

Betts Industries, Inc.

Warren, PA 16365

Phone: 814-723-1250

MAINTENANCE MANUAL FOR PAF 406-96 & 406-98 SURGE RELIEF VALVE

Section 1: Identification of Adjustable PAF 406-96 & 98

Section 2: Maintenance and Testing for PAF 406-96 & 98

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Section 5: Disassembly of PAF 406-96 & 98

Section 6: Assembly of PAF 406-96 & 98

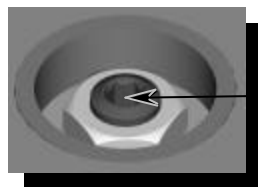
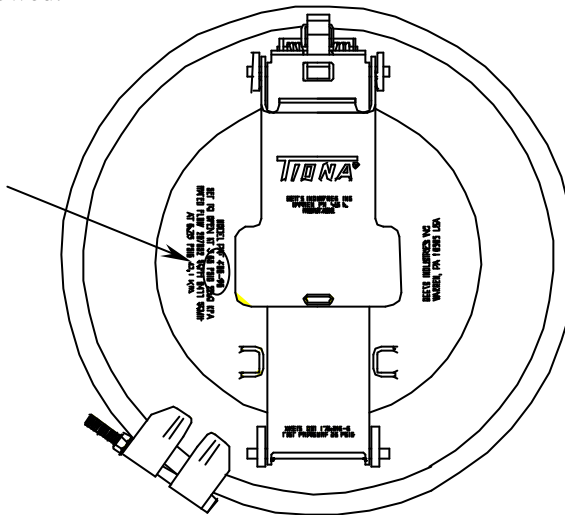
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SECTION 1:
IDENTIFICATION OF ADJUSTABLE
PAF SURGE RELIEF VALVE (PAF 406-96 & 98)

Betts PAF Surge Relief Valves (PAF 406-96 and PAF 406-98) meet or exceed all U.S. DOT requirements for primary pressure relief valves on DOT406 cargo tanks as contained in 49CFR178.345-10 and 49CFR178.346-3 of the Code of Federal Regulations. The Betts PAF Surge Relief Valve is able to withstand a brief pressure surge and contain lading (liquid cargo) leakage to less than one liter (per TTMA RP NO 81).

Betts PAF Surge Relief Valve (PAF 406-96 & 406-98) protects the cargo tank from rupture due to over-pressurization caused by overfilling or fire and is, therefore, crucial to the safe operation of the tank. In order to maintain your Betts PAF Surge Relief Valve in proper working condition, the following procedures must be followed.

All PAF 406-96's are cast with
“MODEL PAF 406-96”
And PAF 406-98's are cast with
“MODEL PAF 406-98”



HEX
DETAIL

PLASTIC CAP

BLACK E-COATED COVER

The adjustable PAF 406-96 & 98 have an internal hex at the top of the stem under the plastic yellow cap, as well as, a Black E-coated cover.

SECTION 2: MAINTENANCE AND TESTING FOR PAF SURGE RELIEF VALVE 406-96 & 98

- A. **U.S. DOT Requirements:** This portion of the manual refers to the DOT regulations and is intended to serve as an interface to relate the manual to the code. *This manual does not take the place of the Code of Federal Regulations.* A current copy of the Code of Federal Regulations should be reviewed and followed to insure the requirements are met for each individual case.

There are three basic tests/inspections mandated by 49CFR Part 180 for MC306 and DOT406 cargo tanks.

Test/Inspection	Interval Period	Code Paragraph
External Visual Inspection	1 year	49CFR180.407(d)
Leakage Test	1 year	49CFR180.407(h)
Pressure Retest	5 year	49CFR180.407(g)

1. **External Visual Inspection:** As part of the annual external visual inspection, 49CFR180.407(d)(3) requires that all pressure relief valves, be visually inspected for any corrosion or damage which might prevent the valve from functioning. If the cargo tank is used to haul product that is corrosive to the relief valve, the valve must be removed from the cargo tank for inspection and bench testing.

Note: Betts recommends that the external visual inspection of vents be performed monthly.

- 1.1. Visually inspect all external surfaces of the manhole and PAF, which includes opening the *Latch (1)* and *Strongback (5)*.
- NOTE:** If any corrosion or damage to the PAF or manhole is observed, it must be repaired and successfully bench tested prior to returning to service. Refer to 3.5 for PAF bench test procedure.
- 1.1.1. Clean and inspect the bottom side of the PAF for signs of damage, corrosion, or product gumming that could effect the operation of the Relief Valve.
- 1.1.2. Closely inspect the *Cylinder (10)* for any damage or dents. Also, insure *Cylinder (10)* is threaded tightly to the *Cover (9)*. See figure 1.
- 1.1.3. Inspect and clean the *Normal Vent (8)*.
- 1.1.4. Inspect the *10" Seat (25)* for damage or corrosion. Build-up or grim on the seat should be removed. Nicks on the 10" seat may cause the gasket not to seal.
- 1.1.5. Inspect the *10" Fill Gasket (24)* for signs of wear or degradation. Replace gasket if required.
- 1.1.6. Inspect the *Clamp Ring Gasket (26)* for evidence of product seepage. Replace any gaskets where seepage is detected.

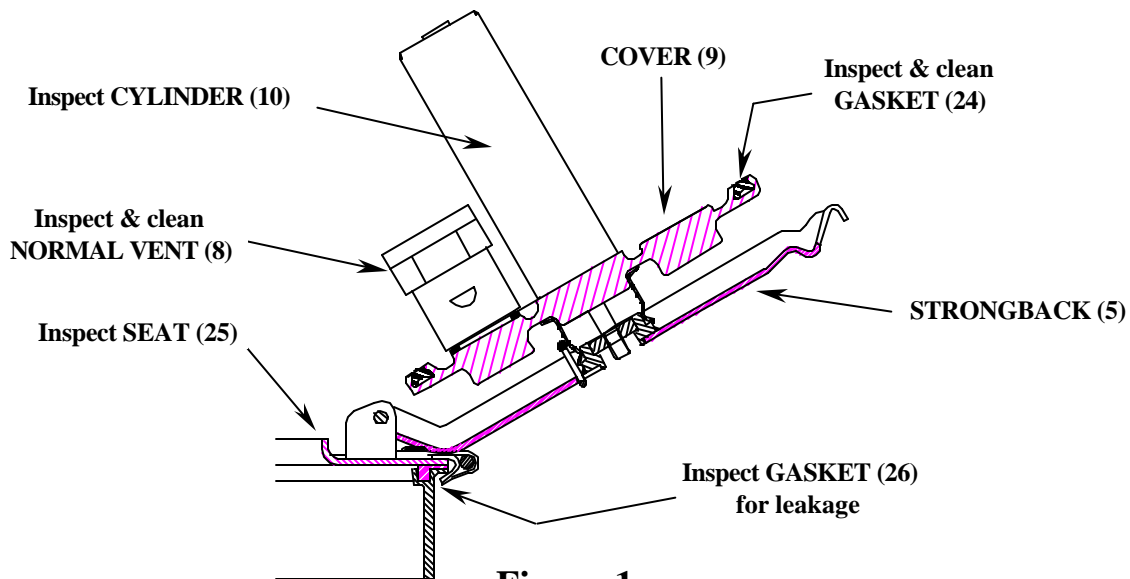


Figure 1

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2. **Leakage Test:** 49CFR180.407(h) requires tanks to be tested annually at 80 % of the tank design pressure or MAWP, whichever is marked on the tank certification or specification plate. All tank components must remain in place during this test, except any re-closing pressure relief valve with a set pressure less than the leakage test pressure must be removed or rendered inoperative during the test. Betts Normal Vents, therefore, must be removed during the leakage test.
 - 2.1. Remove Normal Vent from manhole cover and plug opening with Betts Plug No. 3013.
 - 2.2. Apply test pressure in accordance with 49CFR180.407(h)
 - 2.3. Inspect all gasket joints on PAF and manhole for leaks. If PAF leaks, adjust in accordance with Set Pressure Adjustment instructions (Section 3 of this manual) and retest the unit. Replace damaged or worn gaskets as required.
3. **Pressure Retest:** As part of the pressure retest, 49CFR180.407(g)(ii)(A) requires that all re-closing pressure relief valves be removed from the tank for inspection and bench tested to verify that the relief valve is functioning properly. The pressure retest and the relief valve bench test must be performed at least every five years.

Note: Betts recommends that the PAF 406-96 and PAF 406-98 be bench tested annually.

3.1. Pressure Retest Procedures:

- 3.1.1. 49CFR180.407(g)(1)(vii) requires that all closures except pressure relief devices must be in place during the test.
- 3.1.2. Manholes must remain in place during pressure test.
- 3.1.3. Open 10" PAF Relief Valve.
- 3.1.4. Install Betts Retest Fixture (part no. 6556LCB) to seal the 10" opening. See figure 2.
- 3.2. Betts Push and Air Operated Vapor Recovery Valves remain in place during the test.
NOTE: If vapor recovery valves from other manufactures are installed, refer to the manufacturers' instructions to see if they should be removed.
- 3.3. After preparing the rest of the tank, perform the pressure test in accordance with the regulations. Inspect all parts of manhole assembly for leakage. Repair or replace parts as required.
- 3.4. Remove all clamps or plugs from relief valve immediately after test is completed.

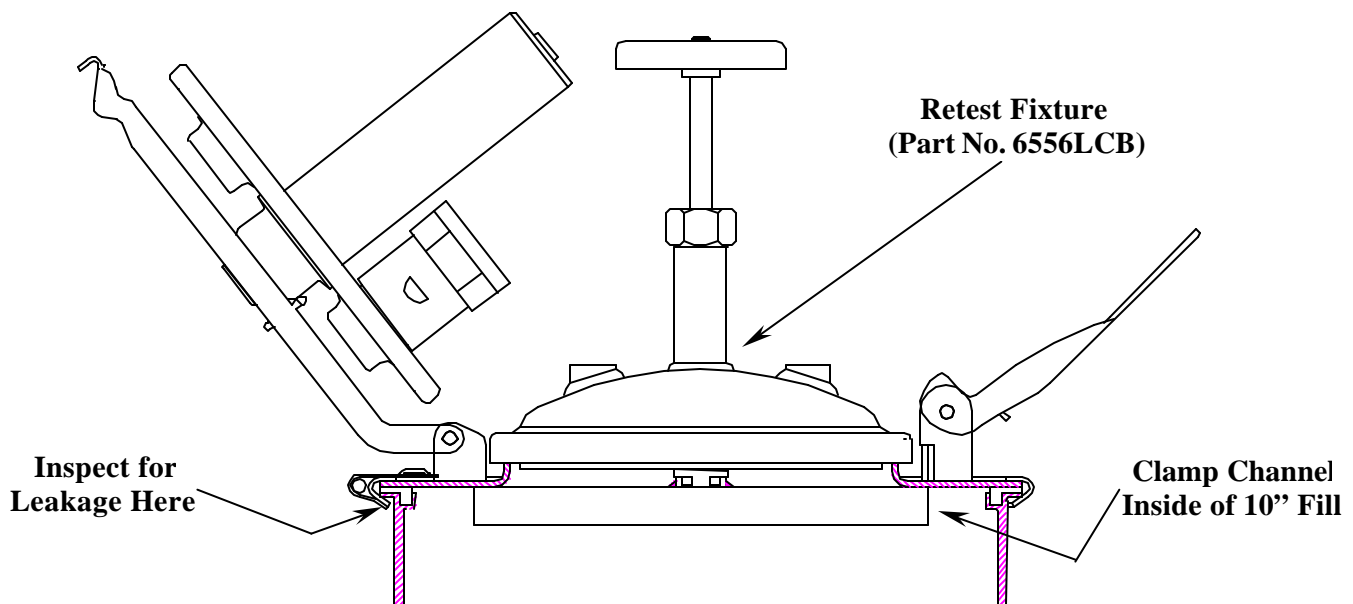


Figure 2

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3.5. Bench Test Procedure for PAF Surge 406-96 & 98

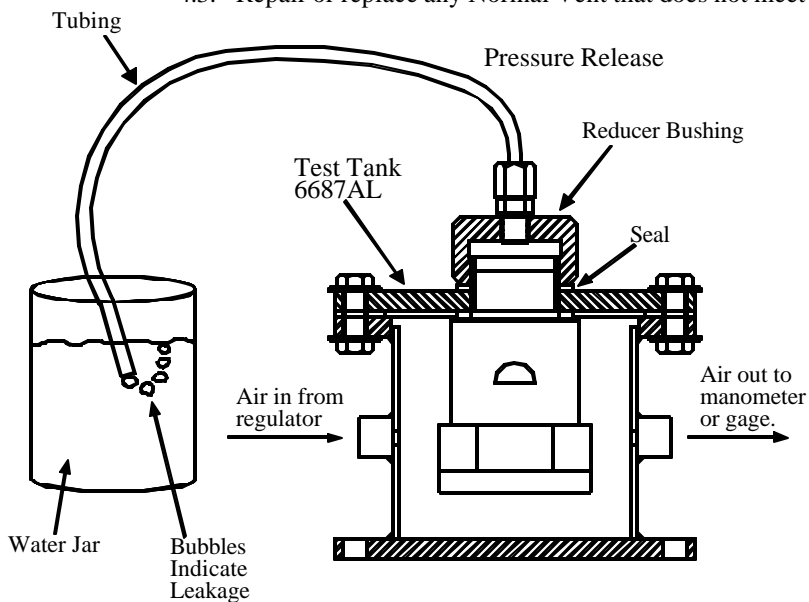
- 3.5.1. Remove manhole assembly from tank by removing the clamp ring bolt and clamp ring.
- 3.5.2. Remove *Normal Vent* (8) and plug port with Betts Plug (No. 3013)
- 3.5.3. Attach manhole assembly to appropriate Betts PAF 406-96 Test Fixture (No. 6685SL.)
- 3.5.4. Apply a soap solution around the perimeter of the DoveTail 10" Gasket.
- 3.5.5. Gradually apply pressure to the tank and observe the pressure at which bubbles first appear.
- 3.5.6. Per 49CFR178.346-3(c) the set pressure must not be less than 3.63 psig and not more than 4.55 psig for a tank with a MAWP of 3.3 psig.
- 3.5.7. Slowly release the pressure from the test fixture and verify the PAF reseals not less than the MAWP of the tank.
- 3.5.8. Replace or adjust any relief valve that fails the set pressure test requirements. Refer to instructions for Set Pressure Adjustment (Section 3 of this manual) to adjust the set pressure, and retest the unit.

4. Model 6496AL (Normal vent for DOT 406) Test Procedure:

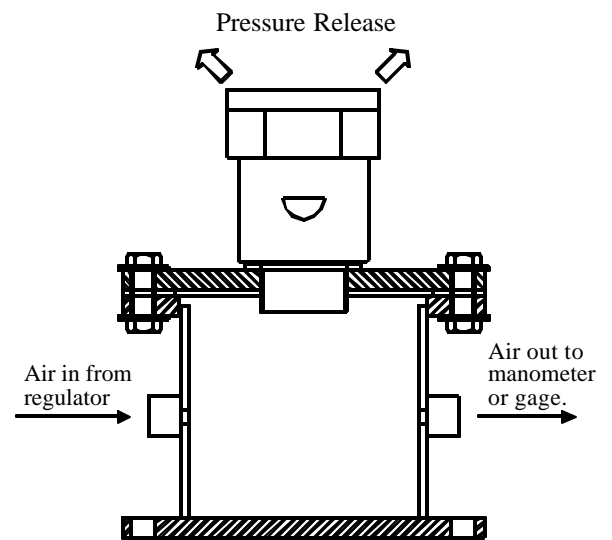
A Normal Vent Test Tank (Part No. 6687AL) must be used to test the Normal Vents.

Note: A regulator must be used to slowly apply pressure to the tank.

- 4.1. Pressure Test: 49CFR 178.346-3(b)(2) states that the normal vent for a DOT 406 must be set to open at not less than 1 psig.
 - 4.1.1. Screw the Normal Vent into the lid of the test tank as shown in figure 3 A. In order to detect leakage, attach the reducer bushing, compression fitting, and tubing. Place the end of the tubing in a water jar. The water jar is not included with the test tank.
 - 4.1.2. Slowly apply pressure to the tank. Bubbles will indicate the opening pressure of the vent.
 - 4.1.3. A properly functioning 6496AL Normal Vent should open between 1.0 to 1.5 psig, but in no case open less than 1 psig.
- 4.2. Vacuum Test: 178.346-3(c)(2) states that the normal vent for a DOT 406 must be set to open at no more than 6 ounces vacuum (.375 psig).
 - 4.2.1. Screw the Normal Vent into the lid of the test tank as shown in figure 3 B.
 - 4.2.2. Slowly apply pressure to the tank and inspect the top opening for pressure release. Apply soapy water to the top of the vent in order to detect the point at which the vent opens.
 - 4.2.3. A properly functioning 6496AL Normal Vent should vacuum relieve between 0.25 to 0.375 psig, but in no case more than 0.375 psig.
- 4.3. Repair or replace any Normal Vent that does not meet the specifications.



PRESSURE TEST
Figure 3A



VACUUM TEST
Figure 3B

SECTION 3: SET PRESSURE ADJUSTMENT OF PAF SURGE RELIEF VALVE

NOTE: THESE INSTRUCTIONS APPLY ONLY TO ADJUSTABLE MODEL 306-98, 406-98 AND PAF 406-96 W/ BLACK E-COATED COVER AND STEM WITH INTERNAL HEX AT THE TOP.

1. Relieve vapor pressure or vacuum from cargo tank.



Failure to relieve tank pressure may result in sudden, unexpected loss of pressure. Severe personal injury or death may result.

2. Open *Latch (1)* to expose yellow *Plastic Plug (2)* as shown in figure 4.
3. Remove yellow *Plastic Plug (2)*.
4. Place an 11/16 box end wrench over *Hex Nut (3)*.
5. Place a 7/32 allen wrench into the hex socket of the *Stem (4)*.
6. Hold the allen wrench stationary and rotate the box end wrench counterclockwise to loosen the *Hex Nut (3)* two full turns.
7. At this point, the PAF can be adjusted by rotating the *Stem (4)* with the allen wrench.
8. To increase the set pressure, turn the *Stem (4)* clockwise.

Note: The *Stem (4)* must fully engage threads of *Hex Nut (3)* when nut is tightened.

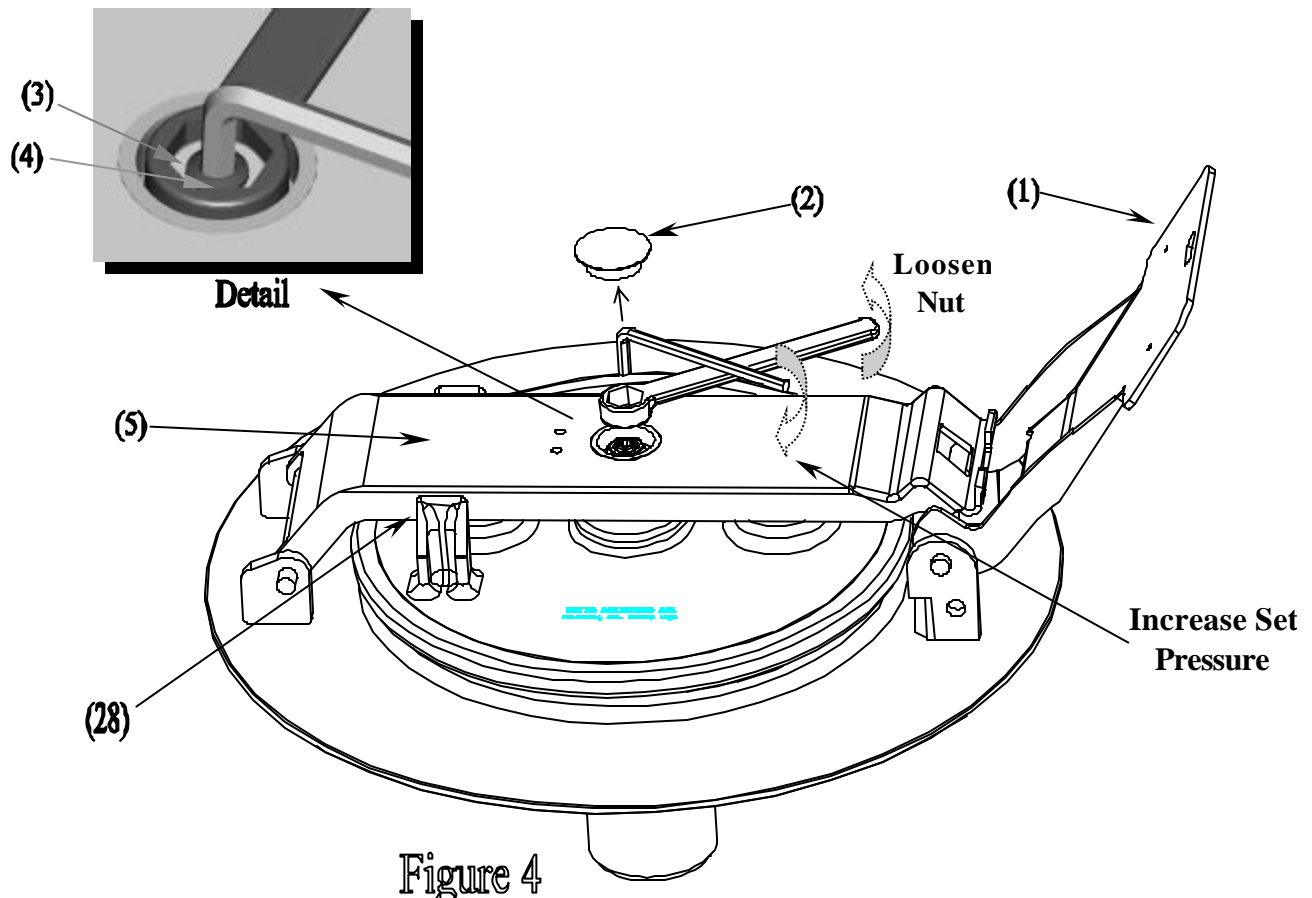


Figure 4

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9. To decrease the set pressure, turn the *Stem (4)* counter-clockwise.

Note: The amount of adjustment in the counter-clockwise direction is limited by a shoulder stop on the *Stem (4)*.

10. The adjustment feature is sensitive, so that, one turn of the stem may increase the set pressure significantly. Adjust stem $\frac{1}{4}$ turn at a time, until the desired setting is achieved.



Never adjust the relief valve so that a person must stand on the *Strongback (5)* to operate the *Latch (1)*. This could cause a person to lose their balance and fall, if there is any residual pressure in the tank when the relief valve is opened.

11. After adjusting the PAF surge relief valve, use the box wrench to tighten the *Hex Nut (3)*, while using the allen wrench to hold the stem stationary.
12. Replace the *Plastic Plug (2)*.
13. After adjustment, test the set pressure to verify that it falls within the required range.
 - 13.1. Per 49CFR178.346-3(c) the set pressure for models PAF406-96 & 406-98 must not be less than 3.63 psig and not more than 4.55 psig for a tank with a MAWP of 3.3 psig.
 - 13.2. Per 49CFR178.341(d)(2) the set pressure of model PAF306-98 must not be less than 3.0 psi for a MC306 tank
14. If the adjustment does not achieve the desired pressure setting, check the following:
 - 14.1. Inspect the 10" metal seat. Remove any build up and repair any nicks.
 - 14.2. Replace the 10" gasket.
 - 14.3. Insure strongback is not bent or damaged.
 - 14.4. Insure the collar that is welded to the tank is not excessively warped.
 - 14.5. Insure closure assembly was mounted correctly to manhole collar.
 - 14.5.1. Unbolt clamp-ring and loosen closure assembly from collar seat.
 - 14.5.2. Release latch to relieve force on 10" fill cover.
 - 14.5.3. While the 10" fill is opened, tighten clamp-ring bolt while tapping circumference of clamp-ring with a hammer.
 - 14.5.4. Close 10" fill and latch.

SECTION 4: REMOVAL OF PAF SURGE RELIEF VALVE FROM CLOSURE ASSEMBLY

NOTE: THESE INSTRUCTIONS APPLY ONLY TO ADJUSTABLE MODEL PAF 406-96 & 98 WITH BLACK E-COATED COVER AND STEM WITH INTERNAL HEX AT THE TOP.

1. Relieve vapor pressure or vacuum from cargo tank.



Failure to relieve tank pressure may result in sudden, unexpected loss of pressure. Severe personal injury or death may result.

2. Open latch to expose *Yellow Plug (2)* as shown in figure 5.
3. Remove yellow Plastic Plug (2).
4. Use an 11/16 socket or box end wrench to remove *Hex Nut (3)*.
5. Remove *Star Washer (6)*.
6. Open fill assembly as shown in figure 6.
7. Place a 7/32 allen wrench in the hex socket of the *Stem (4)*.
8. By rotating the stem clockwise, the PAF assembly can be unscrewed from the closure assembly. NOTE: During removal, care should be taken not to damage the last threads on the stem, by supporting the PAF with a hand under the cylinder.
9. Remove the *Bellow (7)*.
10. At this point, further disassembly should be conducted at a workbench. Follow the procedure "Disassembly of PAF Surge Relief Valve" if disassembly of the cylinder is required.

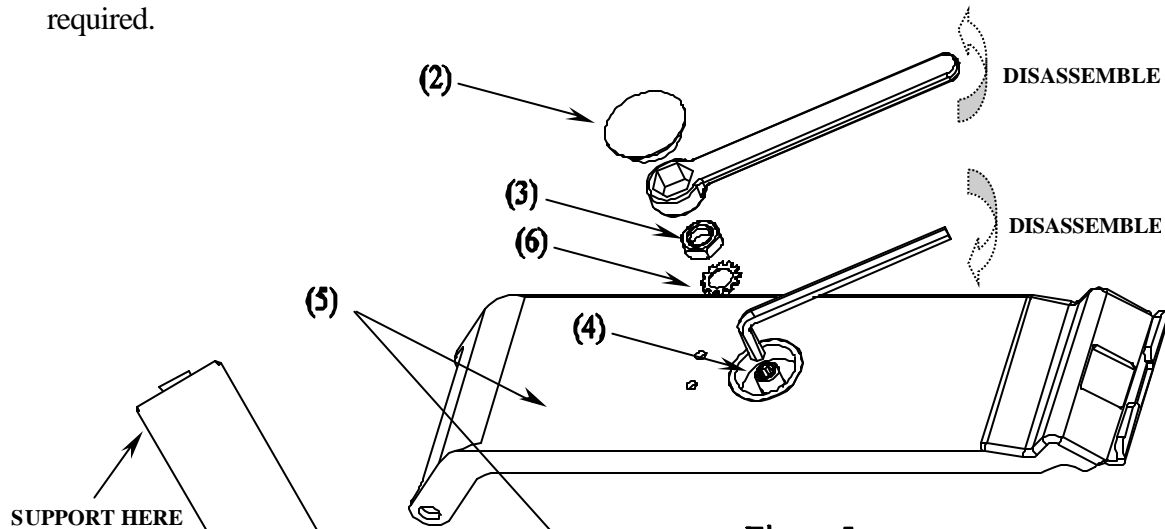


Figure 5

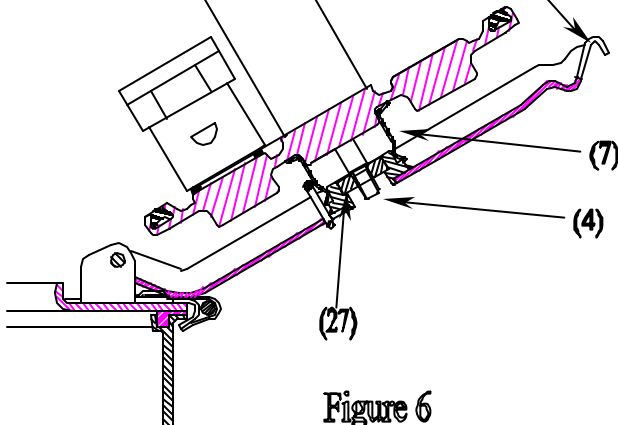


Figure 6

SECTION 5: DISASSEMBLY OF PAF SURGE RELIEF VALVE

NOTES:

- **THESE INSTRUCTIONS APPLY ONLY TO ADJUSTABLE MODEL PAF 406-96 & PAF 406-98 WITH BLACK E-COATED COVER AND STEM WITH INTERNAL HEX AT THE TOP.**
 - **UNDER NORMAL CIRCUMSTANCES, THE DISASSEMBLY OF THE SPRING CYLINDER IS NOT REQUIRED NOR RECOMMENDED, UNLESS ALL OTHER ATTEMPTS TO REPAIR THE RELIEF VALVE HAVE FAILED. IT IS RECOMMENDED THAT THE VALVE BE RETURNED TO BETTS INDUSTRIES FOR REPAIR.**
 - **A PAF SURGE DISASSEMBLY TOOL (PART # 6684MS) IS REQUIRED TO DISASSEMBLE THE SPRING CYLINDER.**
1. Remove the PAF surge relief valve assembly from the closure assembly by following the steps outlined in the procedure "Removal of PAF Surge Relief Valve from Closure Assembly".
 2. Remove *Normal Vent* (8) by gripping with slip joint pliers and unscrewing from *Cover* (9). See figure 7.



The cylinder contains a compressed spring, which could cause injury, if the cylinder is removed improperly. Review the following section carefully before attempting to remove cylinder.

3. The *Cylinder* (10) contains *Hydraulic Oil* (11) that must be drained.
4. Use a 3/8 allen wrench to remove the 1/2 in. NPT Plug (12) while holding the *Cylinder* (10) stationary by gripping with slip joint pliers within one inch from the bottom. *It is very important that the cylinder does not unscrew from the cover at this time.*
5. If the unit has a 1/8 in. NPT Plug (13) remove it at this time.
6. Drain the oil that is on the top and bottom of the *Piston* (14).

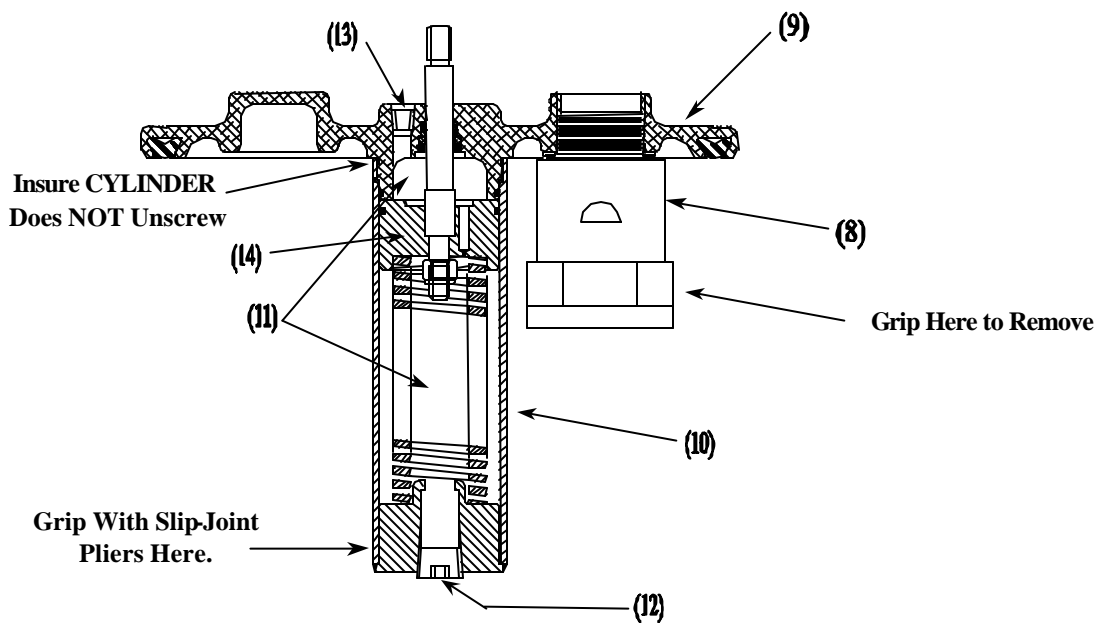


Figure 7

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7. Insert the 3/8 female thread end of the *Disassembly Tool (15)* (part # 6684MS) into the 1/2 in. NPT opening as shown in figure 8.
8. Thread the *Disassembly Tool (15)* onto the 3/8 male thread of the *Stem (4)* that extends from the *Lock Nut (16)*. See figure 8. **The tool should engage at least four threads.**
Note: Use a 7/32 allen wrench on the bottom of the tool and one at the top of the stem to tighten tool completely down.

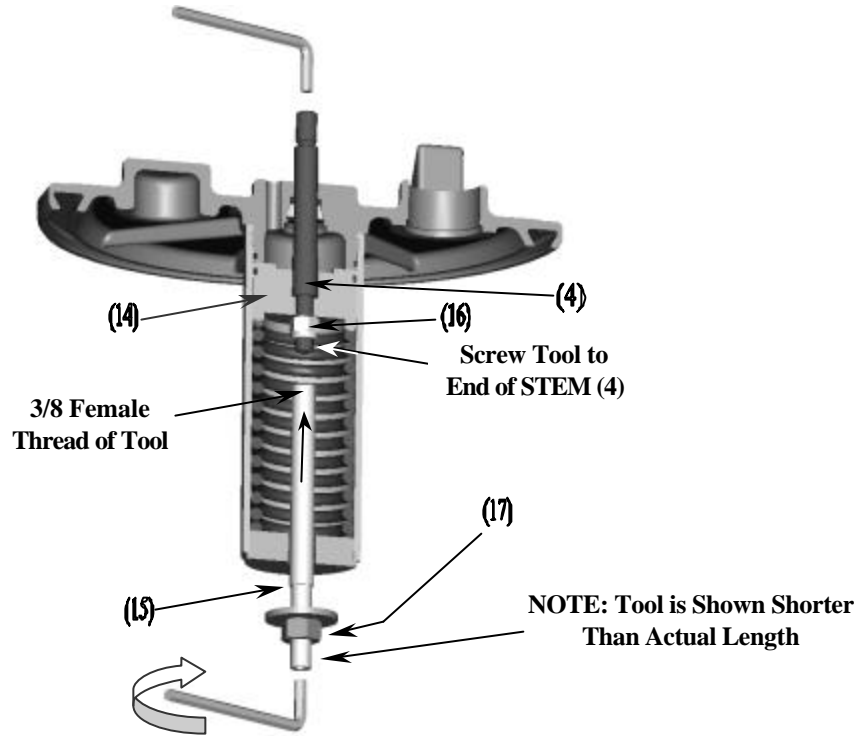


Figure 8

9. At this point, a 7/32 allen wrench must be used to hold the shaft of the tool stationary with respect to the cylinder, while an 11/16 wrench is used to turn the *Tool Nut (17)* clockwise. Once the nut has made contact with the cylinder, turn the nut two complete turns to compress the *Spring (18)*. See figure 9.

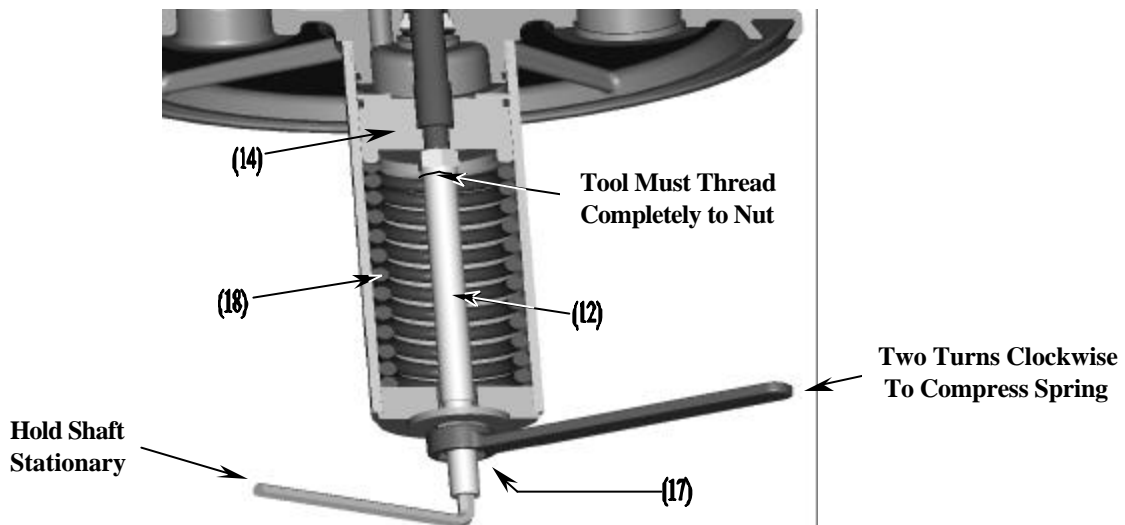


Figure 9

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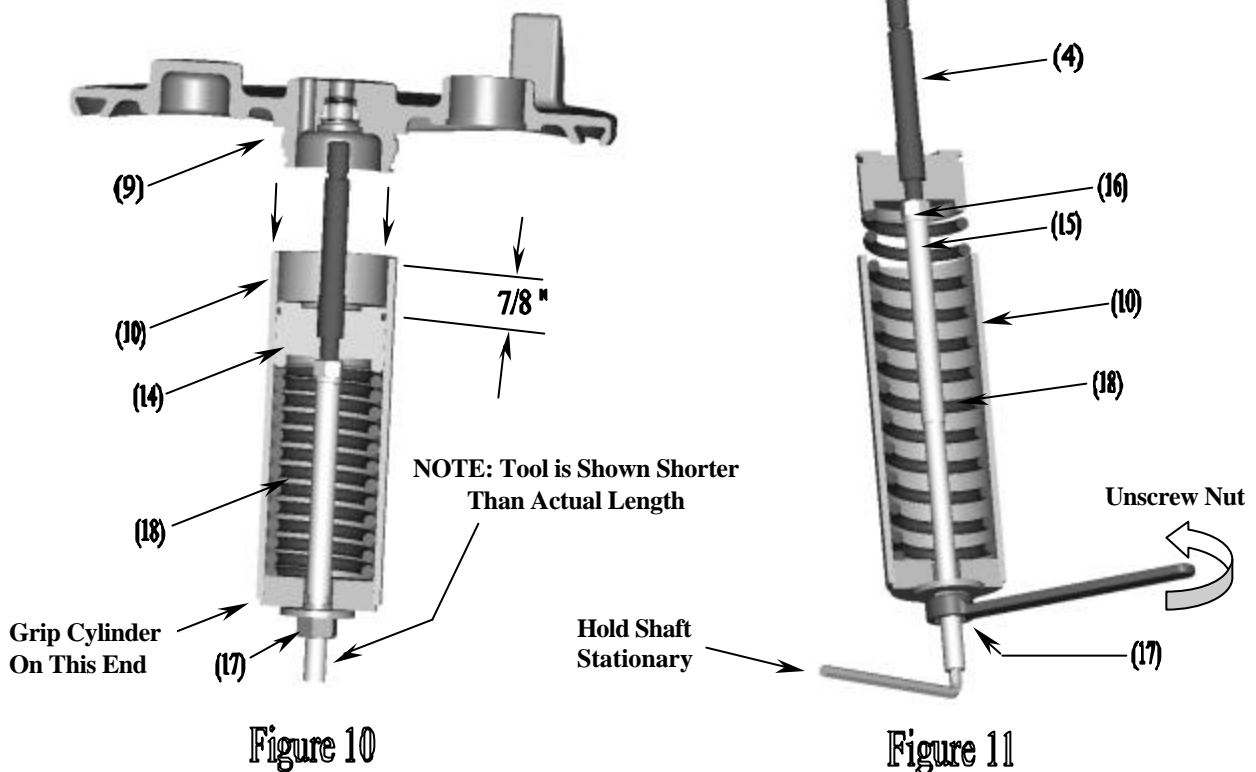
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10. The *Cover (9)* can now be unscrewed from the *Cylinder (10)*. Do **NOT** unscrew the stem from the tool. If slip joint pliers are required to grip the cylinder, only grip within one inch from the end. See figure 10.



After the cover is removed, the spring is still under load in the cylinder. Do **NOT** point the open end of the tube toward yourself or a bystander.



11. To release the spring, hold the allen wrench stationary with respect to the cylinder, and turn the *Tool Nut (17)* counter-clockwise. It is imperative that the shaft of the tool does not unscrew from the Stem (4) during disassembly process. Continue to back off the *Tool Nut (17)* until the piston is extended beyond the length of the spring. See figure 11.
12. At this point insure the spring tension is released, and the *Tool (15)* can be unscrewed from the *Stem (4)*.

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13. Disassemble the stem/piston assembly by inserting a 7/32 allen wrench into the top of the *Stem* (4) and unscrew the *LockNut* (16) using a 9/16 socket. See Figure 12. Note: The piston may appear different than shown depending on the model you may have.
14. If the *Piston O-ring* (19) requires removal, cut the o-ring with a razor blade, being careful not to damage the piston groove.
15. The *Stem O-ring* (22) and *O-ring Retainer* (21) are removed by using a snap ring tool to remove *Snap Ring* (20). See figure 13.
16. If the *Cylinder O-ring* (23) requires removal, cut the o-ring with a razor blade being careful not to damage the o-ring groove.
17. If the 10" *Fill Gasket* (24) requires removal, cut a small slot in the center of the gasket and use a screwdriver to pry gasket out of dovetail groove, being careful not to damage groove. See figure 13.

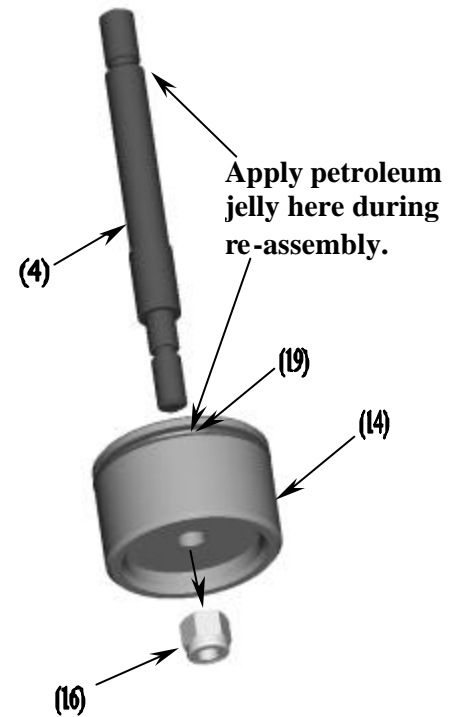


Figure 12

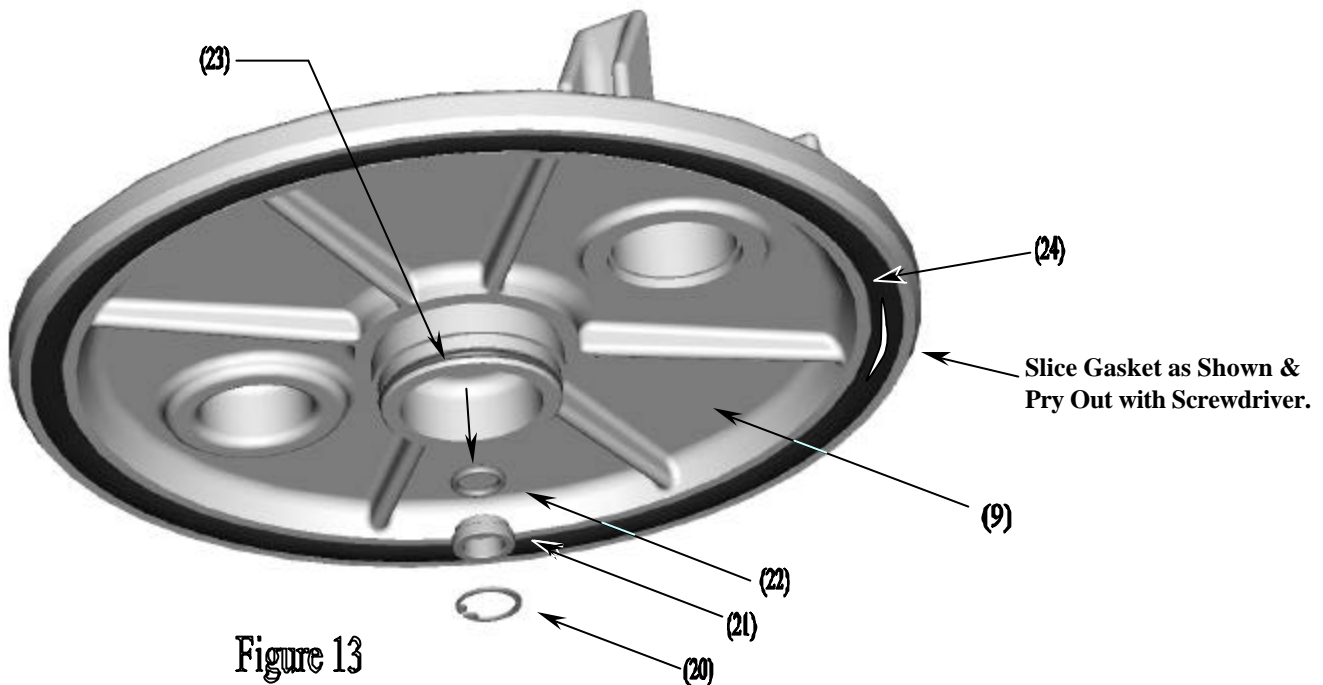


Figure 13

For maintenance or assembly instructions consult appropriate procedures.

SECTION 6: ASSEMBLY OF PAF SURGE RELIEF VALVE

NOTE: THESE INSTRUCTIONS APPLY ONLY TO ADJUSTABLE MODEL PAF 406-96 & PAF 406-98 W/ BLACK E-COATED COVER AND STEM WITH INTERNAL HEX AT THE TOP.

1. Preparation of O-Rings and Components:
 - 1.1. All parts should be cleaned and degreased to insure the removal of all product build up.
 - 1.2. All components should be inspected for damage or wear.
 - 1.3. To insure integrity of the seals, all o-rings and gaskets should be replaced using Betts' replacement parts.
 - 1.4. Inspect all o-ring grooves for damage (nicks, scratches, or burrs).

2. Cover sub-assembly: Refer to figure 14.
 - 2.1. Insert Stem *O-ring* (22) into *Cover* (9).
 - 2.2. Insert *O-ring Retainer* (21) and use a snap ring tool to insert the *Snap Ring* (20) into groove.
 - 2.3. Place black Buna *Cylinder O-ring* (23) into o-ring groove on *Cover* (9).
 - 2.4. Use Betts' *Dove Tail Gasket Tool* (26) to place 10" *Fill Gasket* (24) into *Cover* (9). See figure 14.
 - 2.4.1. Lubricate the gasket and dovetail groove with a soap solution.
 - 2.4.2. Using fingers, pinch the back side of the gasket together and insert a small section of the gasket into the groove.
 - 2.4.3. Use short strokes with the *Dove Tail Gasket Tool* (26) to insert the gasket.
 - 2.4.4. The last portion of the gasket will need to be pushed in with fingers.

Note: The gasket can also be installed by hand. A 10" o-ring (4100BN) is also available for use as a replacement for the dovetail gasket and can be installed in the groove.

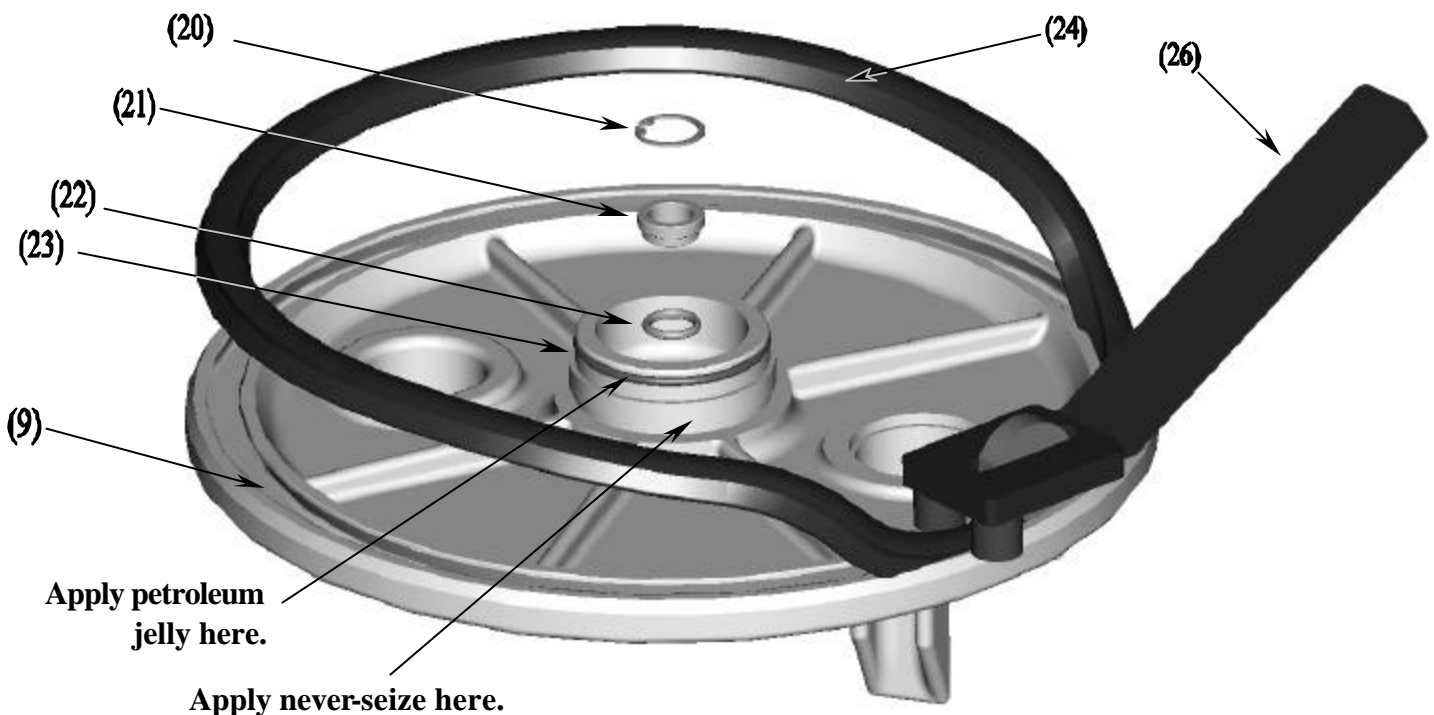


Figure 14

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3. Piston/Stem sub-assembly: Refer to figure 12 of section 5.
 - 3.1. Inspect *Stem (4)* for signs of wear or corrosion. Replace as required.
 - 3.2. Insert 3/8 end of *Stem (4)* into counter sunk hole of *Piston (14)*. Note: The piston may appear different depending on which model you have.
 - 3.3. Insert a 7/32 allen wrench into the top of the *Stem (4)* and tighten the *Lock Nut (16)* completely down using a 9/16 socket. Note: The *Stem (4)* MUST turn freely in the *Piston (14)* after the nut is tightened.
 - 3.4. Pre-heat the orange Tef-Sil *Piston O-ring (19)* in warm water and immediately slide the o-ring over the *Piston (14)* and position it into groove.
 - 3.5. Smear a thin layer of petroleum jelly around the *Piston O-ring (19)* to facilitate ease of installing the piston into the cylinder.
4. Loading the Spring: Refer to figure 11 of section 5.
 - 4.1. Inspect the inside of the *Cylinder (10)* for damage (dents, scratches, or corrosion). If the cylinder is damaged it must be replaced.
 - 4.2. Insert the 3/8 female thread end of the *Disassembly Tool (15)* (part # 6684MS) into the 1/2 " NPT opening of the *Cylinder (10)*.
 - 4.3. Place the *Spring (18)* into the *Cylinder (10)*.
 - 4.4. Thread the 3/8 stub that extends from the Piston/Stem assembly into the *Disassembly Tool (15)* and tighten with two allen wrenches. **NOTE: Ensure the end of tool is tight against the Lock Nut (16) as shown in figure 11 of section 5.**
 - 4.5. Compress the *Spring (18)* by using a 7/32 allen wrench to hold the shaft of the tool stationary with respect to the cylinder, while an 11/16 wrench is used to turn the *Tool Nut (17)* clockwise. (See figure 11 of section 5.) Insure the threads are not damaged on the cylinder when the piston is pulled into the top of the cylinder.



After the spring is compressed in the cylinder, do **NOT** point the open end of the tube toward yourself or a bystander.

- 4.6. Continue to turn the *Tool Nut (17)* until the top of the piston is at least 7/8" below the top of the *Cylinder (10)*. See figure 10 of section 5.
5. Installing the *Cover (9)*:
 - 5.1. Smear a thin amount of never-seize compound on the threads of the *Cover (9)* as shown in figure 14.
 - 5.2. Smear petroleum jelly around Cylinder O-ring (23) as shown in figure 14 and the top of the *Stem (4)* as shown in figure 12 of section 5.
 - 5.3. Position the *Cover (9)* over the *Stem (4)* as shown in figure 12 of section 5.
 - 5.4. Slowly screw the *Cover (9)* onto the *Cylinder (10)*. Care should be taken not to damage the threads of the cylinder or cover. Beware of cross threading. Ensure that the cover is screwed completely down to the cylinder so there is **NO** gap. See figure 15.



The Cylinder must be threaded completely on the Cover prior to the Disassembly Tool being removed.

- 5.5. The *Spring (18)* can now be released by holding the allen wrench stationary with respect to the *Cylinder (10)* and turning the *Tool Nut (17)* counter-clockwise.
 - 5.6. Once the *Tool Nut (17)* has released the spring pressure, the tool can be unscrewed and removed from the *Cylinder (10)*.

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6. Re-filling the hydraulic oil: Refer to figure 15.
Note: Replace the oil in the cylinder with Automatic Transmission Fluid DexronIII/Mercon SAE 5W-20 with a viscosity of 177 SUS at 100°F and a pour point of no greater than -45°F.
 - 6.1. If this unit has a 1/8" NPT, place thread sealant on the 1/8" NPT Plug (13) and insert it in the Cover (9).
 - 6.2. Turn the PAF upside down and pour ATF fluid through the 1/2" NPT opening at the bottom of the Cylinder (10).
 - 6.3. It is **very important** that this lower chamber is completely full of oil, with **NO** air pockets.
 - 6.4. Place thread sealant on the 1/2" NPT Plug (12) and insert it into the bottom of the Cylinder (10). Tighten the plug using a 3/8 allen wrench.
7. Smear a small amount of never-seize compound on the threads of the Normal Vent (8) and screw it into the opening of the Cover (9).

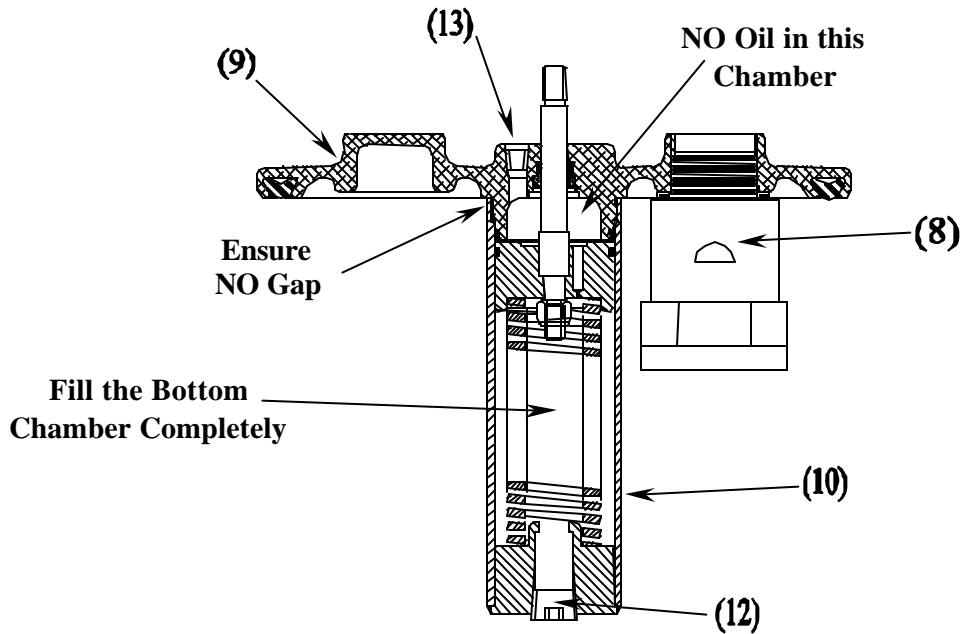


Figure 15

8. To attach the PAF Relief Valve to the closure assembly, refer to figure 6 of section 4.
 - 8.1. Place the Bellow (7) over the Stem (4).
 - 8.2. Thread Stem (4) into Wobble Support (27) on Strongback (5). NOTE: Use an 7/32 allen wrench inserted from the top of the Wobble Support (27) and turn counterclockwise to screw in the stem.
 - 8.3. Insure the first thread is not damaged as the stem is started into the wobble support.
 - 8.4. As the stem is threaded in, insure the Locating Ears (28) are aligned at the hinge side of the Strongback (5) and straddle the strongback as shown in figure 4 of section 3. Tighten the stem all the way in.
 - 8.5. Insert Lock Washer (6) and thread Hex Nut (3) onto Stem (4) as shown in figure 6 of section 4.
 - 8.6. To adjust the set pressure and tighten down the stem, refer to Section 3 of this manual.