctite |
| Sliding seals | PTFE and elastomers | Dow corning 33, #05.1500.012 | - |
| Pipe fittings and vents | Threads | PTFE Tape and dow corning 33, #05.1500.012 | - |

- For oxygen service use Krytoc 240AC