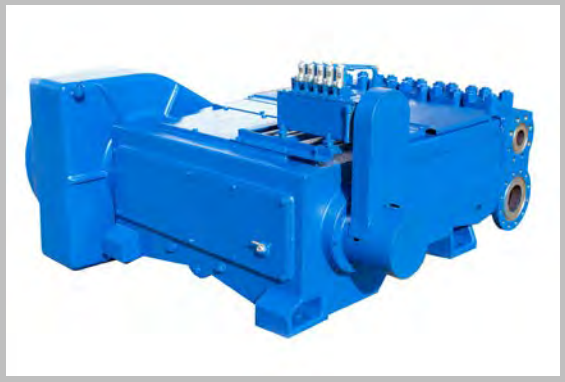
# 415Q-5 PLUNGER PUMP

## Operation Manual

## CONTINUOUS DUTY SINGLE ACTING MULTIPLEX PLUNGER PUMP



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| 415Q-5 OPMNL-001 | C |



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# FOREWORD

This manual is published as a guide for the normal operation of your **NATIONAL OILWELL VARCO** equipment. Because of the many factors, which contribute to the function or malfunction of this machinery, and not having complete knowledge of each factor or combination of factors, we cannot detail all facets of this subject. We must therefore confine the scope of this presentation and when situations encountered are not fully encompassed by complete, understandable instructions, these situations must be referred to the manufacturer.

When other than routine servicing is necessary, it can be most efficiently performed if the unit is removed to an area of adequate space where an over-head crane, hydraulic lift, bearing pullers, impact tools, etc., are accessible.

The dimension and tolerances specified in this publication are those desirable for the most efficient operations of the equipment. When components become worn or when new parts are introduced into a worn unit, it may not be possible or economically feasible to reestablish such strict alignment and correct all dimensional deviations.

Improvements in design, engineering, materials, production methods, etc., may necessitate changes in these products and result in inconsistencies between the content of this publication and the physical equipment. We reserve the right to make these changes without incurring any liability or obligation beyond that which is stipulated in the purchase contract.

*The pictures, photographs, charts, diagrams, drawings, verbal contents and specifications are not to be construed as giving rise to any warranty on the part of NATIONAL OILWELL VARCO. National Oilwell Varco makes no warranty, either expressed or implied beyond that which is stipulated in the purchase contract.*

**NATIONAL OILWELL VARCO** pumps are manufactured by National Oilwell Varco at the Tulsa, Oklahoma plant. The serial number, assigned to each pump, is stamped on the power end. Please refer to this serial number when ordering parts for the pump.

The right and left sides of the pump are determined by viewing the pump from the back of the power end, looking toward the fluid end. This position is also used to identify the plungers and their related parts as being number one, two and three, etc. beginning at the left side of the pump.

NOV Completion & Production Solutions

# ⚠! CAUTION ! CAUTION ! CAUTION !⚠

EXERCISE SAFETY IN ALL PERFORMANCES: DO NOT IGNORE ANY WARNINGS; USE ONLY APPROVED METHODS, MATERIALS AND TOOLS. DO NOT PERMIT ANY FUNCTION OF QUESTIONABLE SAFETY; ACCIDENTS ARE CAUSED BY UNSAFE ACTS AND UNSAFE CONDITIONS. SAFETY IS YOUR BUSINESS AND YOU ARE INVOLVED.

# ⚠! WARNING ! WARNING ! WARNING !⚠

*BEFORE PERFORMING ANY SERVICE FUNCTION, BE CERTAIN THAT THE UNIT IS SEPARATED FROM ITS POWER SOURCE OR THAT THE POWER SOURCE IS LOCKED-OUT TO PREVENT ANY FORM OF ENERGY FROM ENTERING THE EQUIPMENT. THIS WOULD INCLUDE ELECTRICAL OR MECHANICAL ENERGY INTO OR FROM THE PRIME MOVER(S), PNEUMATIC ENERGY FROM THE COMPRESSOR/AIR SYSTEM, ETC.*

# ⚠! WARNING ! WARNING ! WARNING !⚠

FAILURE TO OBSERVE THE WARNINGS AND NOTES OF CAUTION IN THIS PUBLICATION CAN RESULT IN PROPERTY DAMAGE, SERIOUS BODILY INJURY, OR DEATH.

# ⚠! ATTENTION - NOTICE - IMPORTANT !⚠

THESE TERMS ARE USED TO DRAW ATTENTION TO ACTION THAT WILL CAUSE DAMAGE TO THE PUMP, COMPONENTS OR ATTACHMENTS.

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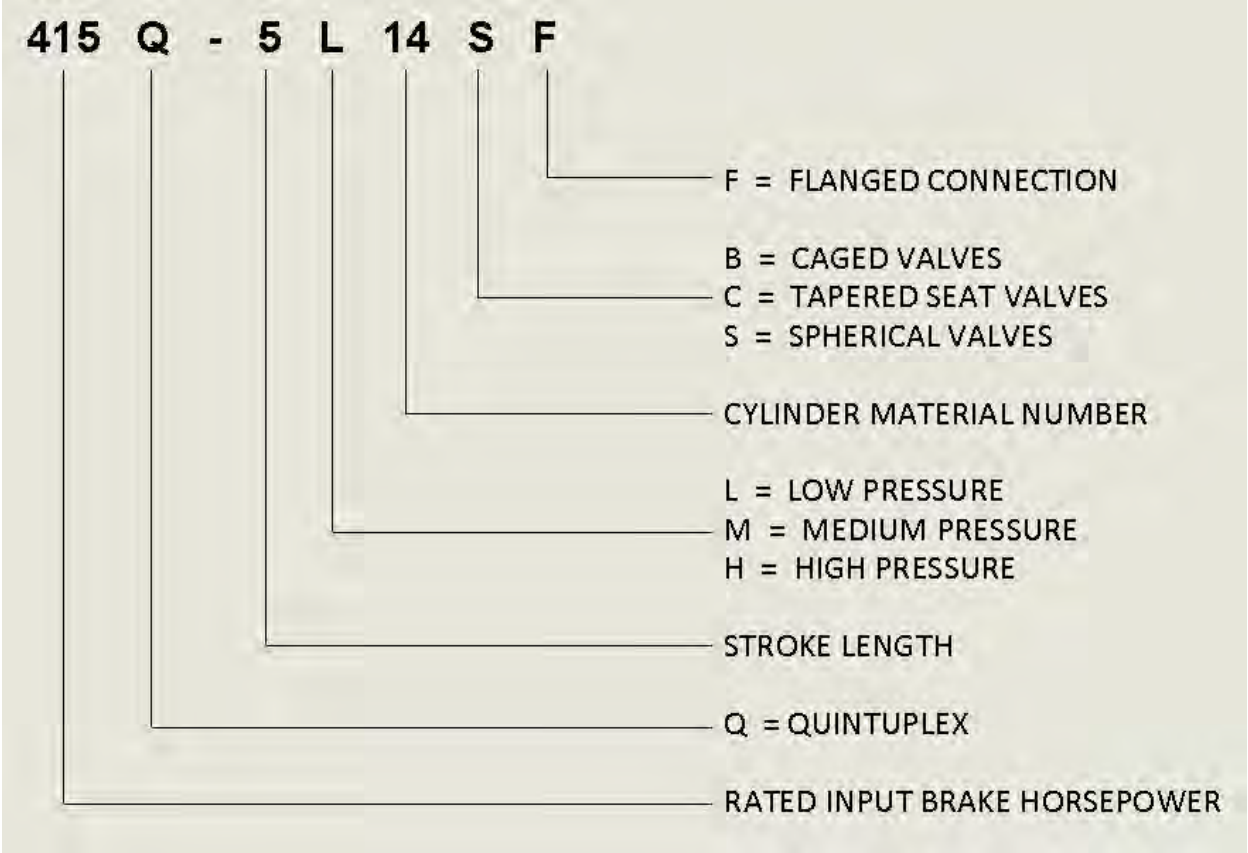
**PUMP NOMENCLATURE**:




# ⚠! WARNING ! WARNING ! WARNING !⚠

**BEFORE SERVICING PUMPS:**

1. *SHUT DOWN OR DISENGAGE THE PUMP POWER SOURCE.*

2. SHUT DOWN ALL PUMP ACCESSORY EQUIPMENT.

3. RELIEVE OR “BLEED OFF" ALL PRESSURE FROM THE PUMP FLUID CYLINDER(S).

   FAILURE TO SHUT DOWN POWER AND RELIEVE PRESSURE FROM THE PUMP BEFORE SERVICING CAN RESULT IN SERIOUS PERSONAL INJURY AND PROPERTY DAMAGE.

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# INSTALLATION

**I. GENERAL**

Careful planning of the plant layout will save considerable time and expense, both initially when the installation is made and later during the operation of the pump. In selecting the location for the pump, consideration should be given to the fact that a positive suction head at the pump inlet contributes toward the pump efficiency. However, the layouts of the piping, the arrangement of the fittings, and restrictions in the suction and discharge lines have even more effect. For this reason, all fittings and valves should be full opening; all bends should be of long radius or should be eliminated where possible. Long radius 45° elbows should be used, particularly if installed near the fluid cylinder. The following points outline the basic requirements for an installation that will contribute greatly toward good pump operation.

**A. LIFTING**

**⚠ ! WARNING ! WARNING ! WARNING ! ⚠**

Extreme care must be made when lifting this pump to avoid property damage, serious bodily injury, or death.

1. CHAIN SELECTION

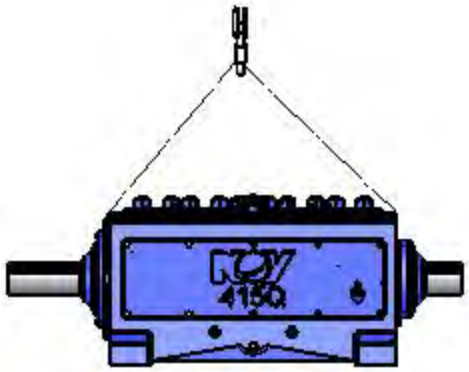
   Minimum chain specification is as follows:

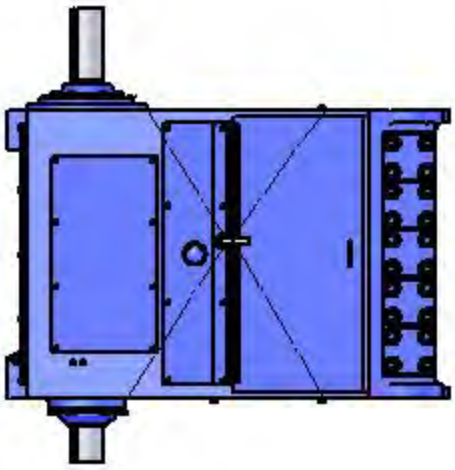
   3/8” size
   31/32” pitch steel
   Rated 5000# Proof Test

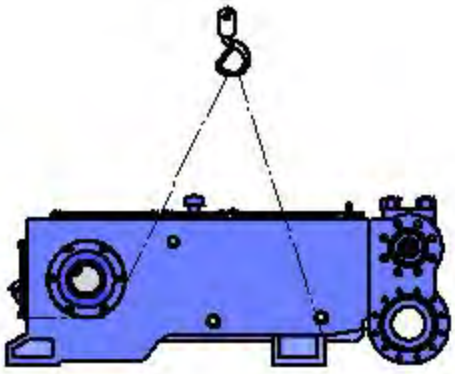
Use of chain below minimum requirements can result in damage, serious bodily injury, or death.

2. CHAIN LOCATIONS

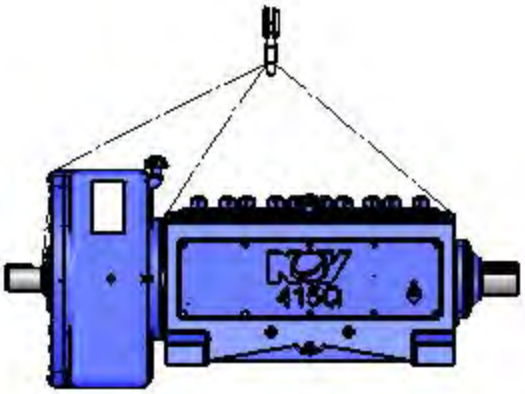
The arrangement drawings on the following sheet indicate the proper slinging method for handling this pump with chains. Any deviation from this plan can result in damage, serious bodily injury, or death.

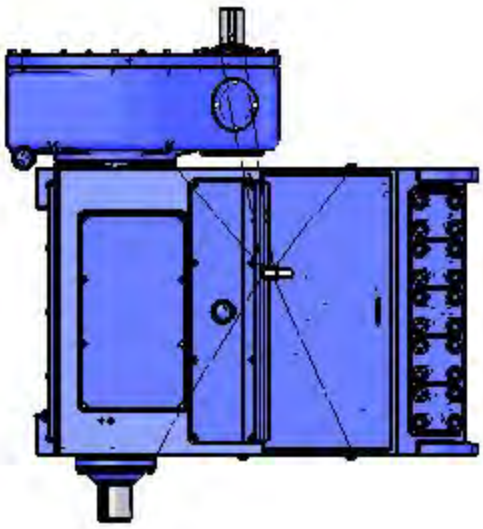


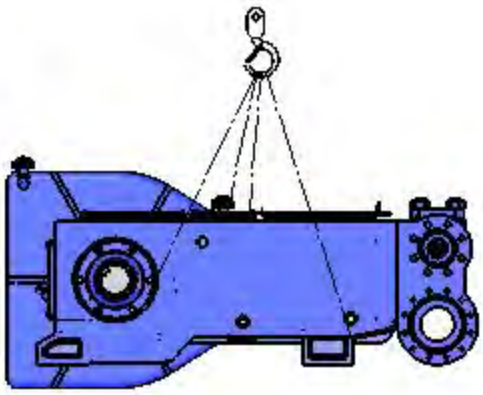





LIFTING ARRANGEMENT
WITHOUT GEAR REDUCER





LIFTING ARRANGEMENT
WITH GEAR REDUCER

**B. PUMP MOUNTING**

1. **The skid or foundation must be level. Angular installation and operation may be detrimental to the lubrication of equipment and may impose high stresses causing equipment failure.**

2. **The skid or foundation must be of sufficient strength to prevent flexing of the equipment.**

3. The skid or foundation must be of sufficient size and design to maintain the equipment free of strain.

4. The equipment must be adequately secured to the foundation. High strength bolts or cap screws with locking devices are generally employed.

5. Consideration should be given to the location of the equipment with its proximity to the associated equipment, fluid supply, fuel supply, environmental contamination, etc.

6. Avoid environmental contamination by providing the proper disposition of drainage from the crankcase, gear case, chain case, sludge sump and any other lubrication reservoirs as well as from the flushing media sump, the pump cradle, the suction line and the discharge line.

**C. ALIGNMENT**

1. **It is most important that the pump be accurately aligned with the prime mover.**

2. Follow the recommended alignment procedures provided by the manufacturer of the belts and sheaves or couplings.

**D. SUCTION LINE**

1. The suction line must not be smaller than the suction intake of the fluid end and may be larger. The length of the suction line should be held to a minimum and should run straight from the supply tank to the pump. If a reducer is required in the suction line between the main line and pump, use an eccentric reducer rather than a concentric reducer with straight portion on top to help avoid air pockets trapped in the suction line.

2. When bends are required, they should be made with long radius 45° elbows. Do not use a bend directly adjacent to the fluid end. Avoid using 90° if at all possible.

3. Provide a full opening gate valve in the suction line adjacent to the supply tank to permit the line to be drained when necessary. Do not use any type of restricting valve.

4. Do not use meters or other restrictions in the suction line. Eliminate any rise or summit in the suction line where air or vapor can collect.

5. Pulsation dampening devices are strongly recommended.

6. When necessary to manifold a number of pumps to a common suction, the diameter of the manifold and suction pipe leading from the supply tank must be such that it has a cross-sectional area equal to, or greater, than the area of the combined individual suction pipes.

7. When a charging or booster pump is used in the suction line, it must have a capacity equal to twice that of the pump output. This is necessary to provide a charging pump with an output great enough to meet the peak volume requirements of the plunger pump during the suction stroke and not act as a restriction in the line.

8. All piping, both suction and discharge must be solidly and independently supported. The first support must be as close to the pump as practical. This is necessary to prevent placing the pump in a strain and to keep any vibration in the system from acting directly on the pump.

**E. DISCHARGE LINE**

1. Use a pulsation dampener or a desurger in the discharge line. It should be placed in the line as near the fluid end as possible and ahead of any bend in the line.

2. Do not reduce the size of the discharge line below that of the pump outlet until the line has passed through the desurger, and is away from the pump approximately 20 feet (6m).

3. Any bend in the discharge line should be made with a long radius 45° elbow. Do not use a bend directly adjacent to the fluid cylinder, particularly a 90° bend.

4. A pressure relief valve should be installed in the discharge line. The relief valve should be set to operate at a pressure no greater than 10% above the maximum rated pressure for the plunger size being used. It should be installed in the line ahead of any valve and be piped so that any flow is returned to the supply tank rather than the suction line. This will prevent possible damage to the suction line and suction dampener.

5. A by-pass line should be installed to permit the pump to be started without load. This allows oil to circulate and reach all parts in the power end before they are loaded.

**F. POWER END**

1. The pump must be mounted level and should be grouted in and be free of strain. This applies to a skid-mounted pump or a pump mounted directly on a concrete base.

2. The sheave of a belt driven pump must be correctly aligned with the prime mover sheave. Care must be used to prevent over-tightening as this will shorten belt life and cause undue additional loads on the crankshaft and bearings. Sheave sizes should not be smaller than the minimum approved diameter.

3. When connecting a direct-driven pump, the shafts must be correctly aligned. Couplings should not be expected to compensate for avoidable misalignment. With flexible shaft couplings, angular misalignment should not exceed one-half degree. Offset misalignment of the centerlines of the two shafts should not exceed .015" (.381 mm). Actually, misalignment should be as small as practical.

4. Provision should be made to stop the pump automatically in the event of supply fluid failure. A pump should not be run dry, as this causes wear on the packing.

5. Adequate plunger chamber drains have been provided in the pump and should not be plugged. Drain lines should never be reduced in size from the connection provided.

6. The pump has been drained of oil after testing at the factory and **MUST** be filled with the proper oil (see Lubrication Section in this manual) before starting. The rust inhibiting oil coating inside the power end need not be removed before filling; however, it is recommended that the power end be checked to make sure dirt or contamination has not entered during shipment.

**G. FLUID END**

1. The fluid cylinder is shipped assembled to the pump complete with valves and covers. The stuffing boxes, plungers, and related items have also been assembled and tested with the pump (unless otherwise specified) and require no further assembly. Before the pump is started, these parts should be checked for tightness as well as for possible damage during shipment.

2. Thoroughly clean the suction line piping before starting the pump. Weld spatter, slag, mill scale, etc., will damage a pump in a short time.

**H. PLUNGER PACKING**

The recommended style of packing has been installed and run at the plant. It does, however, require further "setting up" as the pump is started and brought up to pressure. Refer to the Assembly, Fluid End, Plunger Packing Installation section of this manual for correct procedure for packing used.

**I. PLUNGER PACKING LUBRICATION**

1. Automatic packing lubricators are beneficial on all installations and are required on pumps operating at high pressure (1200 psi [85kg/cm 2] and up) to obtain good packing life.

2. When an automatic lubricator is used in water and power oil service, use Rock Drill (Air Drill) oil of proper viscosity. For butane-propane service, use NATURAL castor oil. Set lubricator to deliver the appropriate amount of oil. A compete sheen of oil on the plunger must be visible. See Lubrication Table on page 119 of this manual.

## ! ATTENTION !

THE FOLLOWING POINTS SHOULD BE CHECKED FOR THE PREVENTION OF TROUBLE OR TO CORRECT TROUBLE THAT MAY ARISE.

# OPERATION CHECKLIST

1. Pump must be a set level for proper lubrication.
2. Make sure pump is filled with clean oil of the proper viscosity (see section on Lubrication).
3. Do **not** over-speed the pump.
4. Do **not** use a smaller diameter sheave than is recommended for the pump.
5. Make sure all safety shutdown switches are operating properly.
6. Keep all suction and discharge line valves fully open.
7. If a bypass is used to regulate output, make sure it is set properly.
8. Make sure the pressure relief valve is set properly.
9. Do **not** exceed the pressure rating of the pump for the particular plunger size.
10. Make sure the suction line is tight, as air entering the suction line will cause severe hammering and knocking of the pump.
11. Make sure plunger and intermediate rod connections are tight and locked.
12. Check the plunger packing for correct adjustment (see page 122).
13. Check the suction and discharge dampeners for proper charge, as this is very important for long life and good pump operation.
14. Make sure the hex nuts holding the cylinder in place are tight.

# PERFORMANCE CHART

| | ENGLISH UNTS | | | | | 100 RPM | | 200 RPM | | 250 RPM | | 300 RPM | | 350 RPM | | 400 RPM | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pump | PLUNGER DIAMETER IN. | PLUNGER AREA SQ. IN. | BARRELS/DAY PER RPM | GALLONS PER MINUTE/RPM | MAX PRESSURE PSI | BPD | GPM | BPD | GPM | BPD | GPM | BPD | GPM | BPD | GPM | BPD | GPM |
| 415Q-5L | 4.500 | 15.9043 | 59.0146 | 1.7212 | 935 | 5901 | 172.1 | 11803 | 344.2 | 14754 | 430.3 | 17704 | 516.4 | 20655 | 602.4 | 23606 | 688.5 |
| | 4.250 | 14.1863 | 52.6396 | 1.5353 | 1050 | 5264 | 153.5 | 10528 | 307.1 | 13160 | 383.8 | 15792 | 460.6 | 18424 | 537.4 | 21056 | 614.1 |
| | 4.000 | 12.5664 | 46.6289 | 1.3600 | 1180 | 4663 | 136.0 | 9326 | 272.0 | 11657 | 340.0 | 13989 | 408.0 | 16320 | 476.0 | 18652 | 544.0 |
| | 3.750 | 11.0447 | 40.9824 | 1.1953 | 1345 | 4098 | 119.5 | 8196 | 239.1 | 10246 | 298.8 | 12295 | 358.6 | 14344 | 418.4 | 16393 | 478.1 |
| | 3.500 | 9.6211 | 35.7002 | 1.0412 | 1545 | 3570 | 104.1 | 7140 | 208.2 | 8925 | 260.3 | 10710 | 312.4 | 12495 | 364.4 | 14280 | 416.5 |
| | 3.375 | 8.9462 | 33.1957 | 0.9682 | 1660 | 3320 | 96.8 | 6639 | 193.6 | 8299 | 242.1 | 9959 | 290.5 | 11619 | 338.9 | 13278 | 387.3 |
| 415Q-5M | 3.250 | 8.2958 | 30.7823 | 0.8978 | 1790 | 3078 | 89.8 | 6156 | 179.6 | 7696 | 224.5 | 9235 | 269.3 | 10774 | 314.2 | 12313 | 359.1 |
| | 3.000 | 7.0686 | 26.2287 | 0.7650 | 2100 | 2623 | 76.5 | 5246 | 153.0 | 6557 | 191.2 | 7869 | 229.5 | 9180 | 267.7 | 10491 | 306.0 |
| | 2.750 | 5.9396 | 22.0394 | 0.6428 | 2500 | 2204 | 64.3 | 4408 | 128.6 | 5510 | 160.7 | 6612 | 192.8 | 7714 | 225.0 | 8816 | 257.1 |
| | 2.500 | 4.9087 | 18.2144 | 0.5312 | 3025 | 1821 | 53.1 | 3643 | 106.2 | 4554 | 132.8 | 5464 | 159.4 | 6375 | 185.9 | 7286 | 212.5 |
| 415Q-5H | 2.250 | 3.9761 | 14.7537 | 0.4303 | 3735 | 1475 | 43.0 | 2951 | 86.1 | 3688 | 107.6 | 4426 | 129.1 | 5164 | 150.6 | 5901 | 172.1 |
| | 2.125 | 3.5466 | 13.1599 | 0.3838 | 4185 | 1316 | 38.4 | 2632 | 76.8 | 3290 | 96.0 | 3948 | 115.1 | 4606 | 134.3 | 5264 | 153.5 |
| | 2.000 | 3.1416 | 11.6572 | 0.3400 | 4725 | 1166 | 34.0 | 2331 | 68.0 | 2914 | 85.0 | 3497 | 102.0 | 4080 | 119.0 | 4663 | 136.0 |
| | 1.875 | 2.7612 | 10.2456 | 0.2988 | 5000 | 1025 | 29.9 | 2049 | 59.8 | 2561 | 74.7 | 3074 | 89.6 | 3586 | 104.6 | 4098 | 119.5 |
| BRAKE HORSEPOWER REQUIRED | | | | | | 104 | | 208 | | 260 | | 312 | | 364 | | 416 | |

Volumetric Rate is based on 100% Volumetric Efficiency.
Brake Horsepower Required is based on 90% Mechanical Efficiency.
For Operation below 100 RPM, an auxiliary lubrication system is required. Not all plunger sizes are shown.
Contact National Oilwell Varco for additional information.
Spherical Valves nust be installed when the pump is fitted with 4.0" or larger plungers.

ROD LOAD = 14,838
STROKE LENGTH = 5"
MECHANICAL EFFICIENCY = 0.90

# MAINTENANCE

The following points are intended to be a guide to be used in setting up a maintenance program. Good preventative maintenance will pay big dividends in the form of reliable service of the pump.

1. Check power end oil level daily by means of the dipstick in the rear cover. Do not attempt to check the oil level with the pump running. Inspect the oil for dirt or contamination and change if necessary. An increase in oil level indicates fluid end leakage into power end. Change oil immediately and check intermediate rod wipers and surface smoothness of the rod. Check for plunger packing leakage.

2. Lubricate the plunger packing frequently. Packing life can be greatly increased by greasing every four (4) hours with a small amount of grease. Grease is not recommended for pressures exceeding 1200 psi. Use an alternate packing lubricator to drip the proper oil for lubrication.

3. Check the Lubricator for proper oil level and operation. Refer to manufacturer specifications.

4. Check plunger packing for excessive leakage. Replace packing as necessary.

5. Drain and refill crankcase on power end as needed and at least every six (6) months maximum. Check for debris in oil.

6. Clean crankcase breather monthly with a non-explosive solvent.

7. Check all nuts and screws for proper torque. Inspect gaskets for leaks; tighten or replace as needed

8. Periodically clean the pump exterior. A clean pump is easier to maintain and it is easier to find and locate potential maintenance issues.

# LUBRICATION

## 1 GENERAL

NATIONAL OILWELL VARCO 415Q/300Q plunger pumps are "splash" lubricated. The main bearings and crankshaft bearings are fed by splash by the operation of the pump. Crossheads and crosshead pin bushings are fed through holes in the crossheads and crosshead reservoir. Intermediate rods are lubricated from the splash they receive from the crosshead.

## 2 A. OIL

Use "extreme pressure" gear oil. The chart below shows the recommended grades for various temperatures surrounding the pump. Use of any other oil or viscosity except those listed is strongly not recommended.

| U.S. UNITS OF MEASURE | |
|---|---|
| **Temperature** | **AGMA Industrial EP Gear Oil** |
| +50°F to +155°F | AGMA No. 6 EP or ASTM/ISO Grade No. 320 (viscosity 1335 to 1632 SSU 100°F) |
| +20°F to +100°F | AGMA No. 5 EP or ASTM/ISO Grade No. 220 (viscosity 918 to 1122 SSU 100°F) |
| -20°F to + 60°F | AGMA No. 2 EP or ASTM/ISO Grade No. 68 (viscosity 284 to 347 SSU 100°F) |

Crankcase Capacity - Quarts: 300Q & 415Q – 12 gallons (48 quarts)

| METRIC UNITS OF MEASURE | |
|---|---|
| **Temperature** | **AGMA Industrial Gear Oil** |
| +10°C to +68°C | AGMA No. 6 EP or ASTM/ISO Grade No. 320 (Viscosity 228-352 cSt at 37.8°C) |
| -7°C to +38°C | AGMA No. 5 EP or ASTM/ISO Grade No. 220 (Viscosity 198-242 cSt at 37.8°C) |
| -29°C to +16°C | AGMA No. 2 EP or ASTM/ISO Grade No. 68 (Viscosity 61-75 cSt at 37.8°C) |

Crankcase Capacity - Liters: 300Q & 415Q – 45.4 liters

Oil must pour freely at minimum operating temperature. Change oil at least every six (6) months or as frequently as operating conditions require to maintain a clean, sludge-free oil of proper viscosity.

**3**. Gear Reducer: Use "extreme pressure" gear oil.

Gear Reducer capacity by Ratio

| | |
|---|---|
| 2.27 | 6.5 gal (24.6 l) |
| 2.89 | 5 gal (18.9l) |
| 3.25, 3.36, 3.69 | 4.5 gal (17.1l) |
| 4.38, 4.84, 5.63 | 3.5 gal (13.3l) |

# OVERHAUL AND REPAIR

Check Points and Adjustments

1. The crankshaft main bearings are non-adjustable, double row tapered roller bearings, factory set for the proper running clearance.

2. The connecting rod crank end shell bearings are zinc coated solid aluminum alloy precision ground with the following tolerances:

   Crankshaft Rod Journal Diameter: 5.000/4.999" (127.00/126.975mm)
   Maximum Clearance: .020" (.508mm)
   Minimum Clearance: .0064" (.163mm)

   Crosshead Wrist Pin Outside Diameter: 3.0015/3.0010" (76.238/76.225 mm)
   Maximum Clearance: .008" (.203mm)
   Minimum Clearance: .002" (.051mm)

3. The minimum allowable clearance between the crosshead and crosshead bore is .012" (.305mm). The maximum allowable clearance, including wear, is .030" (.762mm)

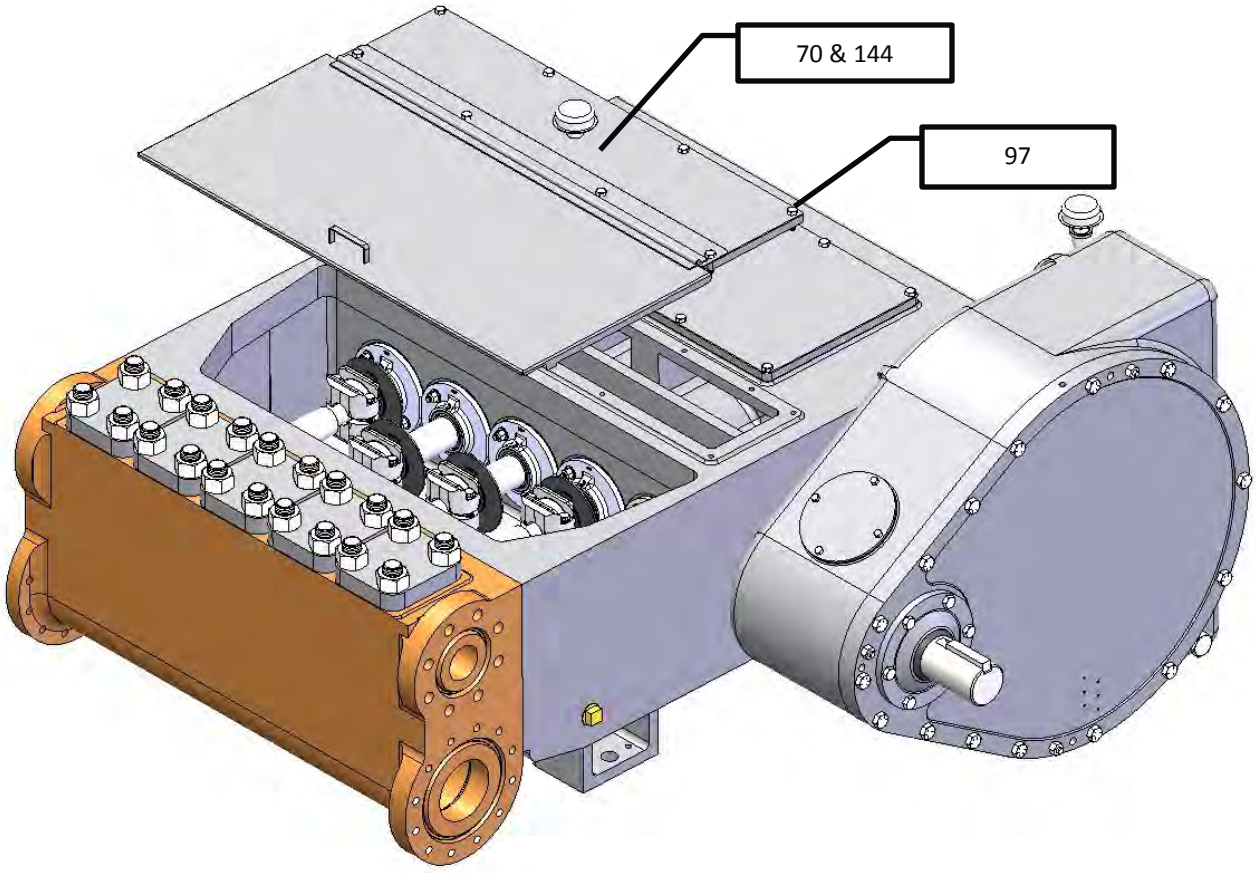
# DISASSEMBLY OF POWER END

## I. GENERAL

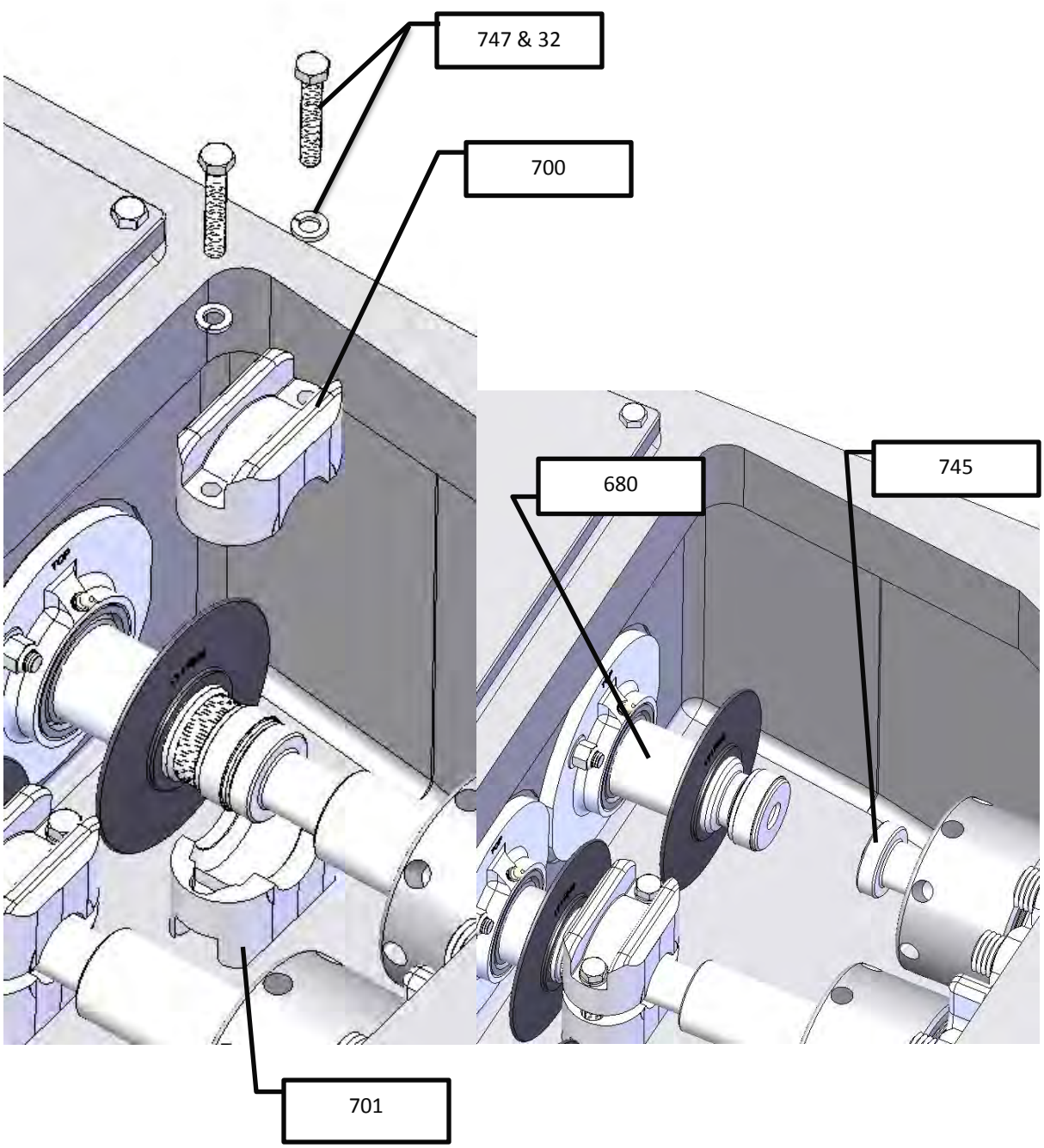
When disassembling the power end it is not necessary to remove the fluid end and the plungers may be disconnected from the intermediate rods and left in the stuffing boxes. It is necessary to drain the oil from the power end. A large clean work area needs to be prepared before disassembly, parts needs to be kept in order and grouped together so they can be reassembled in the same locations as a unit.

## A. INTERMEDIATE RODS AND WIPER BOX

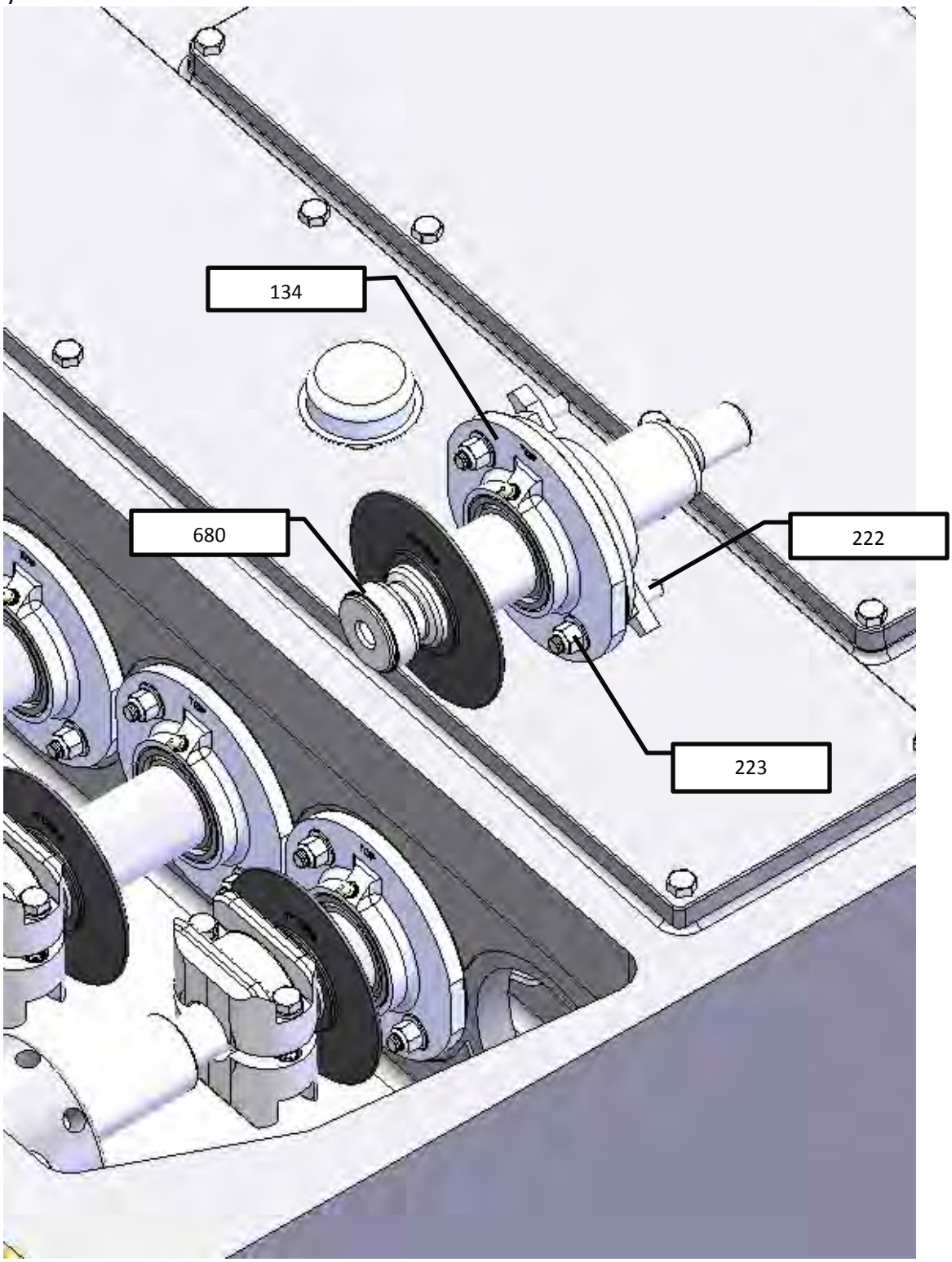
1. Drain oil from sump and dispose of properly. Remove the (Item 97) cap screws for the cradle cover (Item 70) and the crosshead cover (Item 144).



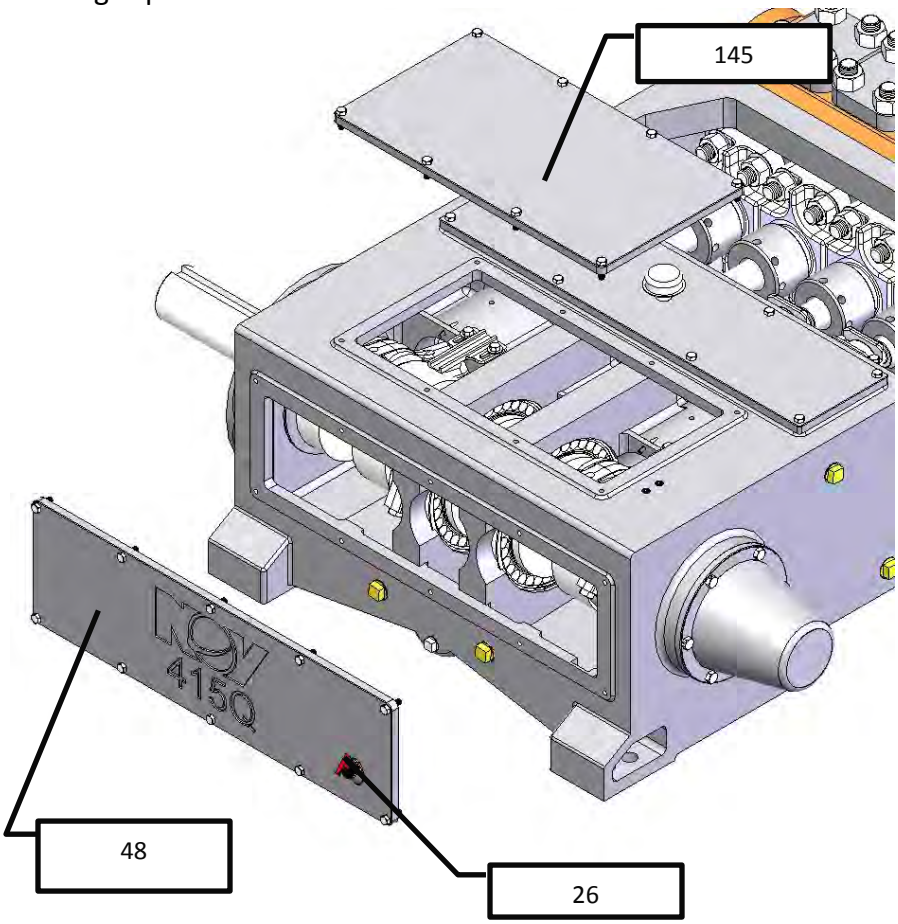
2. Manually rotate the crankshaft to position the plunger completely into the stuffing box. Remove the screws and washers (Items 747 & 32) and disconnect the plunger clamp (Item 700 & 701) and separate the intermediate rod (Item 680) from the plunger (Item 745) and rotate the crankshaft ½ turn to retract the intermediate rod. If threaded plungers are installed, unscrew the (Item 745) plunger from the intermediate rod (Item 680) and slip into stuffing box



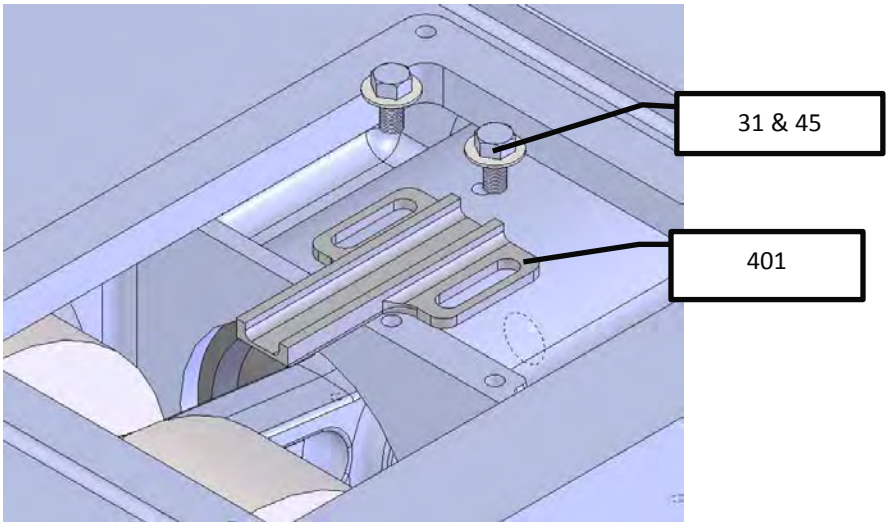
3. Loosen the lock nuts (Item 223) on the wiper box (Item 134) and allow the hook bolts (Item 222) to rotate so they will pass through the bore in the power frame . Unscrew the intermediate rod (item 680) from the crosshead (Item 212) and slide intermediate rod (Item 680) and wiper box out of the cradle as an assembly. Repeat the process with all (5) five cylinders.



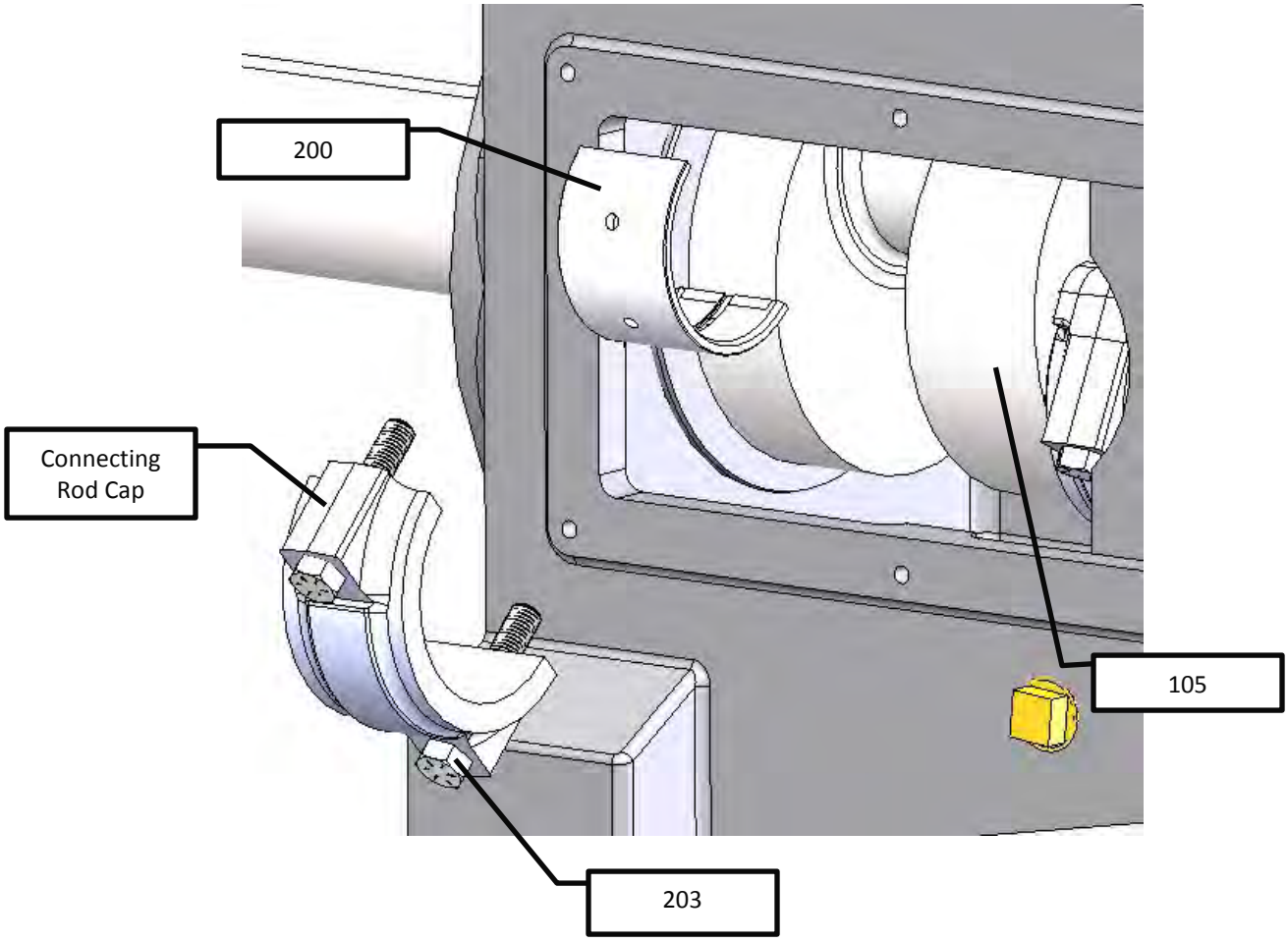
4. Remove the oil level dipstick (Item 26) before removing the cap screws for the rear crankcase cover (item 48) and top crankcase cover (Item 145) to allow easier access to the connecting rod bolts and bearing caps.




Remove oil trough (Item 401), cap screws (Item 36) and washers (Item 31) from inside top of crankcase.

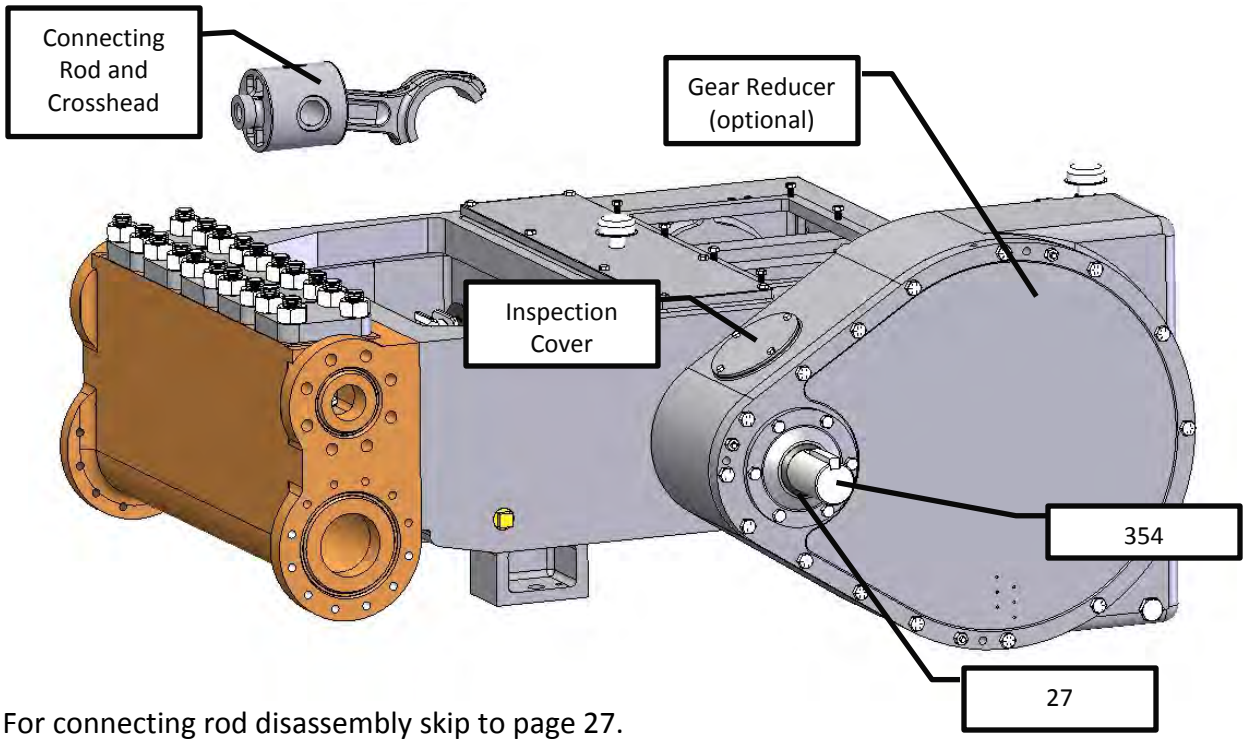


5. Remove connecting rod bolts (Item 203) and remove bearing rod cap. **NOTE: Keep the shell bearings (Item 200) for the connecting rods with their respective mating parts.** Push the connecting rod and crosshead (item 212) into the bore of the power frame, or all the way forward, to separate from the crankshaft (Item 105). Repeat process with all (5) five Connecting Rods.



# DISASSEMBLY AND REMOVAL OF GEAR REDUCER

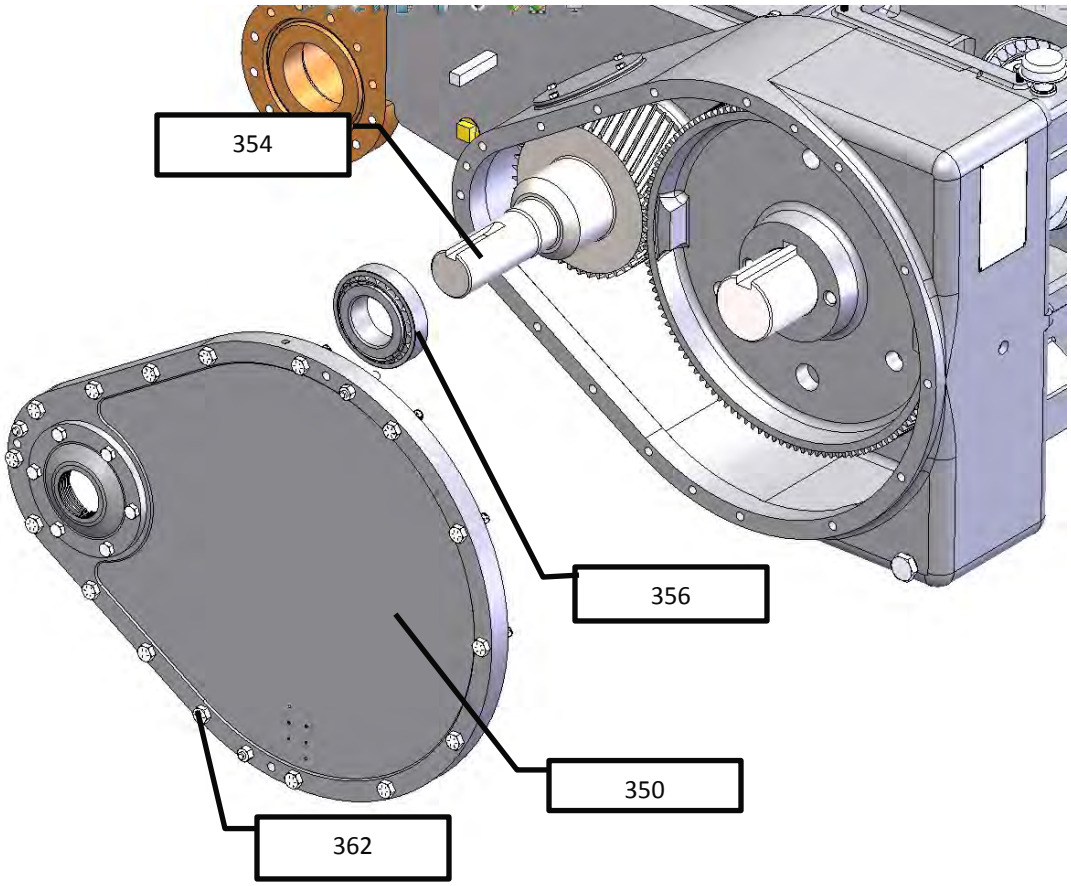
1. If the crankshaft is not being removed, the crosshead and attached connecting rod can be removed through the cradle by sliding them back through the oil chest. Be sure to keep the rod end shell bearings (Item 200) and bearing caps together with their mating parts as they are fitted to one another.



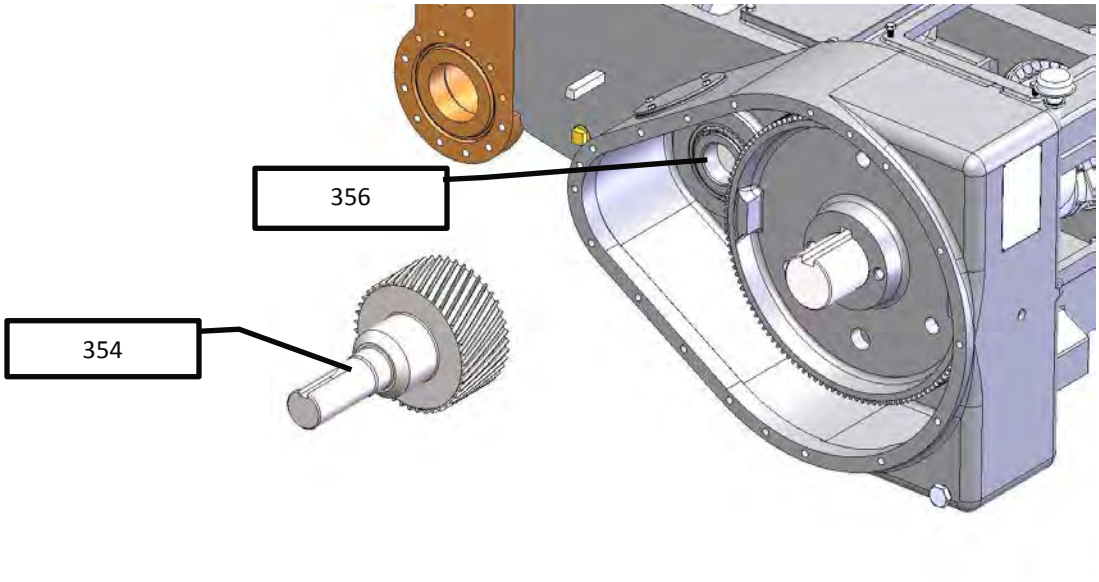

2. For connecting rod disassembly skip to page 27.

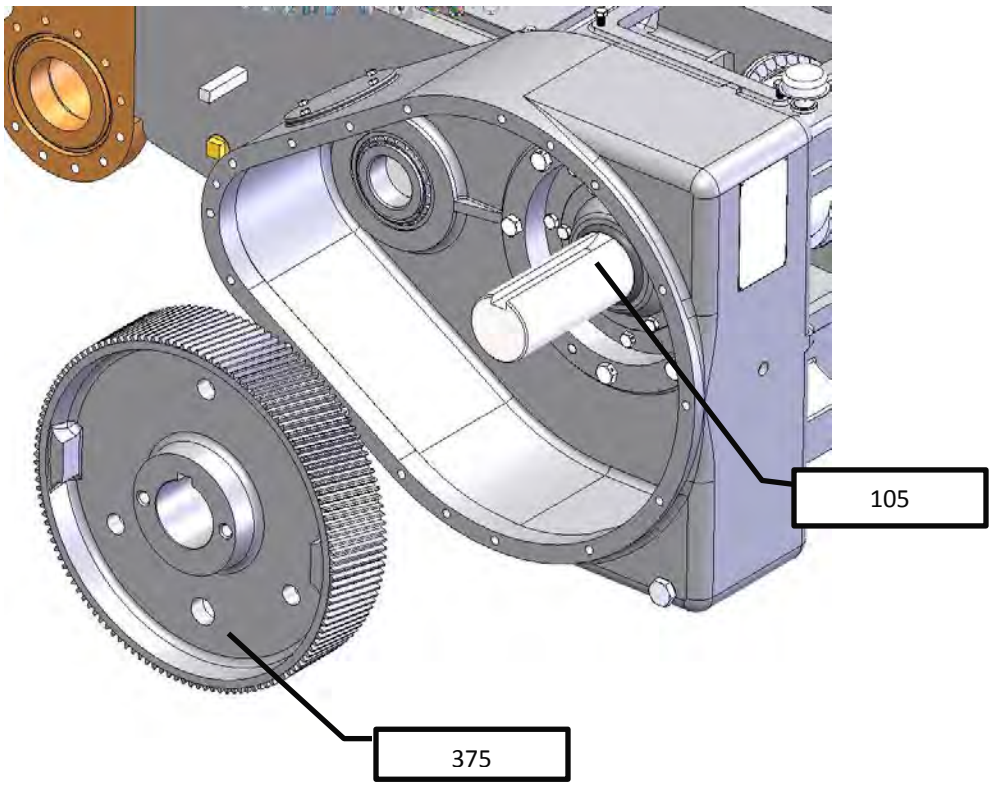
3. The crankshaft can only be removed from the left hand side of pump. If a gear reducer is installed it will need to be removed to access the crankshaft. If no gear reducer is installed, skip to Step 12. Remove inspection cover from gear reducer before removing gear reducer housing cover. Cut away the slinger ring (Item 27) from pinion shaft. **NOTE: Wrap a sling around the pinion gear shaft (Item 354) thru the inspection cover opening and support it with an overhead crane. The pinion gear shaft and bearing (Item 356) can fall out of the housing when removing the cover causing injury and damage to parts.**

4. Drain oil from gear box and dispose of properly. Remove cap screws (Item 362) and gear housing cover (Item 350) from housing. Remove the pinion gear shaft (Item 354) and outer bearing (Item 356). **NOTE: Take care when removing pinion gear shaft that inner bearing does not fall out of housing.**

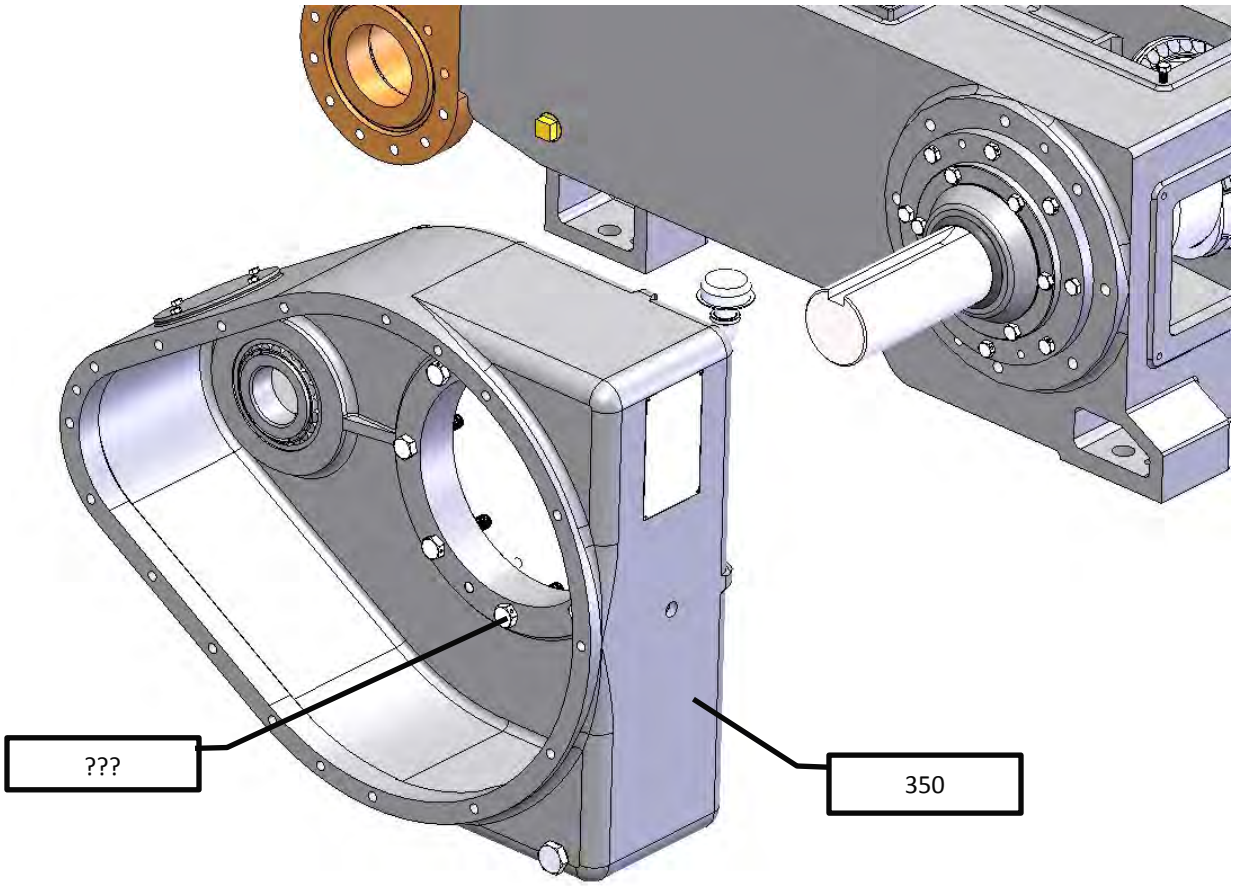


5. Remove the pinion gear shaft (Item 354) taking care the inner pinion shaft bearing (Item 356) does not fall out. Using a large gear puller, dismount the gear (Item 375) from the crankshaft (Item 105).



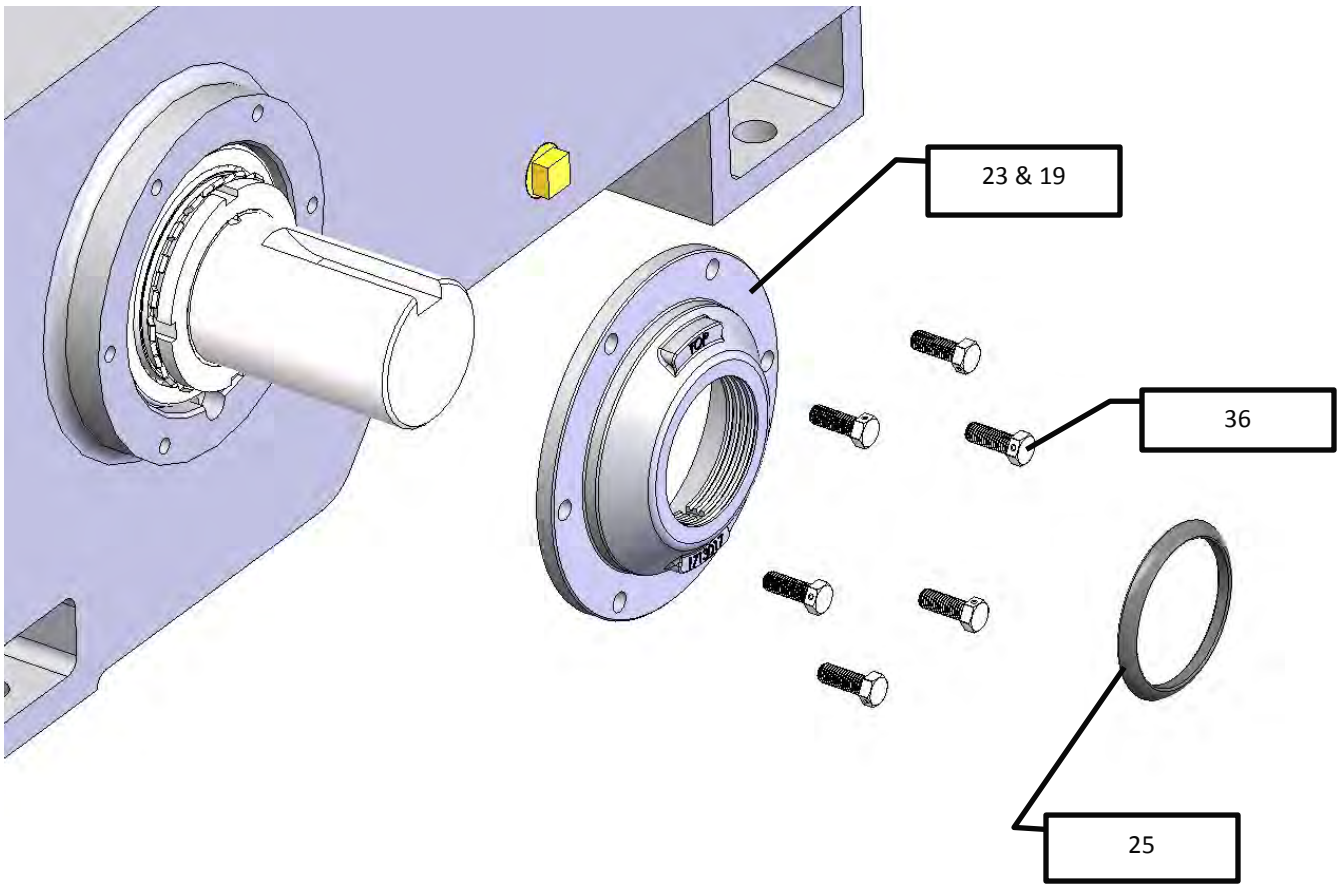



6. Remove mounting screws (item ???) and gear reducer housing (Item 350) from power frame Take care when separating the components, the housing is aligned with tapered dowel pins.

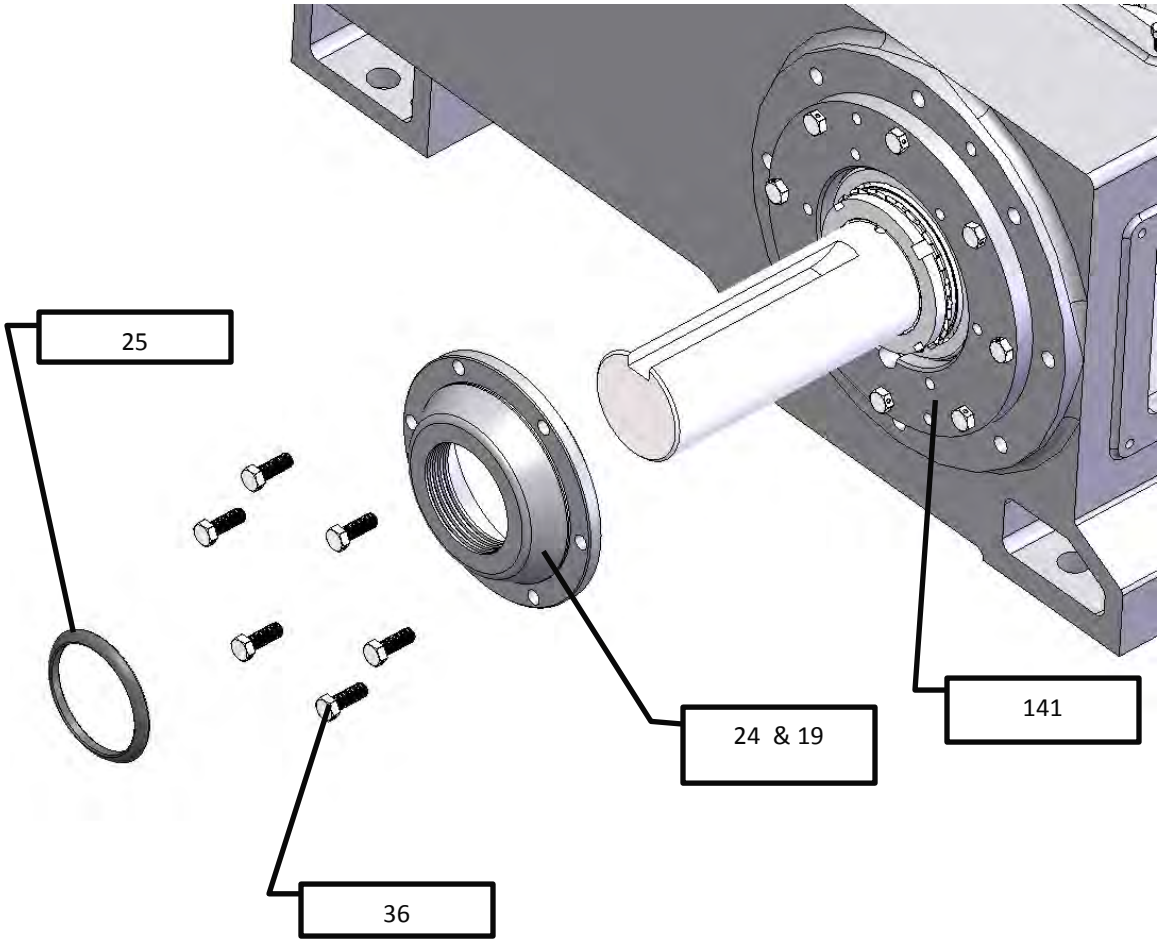


# REMOVAL OF CRANKSHAFT

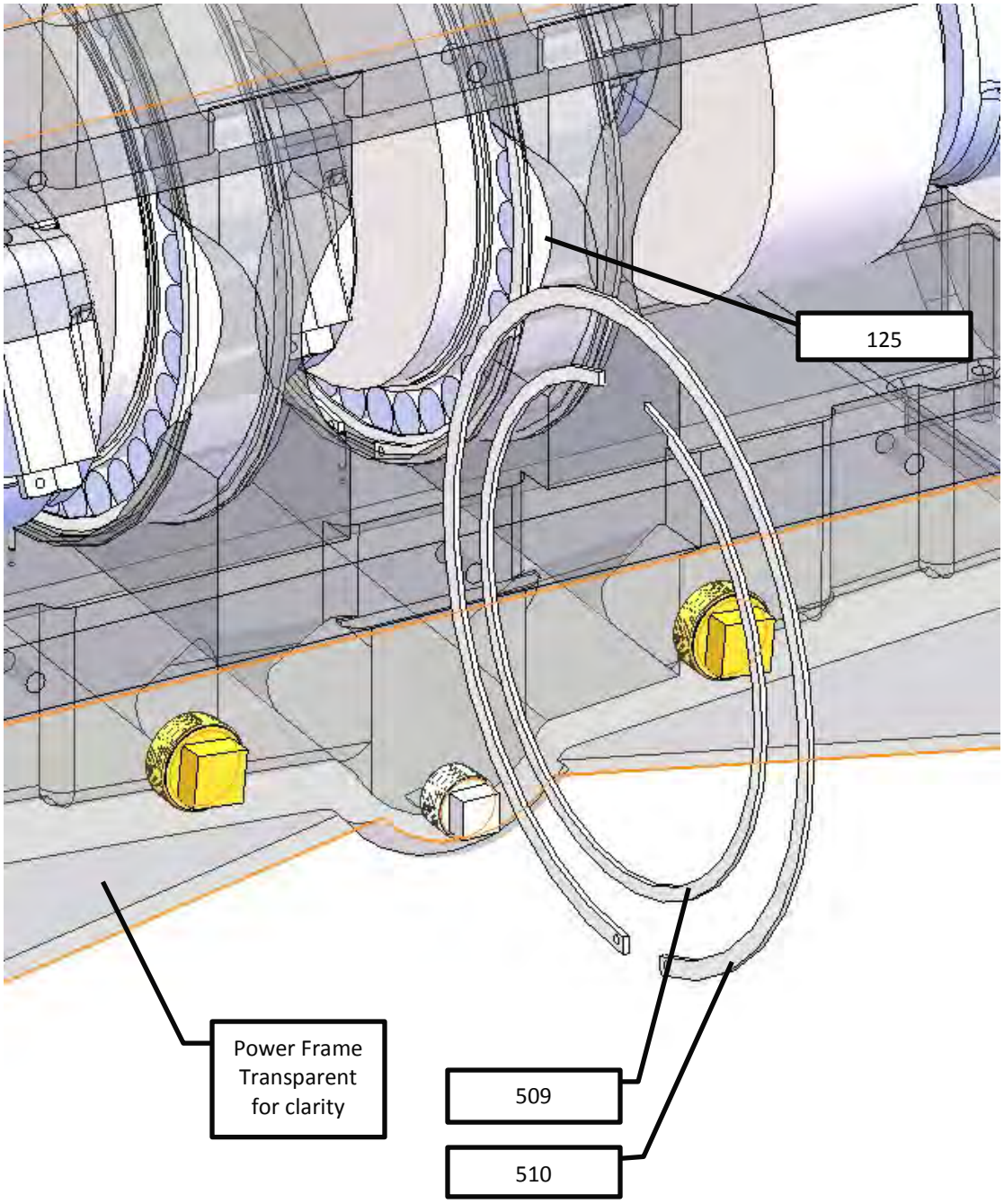
1. Cut away slinger ring (Item 25) and safety wire on hex bolts (Item 36). Remove right hand bearing retainer (Item 23), gasket (Item 19) and hex bolt from power frame. Slinger ring will be replaced at reassembly.



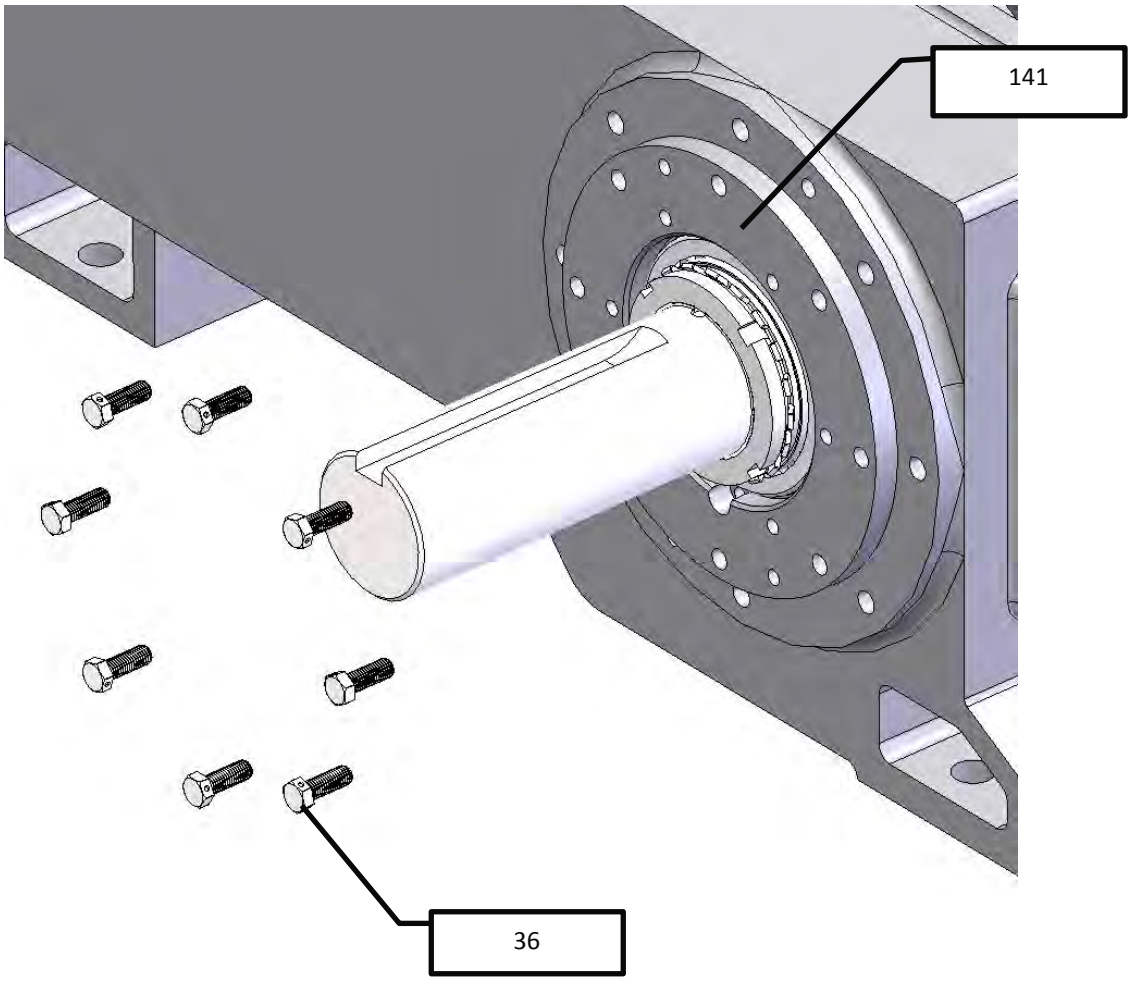
2. Cut away slinger ring (Item 25, on pumps without optional gear reducer) and safety wire on hex bolts (Item 36). Remove caged bearing retainer (Item 24), gasket (Item 23) and hex bolts (Item 36) from bearing cage (Item 141). Slinger ring will be replaced on reassembly.



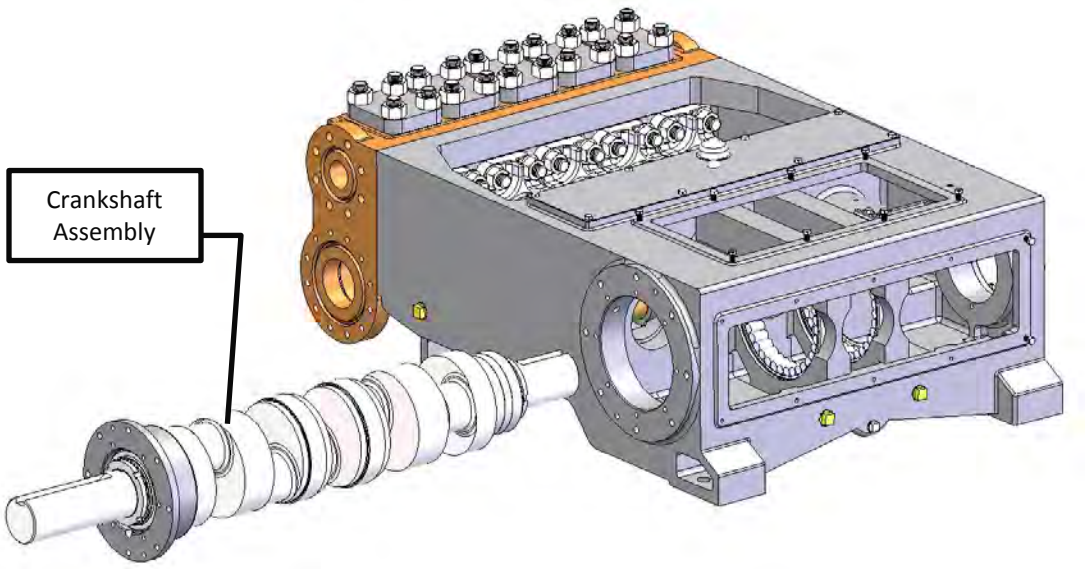
3. Remove the (8) eight main bearing retaining rings (Items 509 & 510) from the center section of the crankcase. These rings keep the crankshaft main bearings (Item 125) in location. There are (2) two inner rings and (2) two outer rings for each bearing.



4. Remove the cap screws (Item 36) mounting the bearing cage (Item 141) to the left side of the power frame.



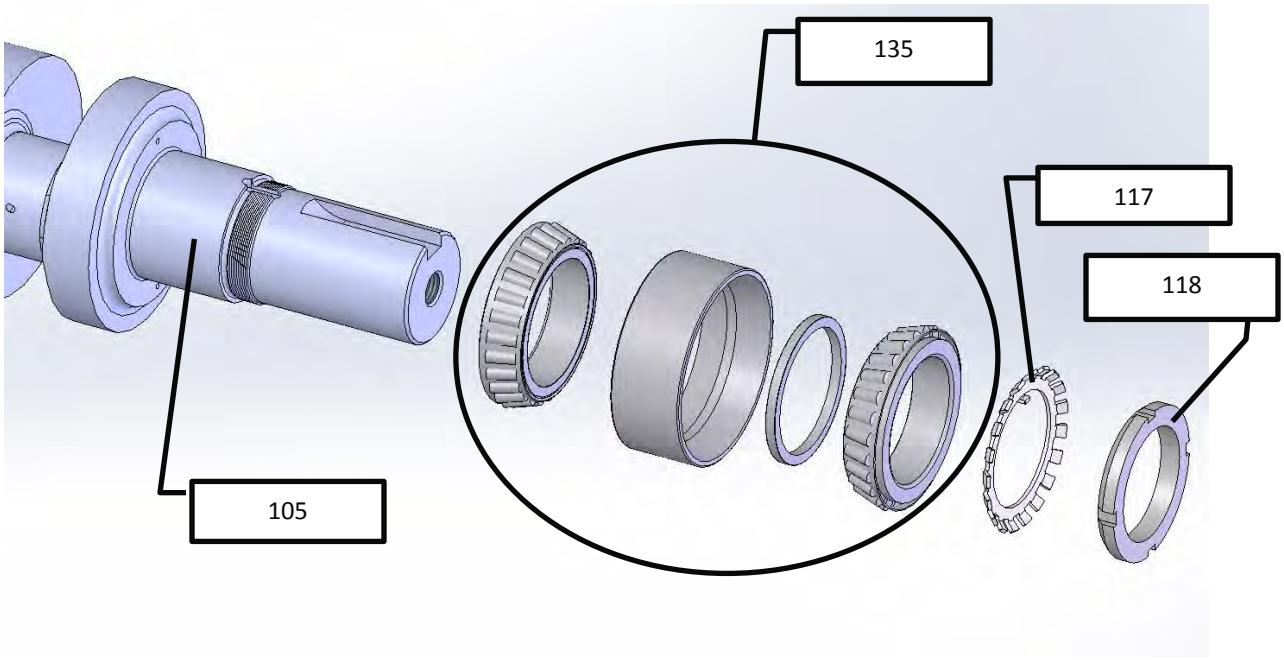
5. Carefully and while supporting the crankshaft (Item 105), gently slide it out the left hand side of the power frame. Care must be taken to keep from damaging the main bearing races and the bores of the power end. The main bearing outer races will remain installed in the power frame while the inner main bearing races will remain mounted to the crankshaft as will the outer tapered roller bearing assemblies.

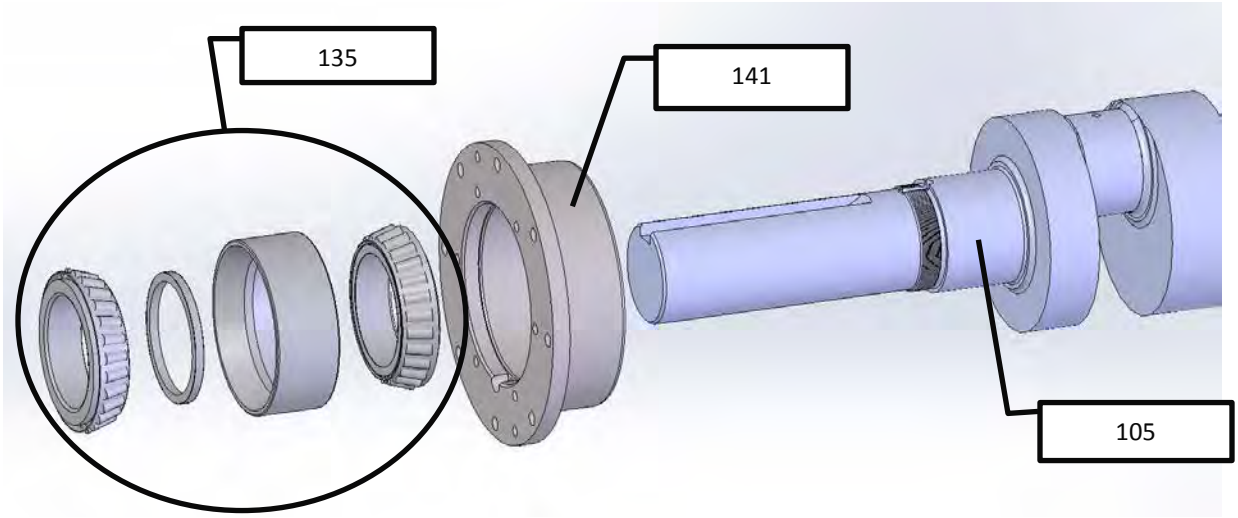



6. The crankshaft main bearing races must be inspected while on the crankshaft and should not be removed unless necessary. If the tapered roller bearings are to be replaced, proper removal tools are required.

# DISASSEMBLY OF CRANKSHAFT

1. To disassemble the outer tapered roller bearings (Item 135), first bend the tang up in the lock washer (Item 117) that is keeping the locking nut (Item 118) from rotating and unscrew the nut from the crankshaft (Item 105). Once the locking nut and washer are removed a bearing puller is used to remove the right side outer tapered bearing. On the left side a bearing puller is used to remove the bearing cage (Item 141) and tapered bearing as a unit. The bearing can then be pressed out of the bearing cage.

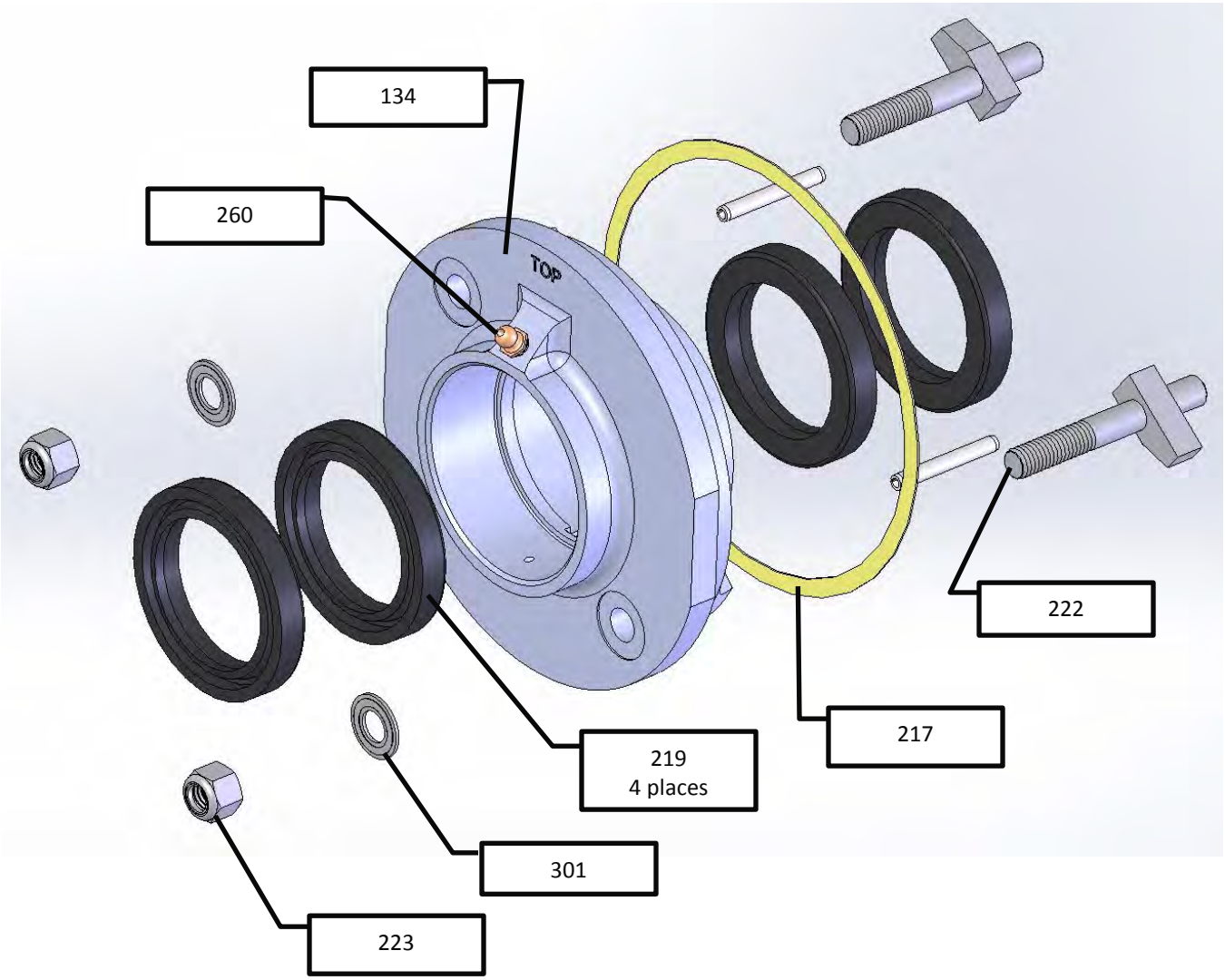



**NOTE: The double row tapered roller bearings are not serviceable. They must be kept together as a matched set if they are to be reinstalled. They are precision matched to the center spacer and must be reassembled exactly as they were removed from the crankshaft**

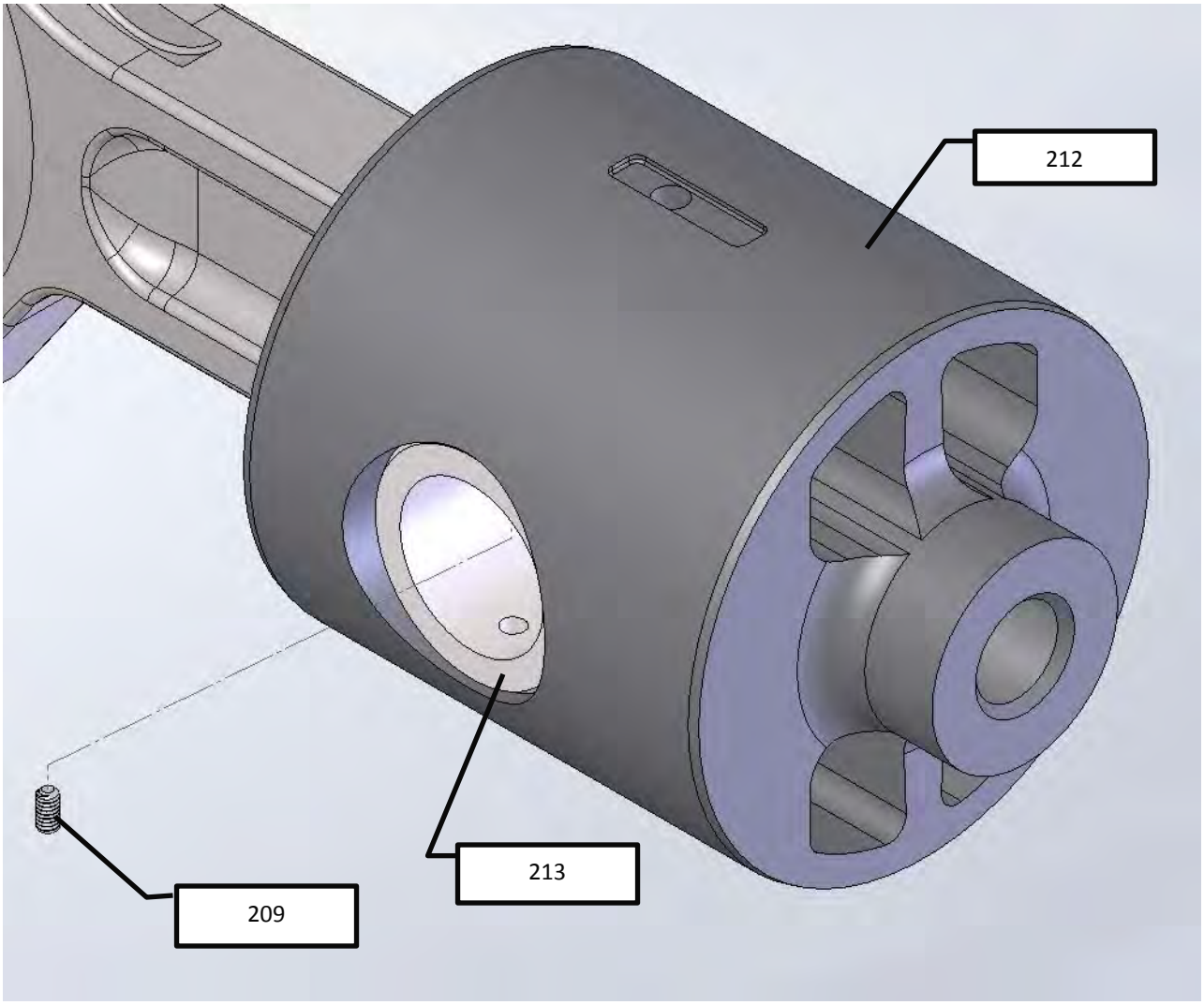
# DISASSEMBLING THE WIPER BOX

1. The wiper box (Item 134) can be disassembled as shown in the image below. Replace the wiper rings (Item 219), the gasket (Item 217) and the sealing washers (Item 301) to rebuild. Inspect the remaining components for damage or excess wear and replace as needed,

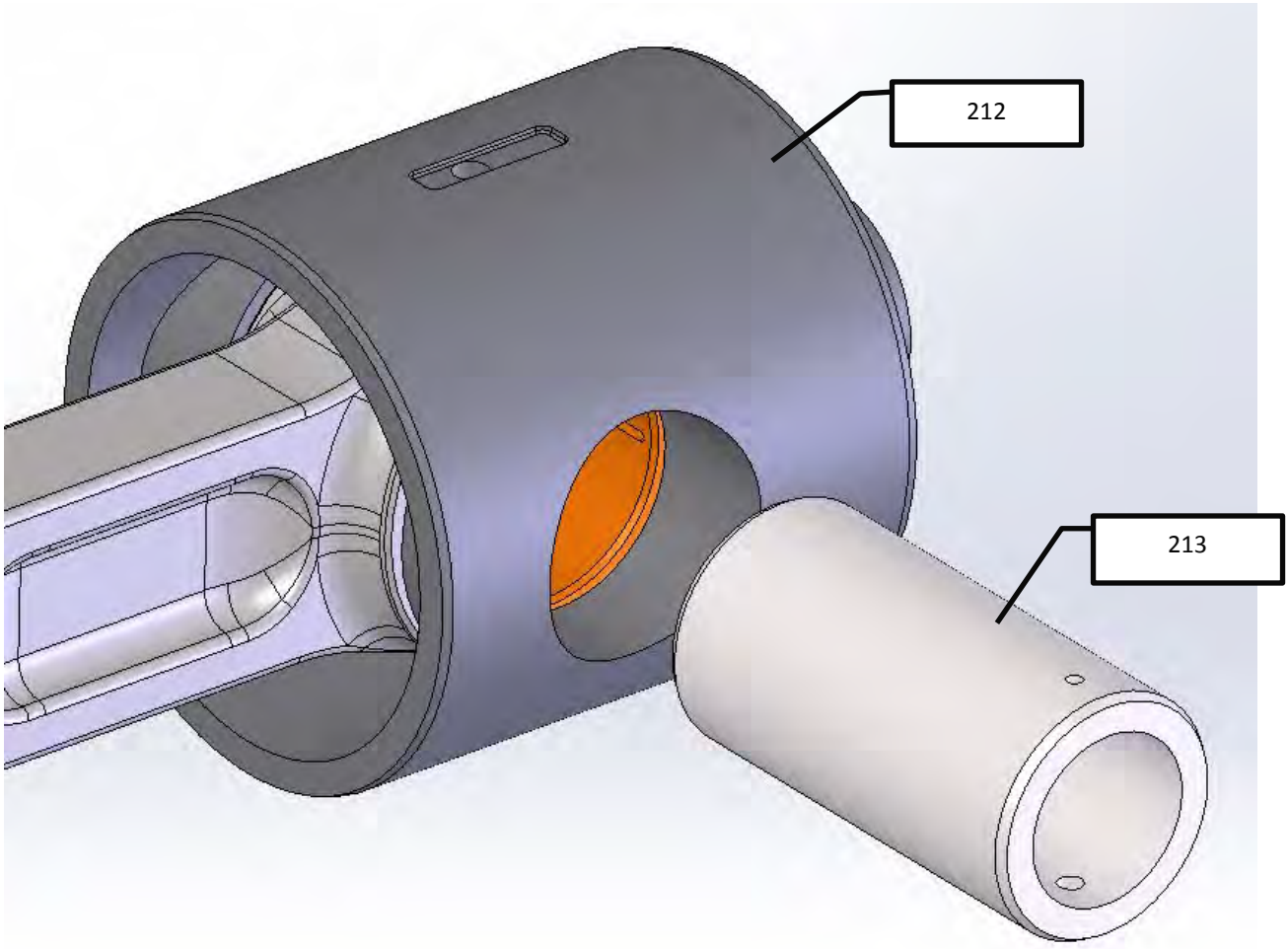


# DISASSEMBLING THE CONNECTING ROD

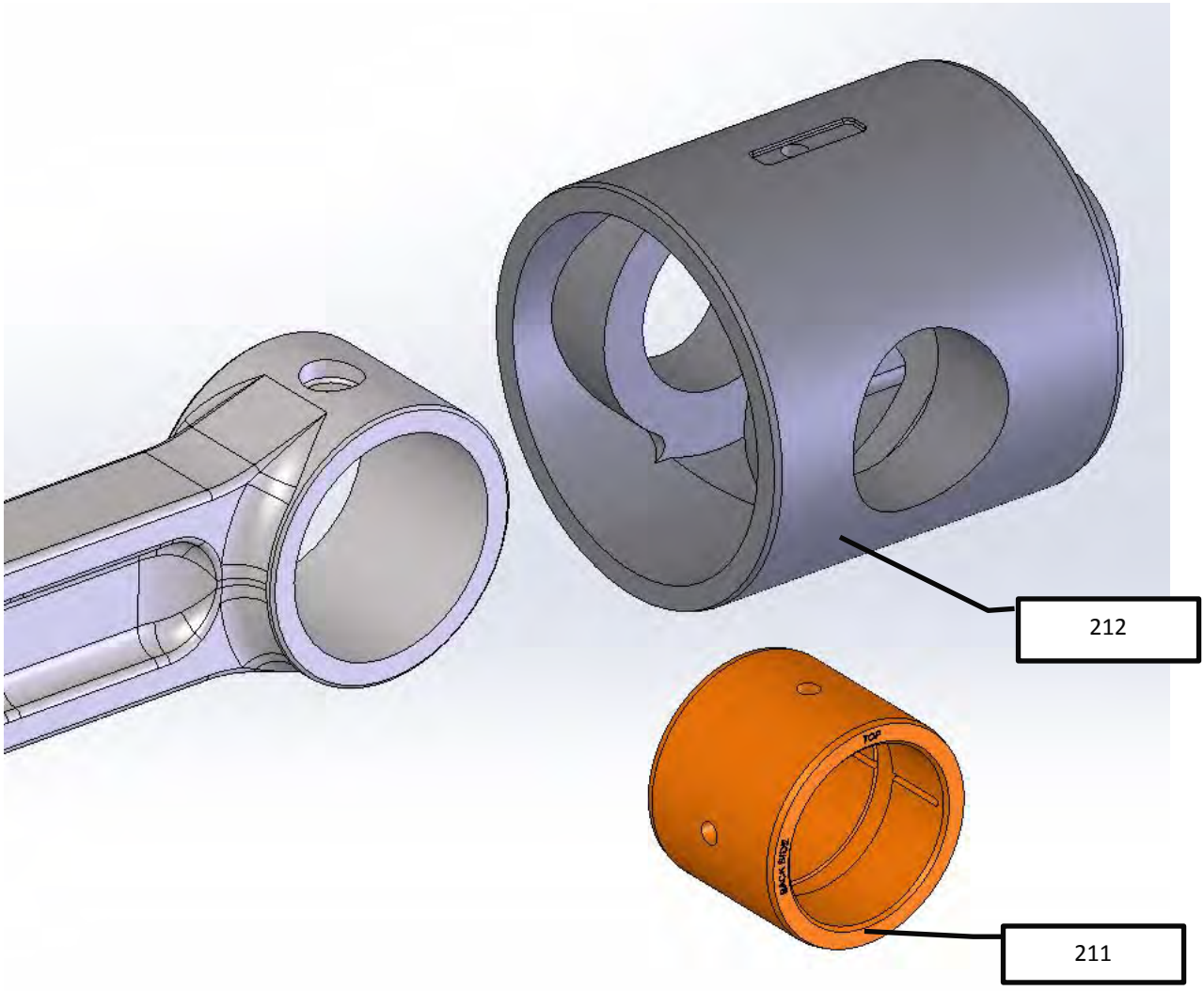
1. Complete disassembly of the connecting rod must be done in a particular order to keep from damaging components. First, to separate the crosshead (Item 212) from the wrist pin (Item 213), remove the set screw (Item 209) through the hole in the wrist pin.



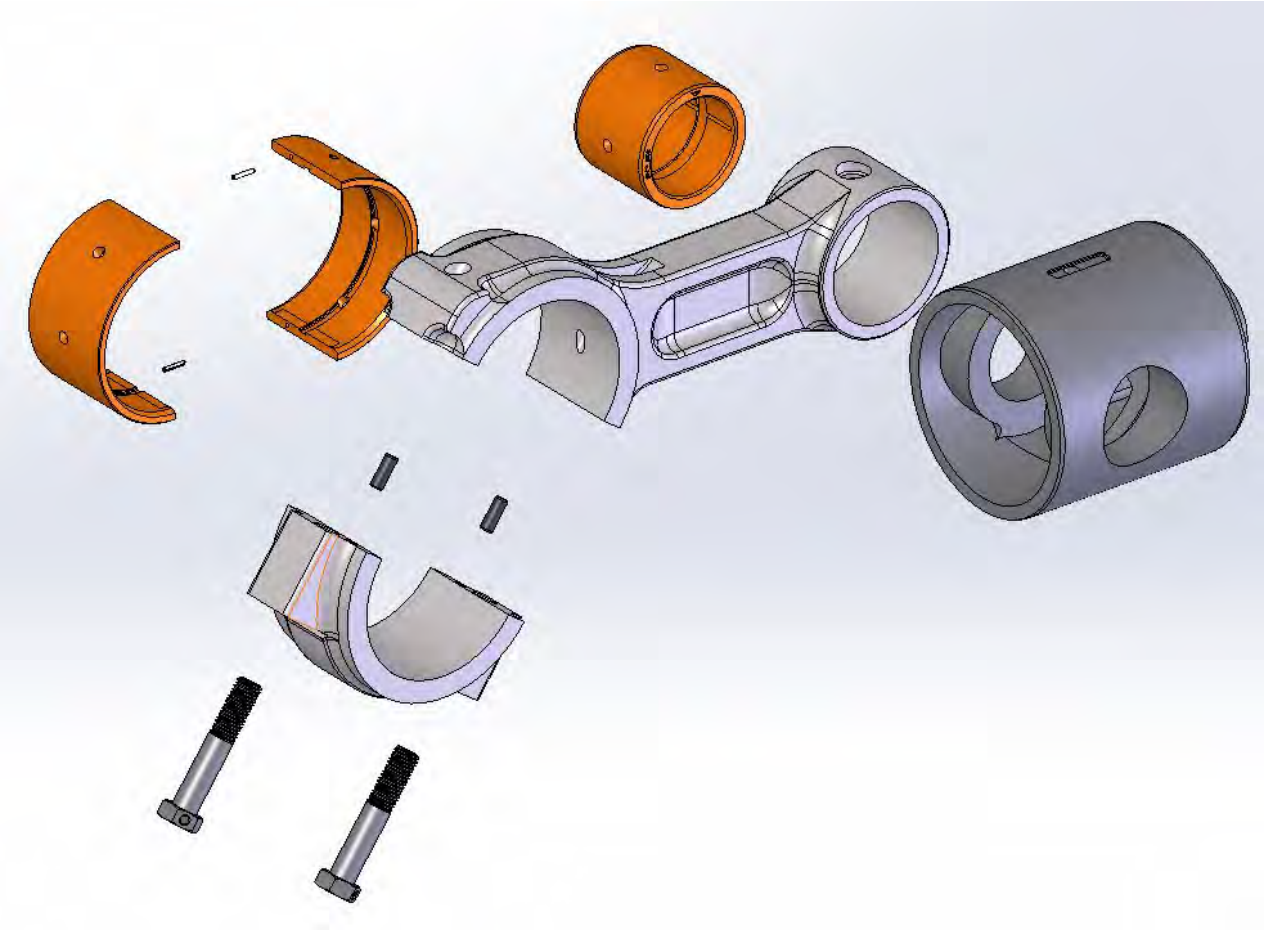
2. Tap the wrist pin (Item 213) out of the crosshead (Item 212) gently to keep from damaging the edges. Make sure the crosshead is secured to keep it from rolling off. Be sure to keep the crosshead and wrist pin together with the rest of the connecting rod, they will need to be reassembled as a matched set.



3. Slide the crosshead (Item 212) from the end of the connecting rod and press out the wrist pin bushing (Item 211). Take care not to damage the connecting rod in the process.

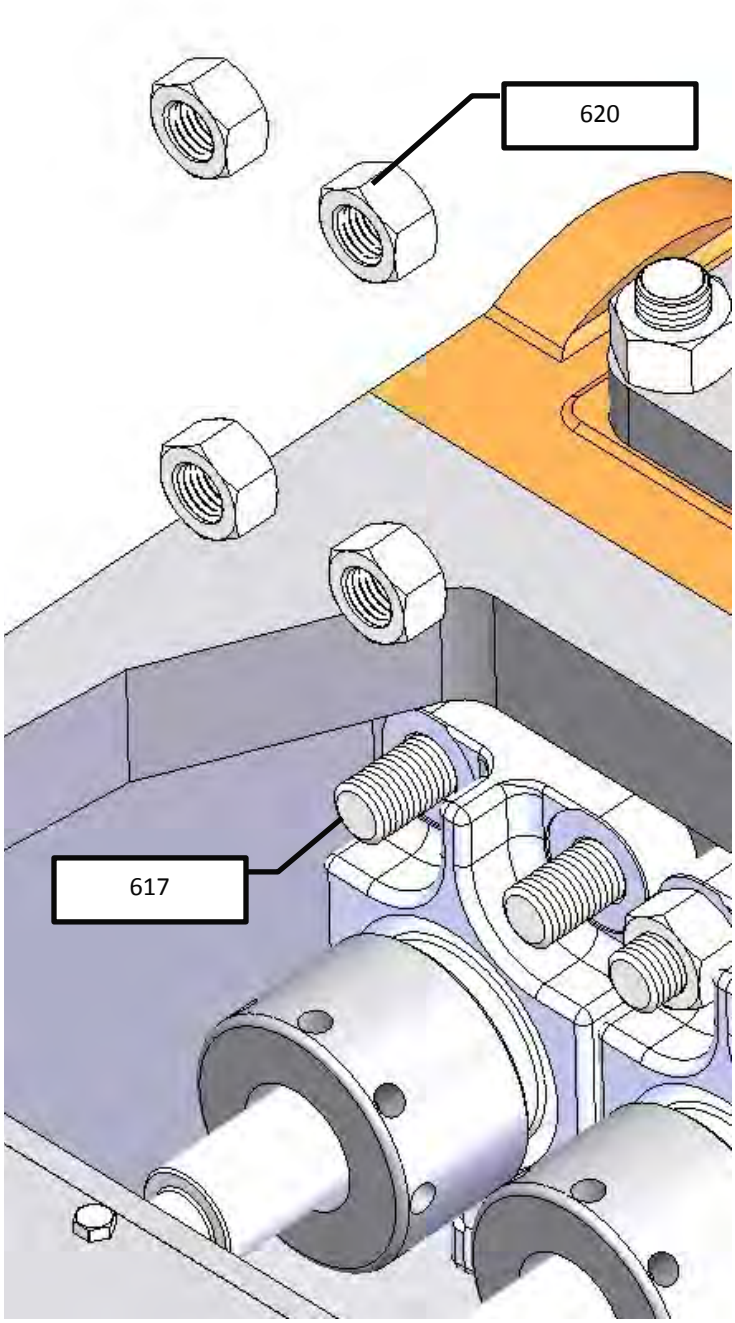


4. Exploded view of all parts of the connecting rod. These parts must be kept together as a matched set. Do not mix parts with other connecting rods.

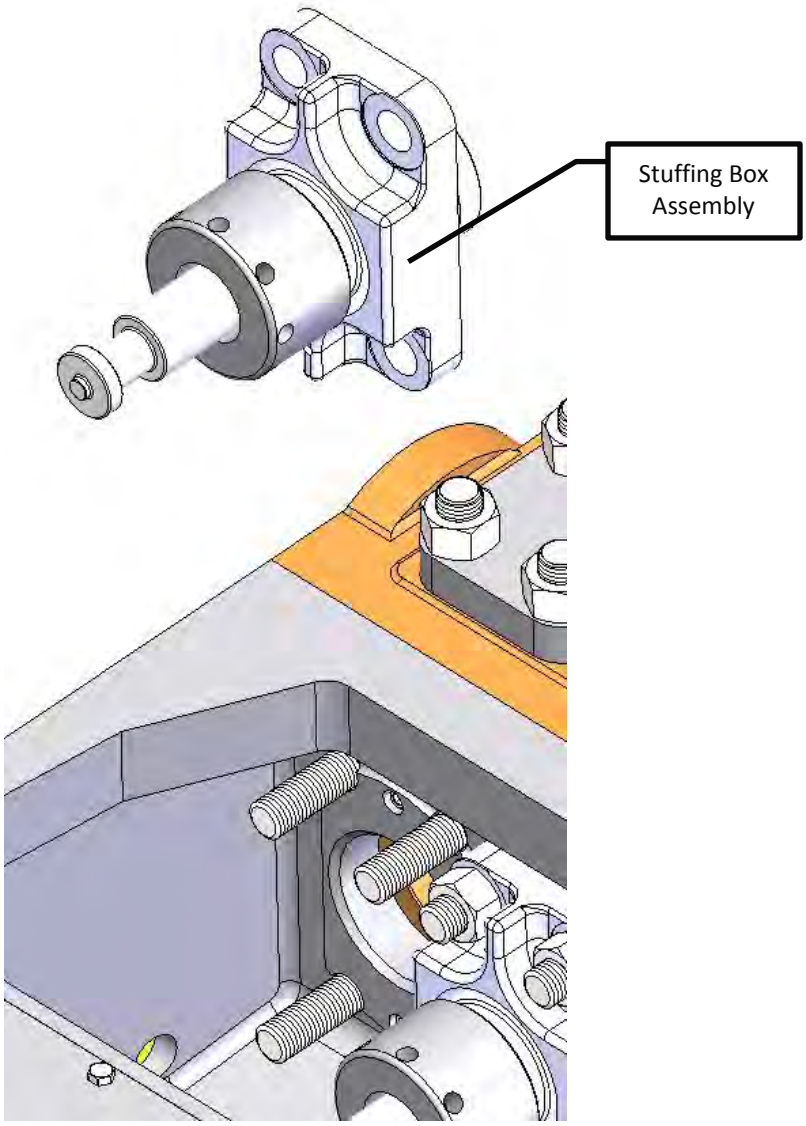


# REMOVAL OF STUFFING BOX

1. Remove four (4) hex nuts (Item 620) from fluid end studs (Item 617).



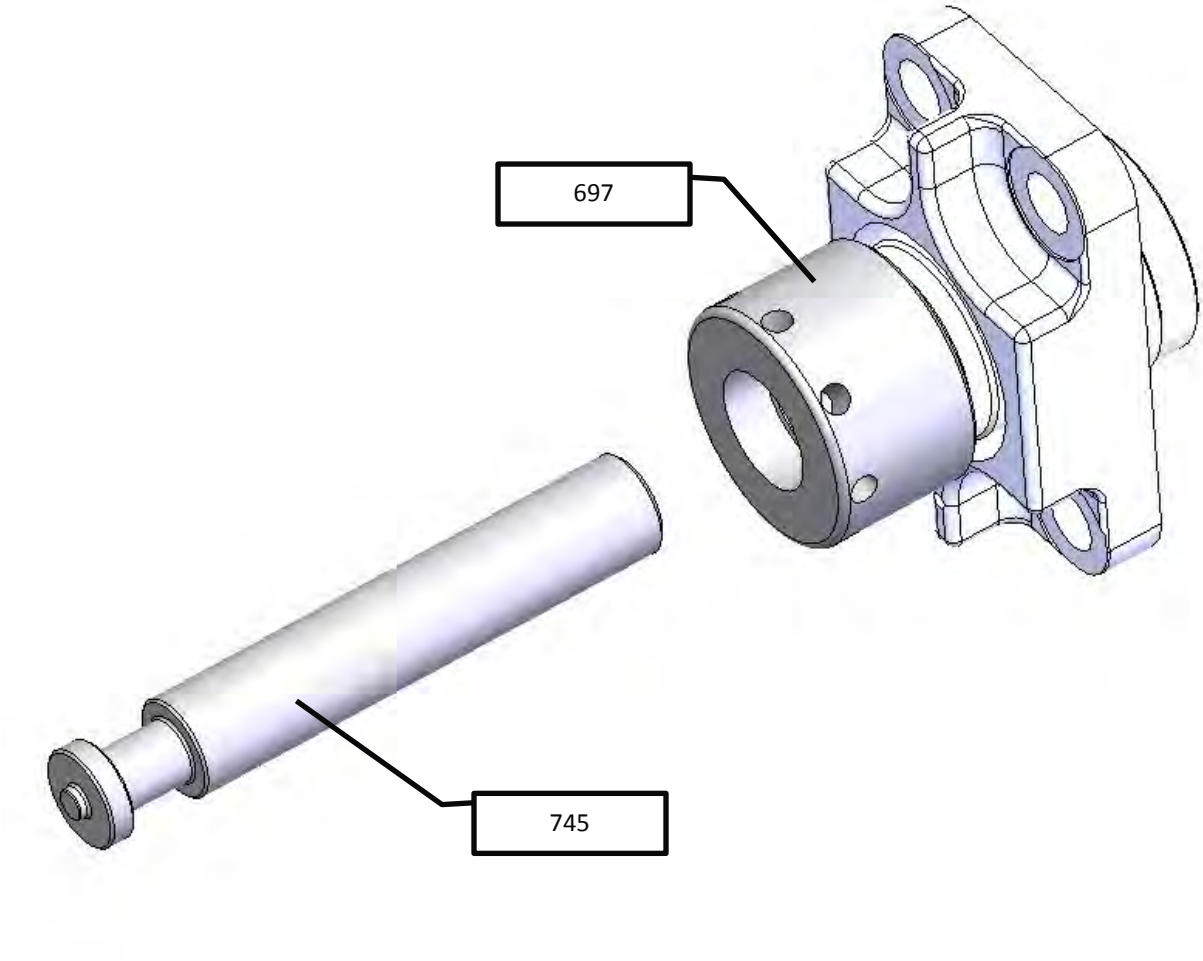
2. Slip stuffing box assembly with plunger from studs and lift out of pump cradle.



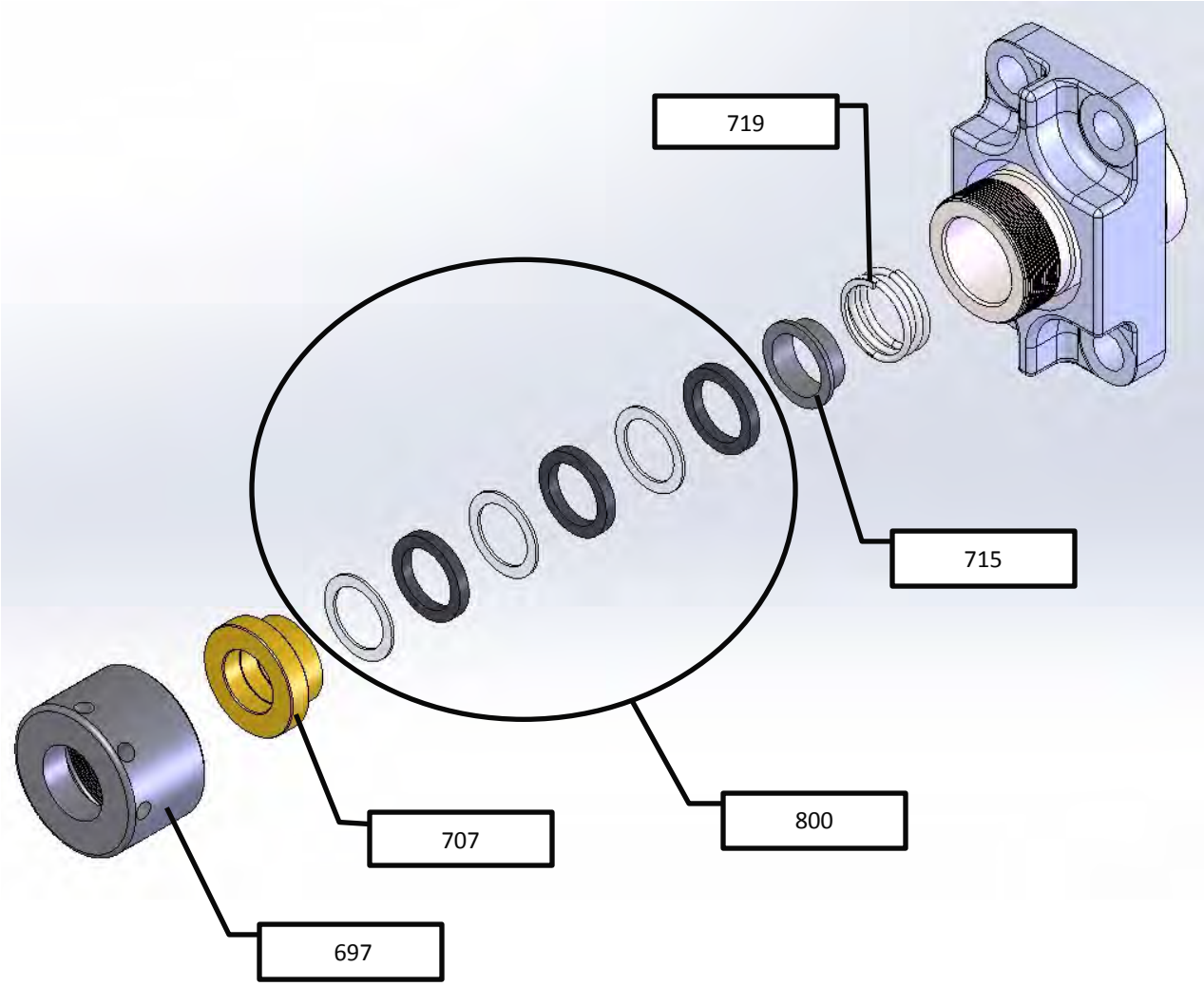

3. Repeat same steps for all five (5) stuffing boxes. Keep parts together for each stuffing box.

# DISASSEMBLY OF STUFFING BOX

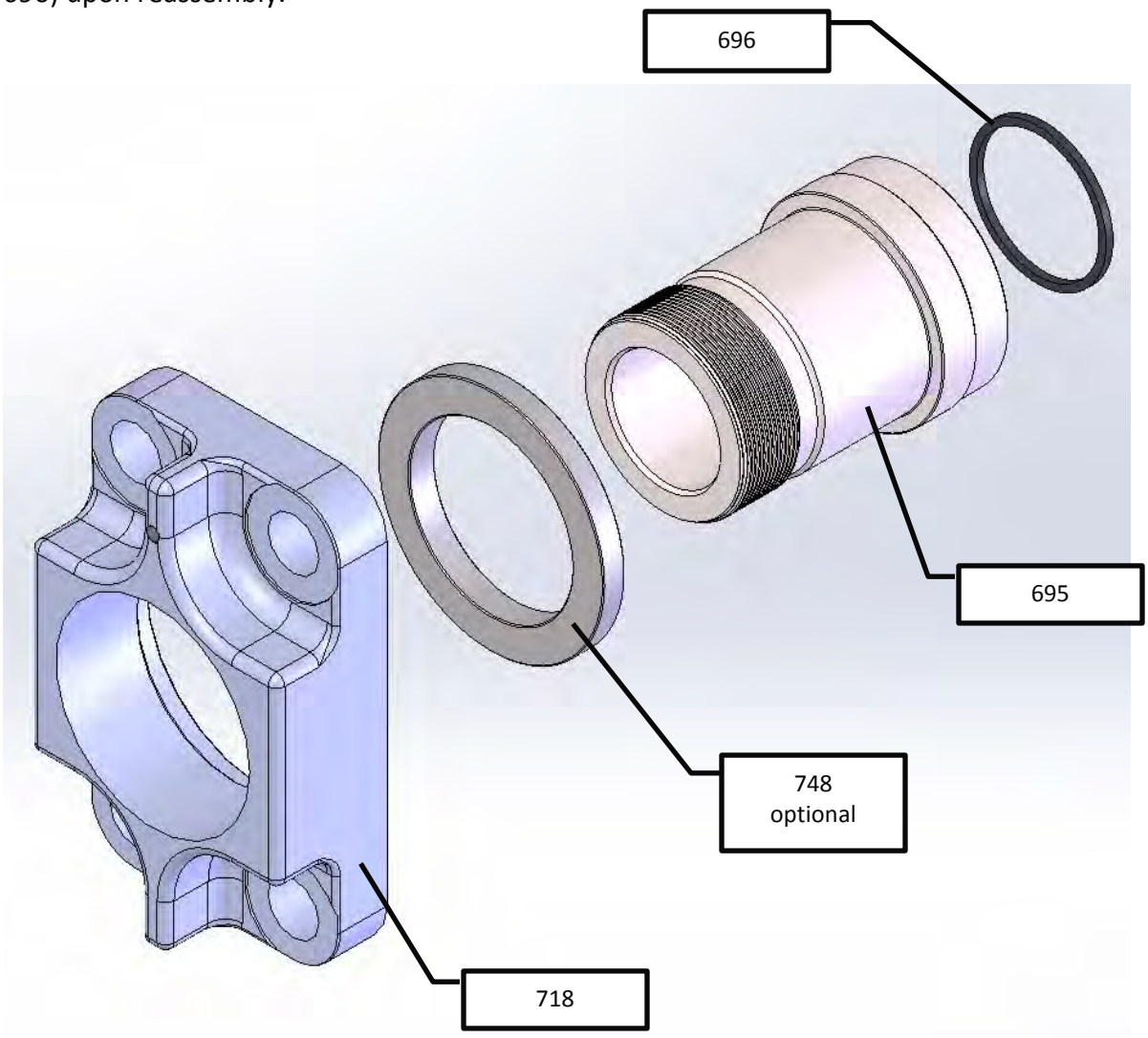
1. Loosen gland nut (Item 697 ) until plunger (Item 745) can be slipped out of packing.



2. Remove gland nut (Item 697) and pull gland (Item 707) and packing (Item 800) from stuffing box. Remove spring follower (item 715) and spring (Item 719) to complete packing set removal.

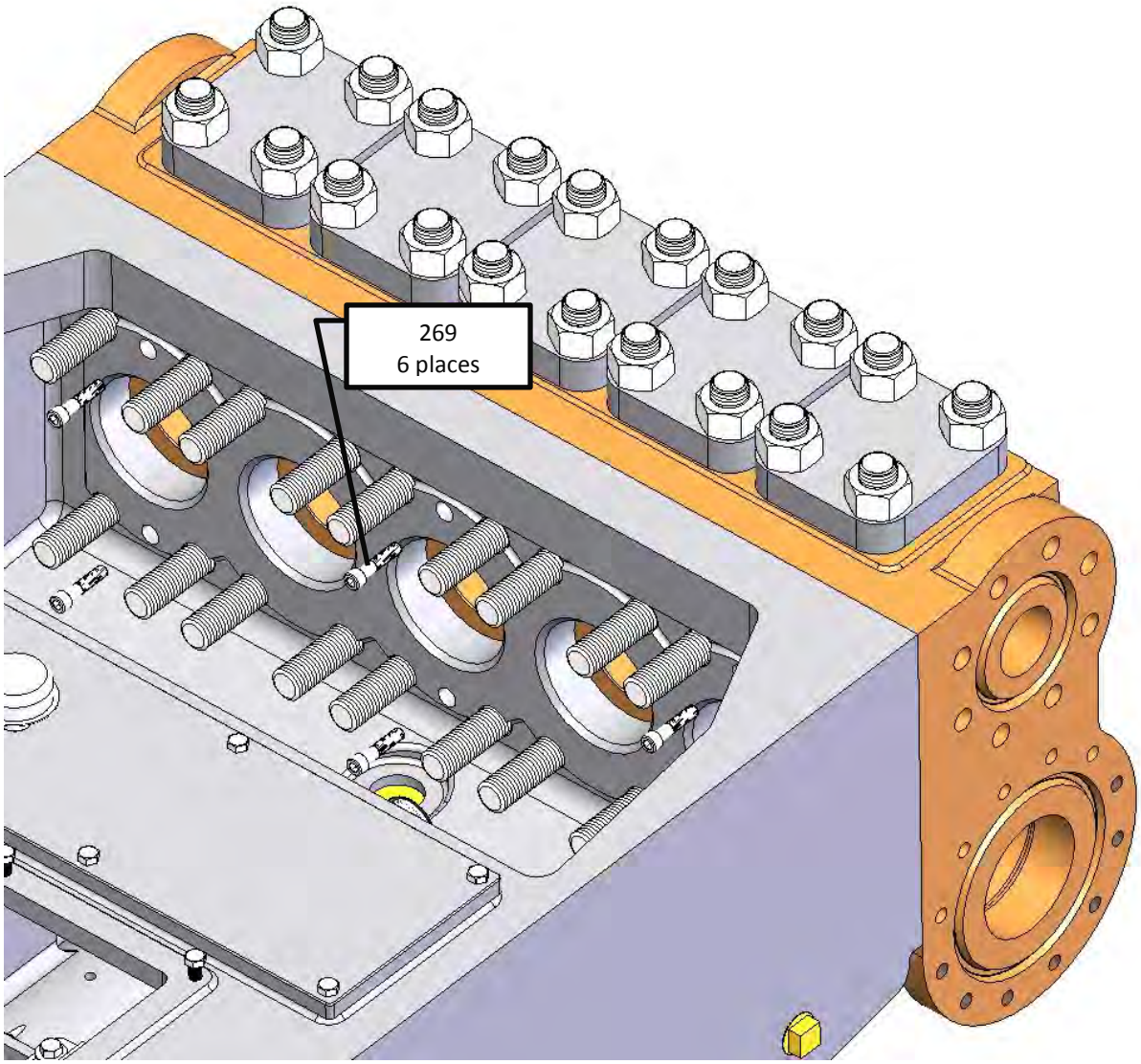


3. Slip stuffing box (item 695) from retainer (Item 718). High pressure H Model stuffing boxes use a retainer adapter (Item 748) to allow smaller stuffing boxes to fit retainer. Replace stuffing box seal (Item 696) upon reassembly.

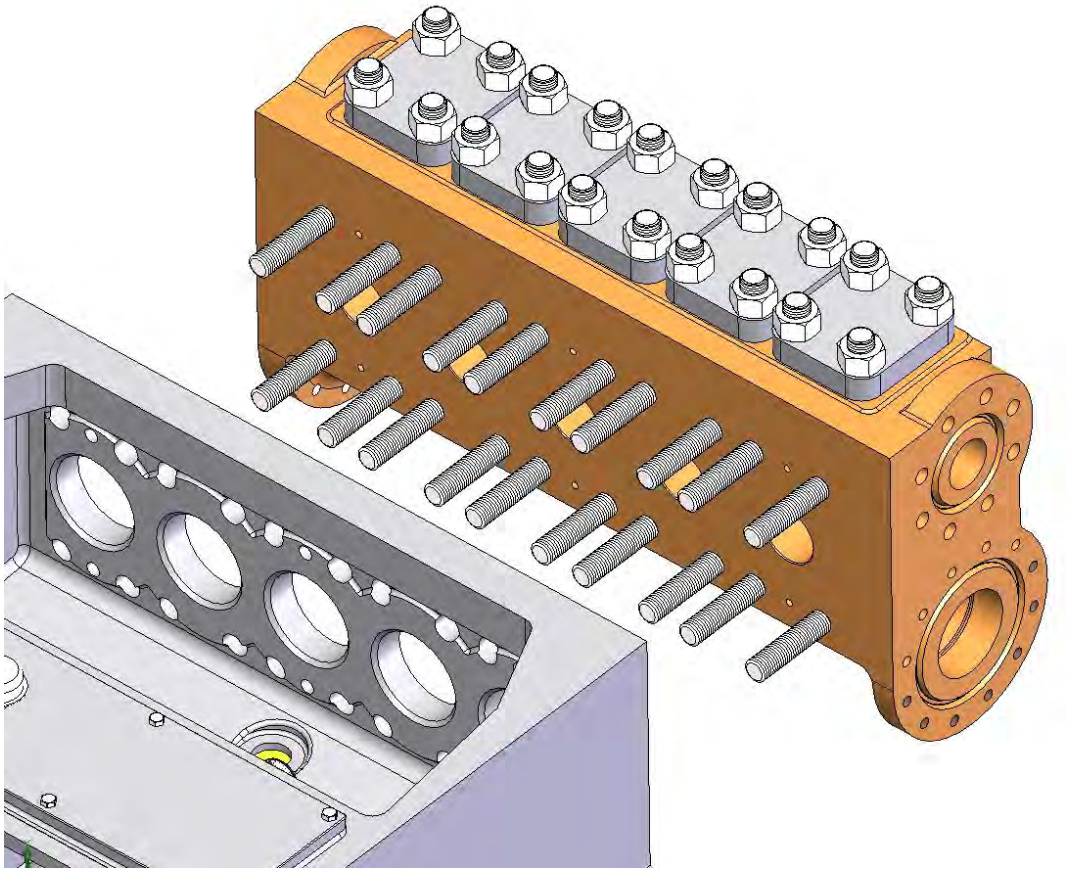


# SEPARATING FLUID END FROM POWER FRAME

1. With stuffing boxes removed, the six (6) socket head cap screws (Item 269) holding the fluid end to the power frame are accessible. Support the fluid end with a crane and remove the screws.

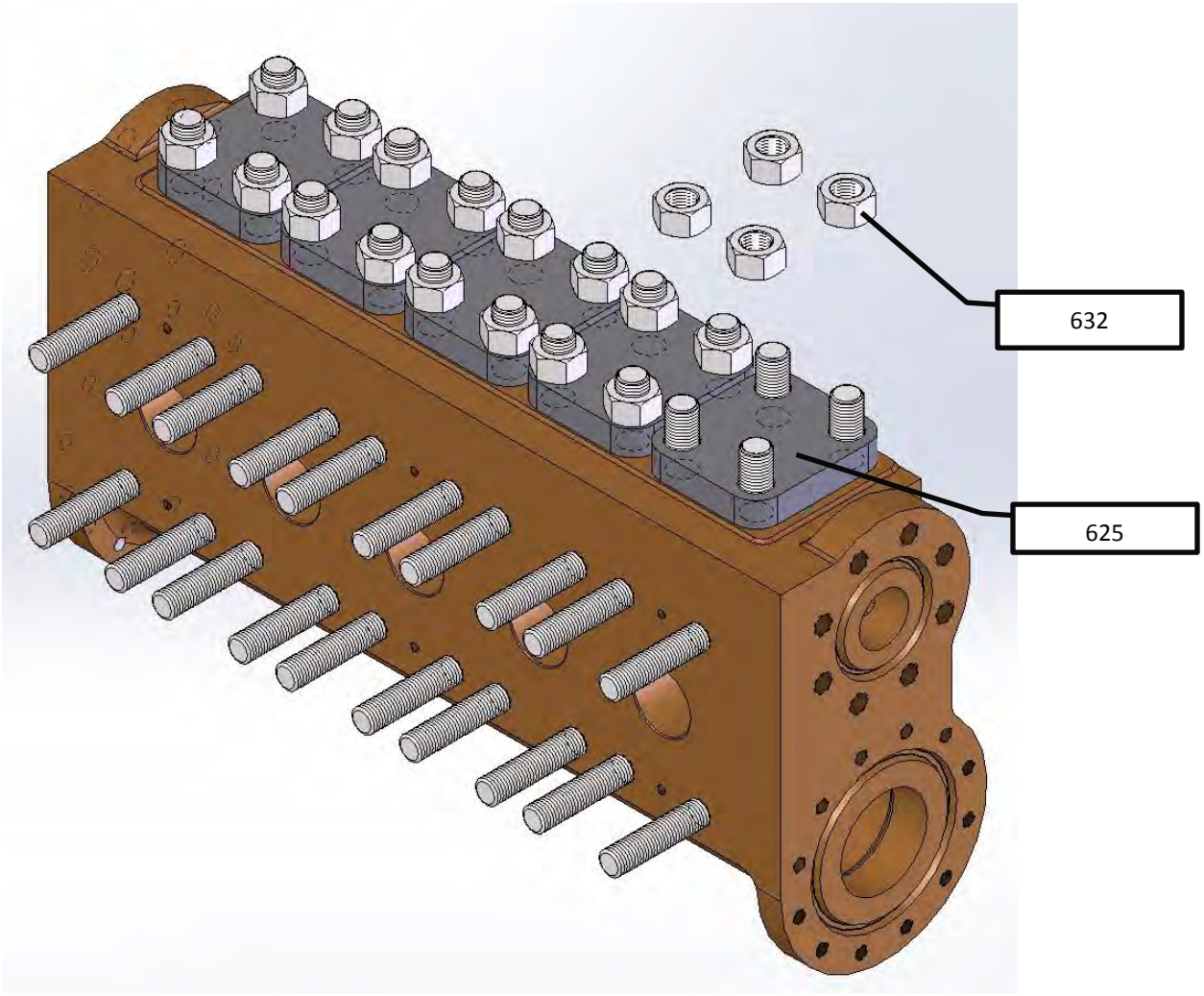


2. Slip the studs and fluid end from the power frame. The fluid end is now ready for tear down and rebuild.

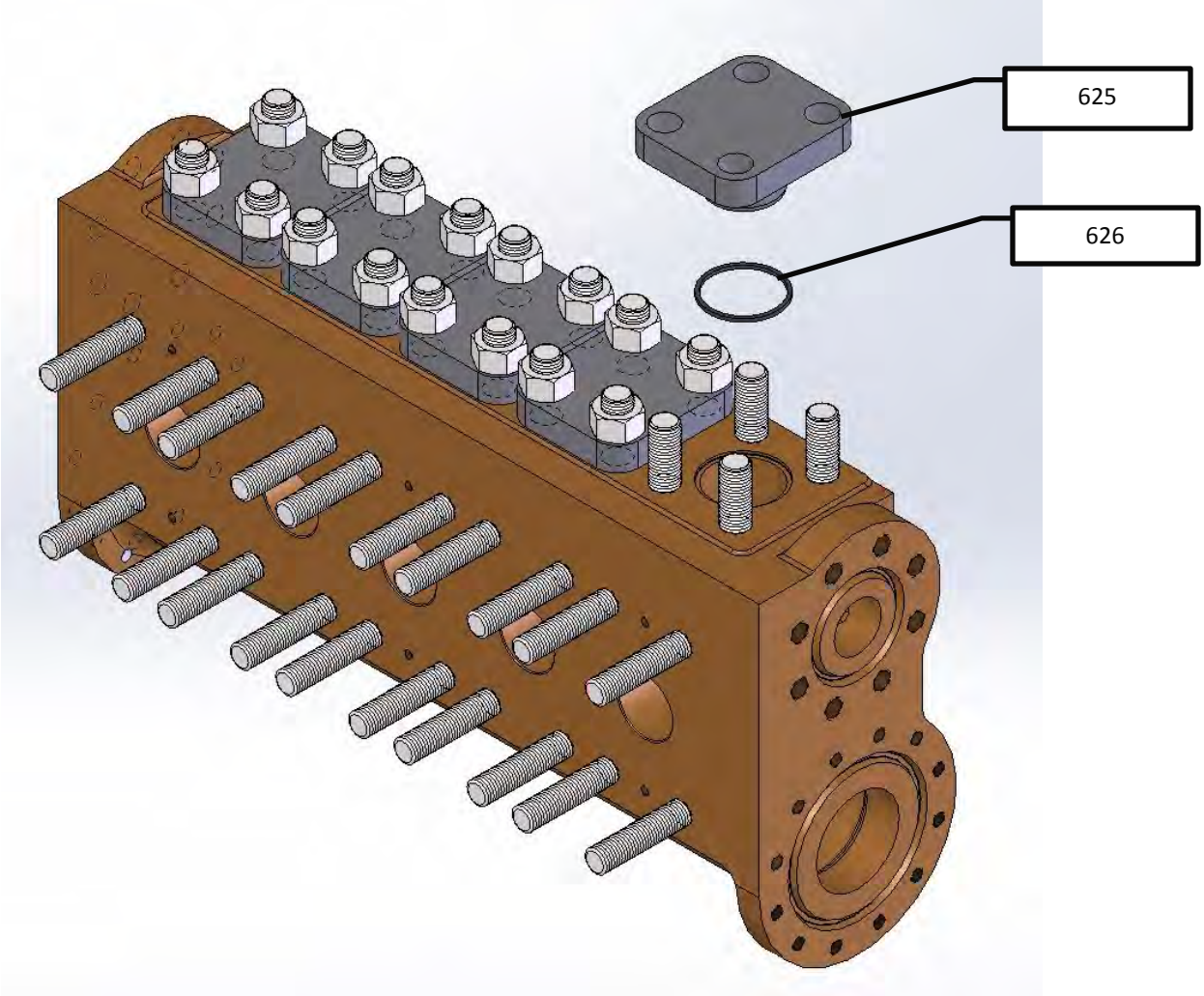


# DISASSEMBLY OF FLUID END WITH SPHERICAL VALVES AND SPHERICAL SEVERE DUTY VALVES (415Q-5L & 415Q-5M)

1. With fluid end resting in a stable position, remove hex nuts (Item 632) on valve covers (Item 625).



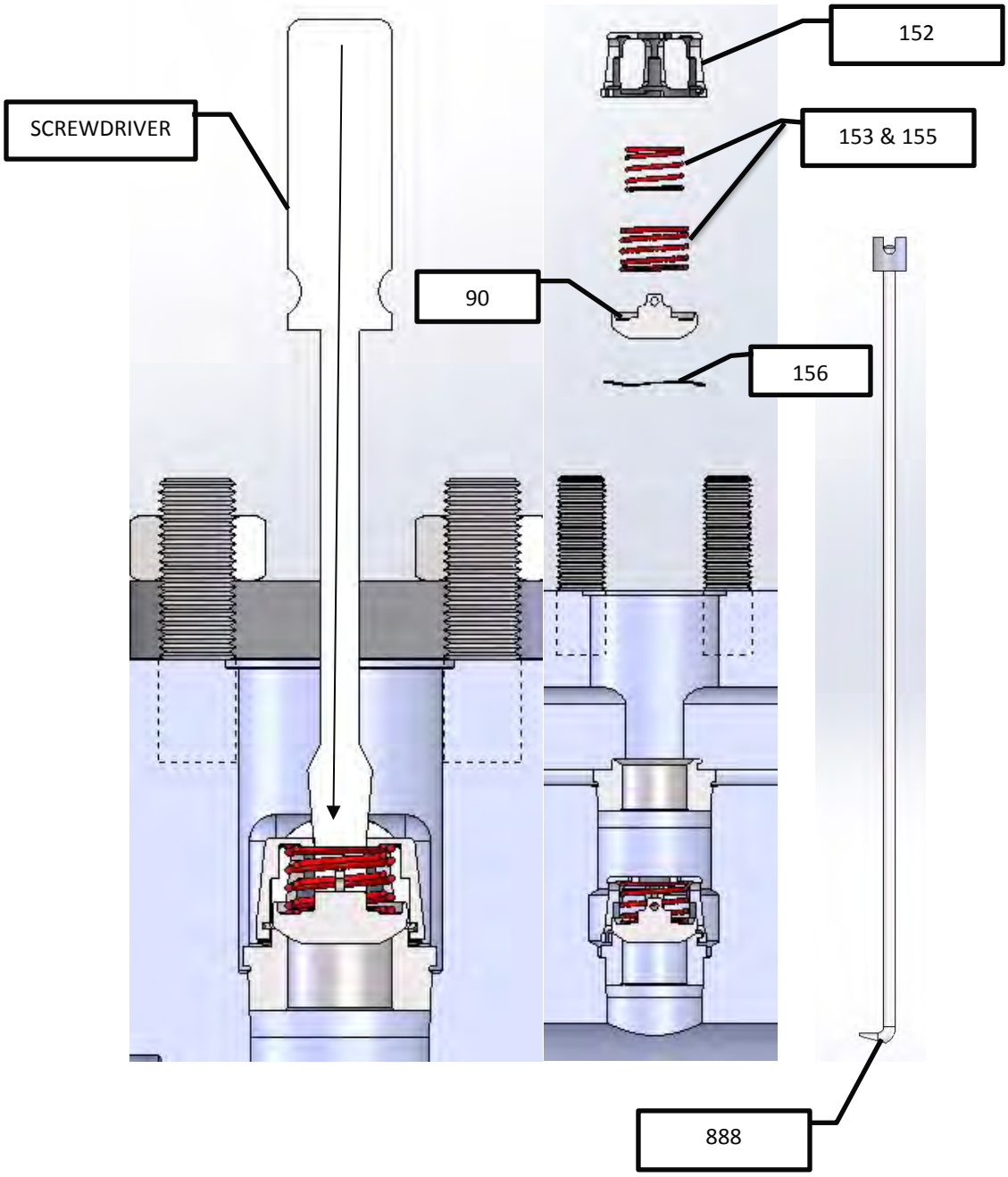
2. Gently pry valve cover (Item 625) loose and lift off. Locate and remove o-ring seal (Item 626) if it did not stay with the valve cover.



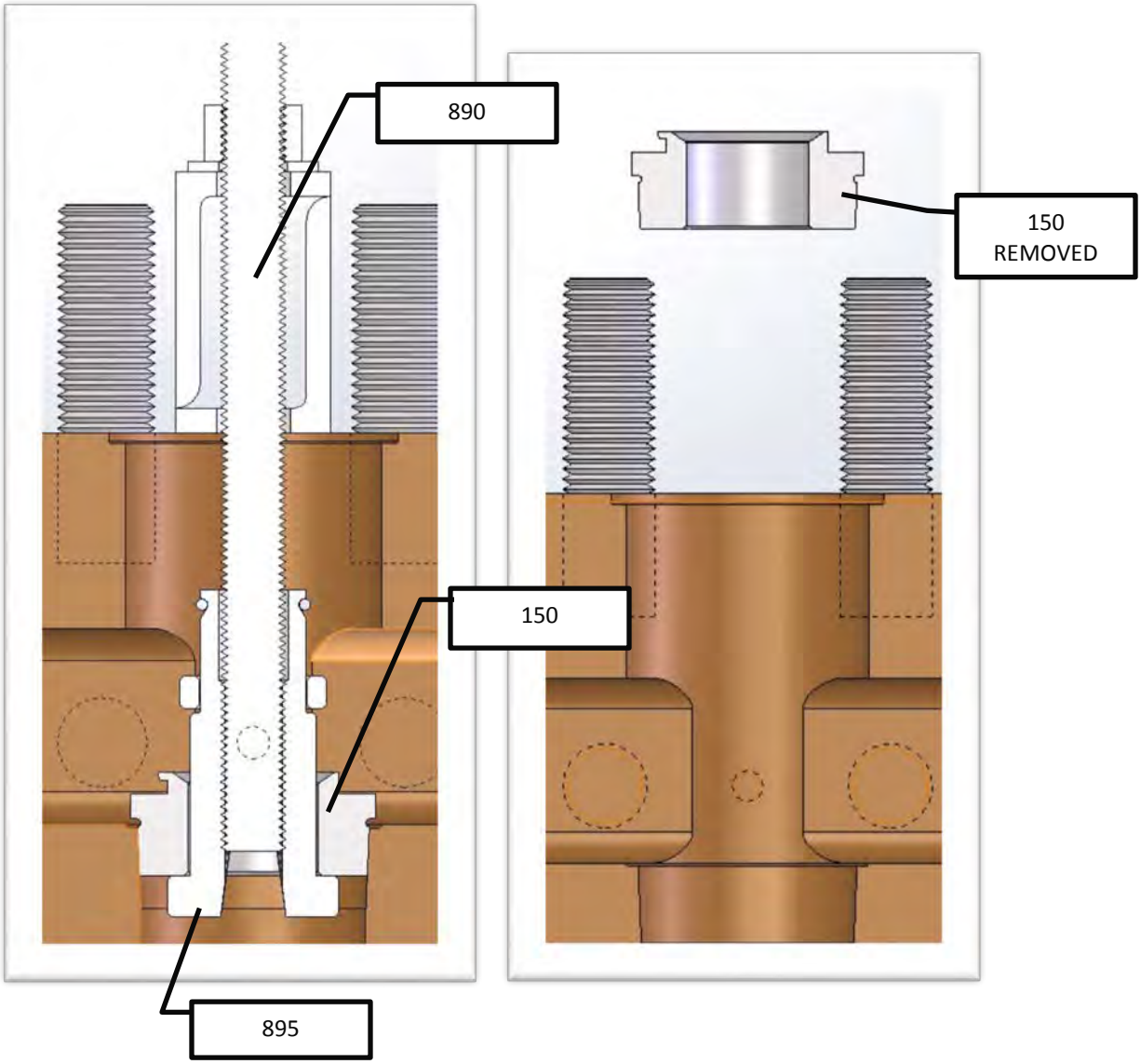

3. Repeat process for all (5) five valve covers.

4. Both the spherical suction valve assembly and spherical discharge valve assembly (Item 911) are removed from the top of the fluid end. It is necessary to remove the discharge valve assembly prior to removing the suction valve assembly.

5. Remove the spring retainer for the discharge valve assembly by pressing downward on the spring retainer with a large screw driver. Rotate 1/4$^{th}$ turn counter clockwise to unlock the spring retainer. Remove the spring retainer, valve springs wave spring and valve body (with the retriever tool (Item 888).



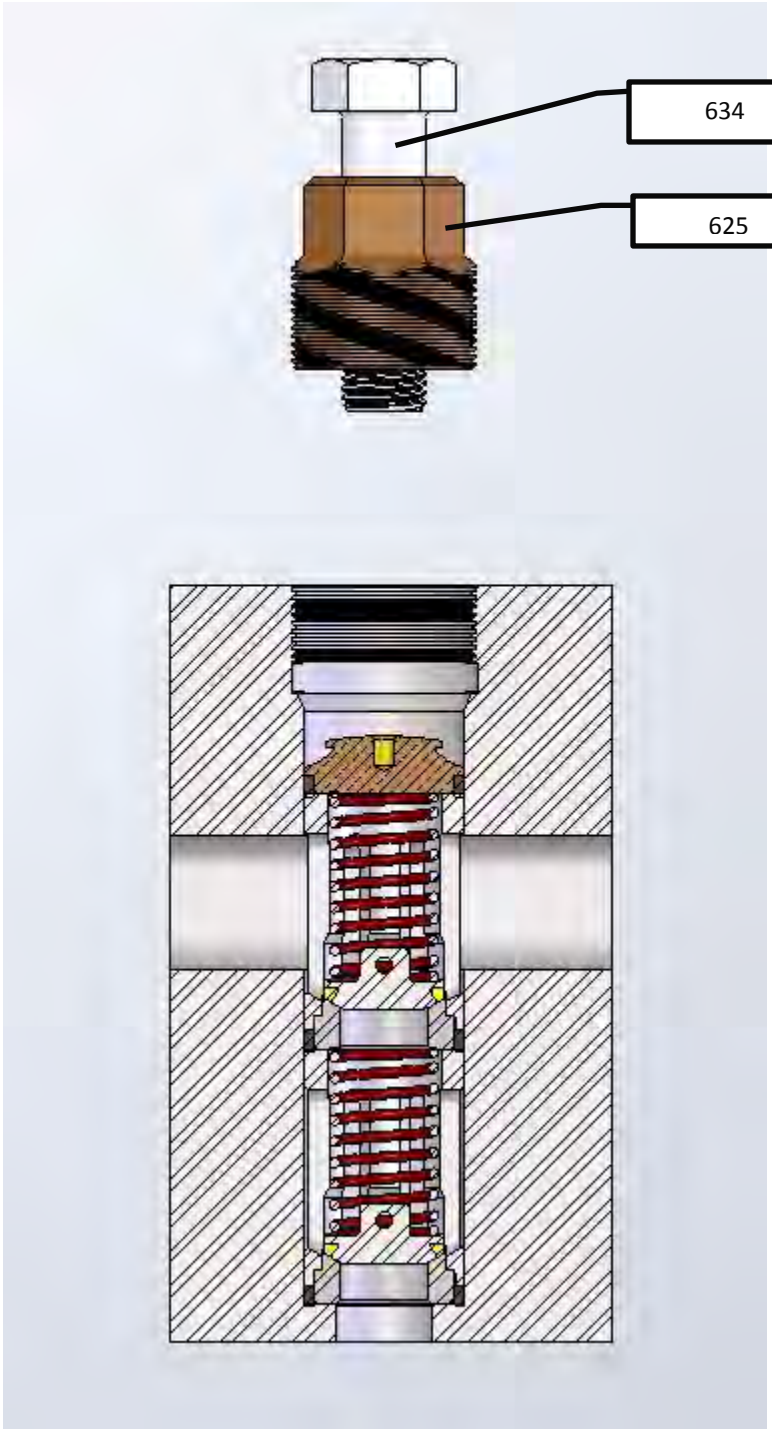
6. Remove discharge valve seat by placing the puller head (Item 895) through the seat opening and engaging the lugs to the underside of the valve seat. Pull seat loose using the puller tool (Item 890) and remove from fluid end. Repeat Process for discharge valve assembly. See drawing 1716908 for the puller tool assembly.



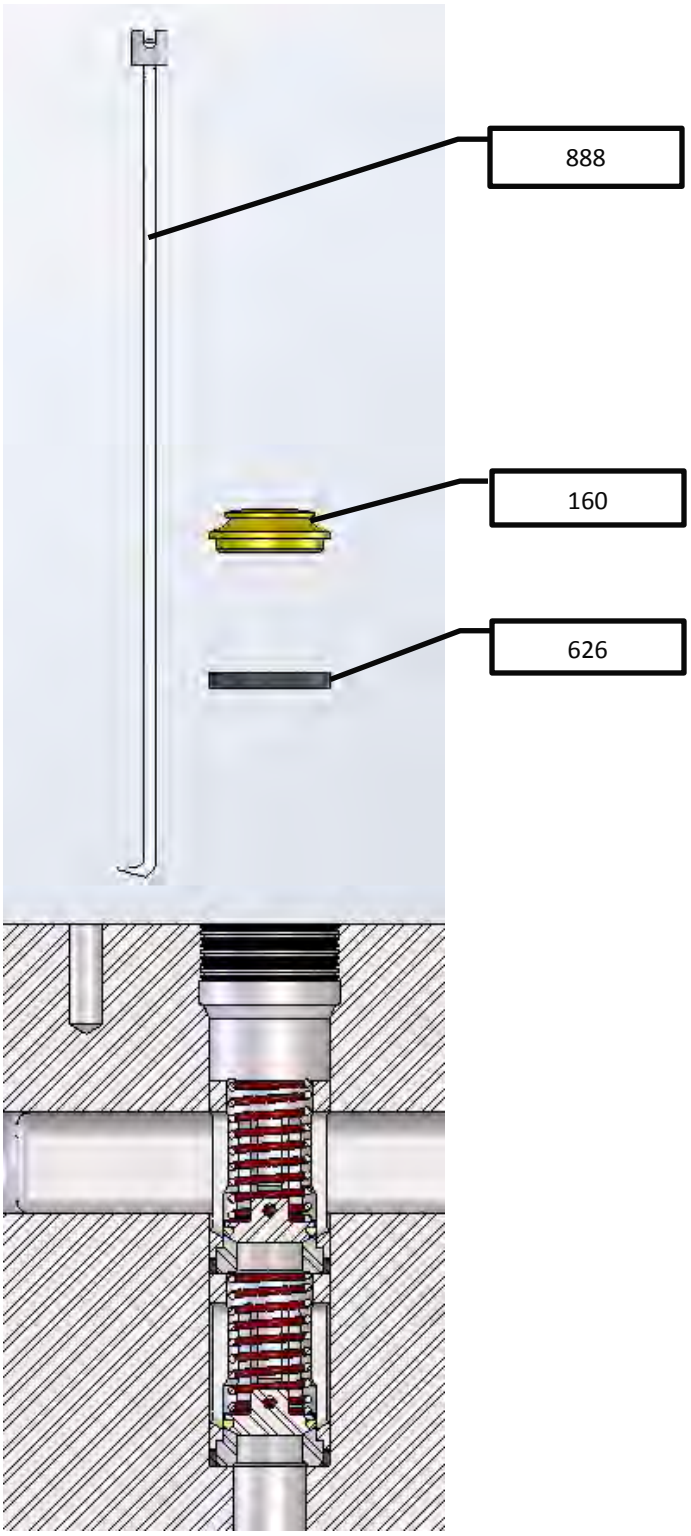

7. Repeat the process for each valve set until all five discharge valve and suction valve sets are removed. It is very important to keep each valve with its seat as they are worn and mated to each other.

# DISASSEMBLY OF FLUID END WITH CAGE TYPE VALVES (415Q-5H)

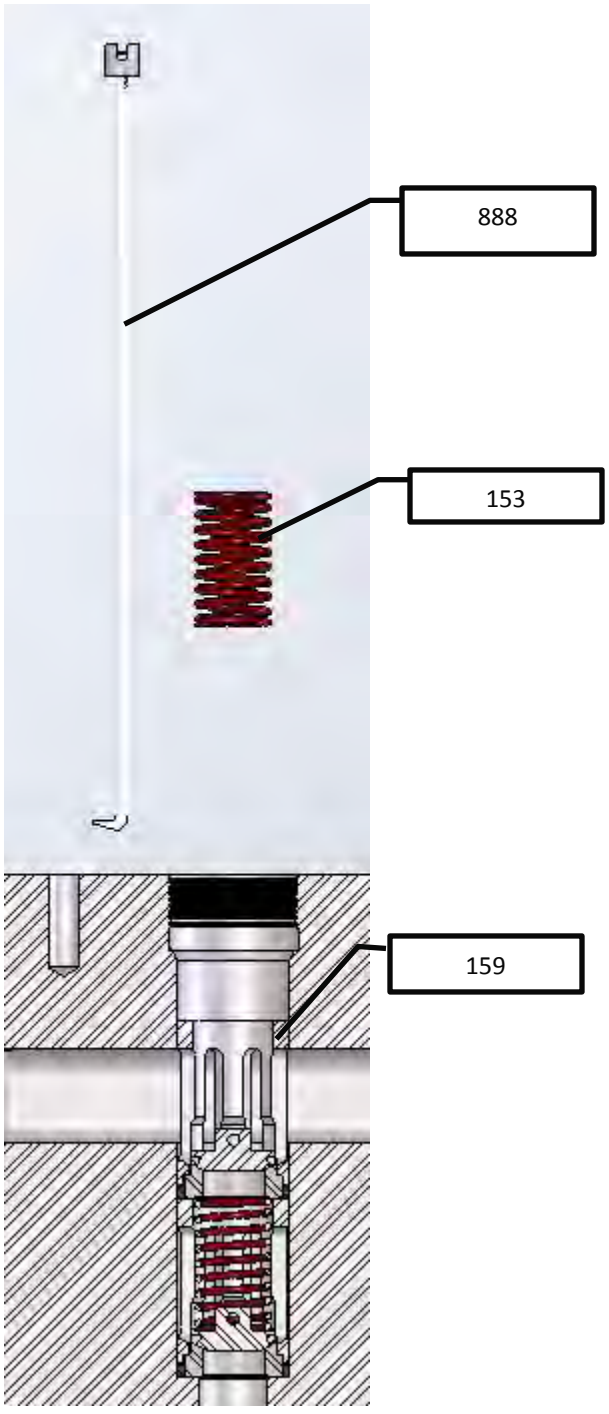
1. With fluid end resting in a stable position, remove threaded cylinder cover (Item 625) and cage loading hex bolt (Item 634).



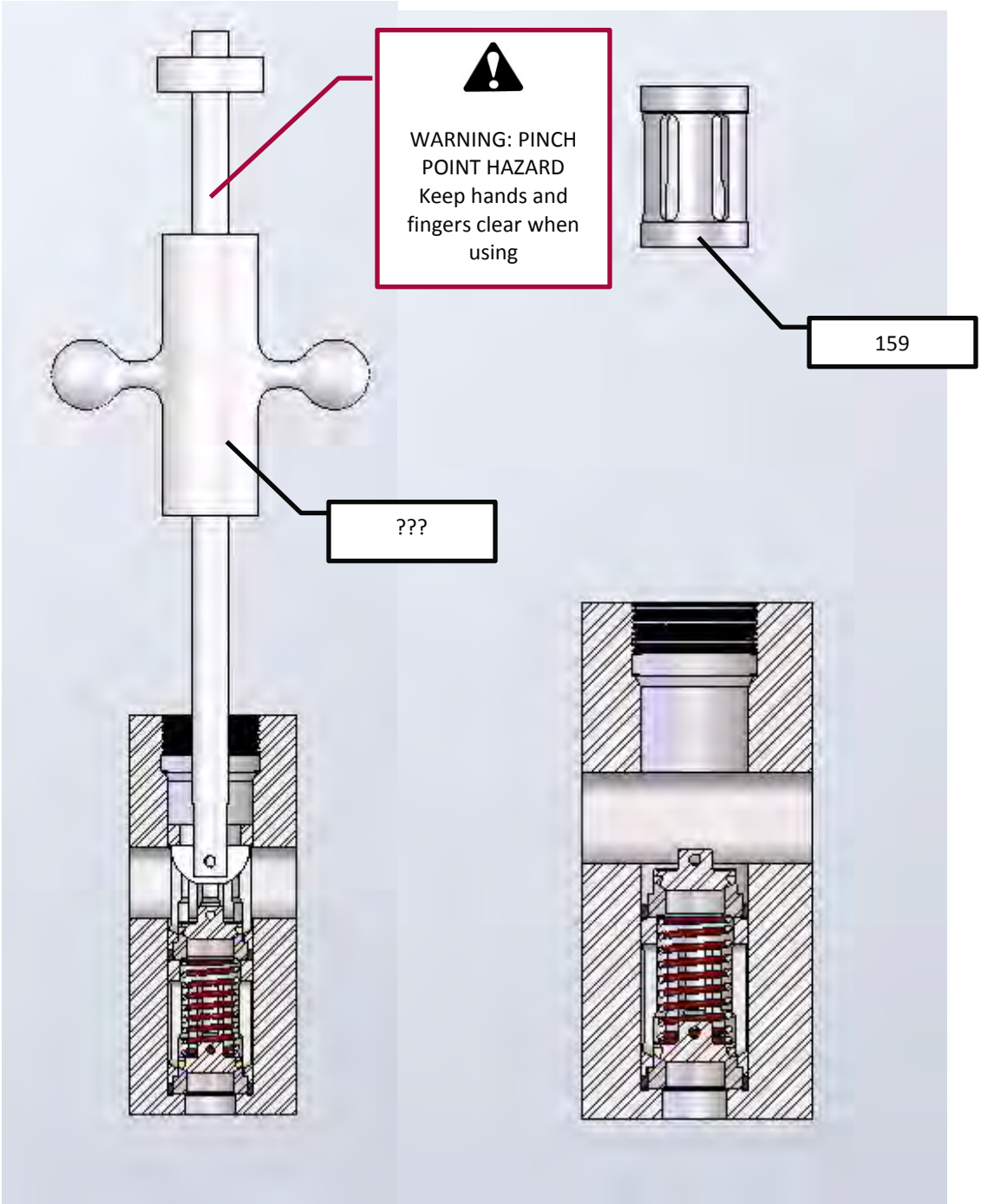
2. Remove discharge valve retainer (Item 165) with hook end of valve retriever tool (Item 888).
3. Remove cover seal (Item 626) from top of upper valve cage with hook end of valve retriever tool (Item 888).



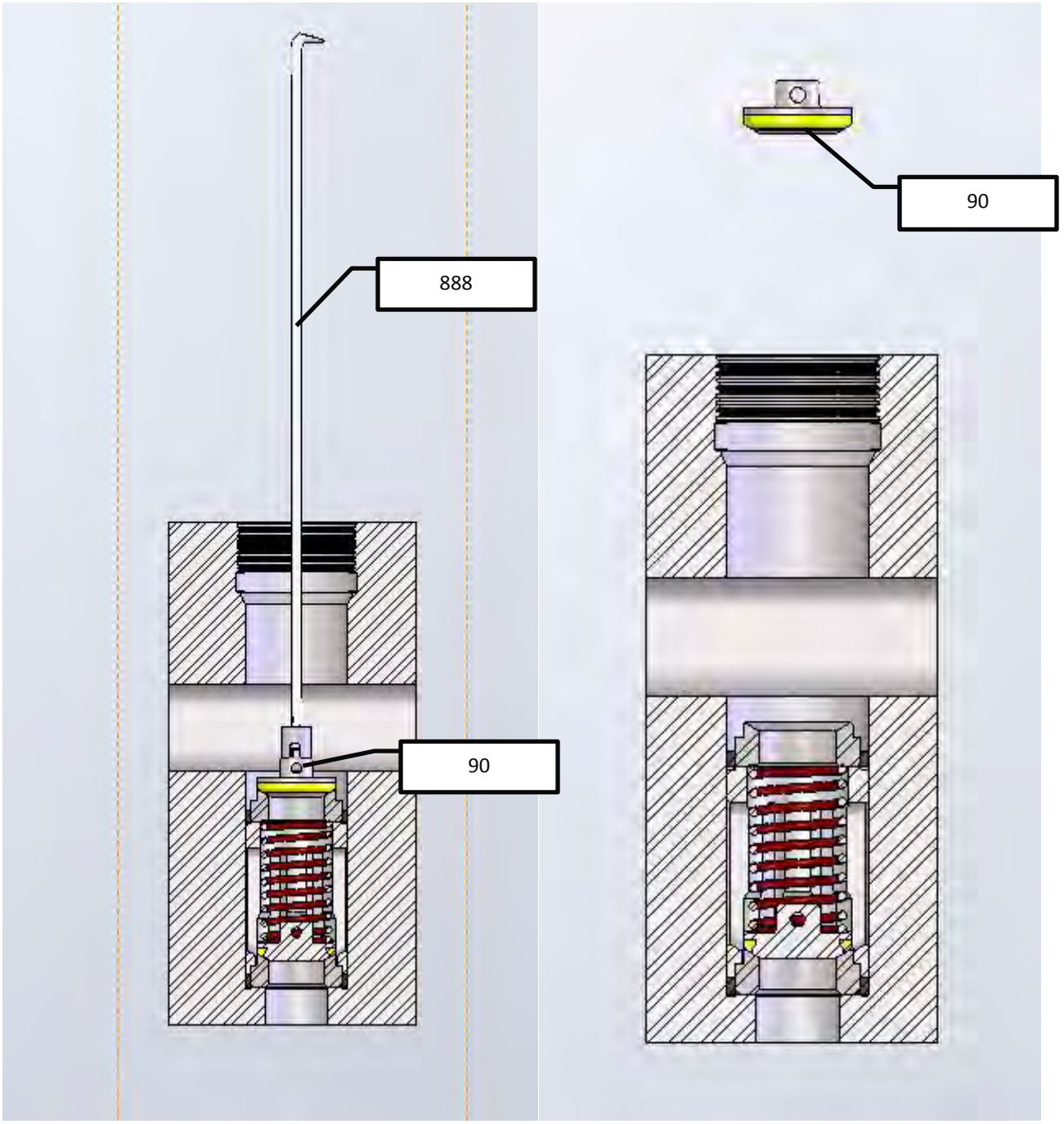
4. Before removing discharge valve spring, observe amount of pre-load of spring at rest. Spring should extend 1/8” to 3/16” above the top of the valve cage. If spring does not extend above the valve cage it has become fatigued and will need to be replaced at rebuild. Remove valve spring with hook end of valve retriever tool (Item 888).



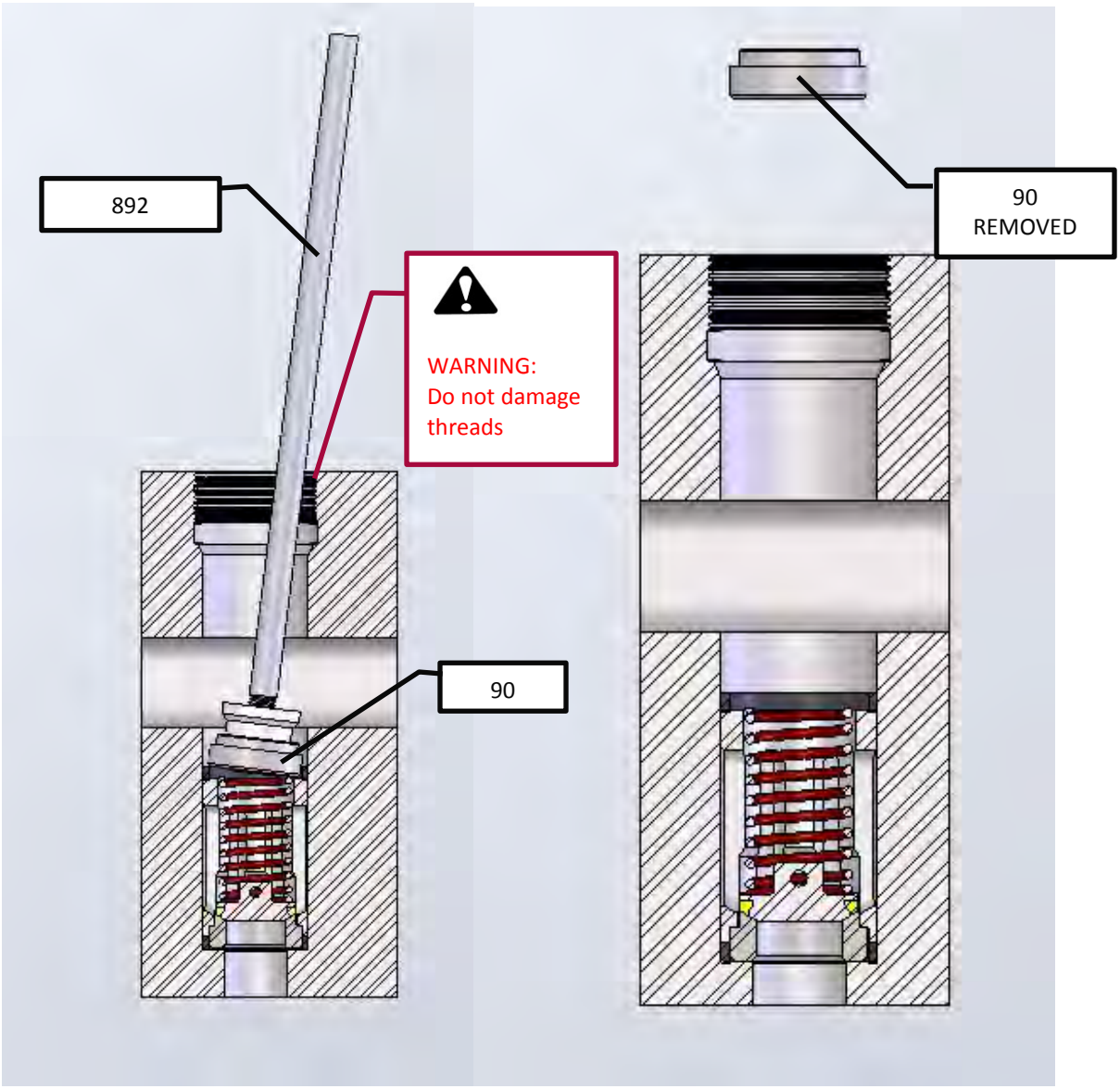
5. Remove upper valve cage with valve installation tool (Item 159). **WARNING: Take care not to pinch hand or fingers between** hammer **and end stop when using valve installation tool.**



6. Remove discharge valve (Item 90) with magnet end of valve retriever tool (Item 888).



7. Insert valve seat Installation tool (Item 892) into discharge valve seat and rock back and forth to break seal. Remove valve seat with hook end of valve retriever tool (Item 888). **WARNING: Do not damage thread on fluid end while prying out valve seats, place a rag over the edge of the valve bore opening to avoid damage.**



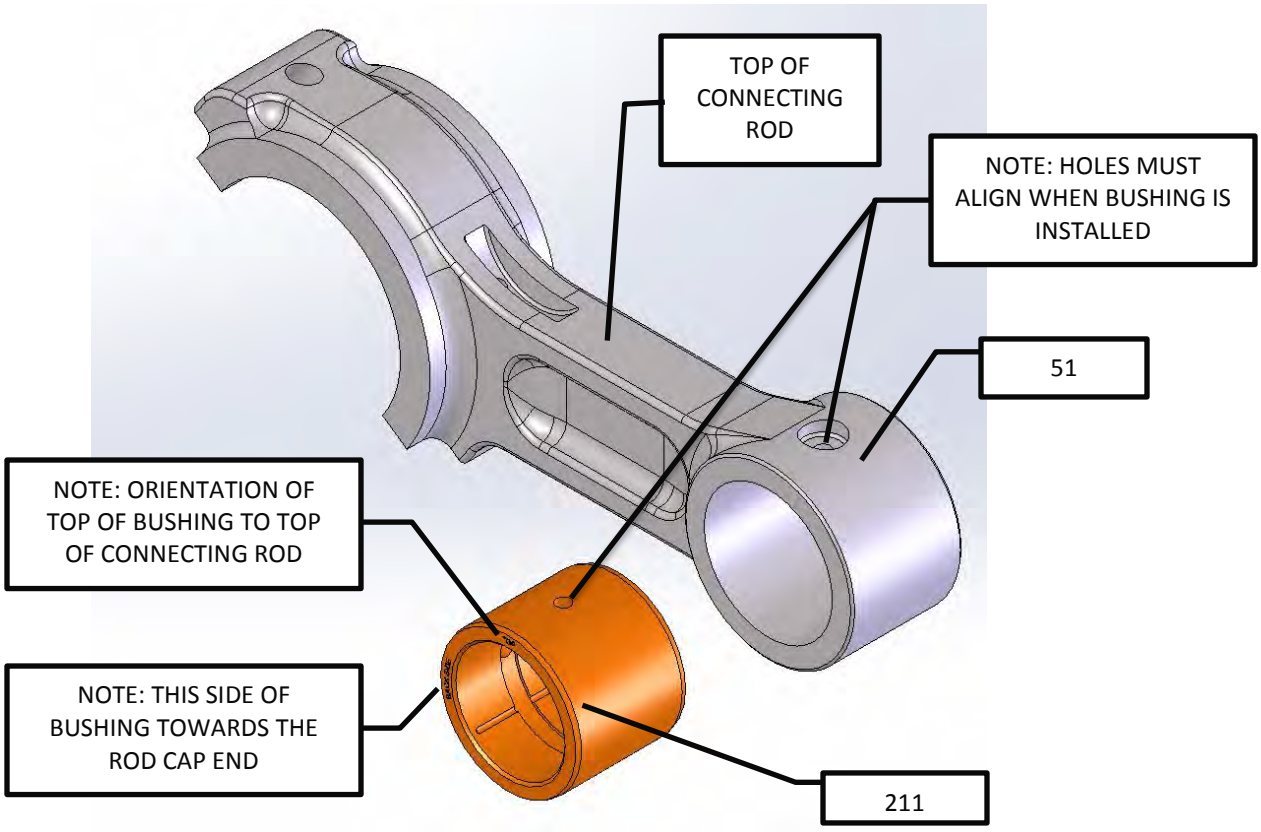

8. Remove lower valve components in the same manner at Steps 3 thru 7. Remove bottom valve with hook end of valve retriever tool (Item 888).
9. Repeat these steps on all bores to complete disassembly of valve components.

## ⚠ ! ATTENTION ! ⚠

Many components in the Power End are large, heavy and difficult to handle. Care must be taken to avoid injury. Always use a hoist or crane and slings appropriate for the job.

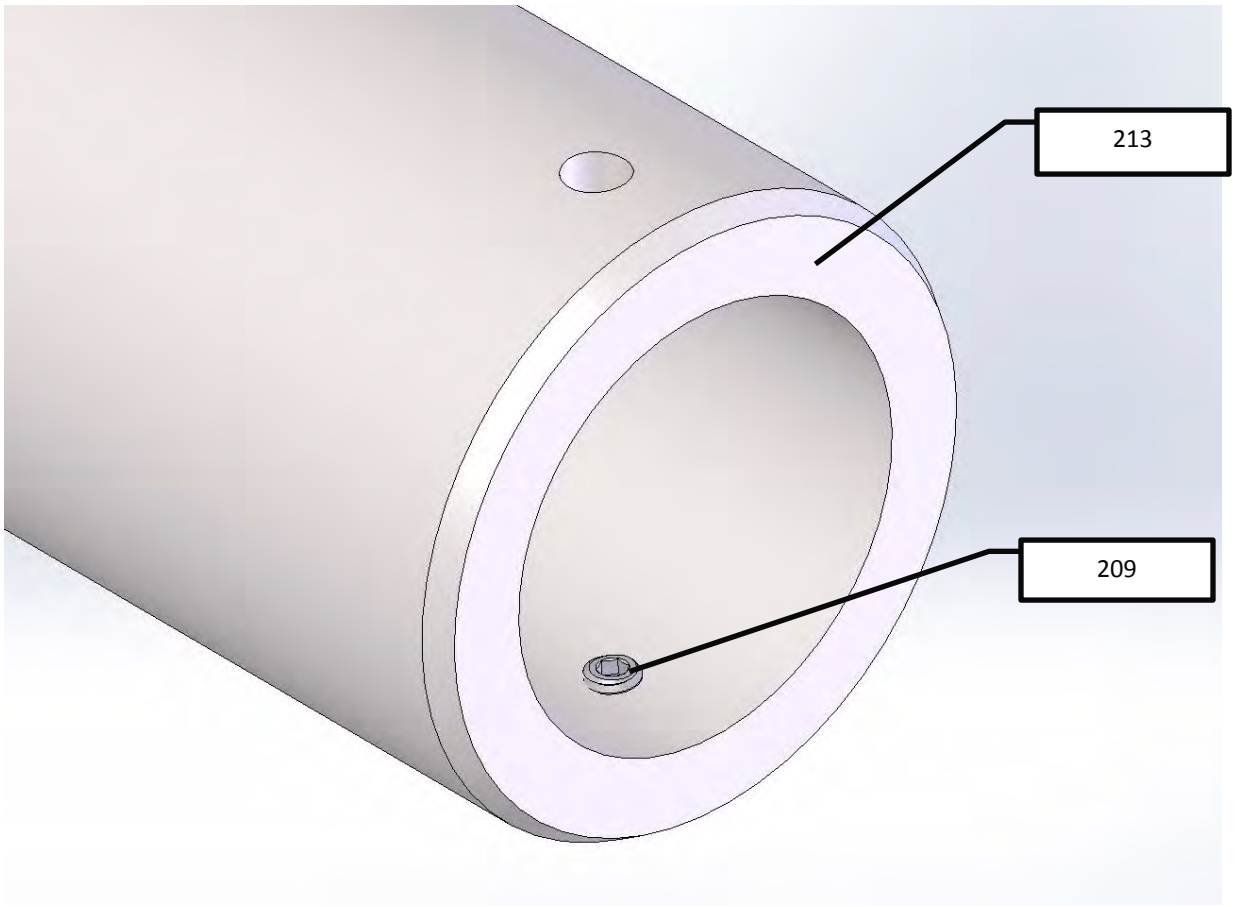
# CONNECTING ROD ASSEMBLY

1. Clear an area to work that is clean and free of debris. Most parts of the connecting rod are a precision fit and need to be clean and free of dirt and debris to assemble correctly. The connecting rod cap and rod are a matched set and marked as such. Make sure the cap and rod are the mates from the factory. Locate the wrist pin bushing (Item 211) and find the marking on the edge for orientation and press into the connecting rod end (Item 51). **NOTE: FAILURE TO ALIGN HOLES CORRECTLY BETWEEN CONNECTING ROD AND WRIST PIN BUSHING WILL QUICKLY CAUSE CONNECTING ROD FAILURE DUE TO LACK OF LUBRICATION**

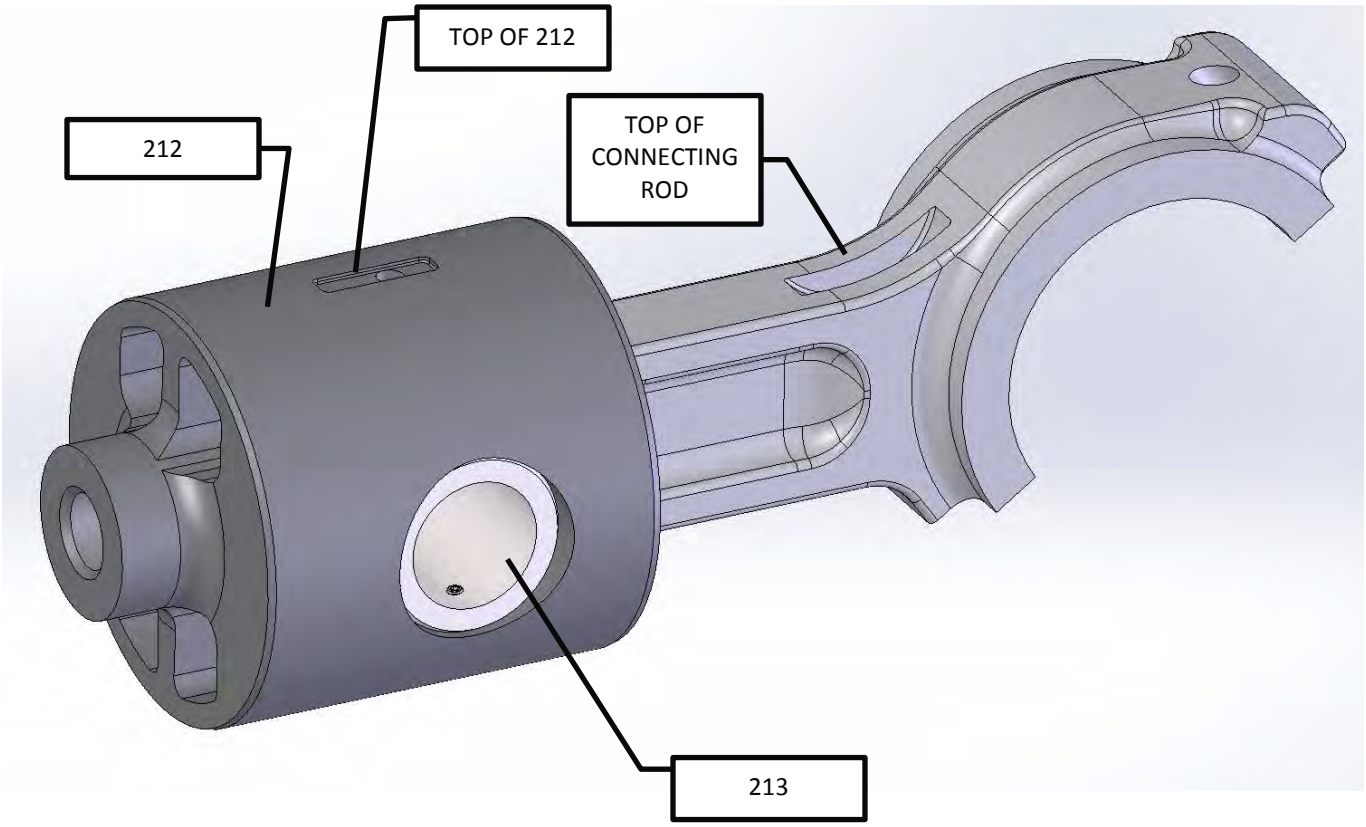



CONNECTING ROD WITH DRIP LUBRICATION SHOWN

2. Install the set screw (Item 209) into the wrist pin (Item 213) from the inside with medium thread locking compound. Thread in the set screw fully but not extending outside the wrist pin.

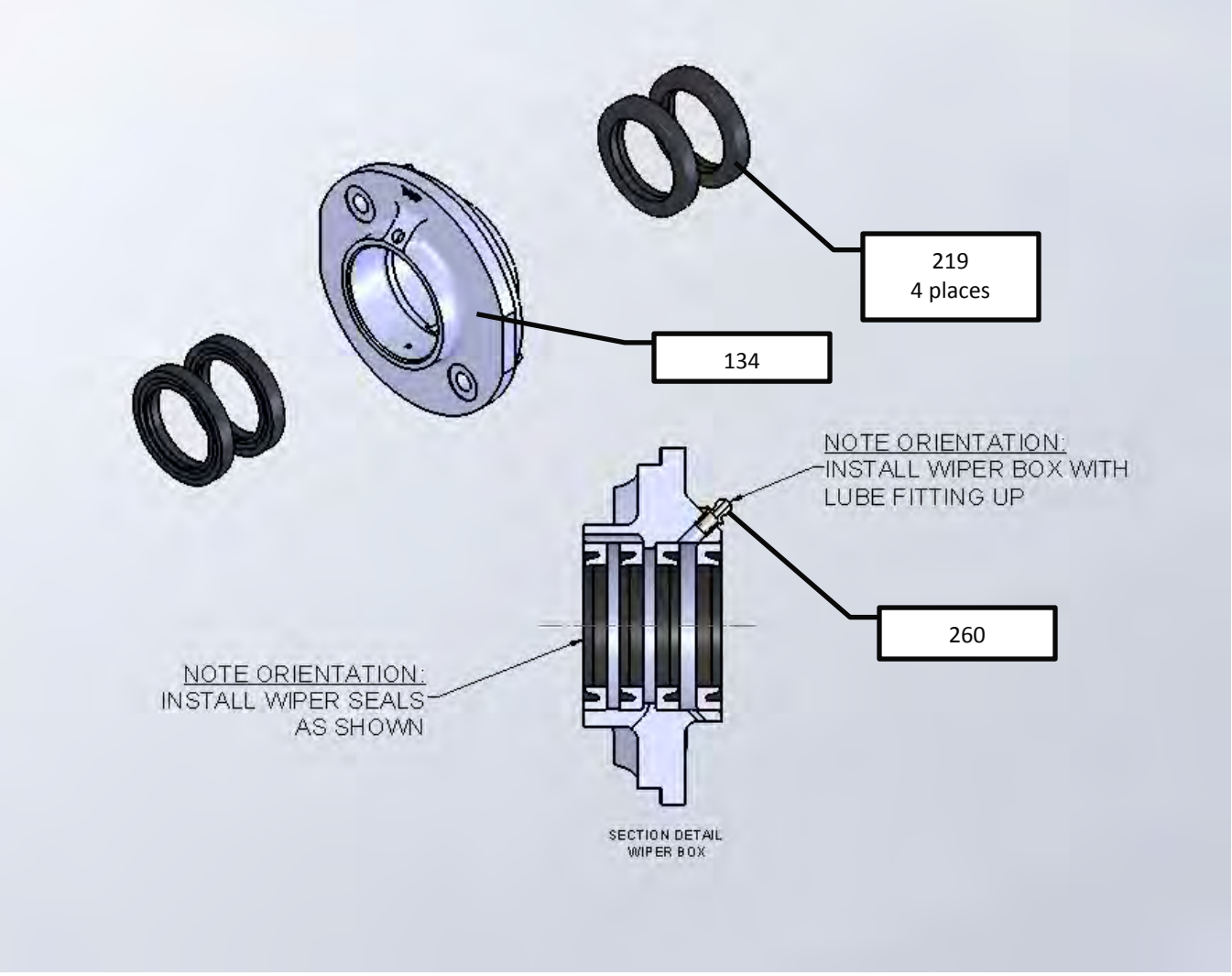


3. Slide wrist pin (Item 213) through the crosshead (Item 212) and wrist pin bushing (Item 211) until evenly located in bore of crosshead. Tighten set screw to lock into place. Crosshead should pivot freely.
   **WARNING: ASSURE CORRECT ORIENTATION OF CONNECTING ROD AND CROSSHEAD OIL HOLE WHEN ASSEMBLING. ASSEMBLING THE CROSSHEAD UPSIDE DOWN TO THE CONNECTING ROD WILL RESULT IN WRIST PIN BUSHING FAILURE DUE TO LACK OF LUBRICATION.**

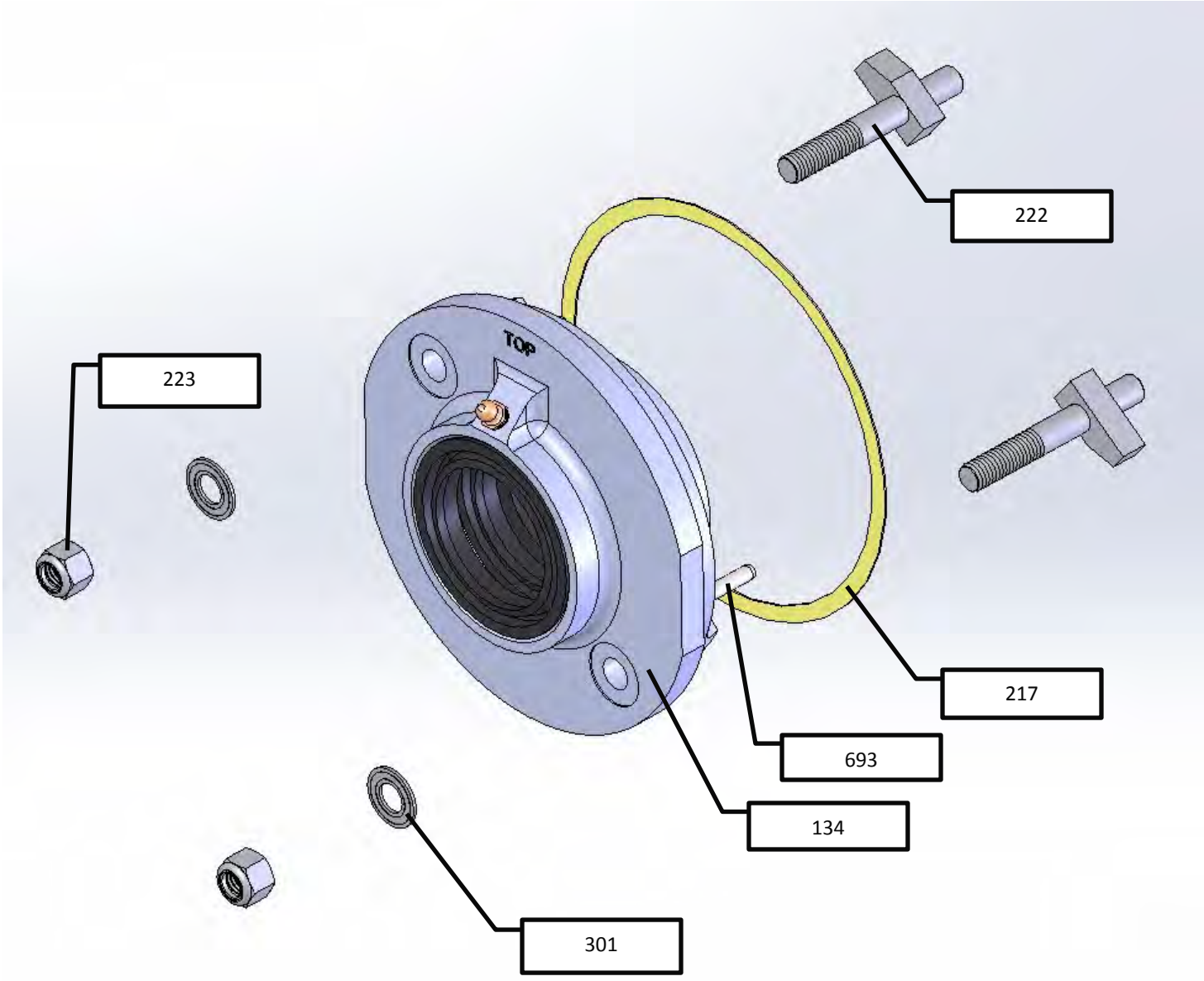


# WIPER BOX ASSEMBLY

1. Install the wiper seals (Item 219) in the wiper box housing (Item 134) with a rubber mallet or dead blow hammer in the orientation noted in the image below. Install grease lube fitting (Item 260) into top hole of housing.



2. Install hook bolts (Item 222), sealing washers (Item 301) and lock nuts (Item 223) loosely through wiper box housing (Item 134) with nuts opposite the gasket surface as shown in the image below. Install two roll pins (item 693) into wiper box housing. Do not tighten until the wiper box assembly is ready to be installed in the power frame. Stick the gasket (Item 217) to the wiper box housing with grease.

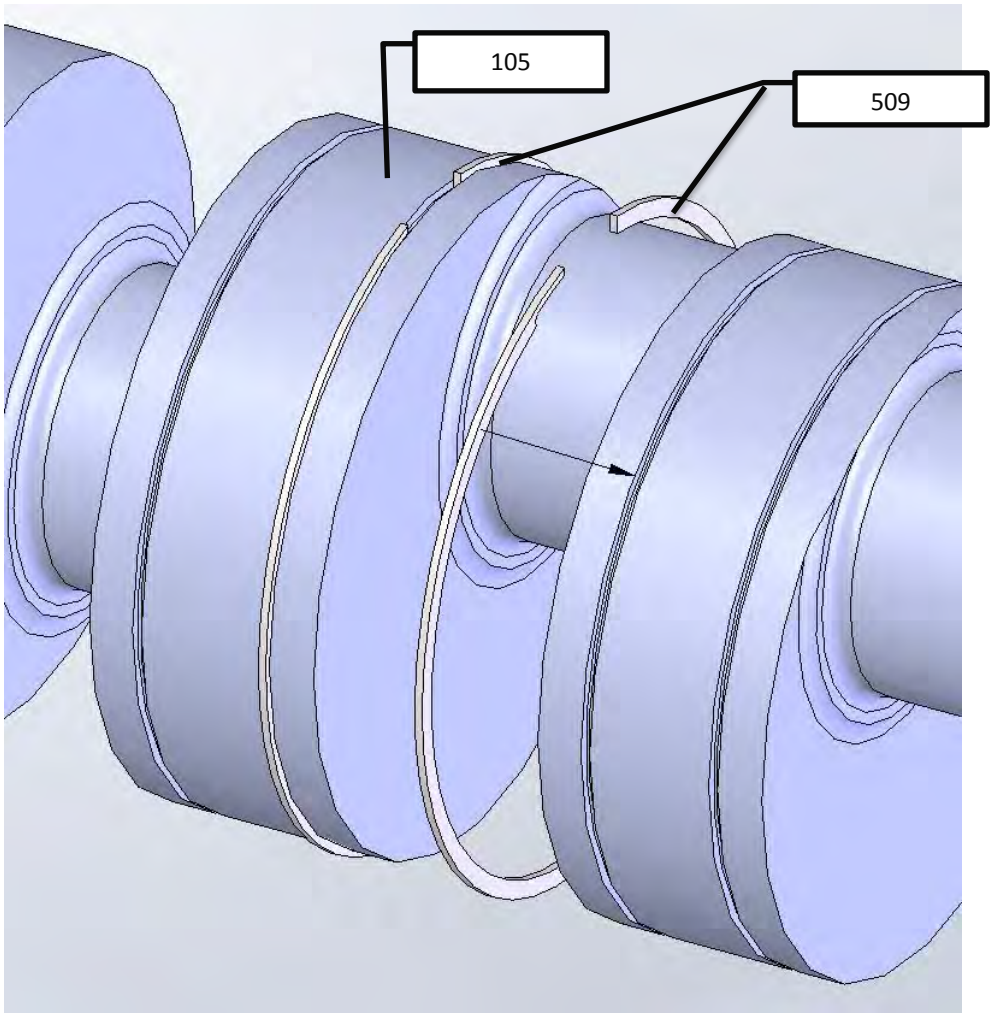


# CRANKSHAFT ASSEMBLY

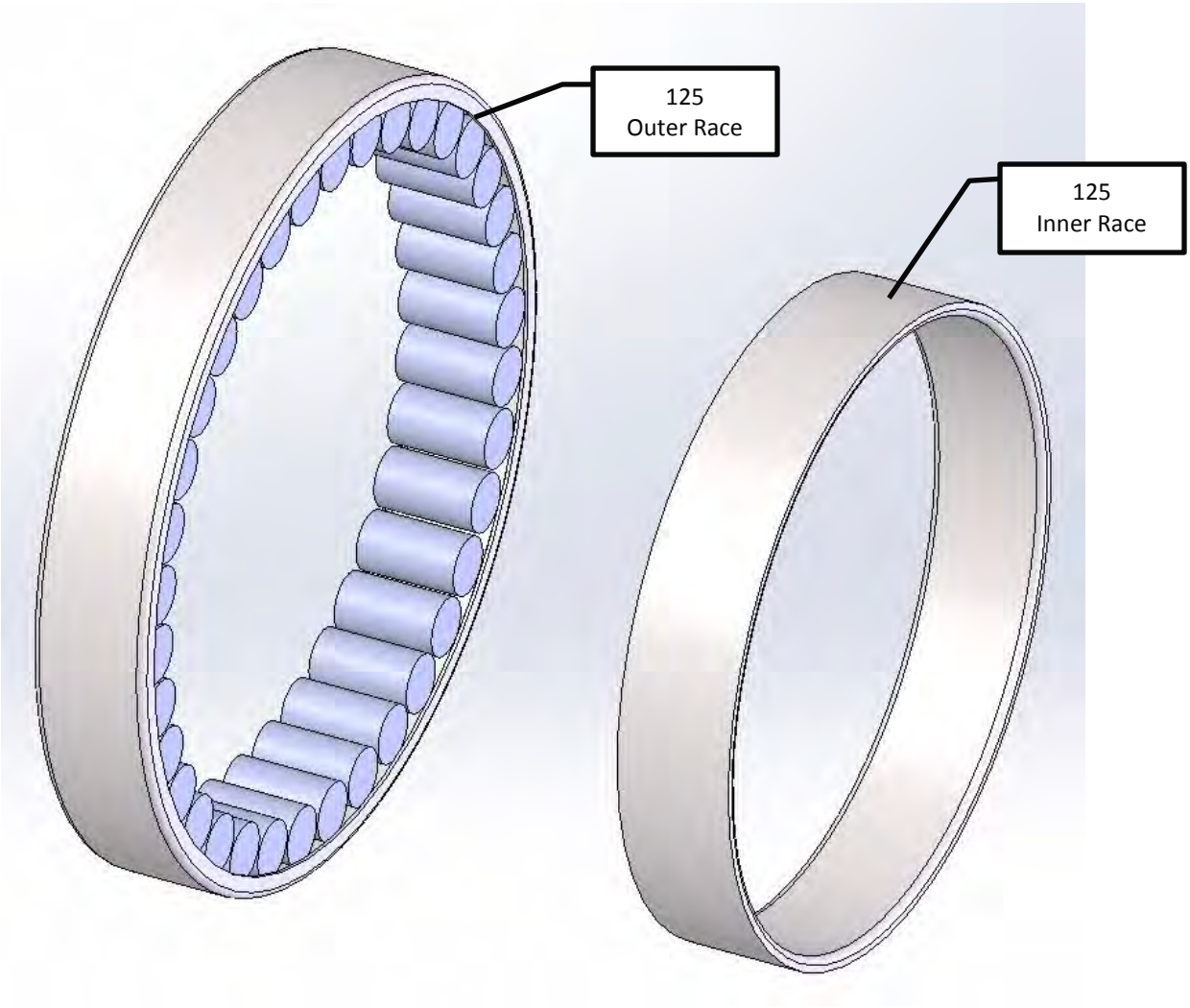
1. Clear an area to work that is clean and free of debris. All parts of the Crankshaft Assembly are precision fit and have easily damaged surface finishes, they must be kept clean and free of dirt and debris to assemble correctly. The Crankshaft is very large and very heavy and must be secured to keep it from rolling or injury may occur.

   **WARNING: DAMAGE TO THE BEARING JOURNAL SURFACES WILL DRASTICALLY REDUCE SERVICE LIFE FOR THE CRANKSHAFT ASSEMBLY, CARE MUST BE TAKEN.**

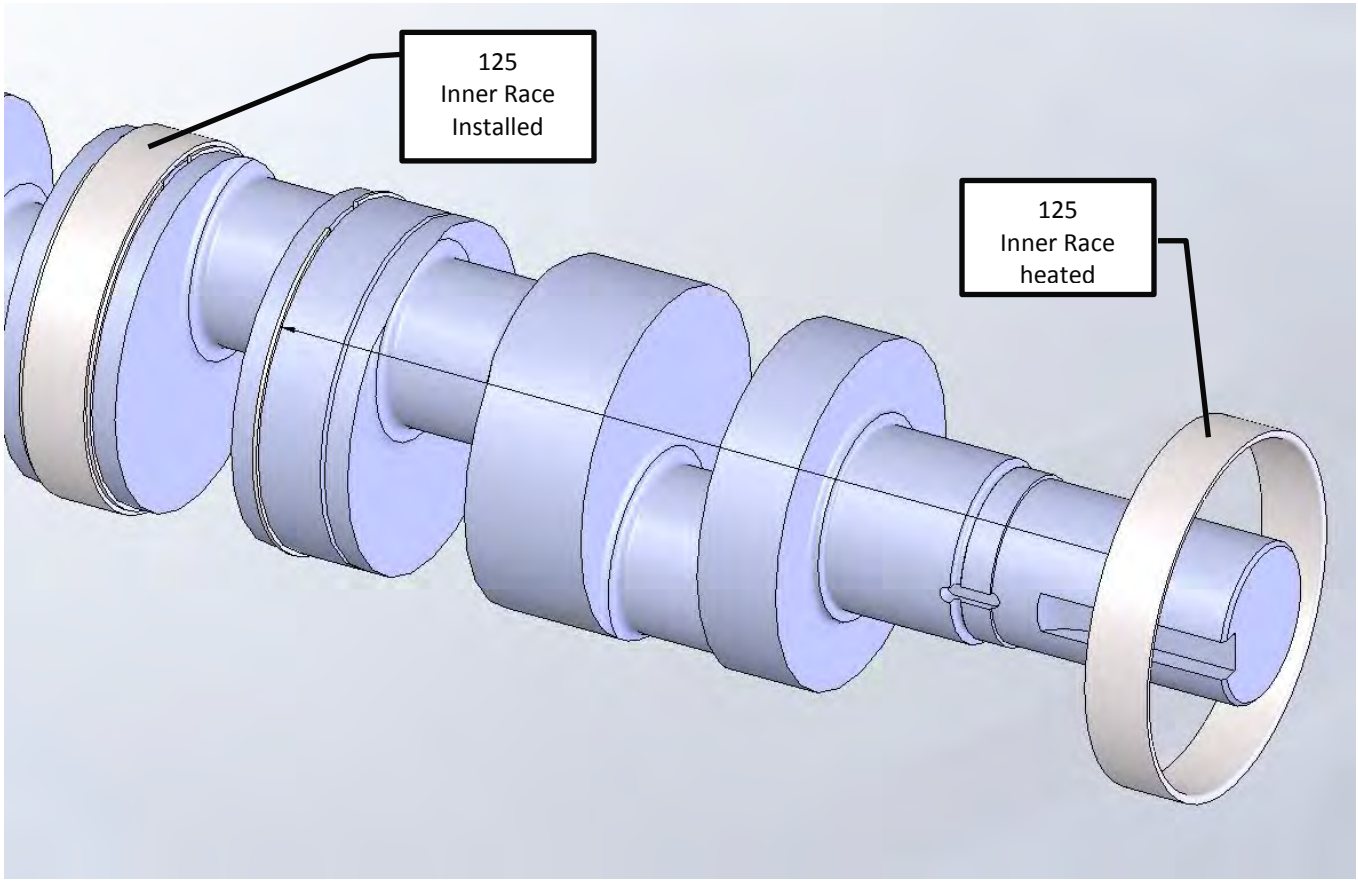
   Install the inner most set of Bearing Retaining Rings (Item 509) on the Crankshaft (Item 105) as shown in the image below.



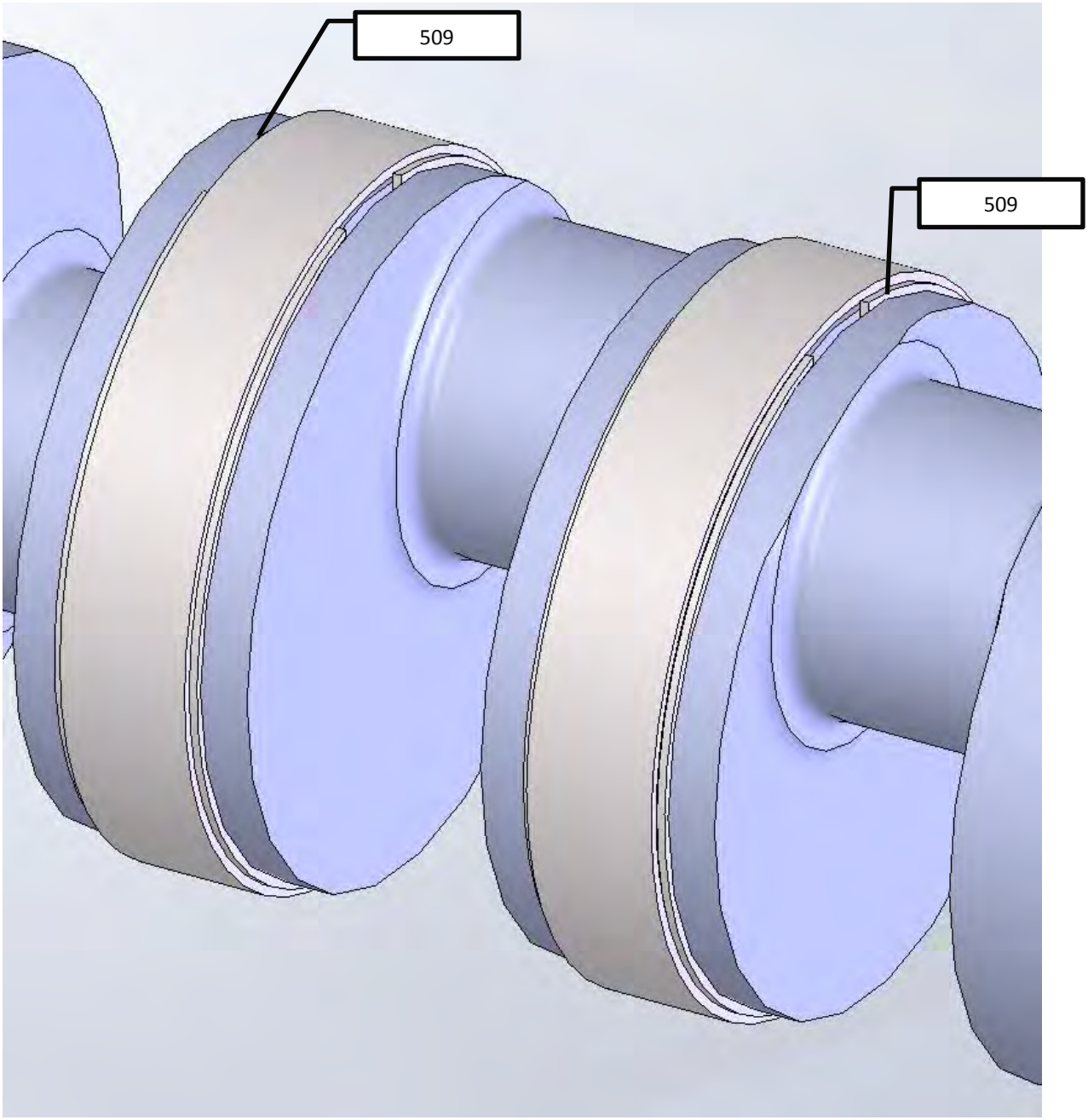
2. Remove the inner bearing race from the main bearings (Item 125) and heat evenly to prepare for press fit to crankshaft (Item 105). Induction heating for the bearing races is recommended to apply even heat and prevent warping or cracking the races. The outer main bearing assembly needs to be mated back with its factory inner race at final assembly.



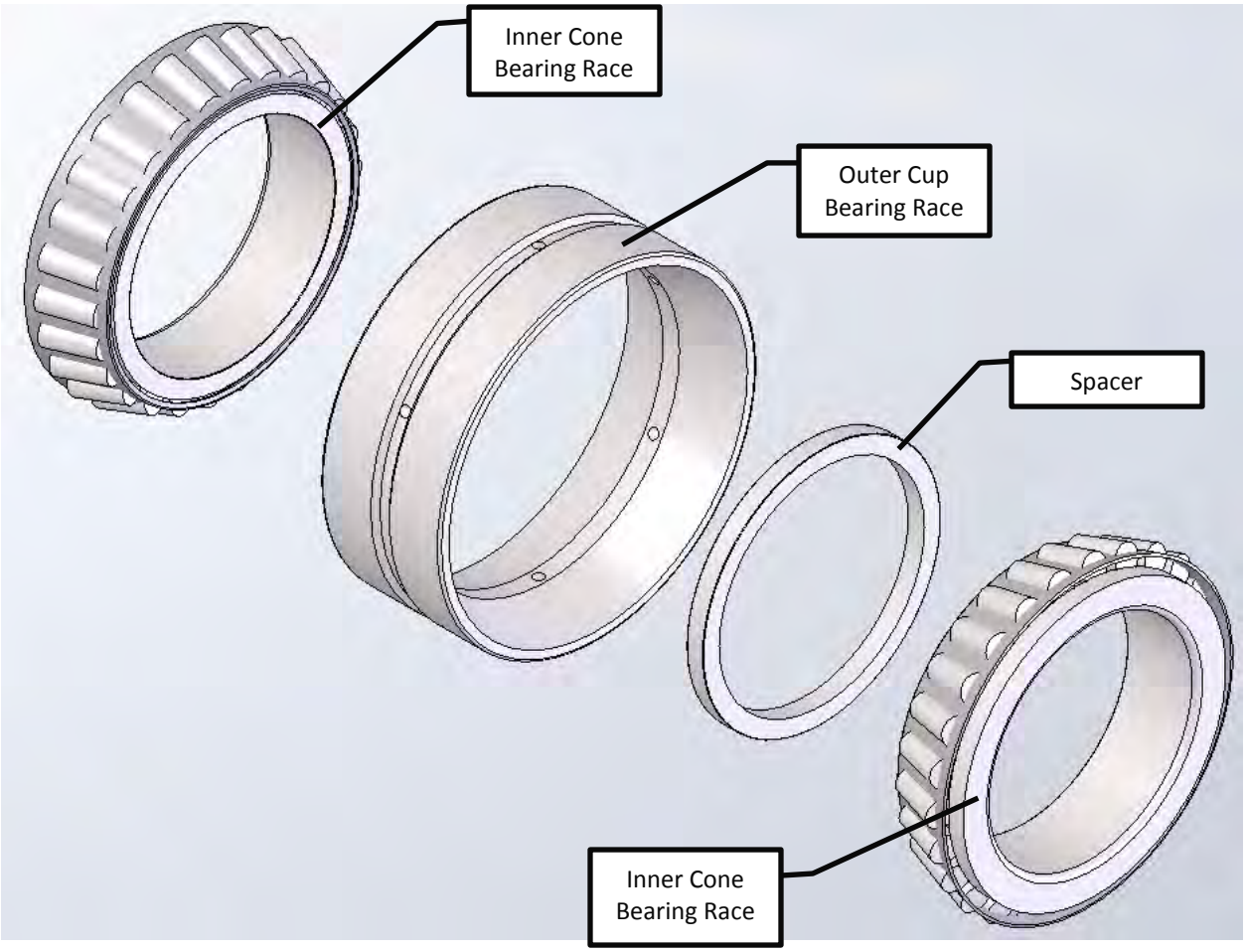
3. Slip heated inner bearing race onto crankshaft and gently tap up to bearing retaining ring (Item 509). Do not damage the bearing race or the mating surfaces on the crankshaft during installation.



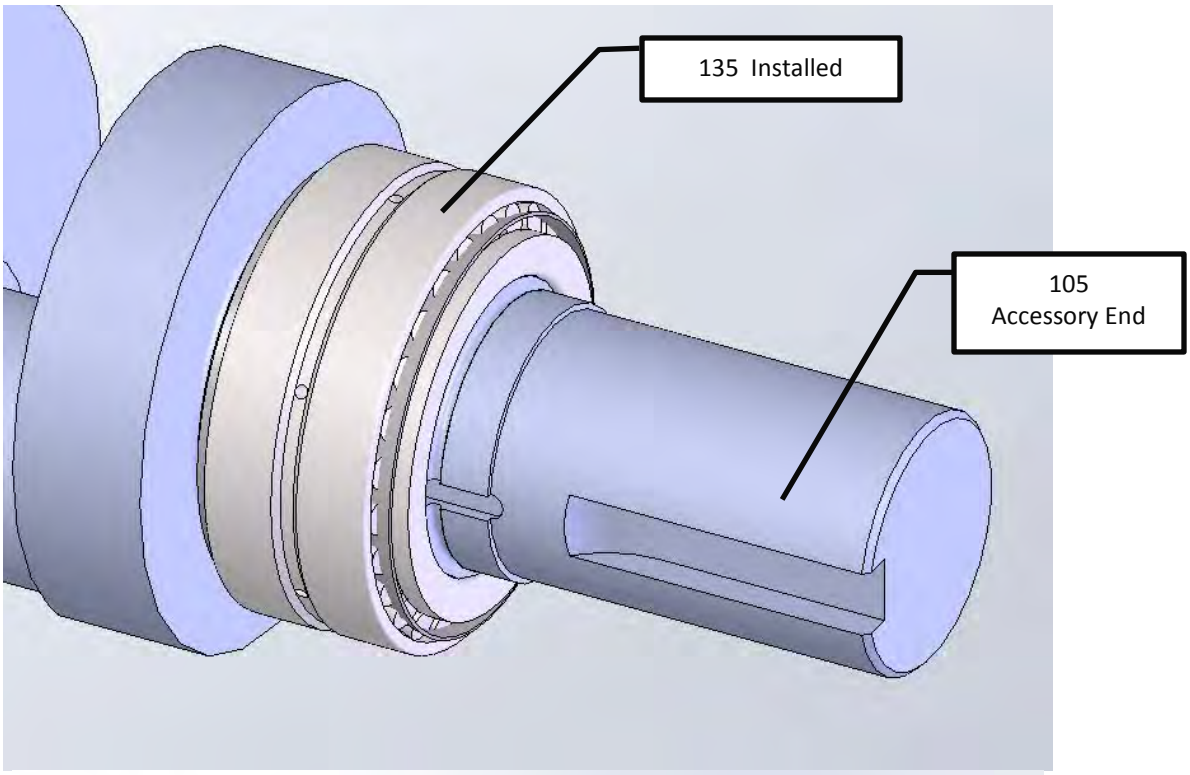
4. Install the final pair inner main bearing retaining rings (Item 509).



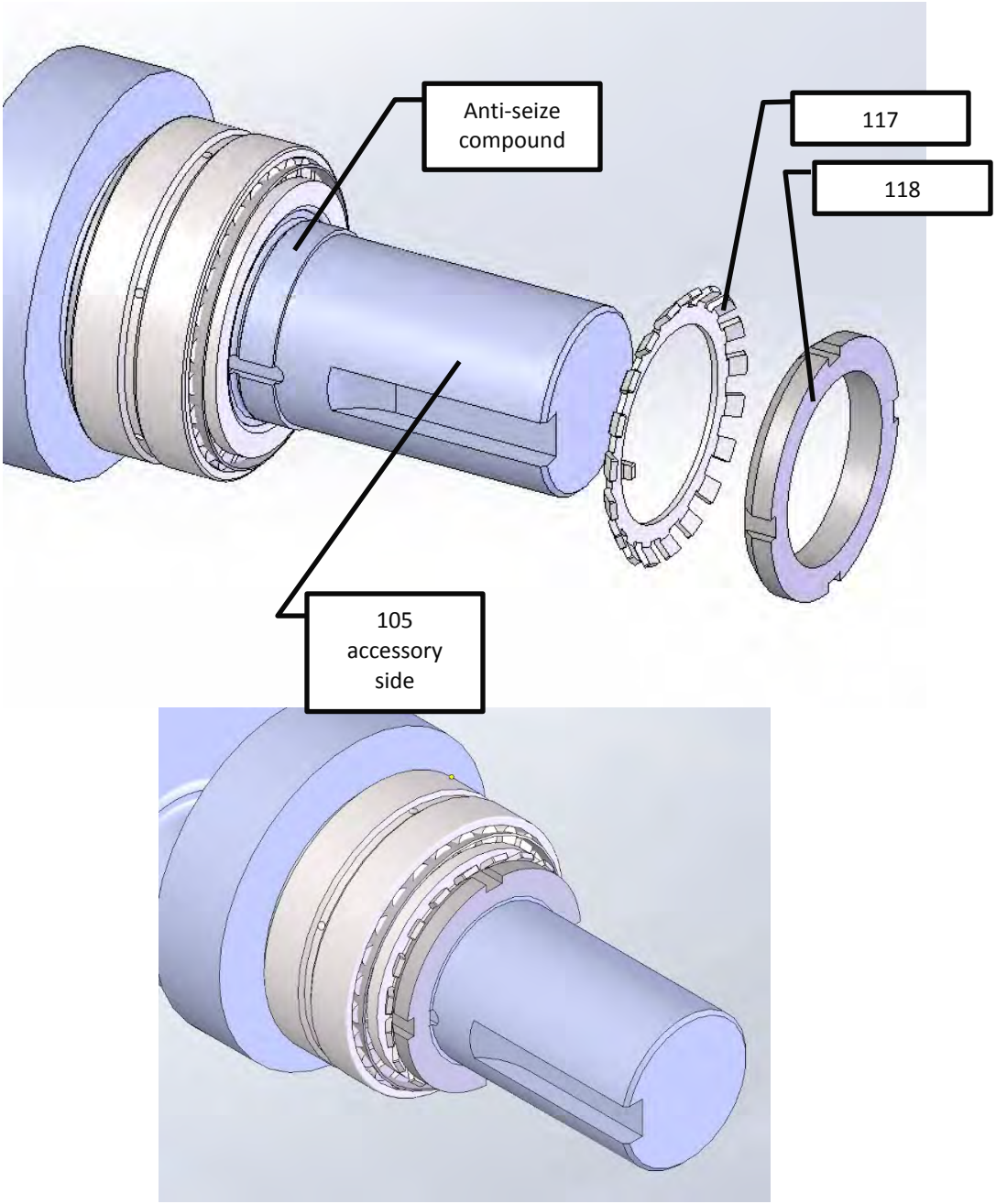
5. Separate the outer dual roller bearings (Item 135) into four (4) parts; the two (2) tapered inner cone races, the center spacer and the outer cup race. The two (2) tapered inner cone races must be heated to press fit them onto the crankshaft in the same manner as the inner main bearing races. Induction heating for the bearing races is recommended to apply even heat and prevent warping or cracking the races.



6. Slip heated inner bearing races onto accessory side of crankshaft (Item 105) and reassemble bearing as shown in image below. Do not damage the bearing race or the mating surfaces on the crankshaft during installation. Do not install bearing on drive side of crankshaft yet.

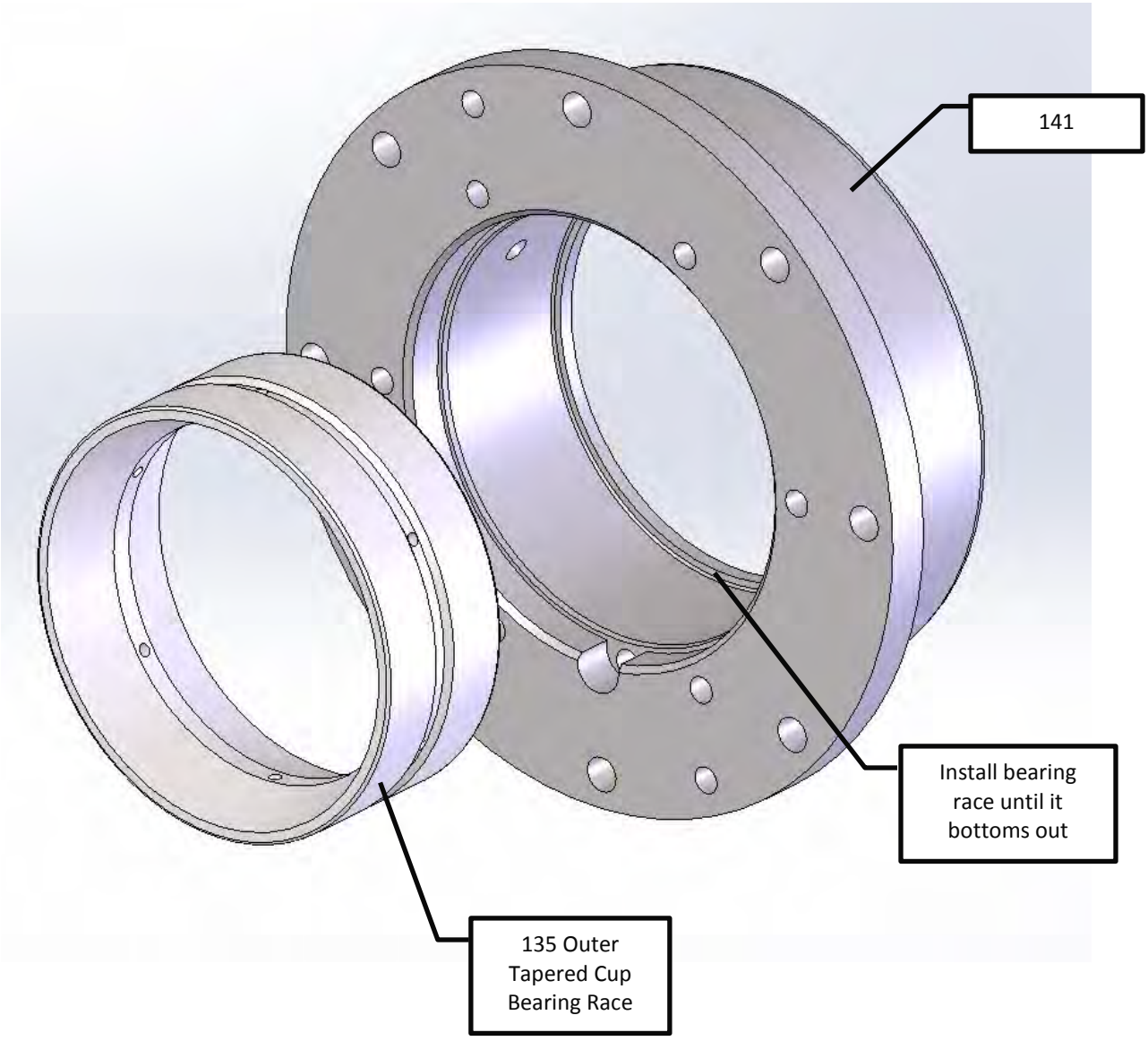


7. Install locking washer (Item 117) and bearing retainer nut (Item 118) on crankshaft (Item 105) and snug against inner bearing race finger tight. Use anti-seize compound on the threads on the locking nut and crankshaft

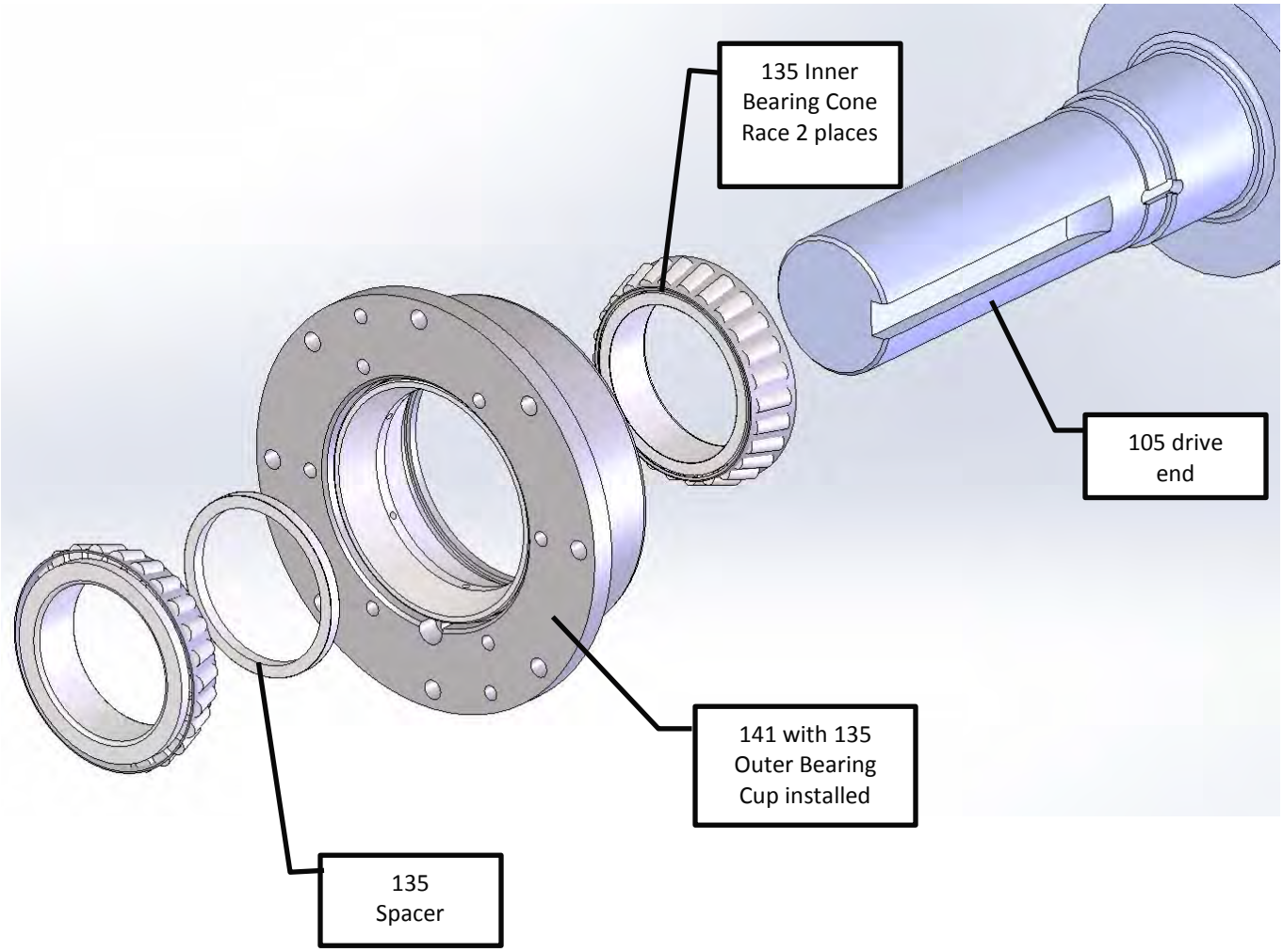



**COMPLETED ACCESSORY SIDE BEARING INSTALLATION**

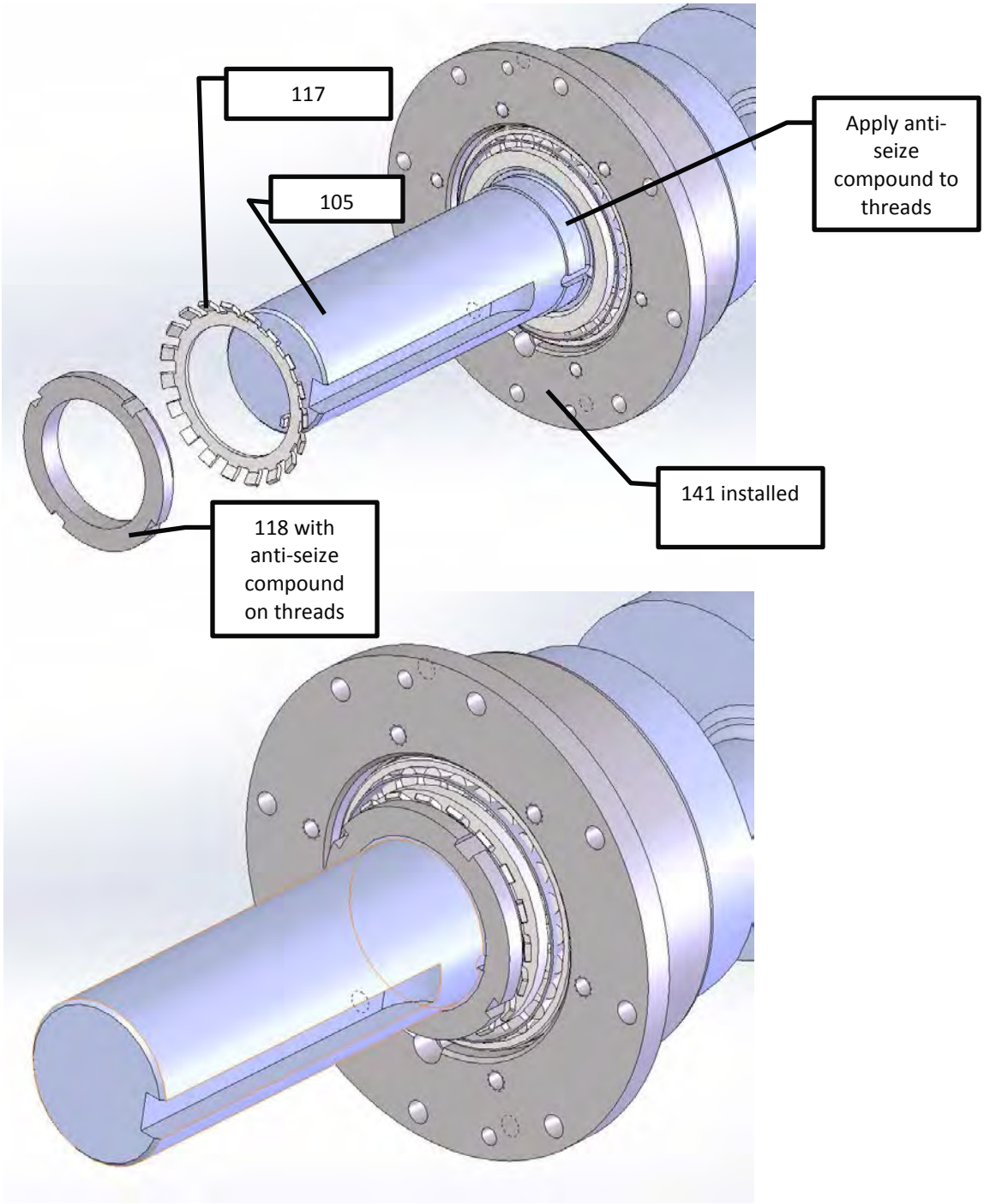
8. Separate the remaining dual tapered roller bearing for the drive side of the crankshaft same as Step 5. The inner cup races need to be heated to press fit them to the crankshaft (Item 105) and the outer bearing cup (Item 135) needs to be frozen to press fit the bearing cage (Item 141). Press fit the outer bearing cup race to the bearing cage first until it bottoms against the lip of the bearing cage.



9. Install dual roller tapered bearing (Item 135) and bearing cage (Item 141) in order as shown in image below. Do not damage the bearing race or the mating surfaces on the crankshaft during installation.

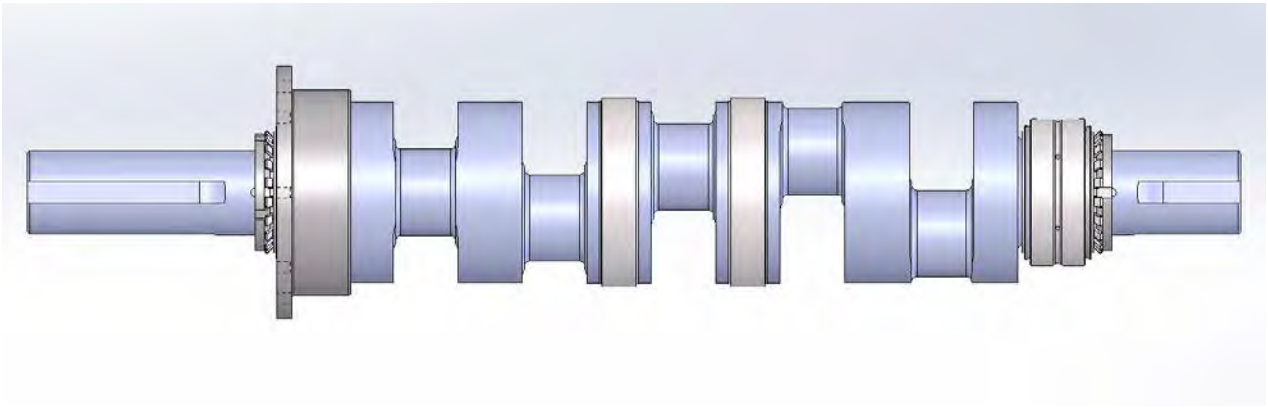


10. Install locking washer (Item 117) and bearing retainer nut (Item 118) on crankshaft (Item 105) and snug against inner bearing race finger tight in the same way as the accessory side. Use anti-seize compound on the threads on the locking nut and crankshaft.



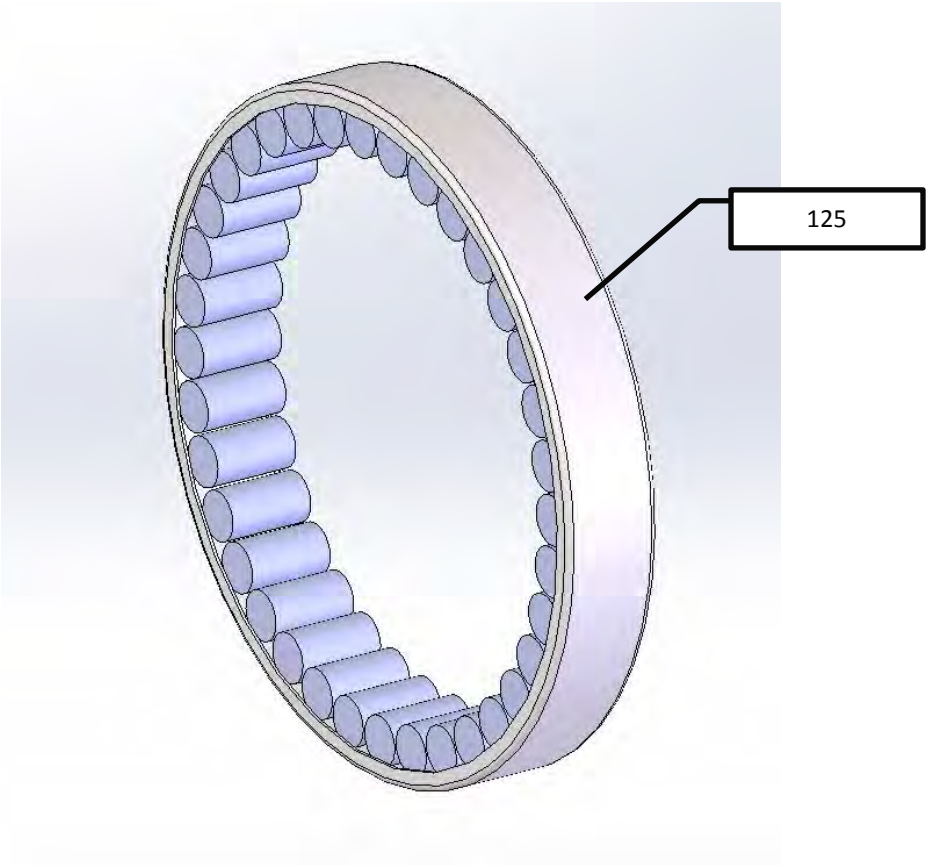

**COMPLETED DRIVE SIDE BEARING INSTALLATION**

11. Crankshaft assembled ready for installation into Power Frame.

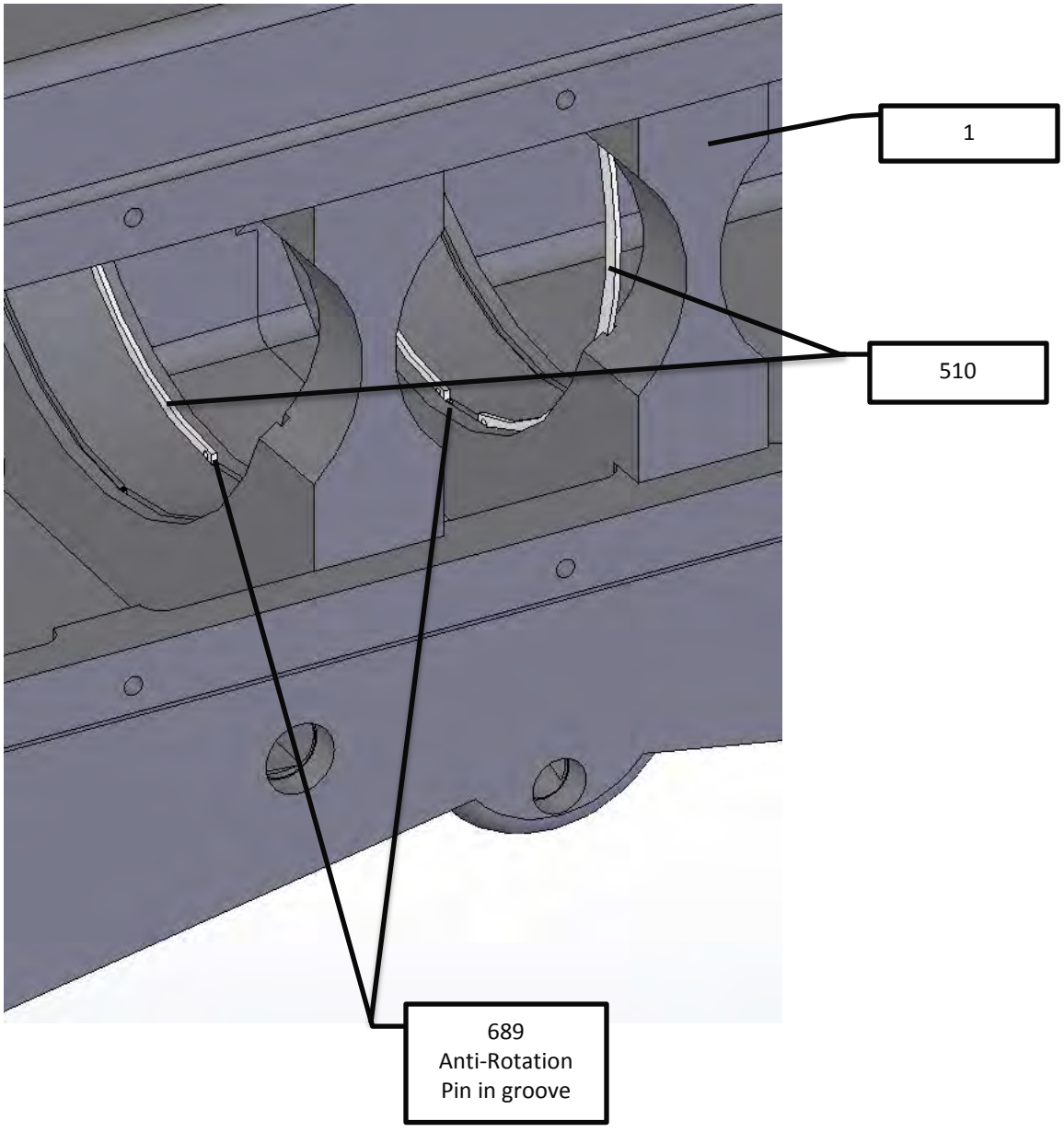


# INSTALLATION OF MAIN BEARINGS

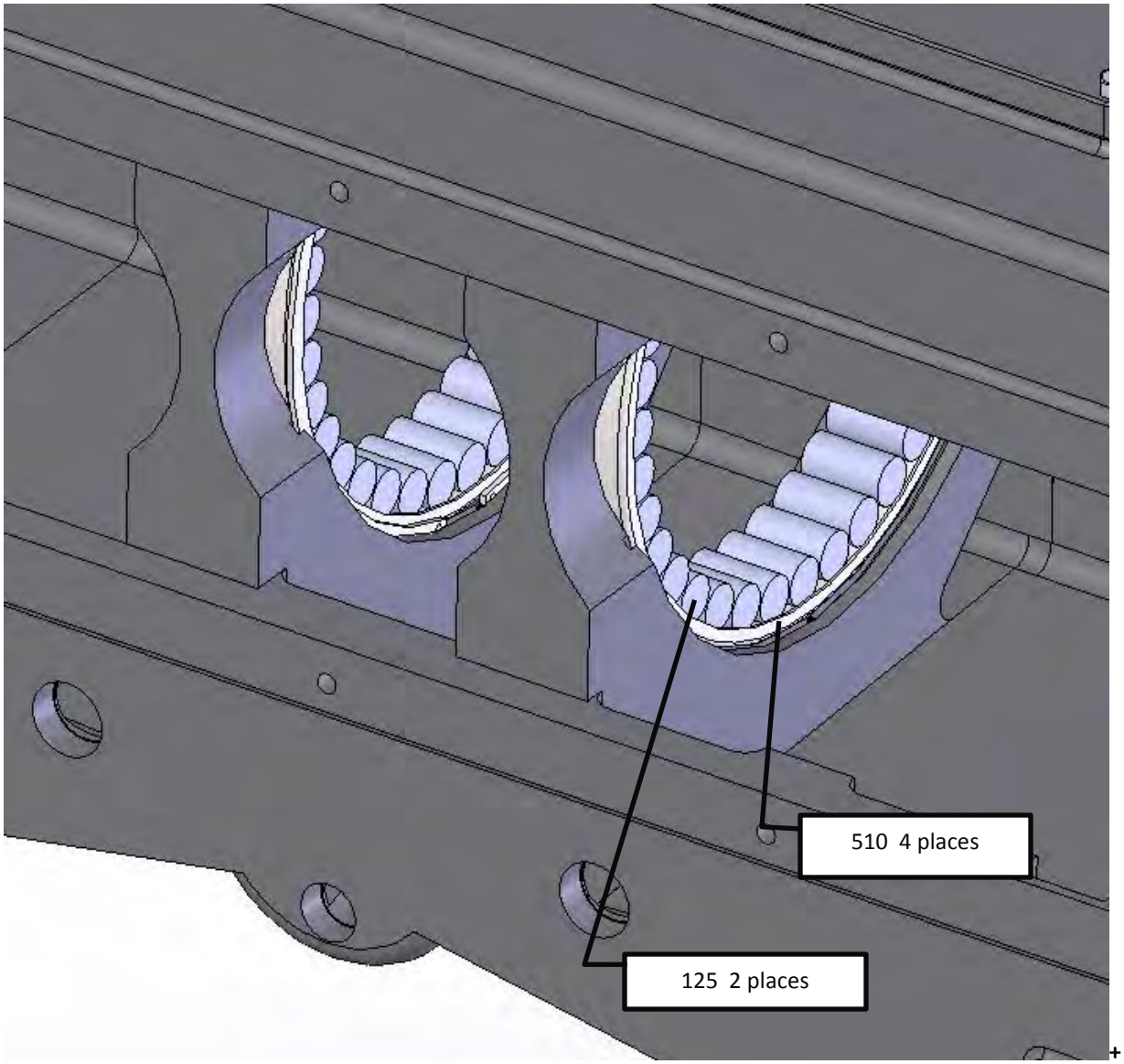
1. Freeze two (2) outer main roller bearing races (Item 125) to prepare to press fit them into the power frame.



2. Install the main bearing outer snap rings (Item 510) into the inner most set of grooves in the power frame (Item 1) as shown in the image below. Rotate snap rings so that the gap in the ring is positioned at the bottom of the crankshaft bore and on each side of the anti-rotation pin (Item 689) located in the bottom of the groove.

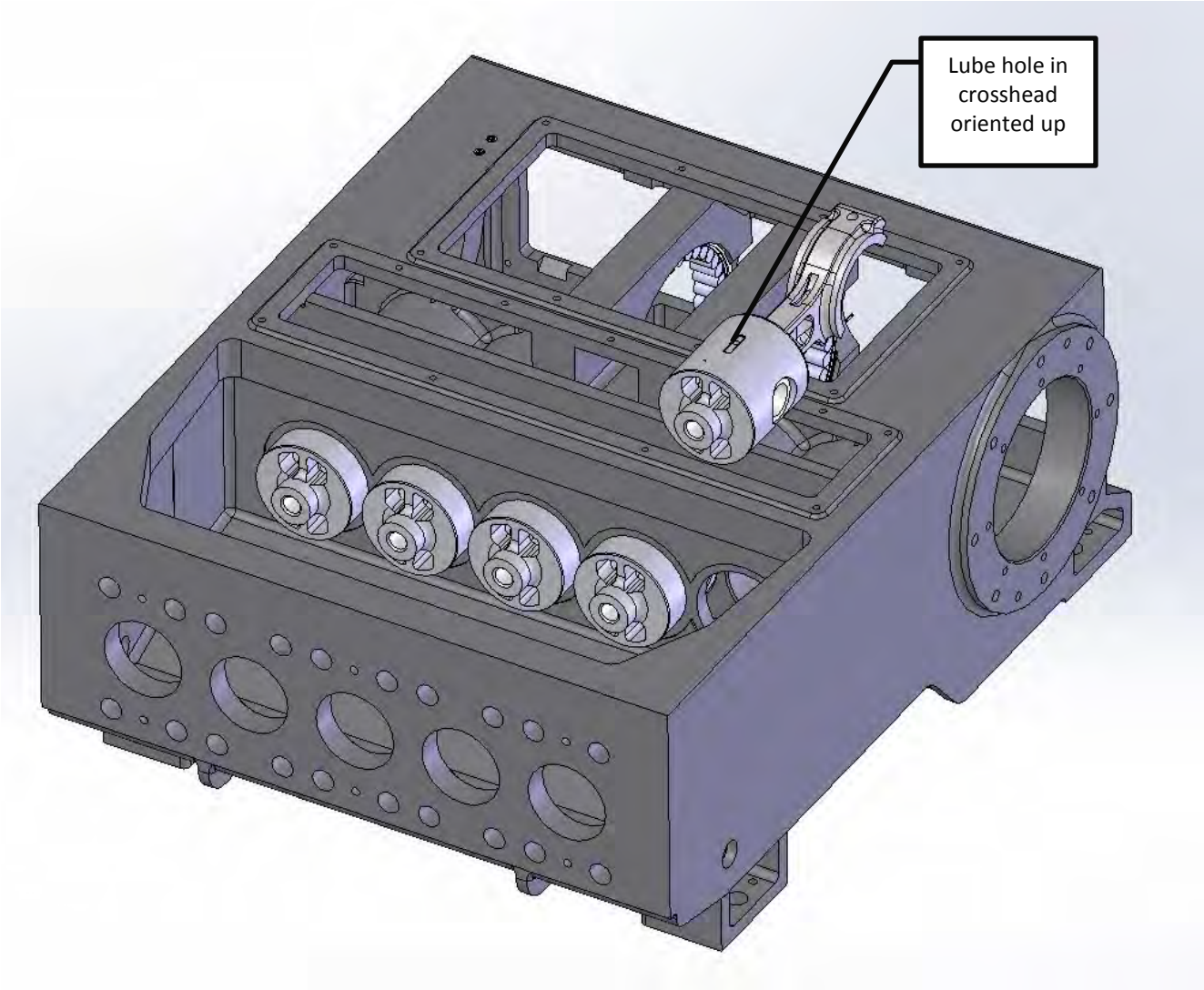


3. Slip cold main bearing outer races (Item 125) into power frame bearing supports and press up to main bearing snap ring (Item 510). Install final main bearing snap rings on outside of main bearings. Main bearing outer races are now installed with a snap ring on each side.



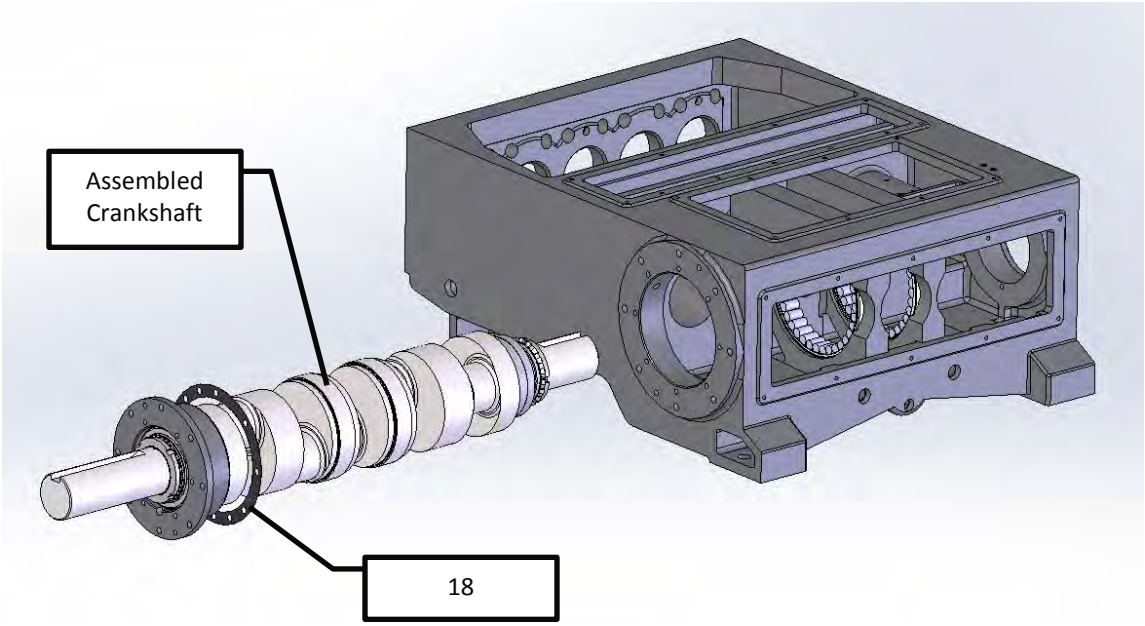
# INSTALLATION OF CONNECTING RODS AND CROSSHEADS

1. Slide the assembled crosshead and connecting rod end into the crosshead bore through the power frame cradle and slide it back until the connecting rod is the end of the crosshead bore. Coat the crosshead with oil before installation.
   **NOTE: ORIENTATION OF CONNECTING ROD AND CROSSHEAD ASSEMBLY. OPEN END OF CONNECTING ROD IS AIMED DOWN AND THE LUBE HOLE ON THE CROSSHEAD IS AIMED UP.**

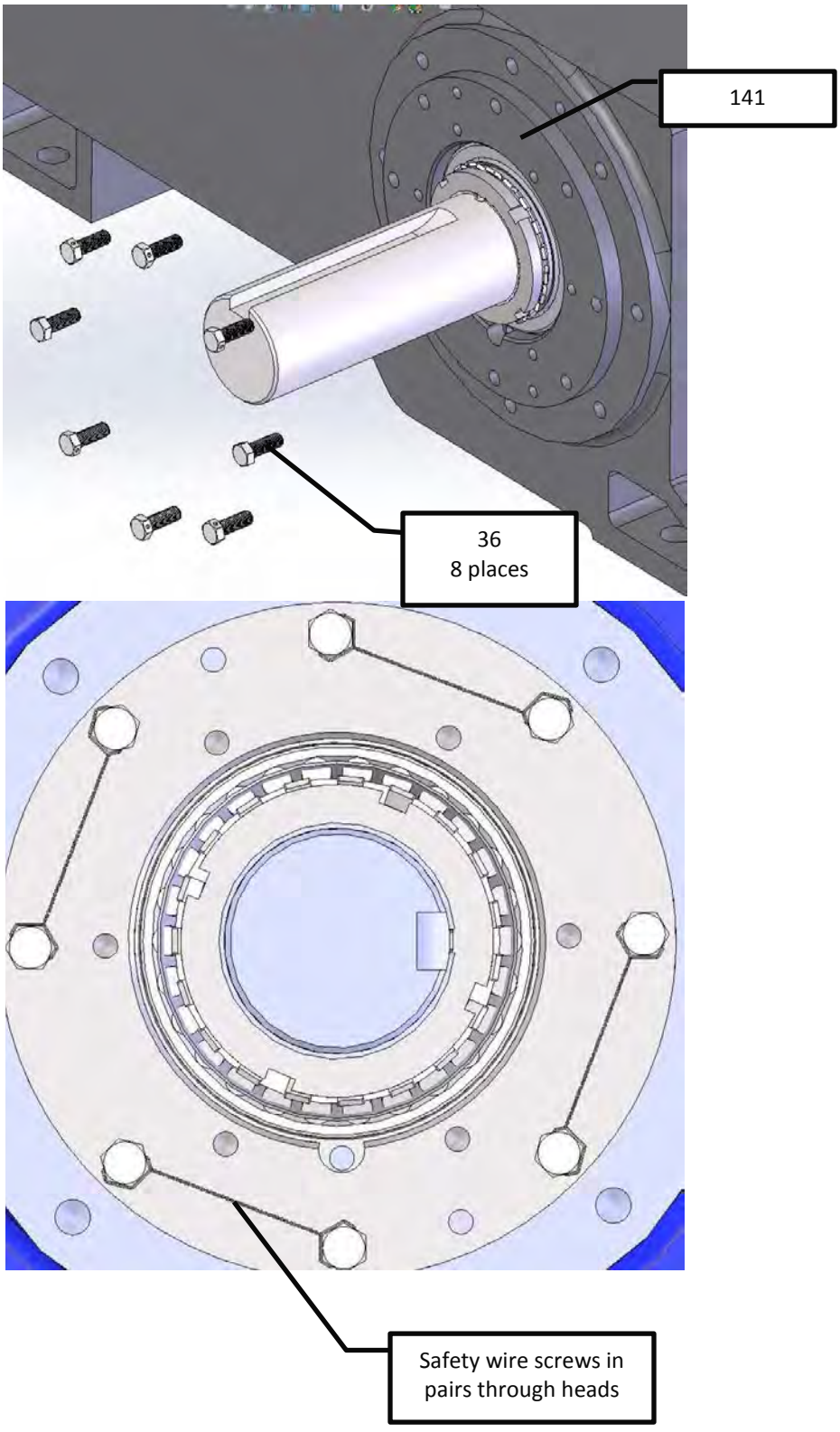


# INSTALLATION OF CRANKSHAFT

1. The assembled crankshaft is now ready to be installed into the prepared power frame. Coat all bearing surfaces with oil. Slip the bearing cage gasket (Item 18) over the crankshaft assembly into position on the bearing cage.
   **WARNING: EXTREME CARE MUST BE TAKEN WHEN INSERTING THE CRANKSHAFT INTO THE POWER FRAME TO NOT DAMAGE THE BEARINGS. TAKE TIME TO MAKE SURE IT IS ALIGNED CORRECTLY OR DAMAGE MAY OCCUR.**



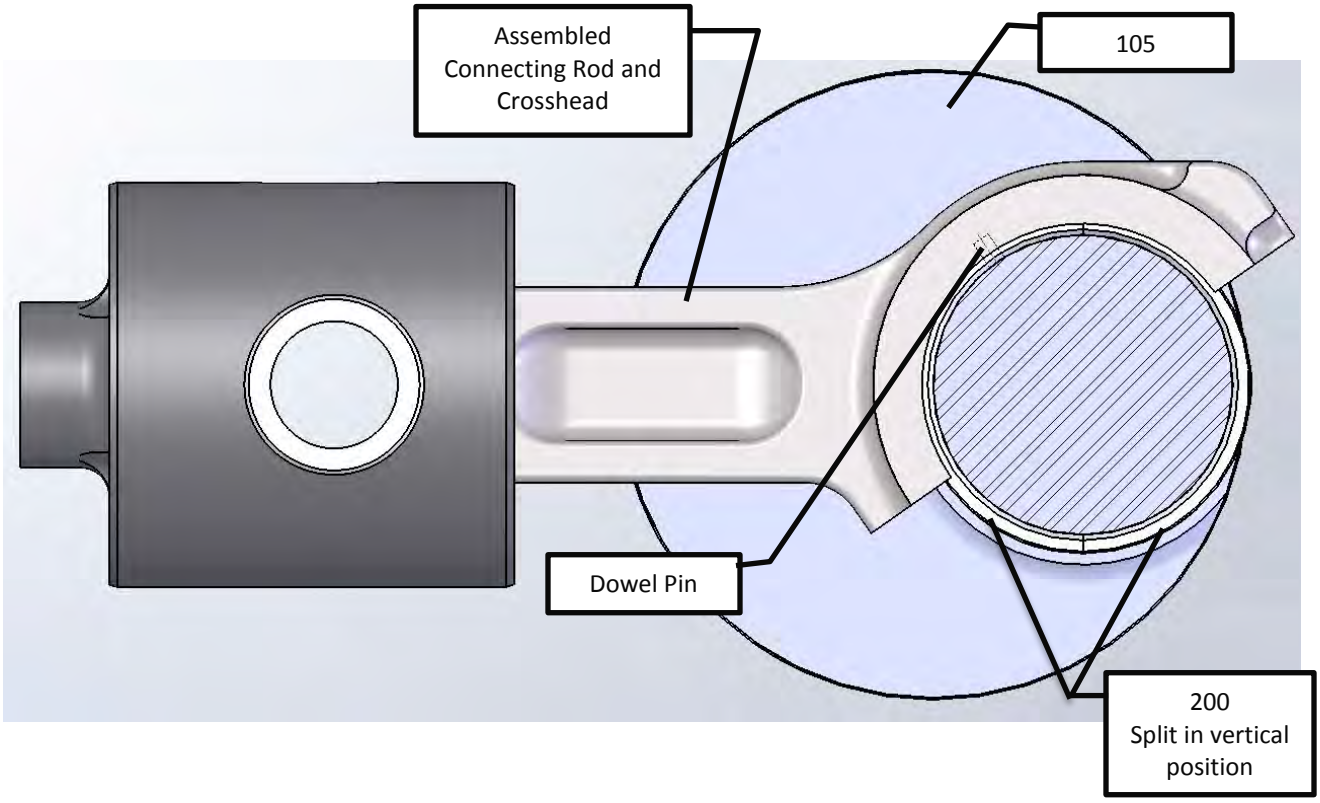
2. Install eight (8) drilled head hex head cap screws (Item 36) in bearing cage (Item 141). Using safety wire, wire together the cap screws in pairs to prevent them from breaking loose.



# COMPLETION OF CONNECTING ROD INSTALLATION

1. Rotate the crankshaft until the first throw is closest to the rear of the power frame. Install the shell bearing (Item 200) halves onto the crankshaft (Item 105) as shown in the image below. Pull the connecting rod up to the shell bearing and rotate the bearing until the dowel pin engages. The shell bearing will snap into place locking it to the connecting rod. The shell bearing split should be vertical and not aligned with the split in the connecting rod. If not as shown below, it is misaligned and must be corrected.

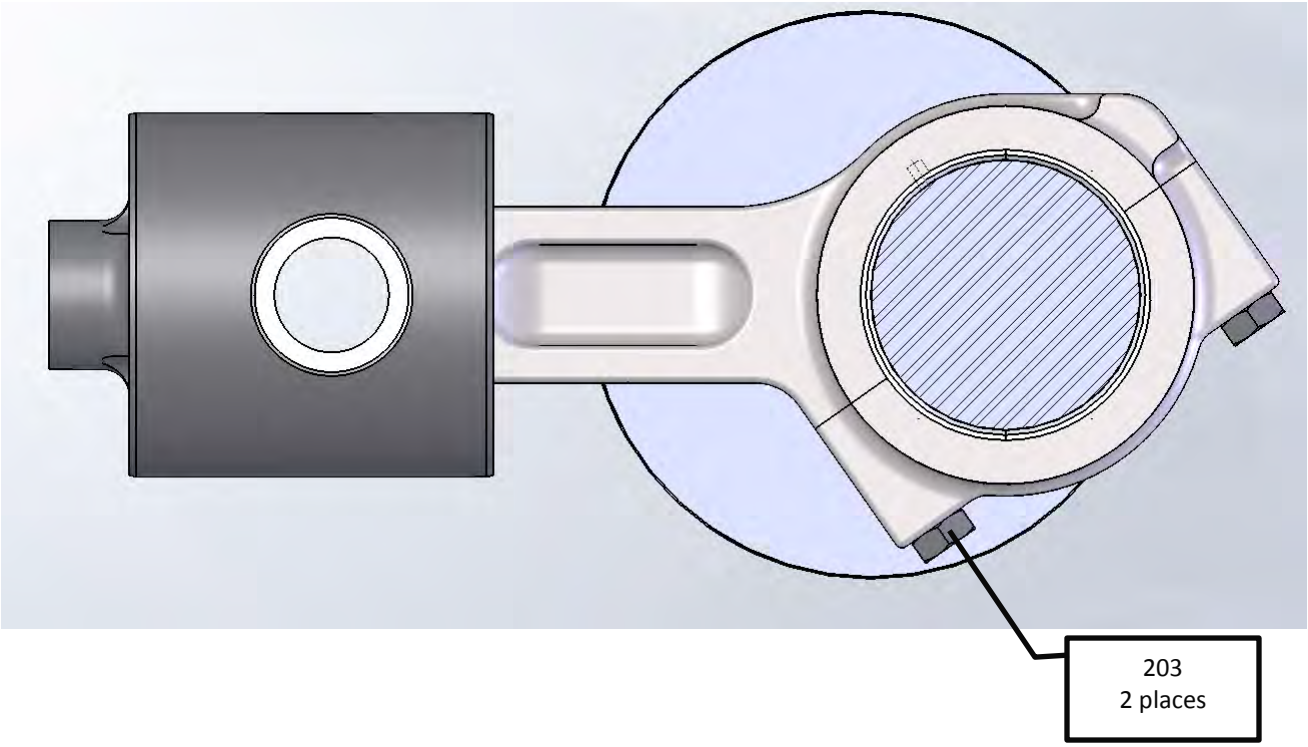
   **WARNING: IMPROPER INSTALLATION OF SHELL BEARING WILL CAUSE IMMEDIATE DAMAGE TO THE CRANKSHAFT AND BEARING SURFACES AND QUICKLY CAUSE CONNECTING ROD FAILURE UPON STARTUP. TAKE CARE TO FOLLOW INSTRUCTIONS AND DIAGRAMS CLOSELY.**




**CRITICAL ASSEMBLY INSTRUCTION FOR CORRECT INSTALLATION**

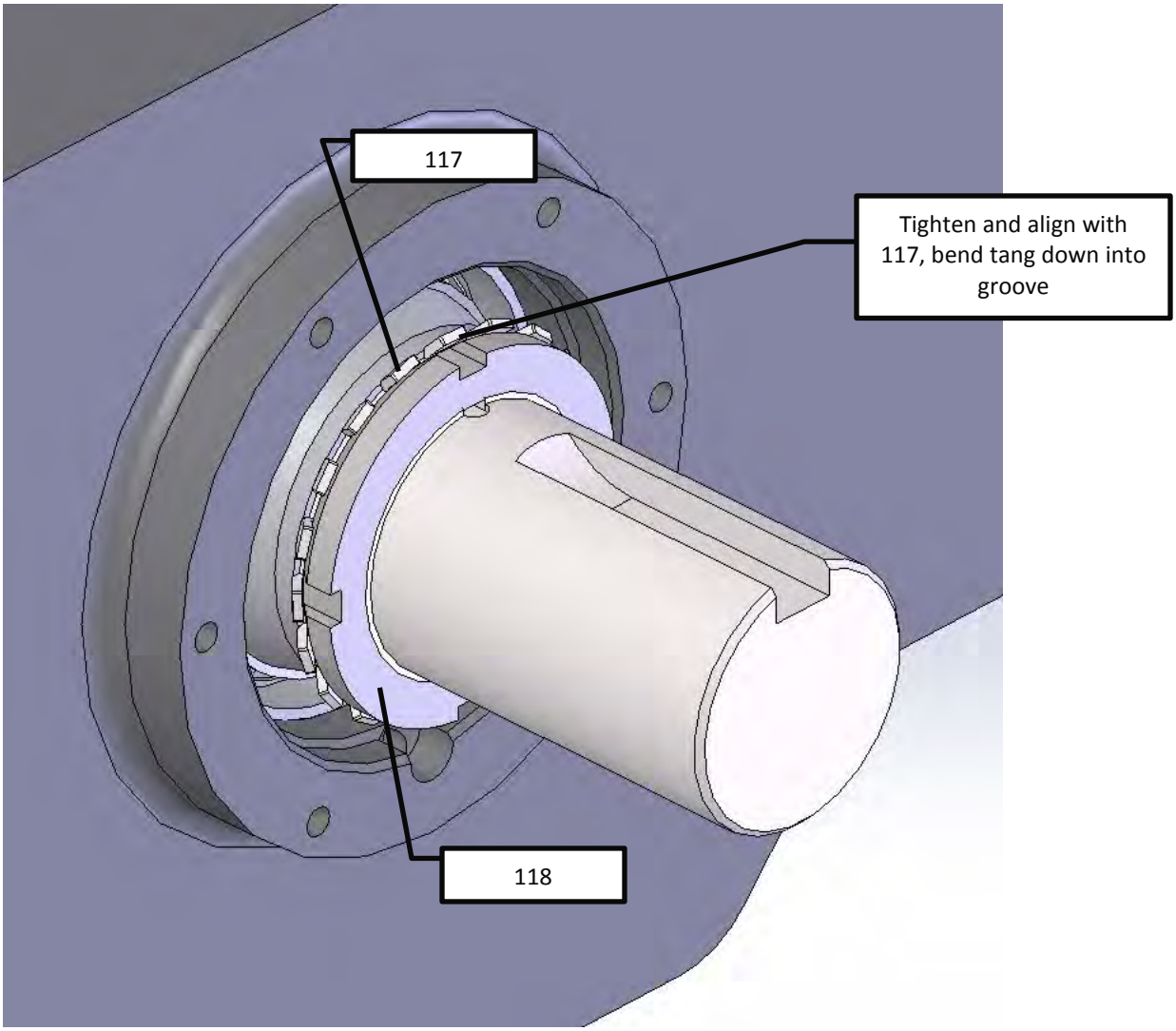
**POWER FRAME REMOVED FROM ILLUSTRATION FOR CLARITY**

2. Repeat process with all five (5) connecting rods. Torque connecting rod bolts (Item 203) to 250 lbs-ft. Using safety wire tie connecting rod bolts to one another.

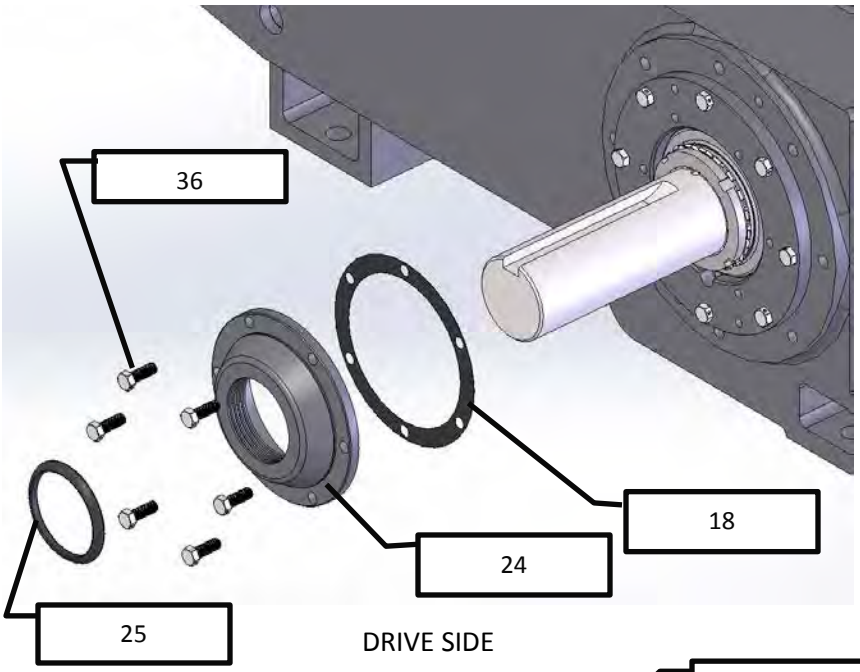


# COMPLETION OF CRANKSHAFT INSTALLTION

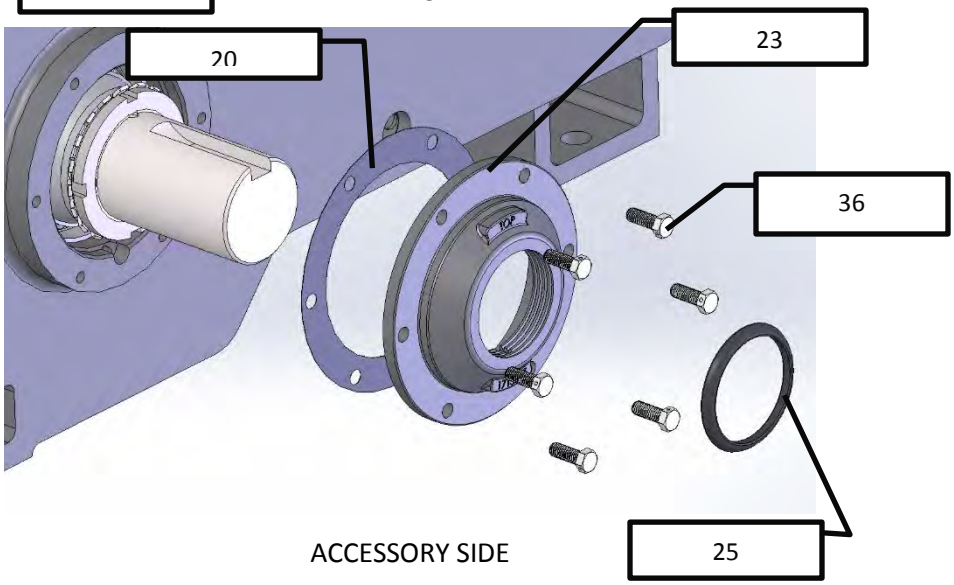
1. Using a block of wood positioned over the end of the crankshaft, strike each end of the crankshaft with a sledgehammer two times to fully seat the outer tapered roller bearing races. **WARNING: DO NOT STRIKE THE CRANKSHAFT DIRECTLY WITH A HAMMER!** Using a strap wrench, rotate the crankshaft and tighten the lock nut on each end of the crankshaft. Align slot in locking nut (Item 118) with one of the tangs on the locking washer (Item 117) and bend the tang down flat into the slot. The crankshaft is now completely installed and located correctly in the power end.



2. Install the bearing retainer (Item 24) on drive side with gasket (Item 18) and bearing retainer (Item 23) with gasket (Item 20) on the accessory side. Secure with drilled head hex head cap screw (Item 36). Using safety wire tie pairs of screws to each other. Slip new slinger ring (Item 25) onto crankshaft and tap down to the bearing retainer with a soft faced mallet. **NOTE:** If pump has gear reducer installed, do not install slinger ring (Item 25) on drive side.



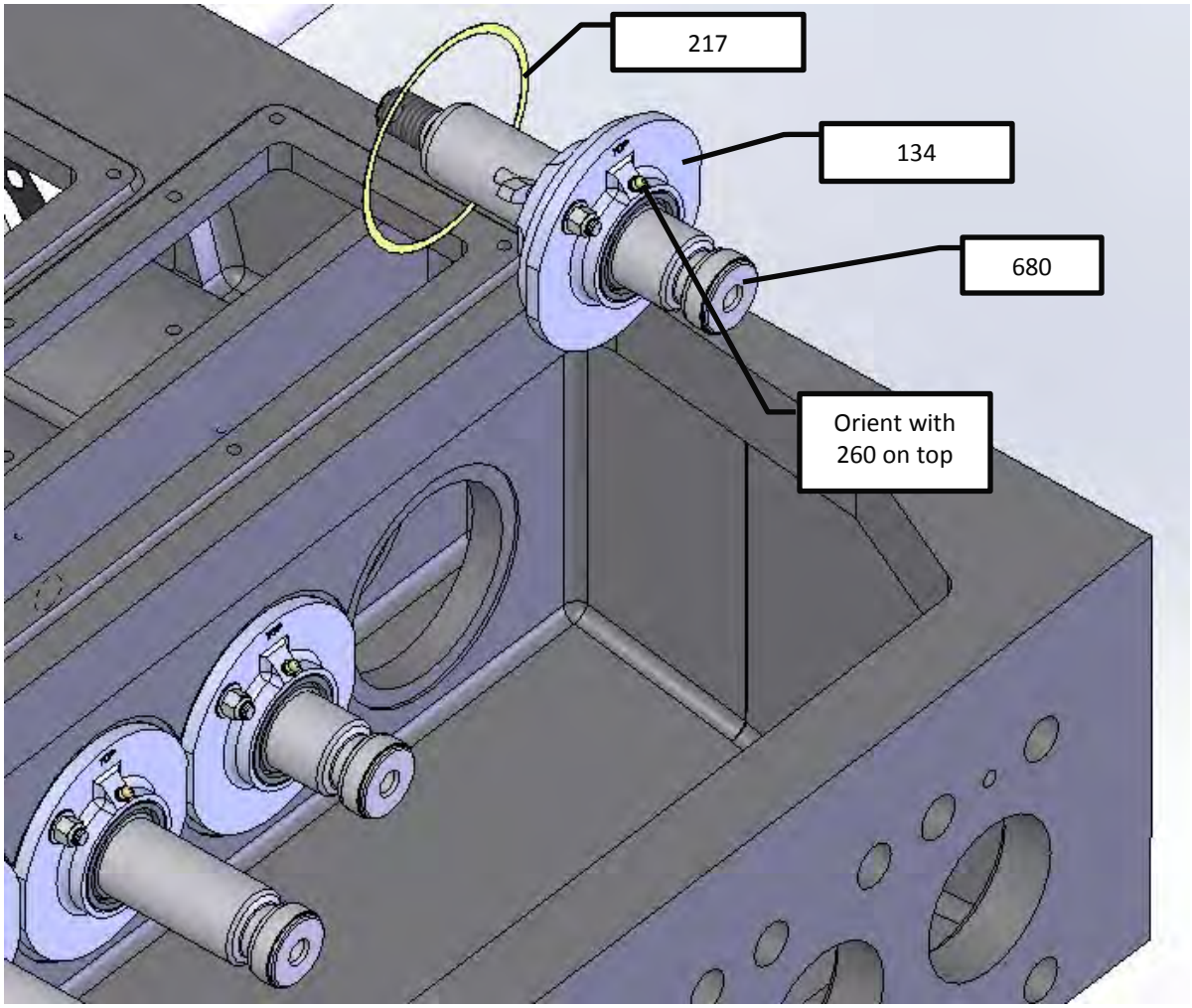

DRIVE SIDE




ACCESSORY SIDE

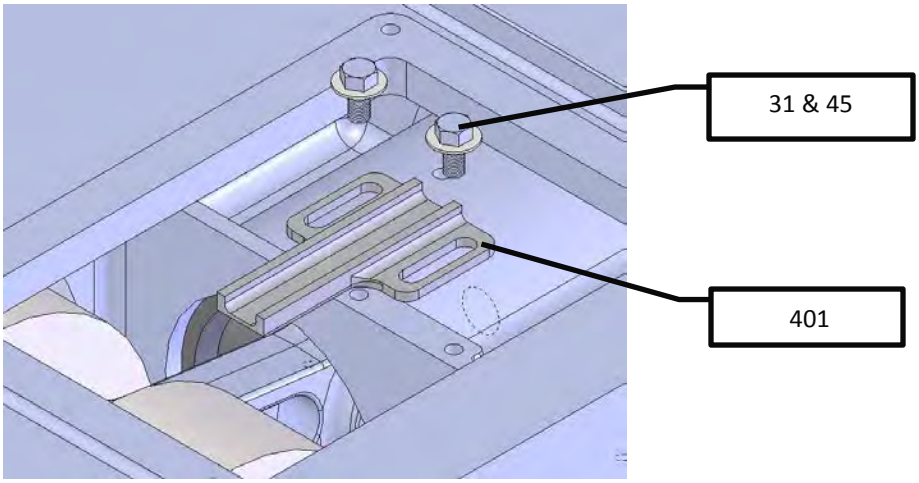
# WIPER BOX INSTALLTION

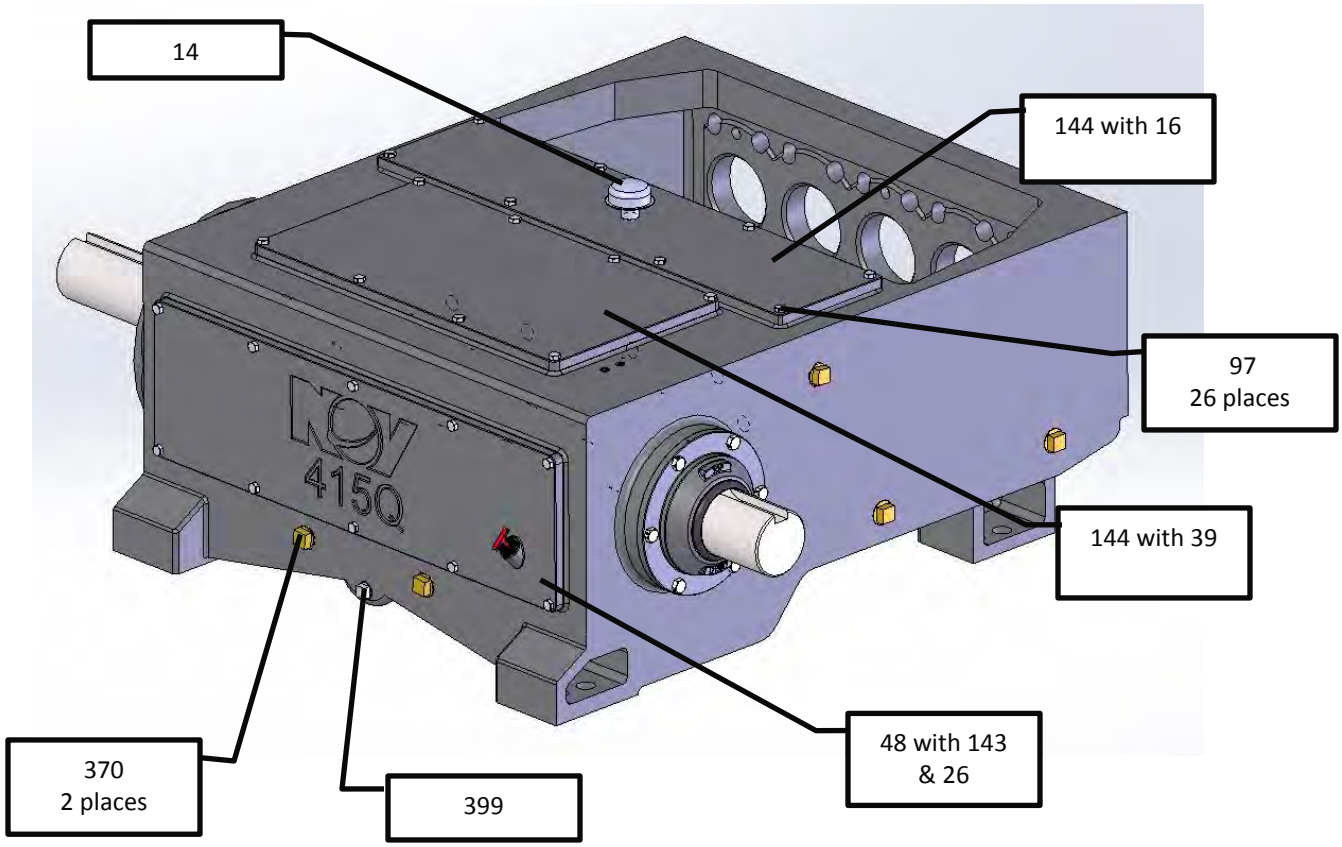
1. Coat intermediate rod (Item 680) with grease and slip through the assembled wiper box. Position wiper box assembly with gasket (item 217) in power frame cradle and hand thread the intermediate rod into the crosshead. Push the wiper box assembly up to the power frame, rotate the hook bolts (Item 222) so they pass through the bore and rotate so they hook the power frame and contact the stop pins on the wiper box housing, then tighten the lock nuts (Item 223). Make sure the wiper box assembly is oriented with the lube fitting (Item 260) upwards. Repeat process for each of the five (5) wiper box assemblies. Torque intermediate rod to crosshead 480 ft-lbs (dry) or 385 ft-lbs (lubricated).



# FINAL POWER FRAME ASSEMBLY

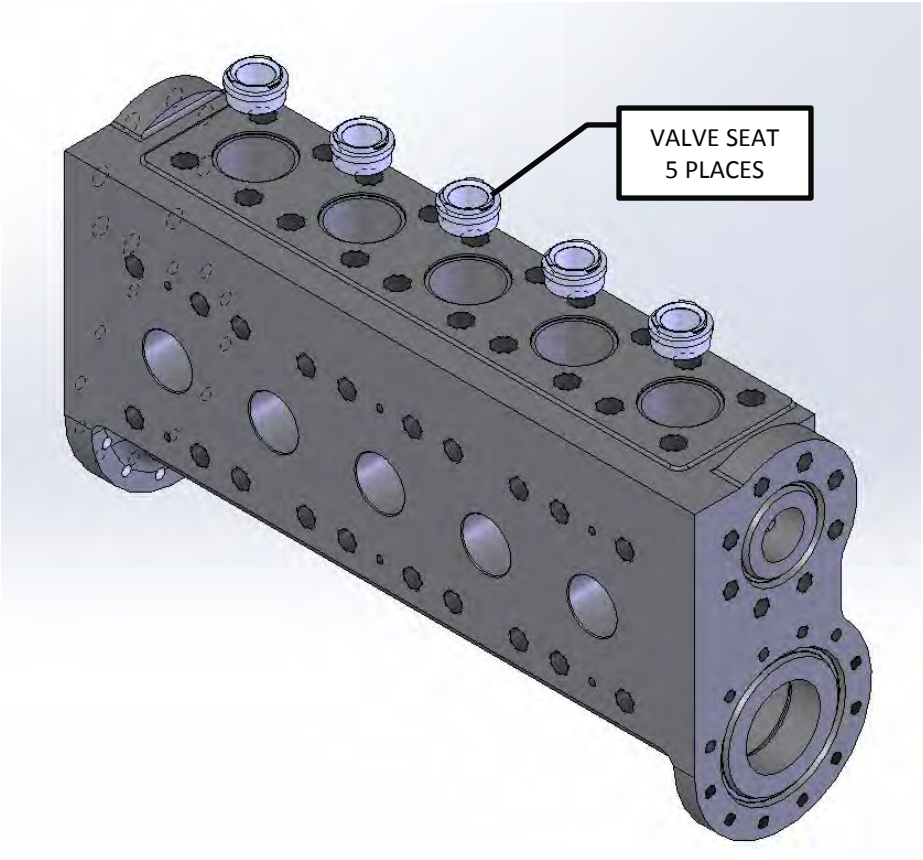
1. Install pipe plugs (Items 370) as shown in image below and rear cover (Item 48) with gasket (Item 143) and oil level dipstick (Item 26) before filling crankcase with oil. Install oil troughs (Item 401) with screws and washers (Items 31 & 45). After adding oil, mount crosshead cover with gasket (Items 144 & 16) and breather (Item 14) on top of power frame. Install crankcase cover and gasket (Item 144 & 39). Install all covers with hex cap screws (Item 97). Install crankcase sump drain plug (Item 399). Power end is now fully assembled and ready for stuffing Box and Fluid End installation.

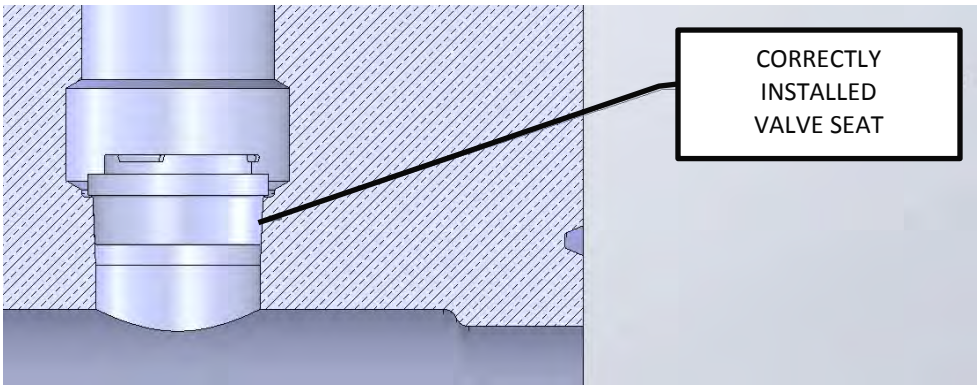


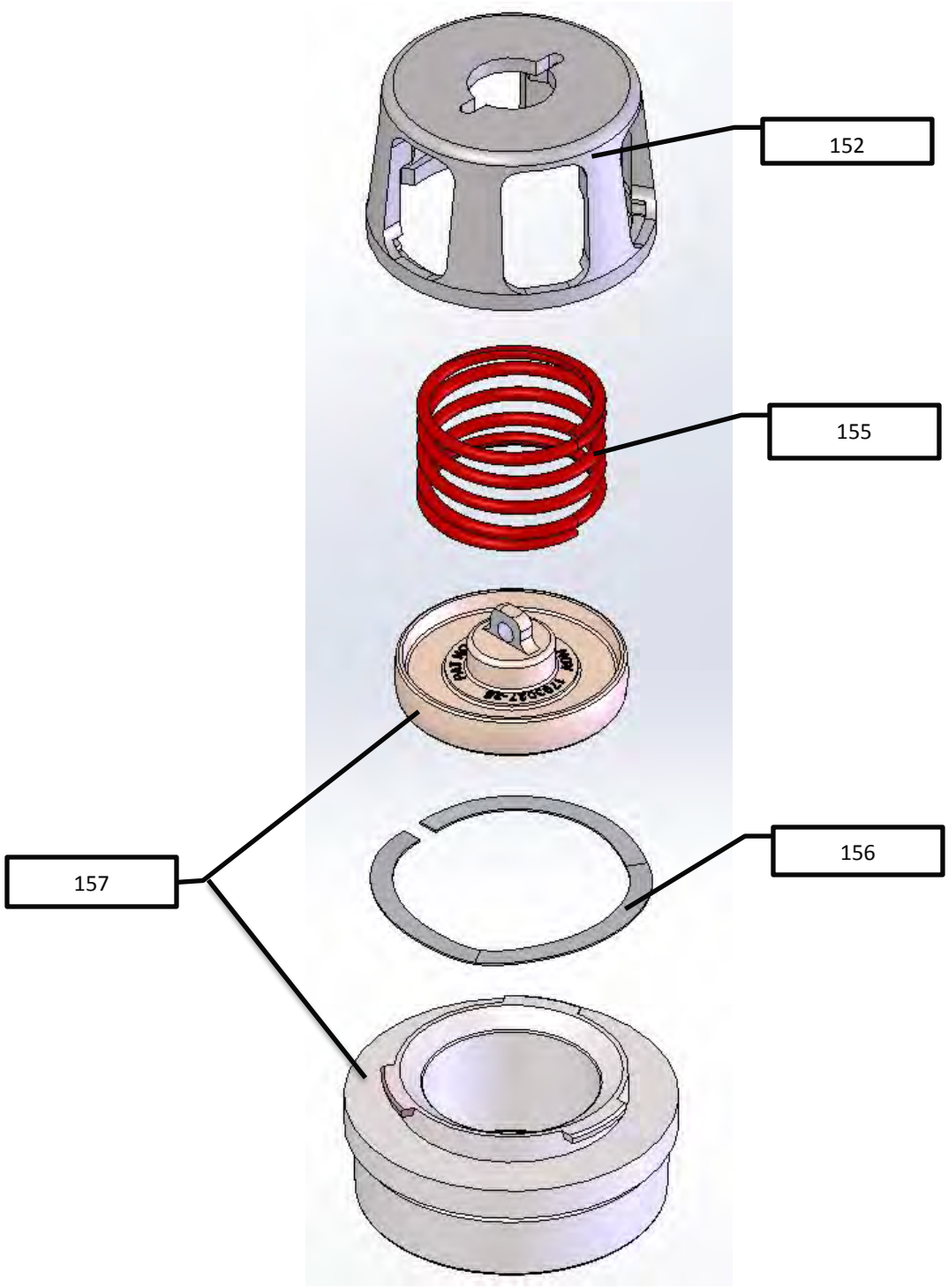
# FLUID END ASSEMBLY – TAPERED VALVE SEATS

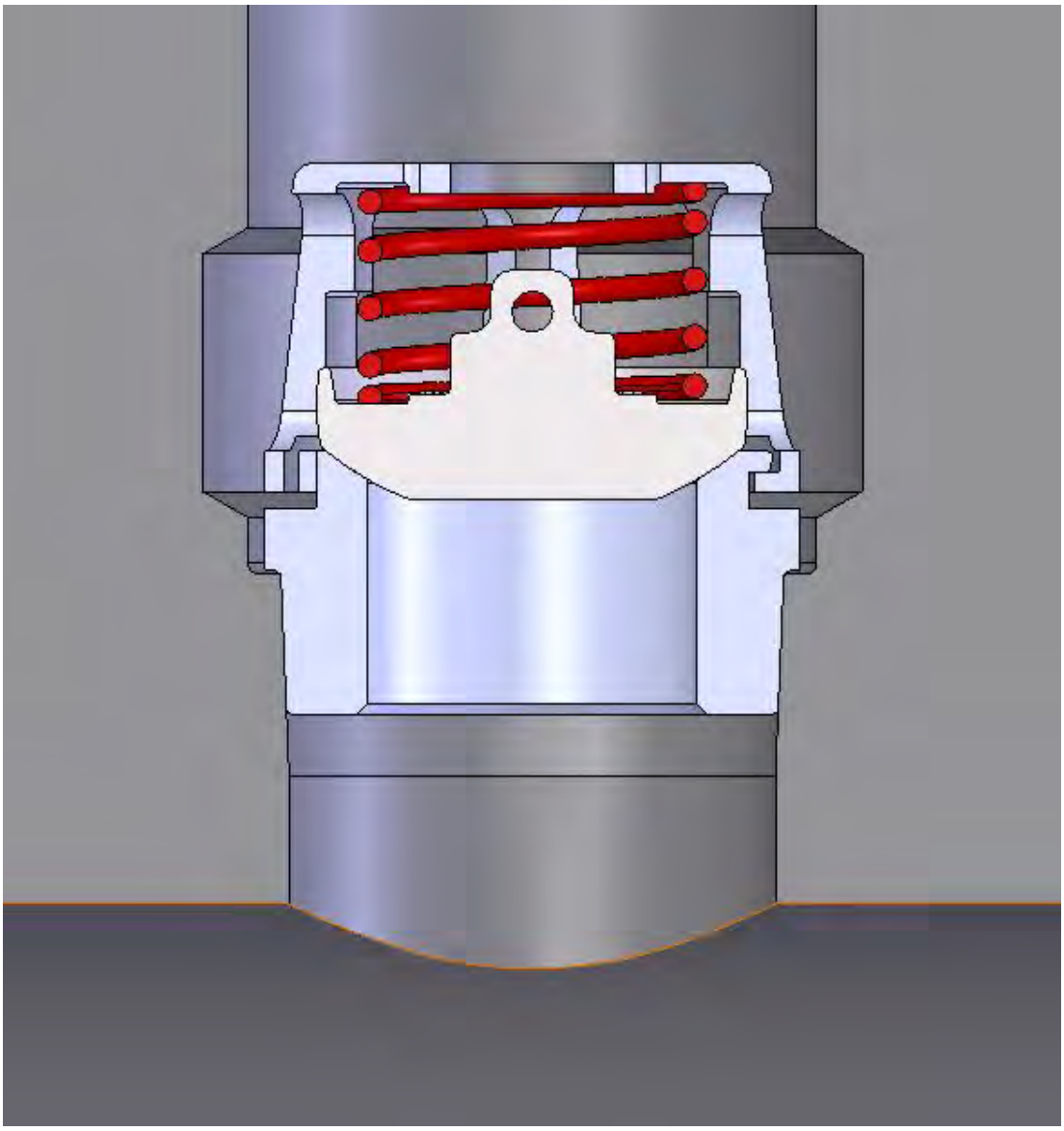
1. Clean the fluid end bores completely and wipe down the suction valve seat. The tapered seat and the tapered bore in the fluid end must be clean and free of all debris for valve seat to be installed correctly. **WARNING: NEVER use grease or oil on tapered valve seats, valve seats are to be installed clean and dry.** Slip the suction valve seat into the tapered bore in the fluid end and using a brass bar and hammer tap the valve seat into place. Repeat this process for all five (5) valve seats. The seat will be raised slightly when installed and will be completely engaged when fluid end is pressurized at startup. Check after installation that the seat is tight.



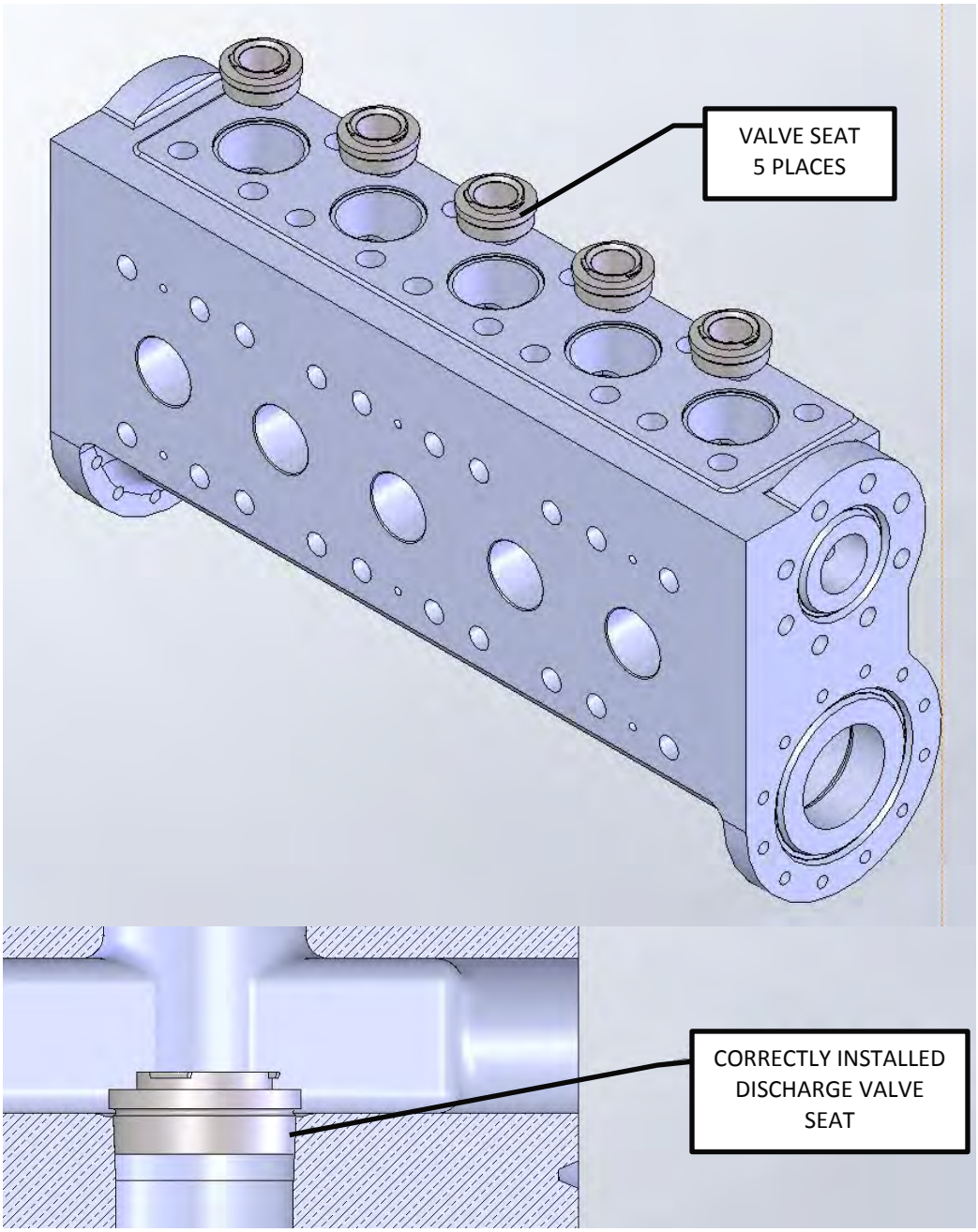
2. Assemble the remaining parts for the suction valve on top of the suction valve seat. Position the wave spring on top of the valve seat, below the tabs on the seat. Then position the suction valve body on top of the valve seat. Positon the valve spring on top of the suction valve body. Then slip the valve spring retainer over the valve spring, push it down to compress the spring and rotate clockwise to lock it into positon with a large screwdriver.



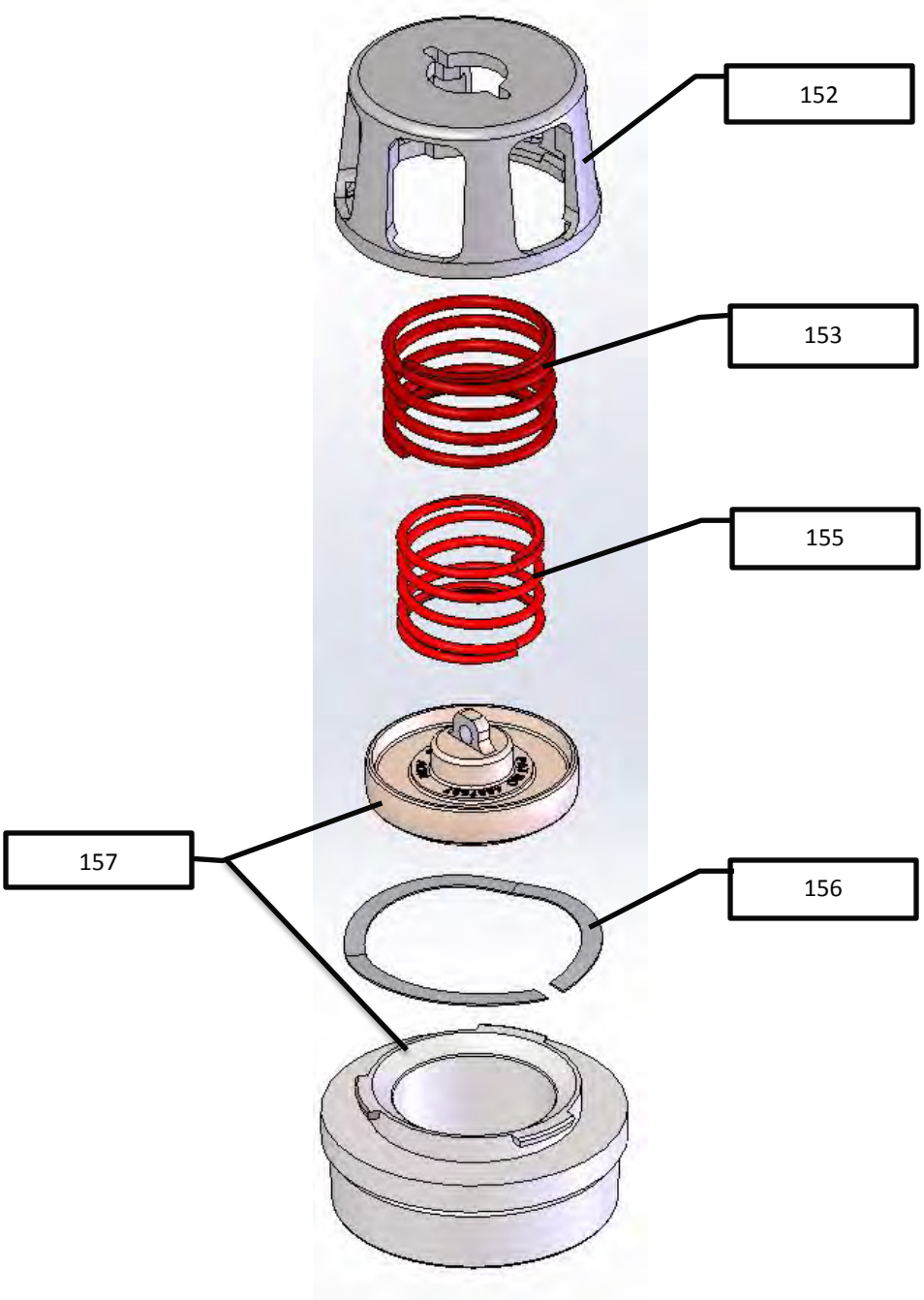


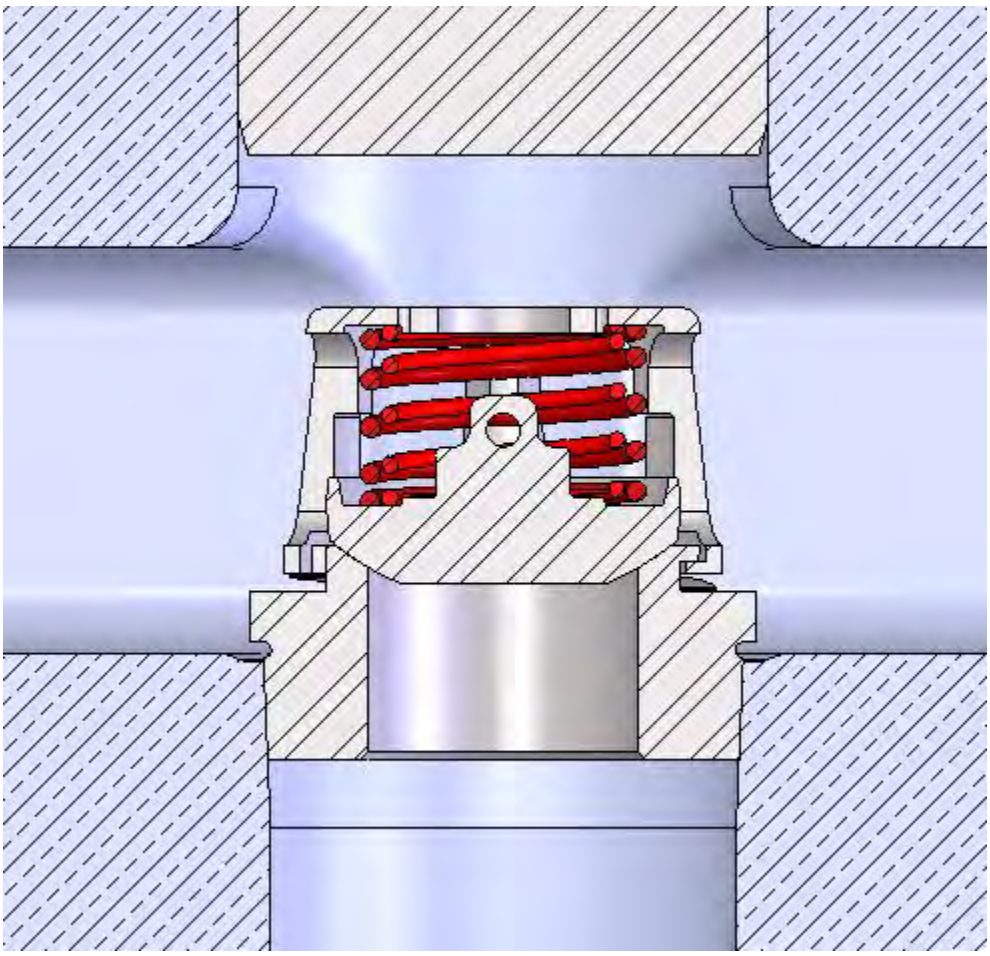
CORRECTLY INSTALLED COMPLETE SUCTION VALVE

3. Wipe down the discharge valve seat. The tapered seat and the tapered bore in the fluid end must be clean and free of all debris for valve seat to be installed correctly. **WARNING: NEVER use grease or oil on tapered valve seats, valve seats are to be installed clean and dry.** Slip the discharge valve seat into the tapered bore in the fluid end and using a brass bar and hammer tap the valve seat into place. Repeat this process for all five (5) valve seats. The seat will be raised slightly when installed and will be completely engaged when fluid end is pressurized at startup. Check after installation that the seat is tight.



4. Assemble the remaining parts for the discharge valve on top of the discharge valve Seat. Position the wave ring spring on top of the valve seat, and below the tabs on the valve seat. Then position the valve body on top of the valve seat. Positon the inner valve spring on top of the suction valve body, then slip the outer valve spring over the inner valve spring. Next slip the valve spring retainer over the valve springs, push it down to compress the spring and rotate clockwise to lock it into positon with a large screw driver.



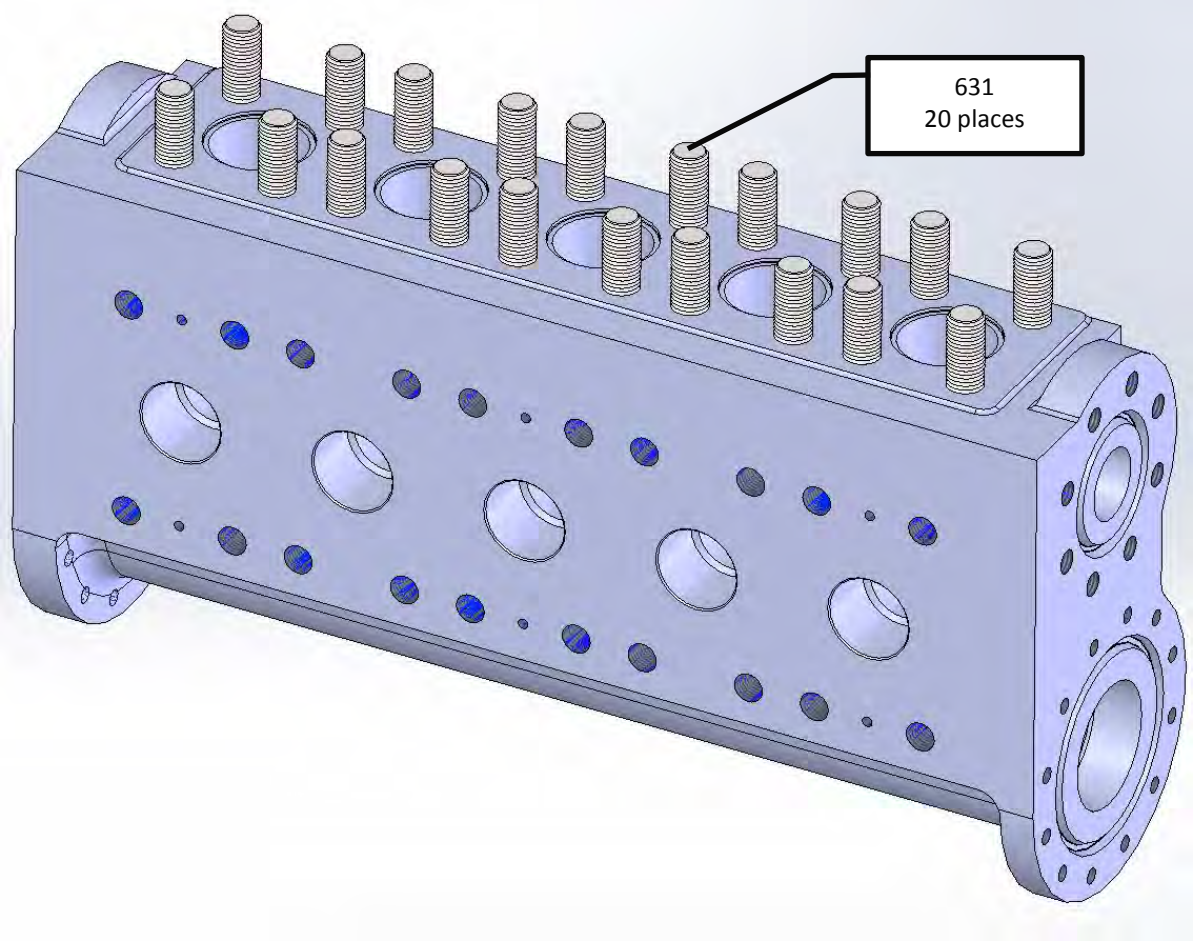


CORRECTLY INSTALLED COMPLETE DISCHARGE VALVE

5. If the studs have been removed, insert four (4) studs (Item 631) per cylinder on the top of the Fluid End with medium thread locking compound.
6. The valve cover studs (Item 631) should extend above the top deck of the fluid end by the amount listed below to correctly allow for mounting the cylinder covers.

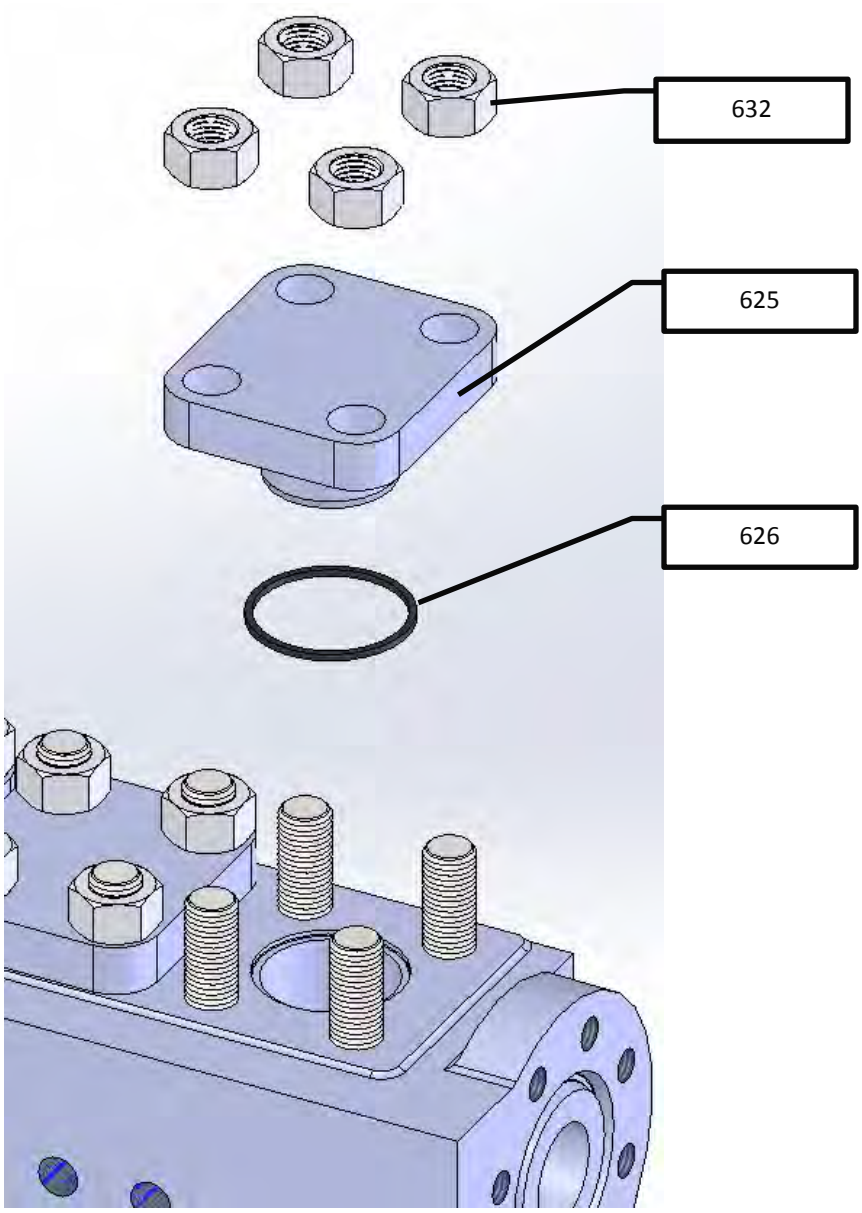
   415Q-5L - 2 1/4”

   415Q-5M – 3 1/2”

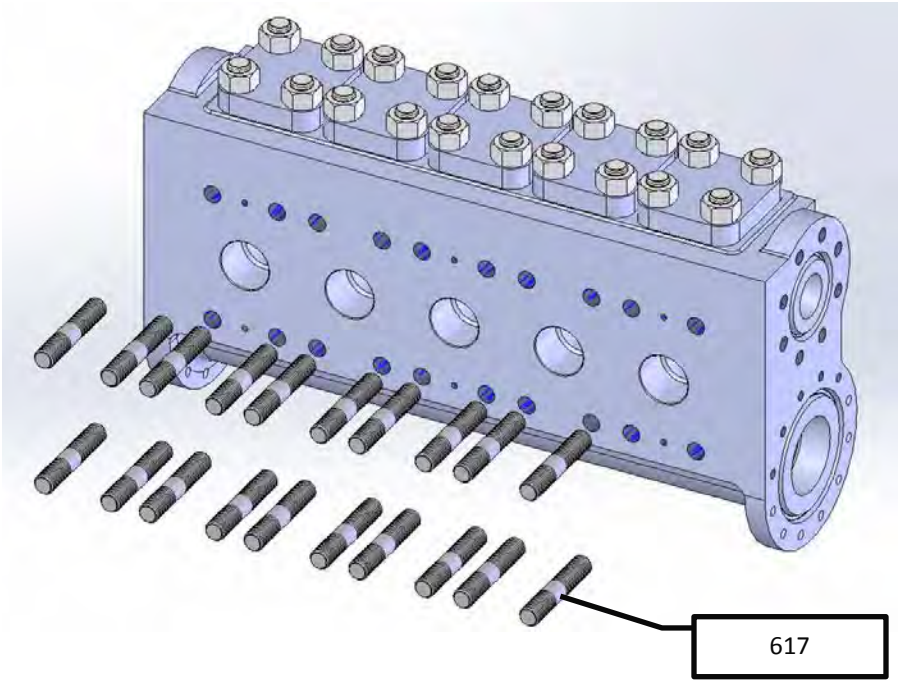


7. Coat the valve cover o-ring (Item 626) with grease and slip it over the round section of the valve cover (Item 625). Slip the valve cover over the studs and screw the four (4) hex nuts (Item 632) onto each stud. Apply an anti-seize compound with a K-factor of 0.14-0.16 to the threads of the hex nuts.
8. For 415Q-5M: Torque each hex nut to 670 lbs-ft dry or 500 ft-lbs lubricated (K-Factor = .15).

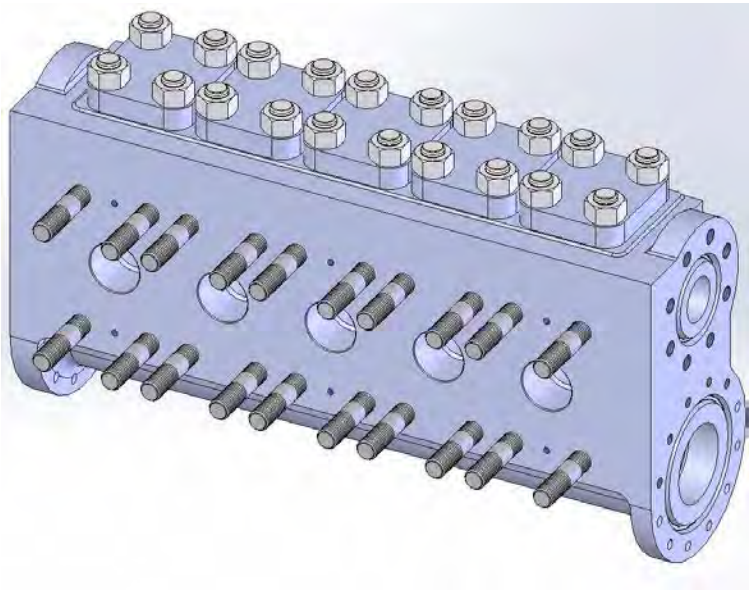
   For 415Q-5L: Torque each hex nut to 190 lbs-ft dry or 250 ft-lbs lubricated (K-Factor = .15).
9. Repeat process for all five (5) bores.



10. Install the twenty (20) fluid end studs (Item 617) into the fluid end using a medium strength thread locker. The studs should be 5 ½" above the mounting face when installed.

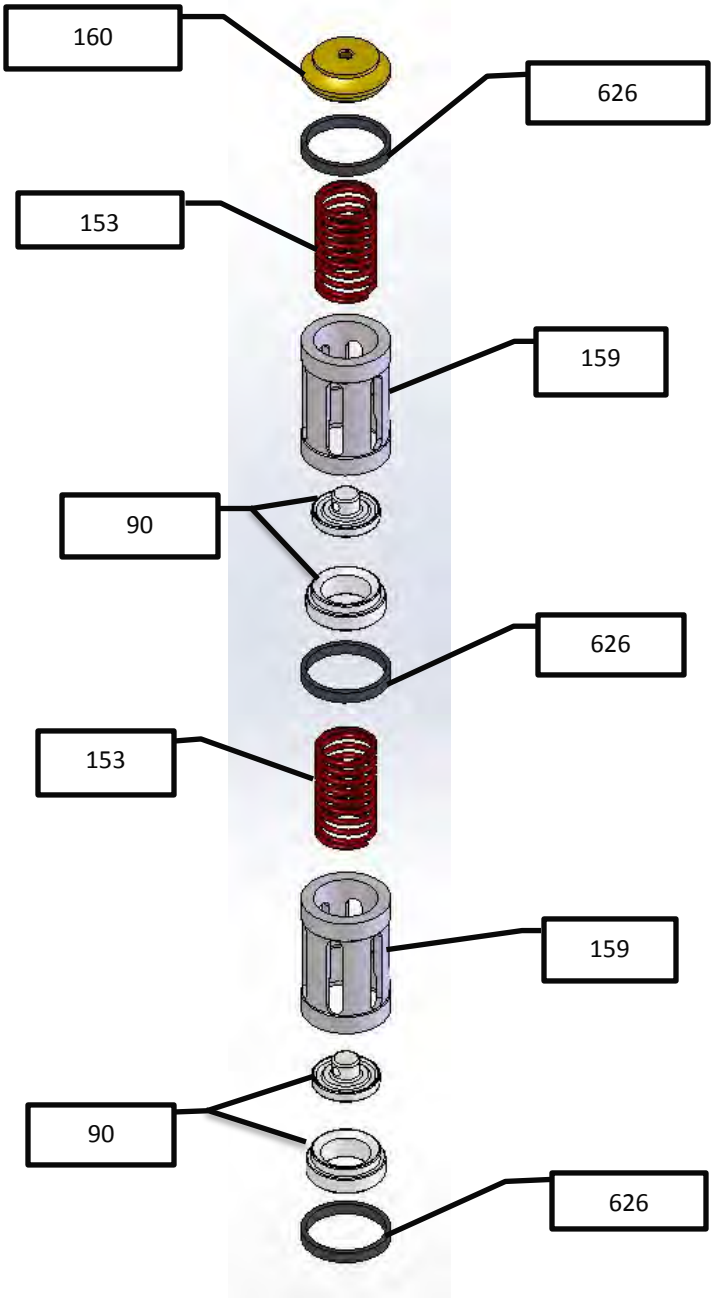


11. The M or L fluid end is now assembled and ready to mate up to the power end assembly.

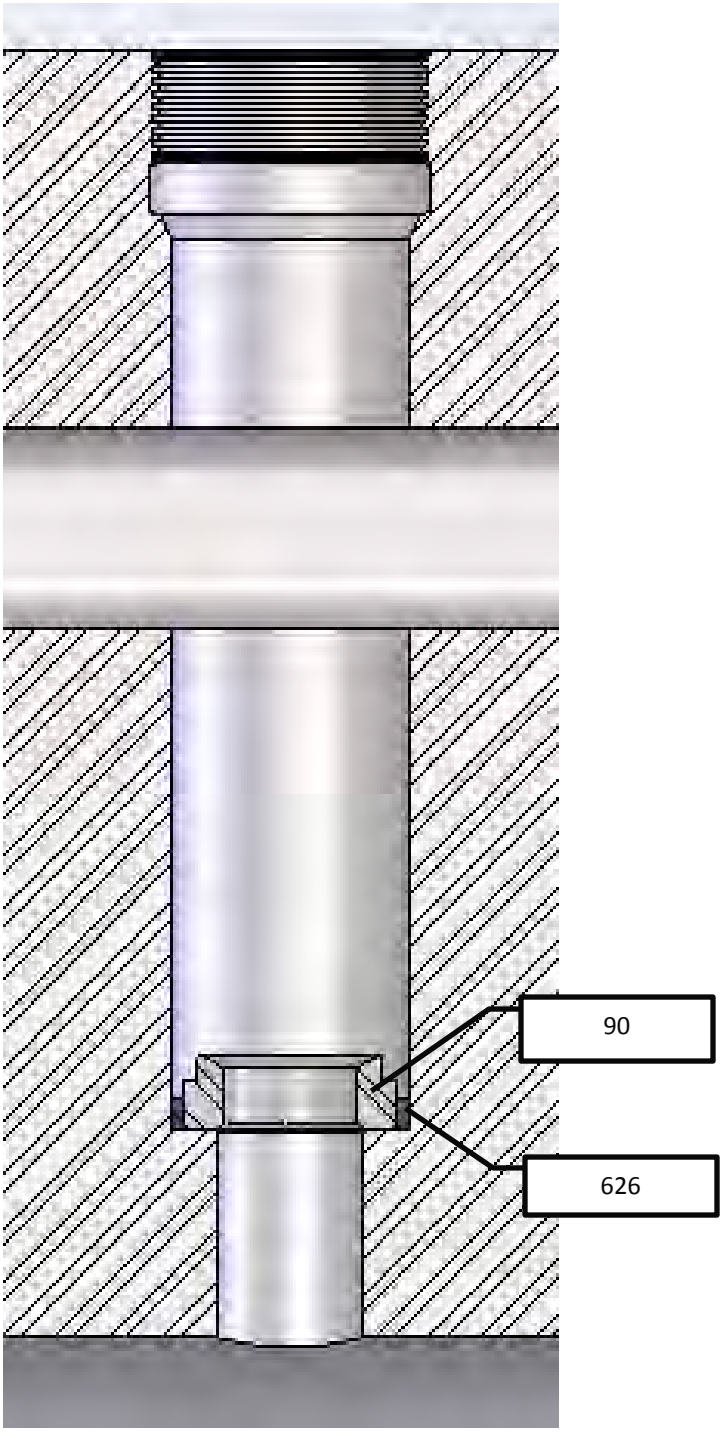


# FLUID END ASSEMBLY – CAGED VALVES, H FLUID END

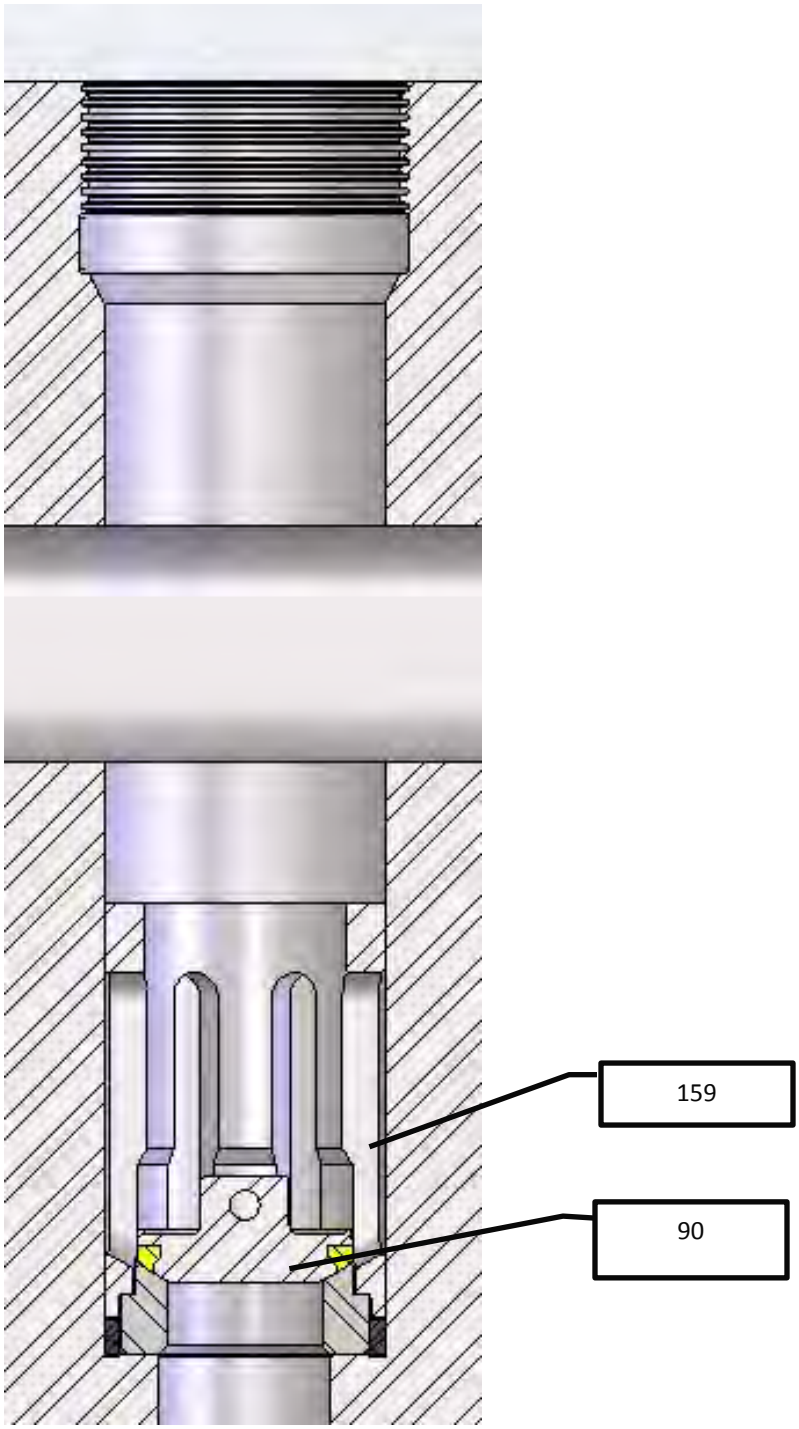
1. The caged style valves, spherical and spherical severe duty, are for the H model fluid end only. Clean the fluid end bores completely and wipe down the valve subassembly components. The valve components and bore in the fluid end must be clean and free of all debris for valves to be installed correctly. The diagram below shows the correct order for assembling the caged valve components. **NOTE: Spherical severe duty valve and seat are available as individual components, the spherical severe duty valve and seat are available as a matched set.**



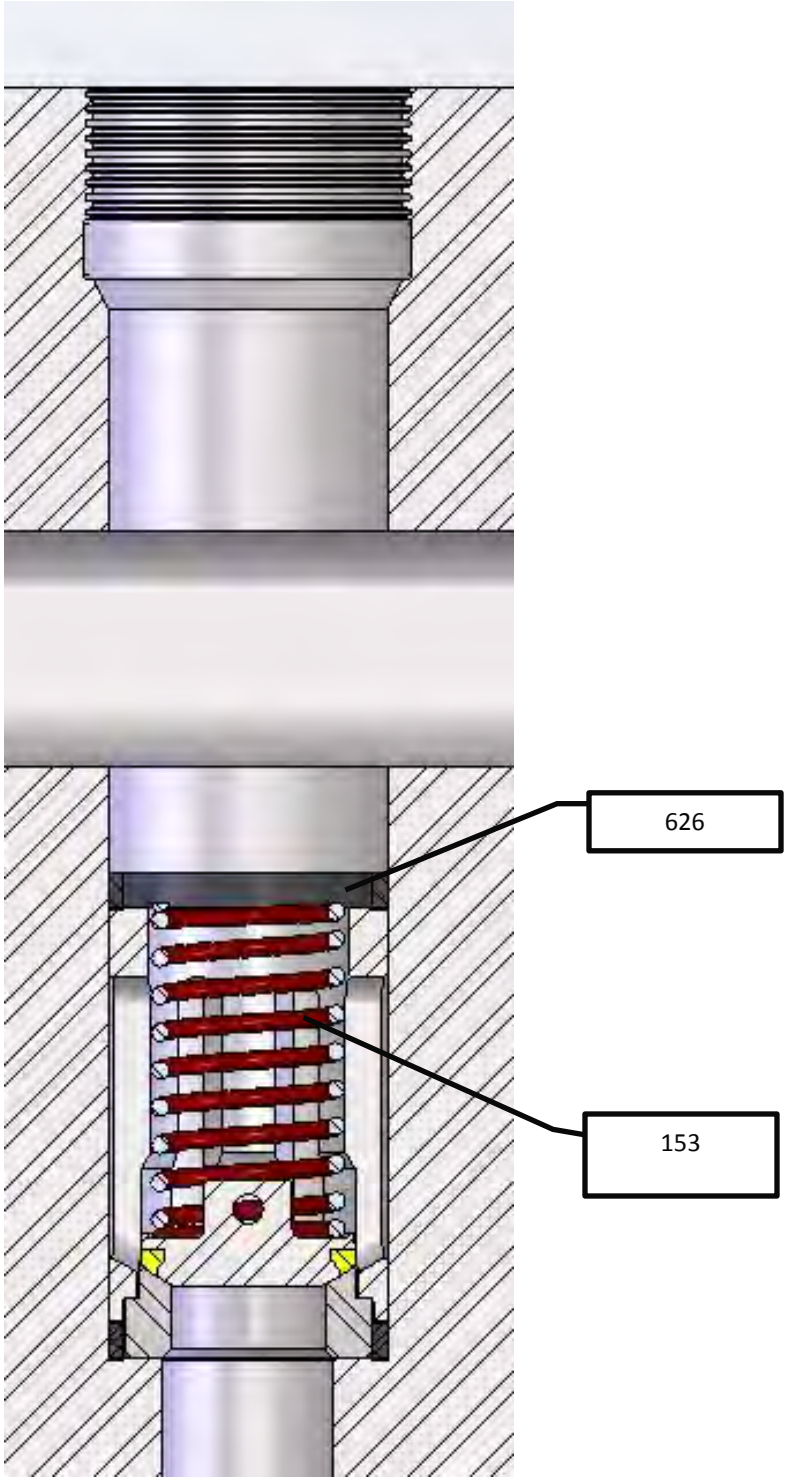
2. Insert the first of three (3) seals (Item 626) into the bore of the fluid end and push it to the bottom. Slip the first of two (2) valve seats into the bore on top of the seal. Push seat down until it goes through seal and rests on the fluid end. A small amount of grease on the seal will help with assembly. **NOTE: Spherical severe duty valve shown.**



3. Insert the first of two (2) valve bodies into the bore on top of valve seat. Slip valve cage down around valve body against valve seat. NOTE: Severe duty valve assembly has an integrated urethane valve insert. Spherical valve assembly does not use the urethane Insert**. NOTE: Spherical severe duty valve and seat are available as individual components, the spherical severe duty valve and seat are available as a matched set. Spherical severe duty valve shown.**

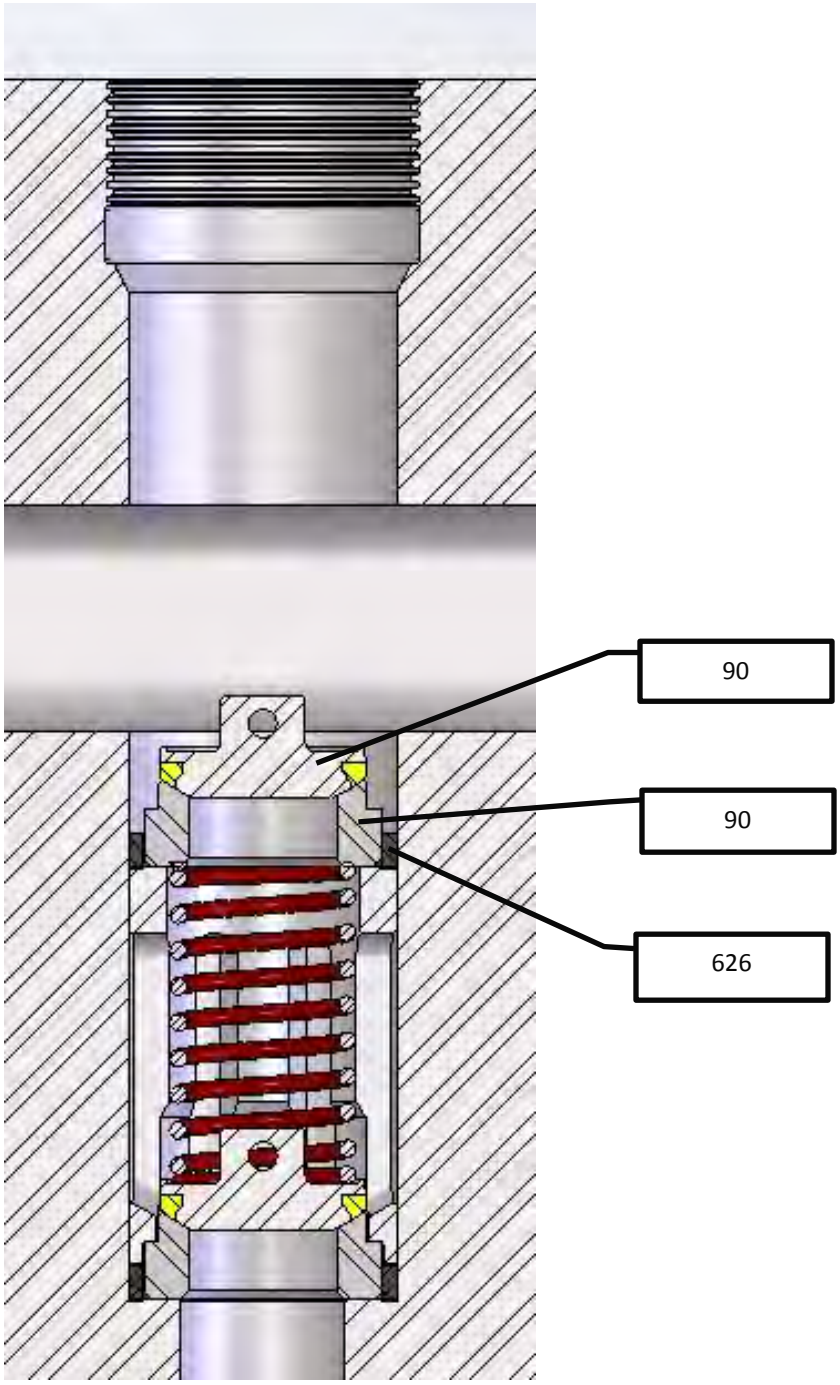


4. Slip the first of two (2) valve springs to the top of the valve body. Insert the second of three (3) seals (Item 626) and push down to the top of the suction valve cage. A small amount of grease on the seal will help with assembly.

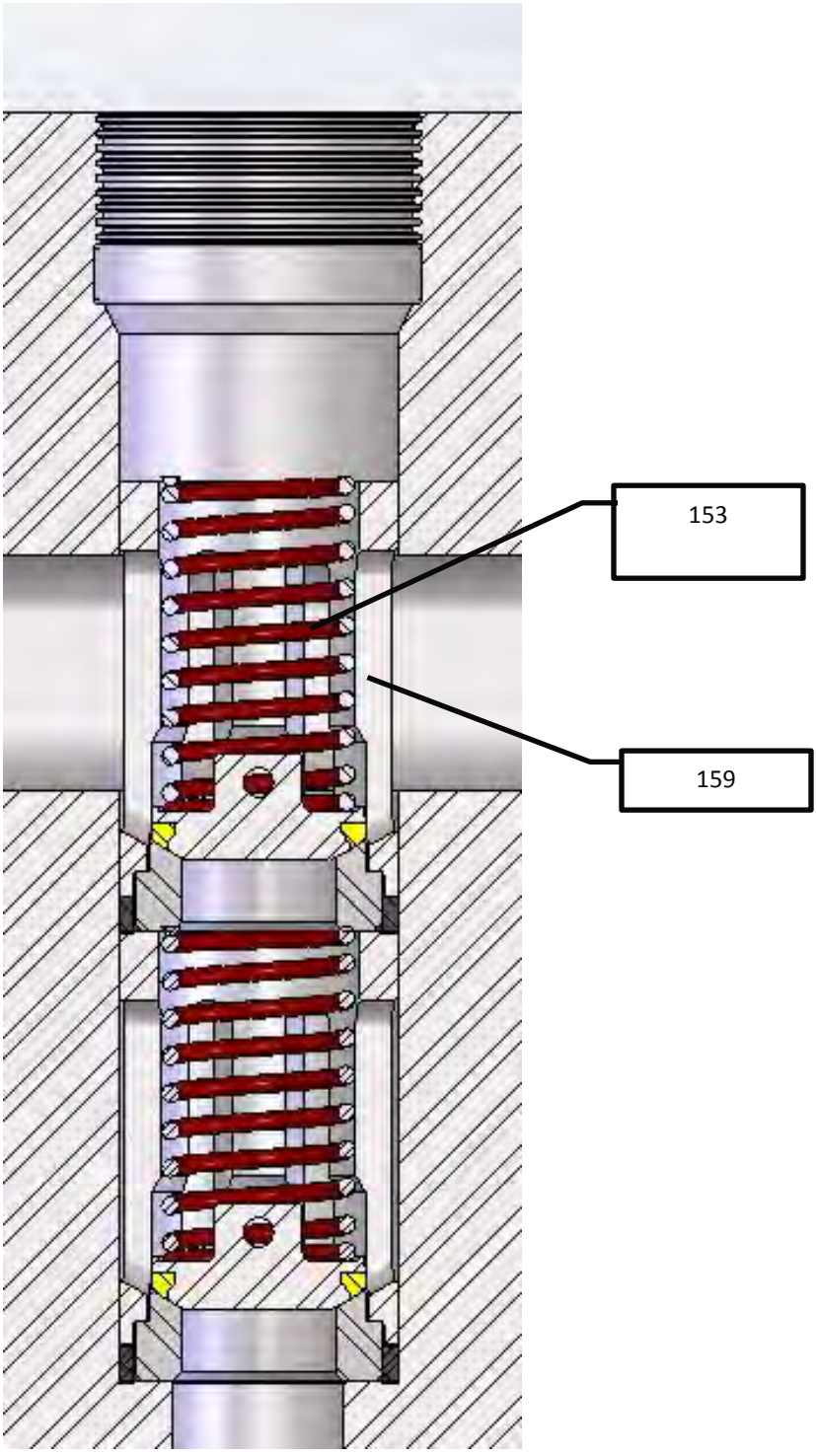



CORRECTLY INSTALLED CAGED SUCTION VALVE

5. Slip the second of two (2) valve seats into the bore on top of the seal (Item 626) and valve cage. Slip the second of two (2) valve bodies with urethane on to the top of the valve seat.

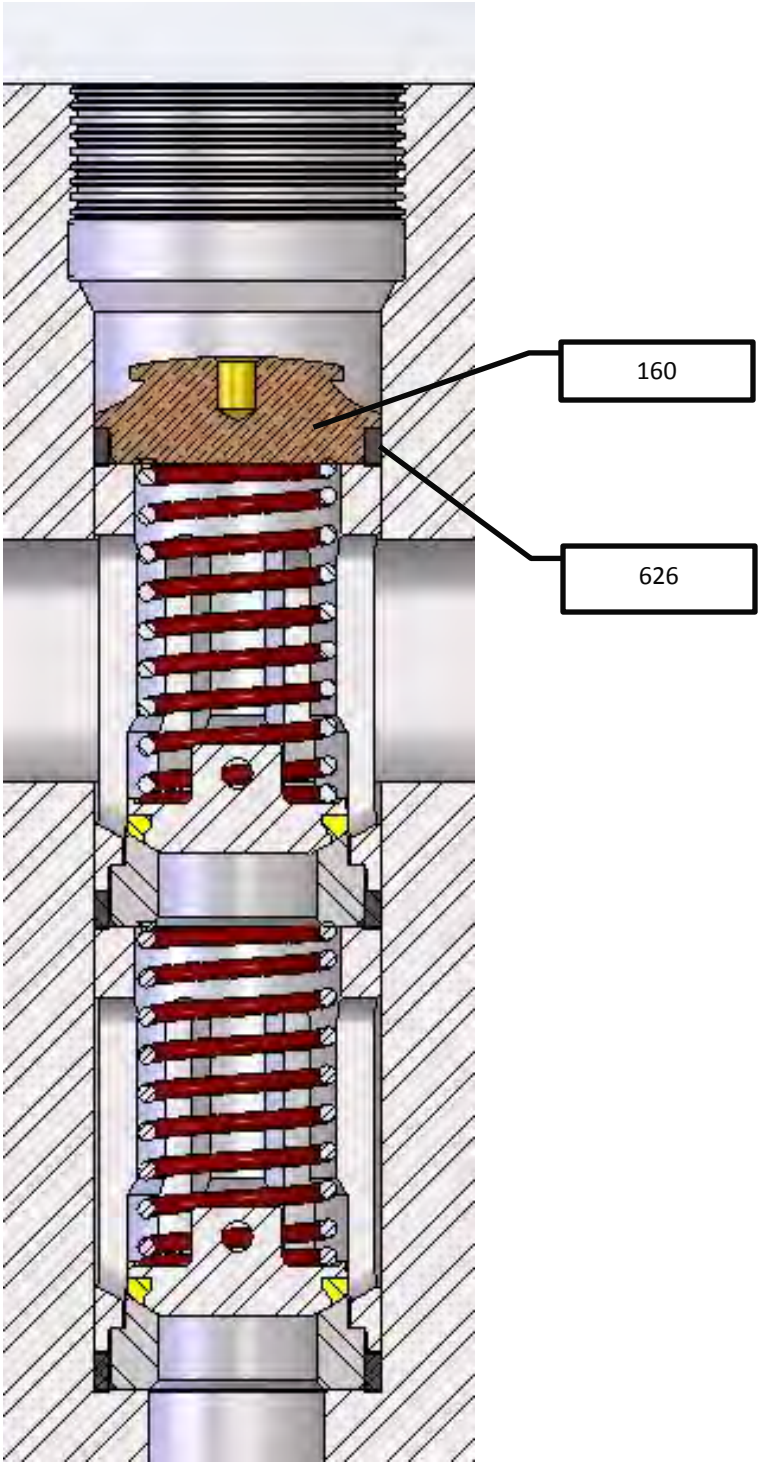


6. Insert the second of two (2) valve cages and push down to the top of the discharge valve seat. Slip the second of two (2) valve springs to the top of the valve body.

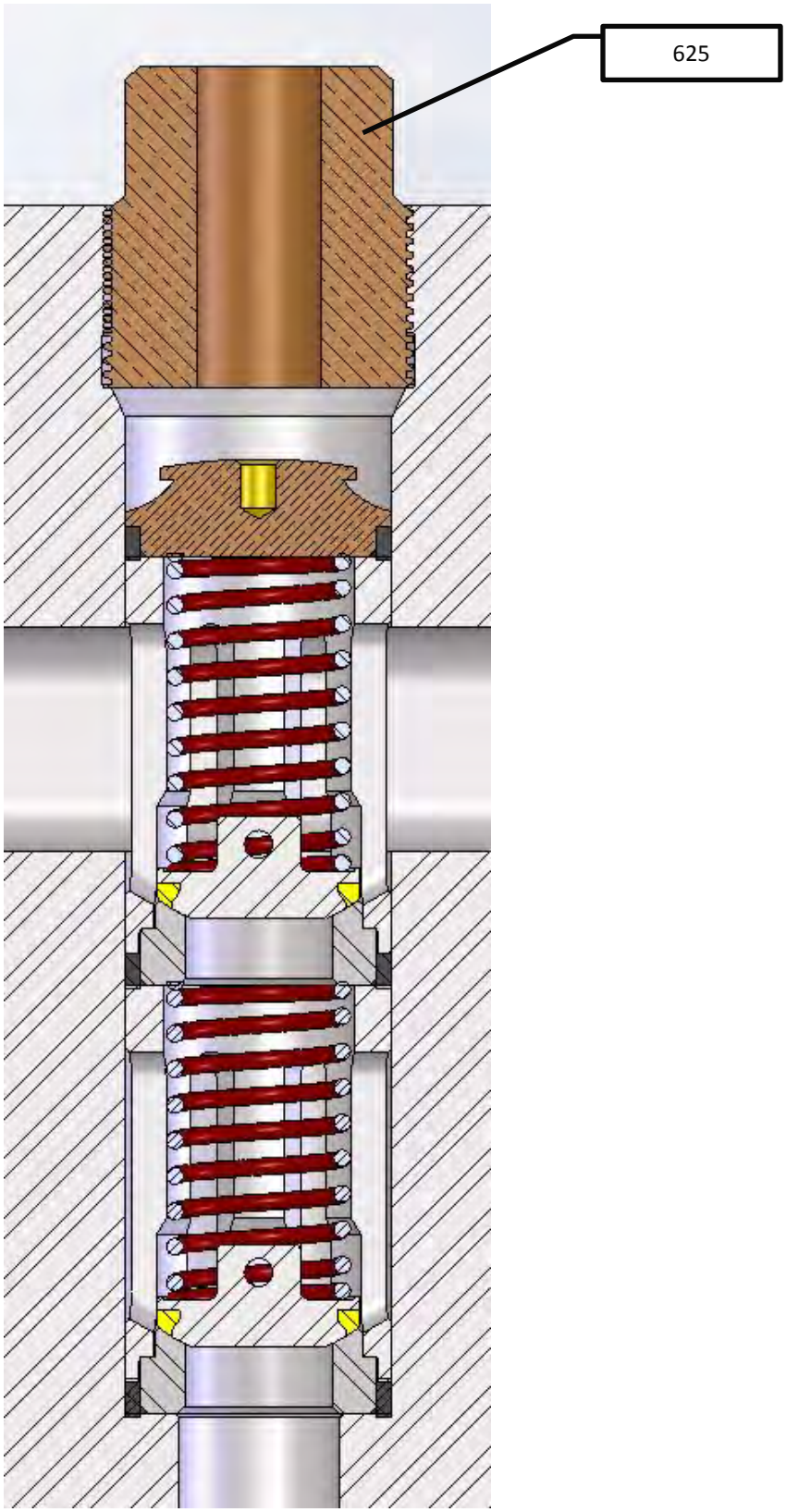



CORRECTLY INSTALLED CAGED DISCHARGE VALVE

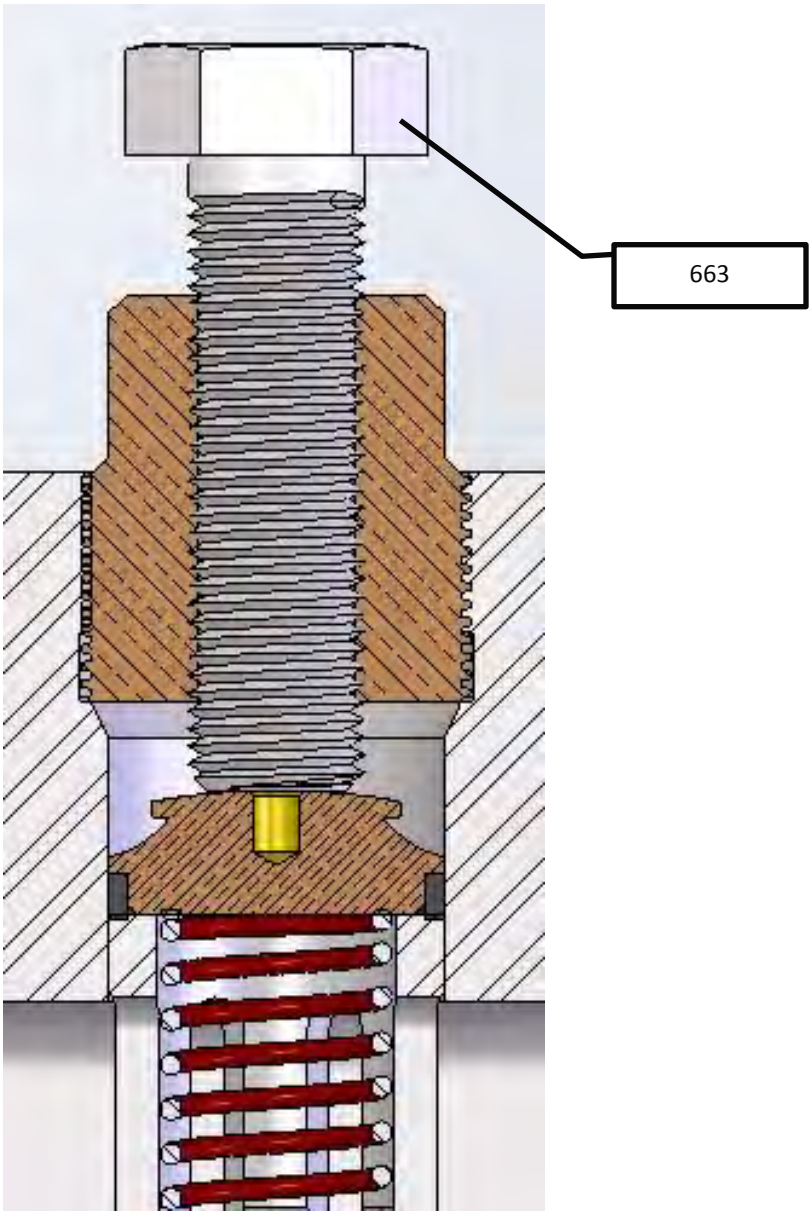
7. Insert valve cage retainer (Item 160) and seal (Item 626) on top of valve cage. Apply a small amount of grease to the seal to aid in assembly.



8. Screw valve cover (Item 625) into fluid end.

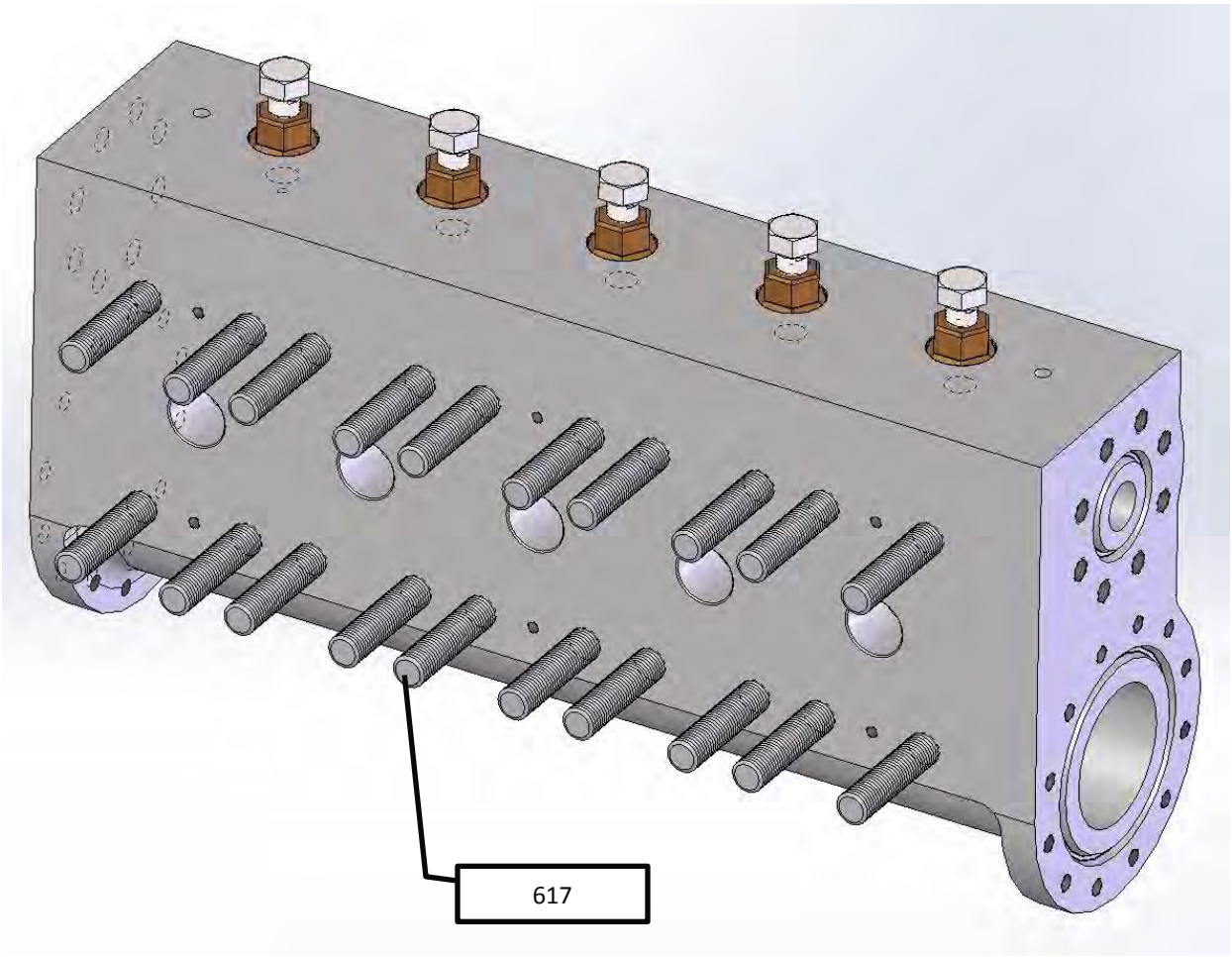


9. Screw cage loading screw (Item 663) into valve cover and torque 900 ft-lbs dry or 735 ft-lbs lubricated ( K-factor = .15).




10. Repeat these steps for all five (5) valve bores.

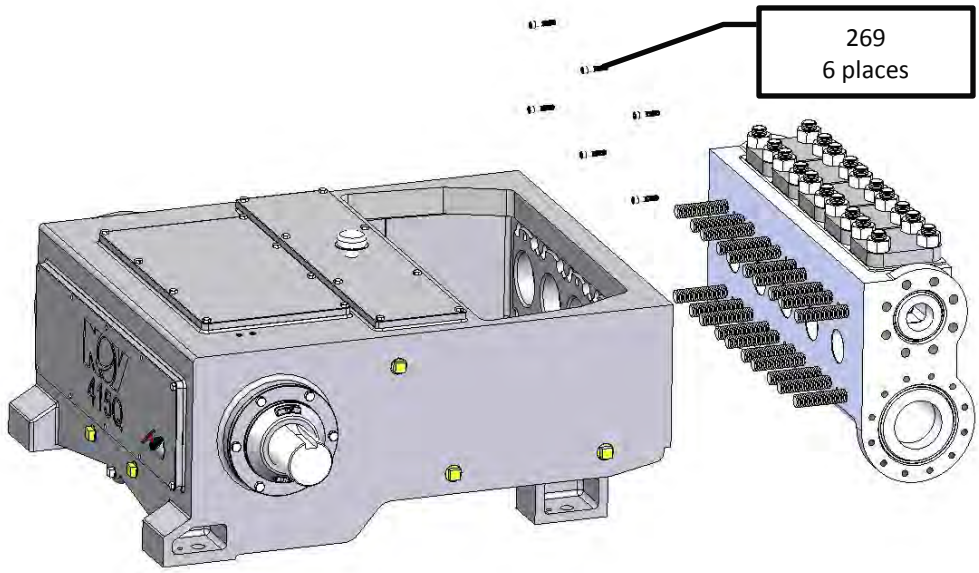
11. Install the twenty (20) fluid end studs (Item 617) with medium strength thread locker into the fluid end. The studs should extend outside the fluid end by approximately 5 ½”.



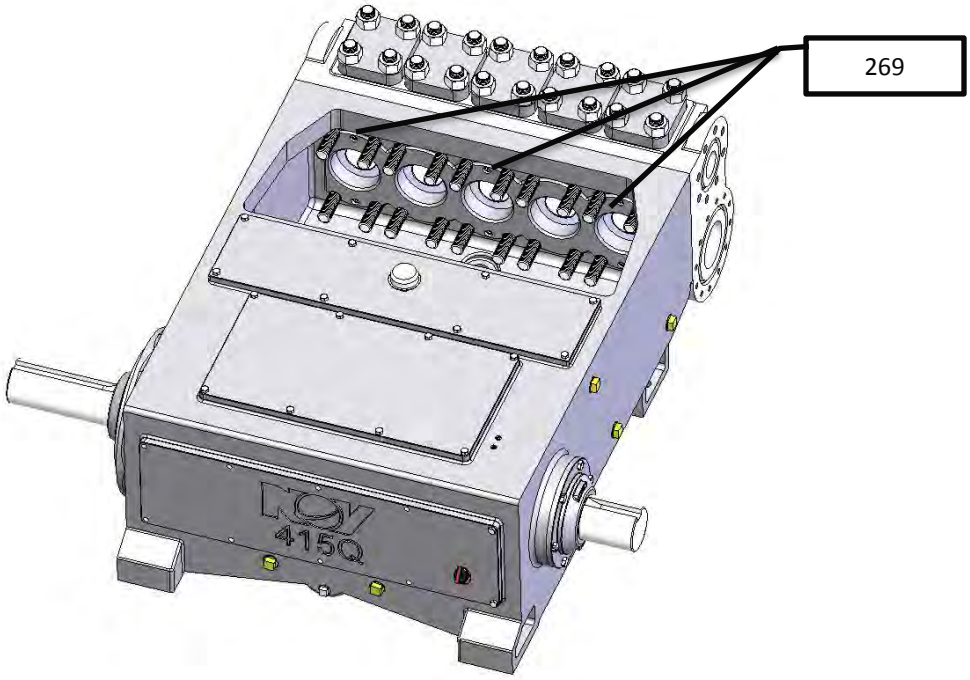

12. The H Fluid End is now assembled and ready to mate up to the power end assembly.

# FLUID END ASSEMBLY – MATING TO POWER END

1. Position the fluid end assembly against the mount end of the power end assembly. Screw in the six (6) socket head cap screws (Item 269).

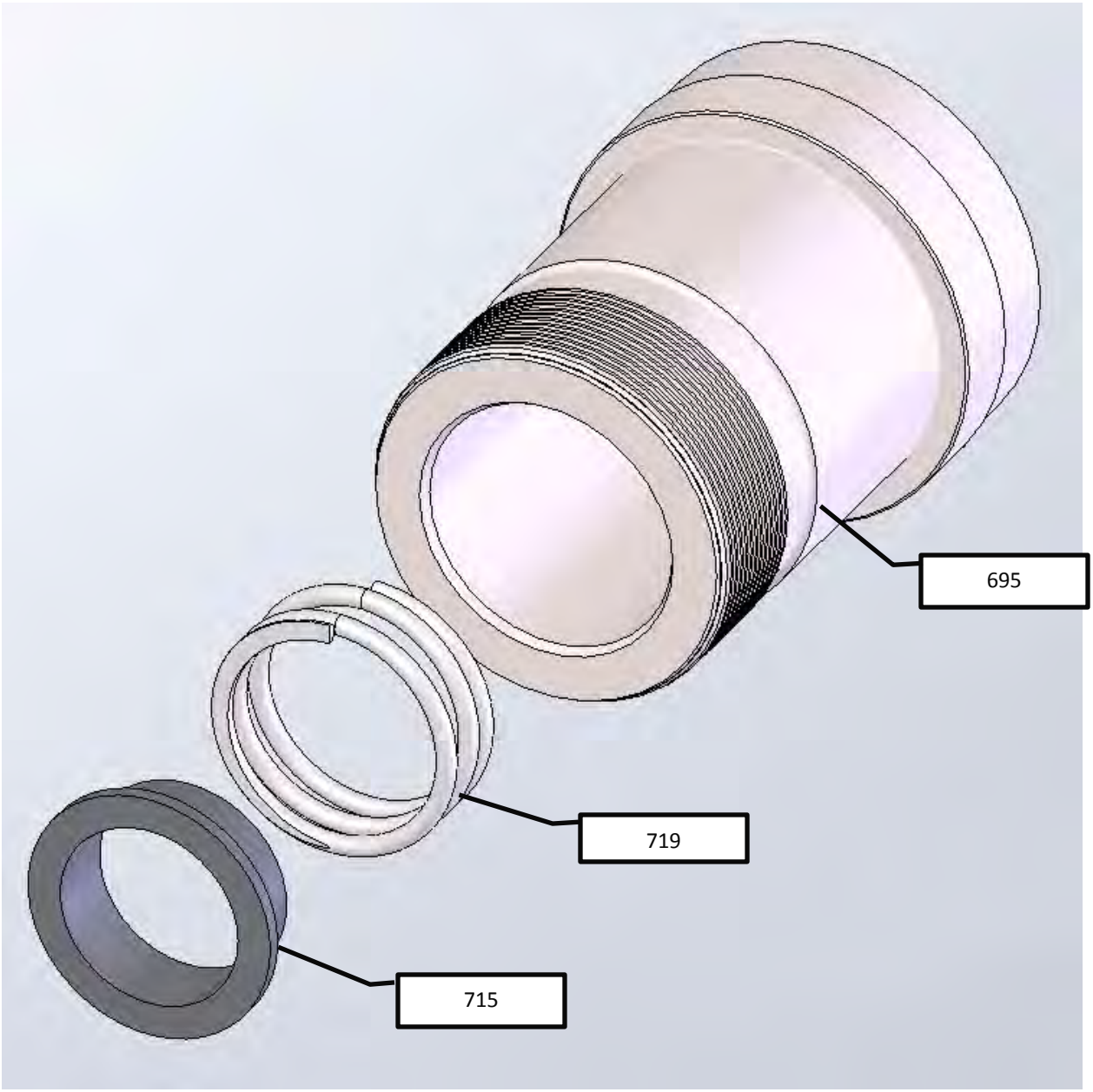



2. The assembled unit is now ready to install the stuffing boxes.

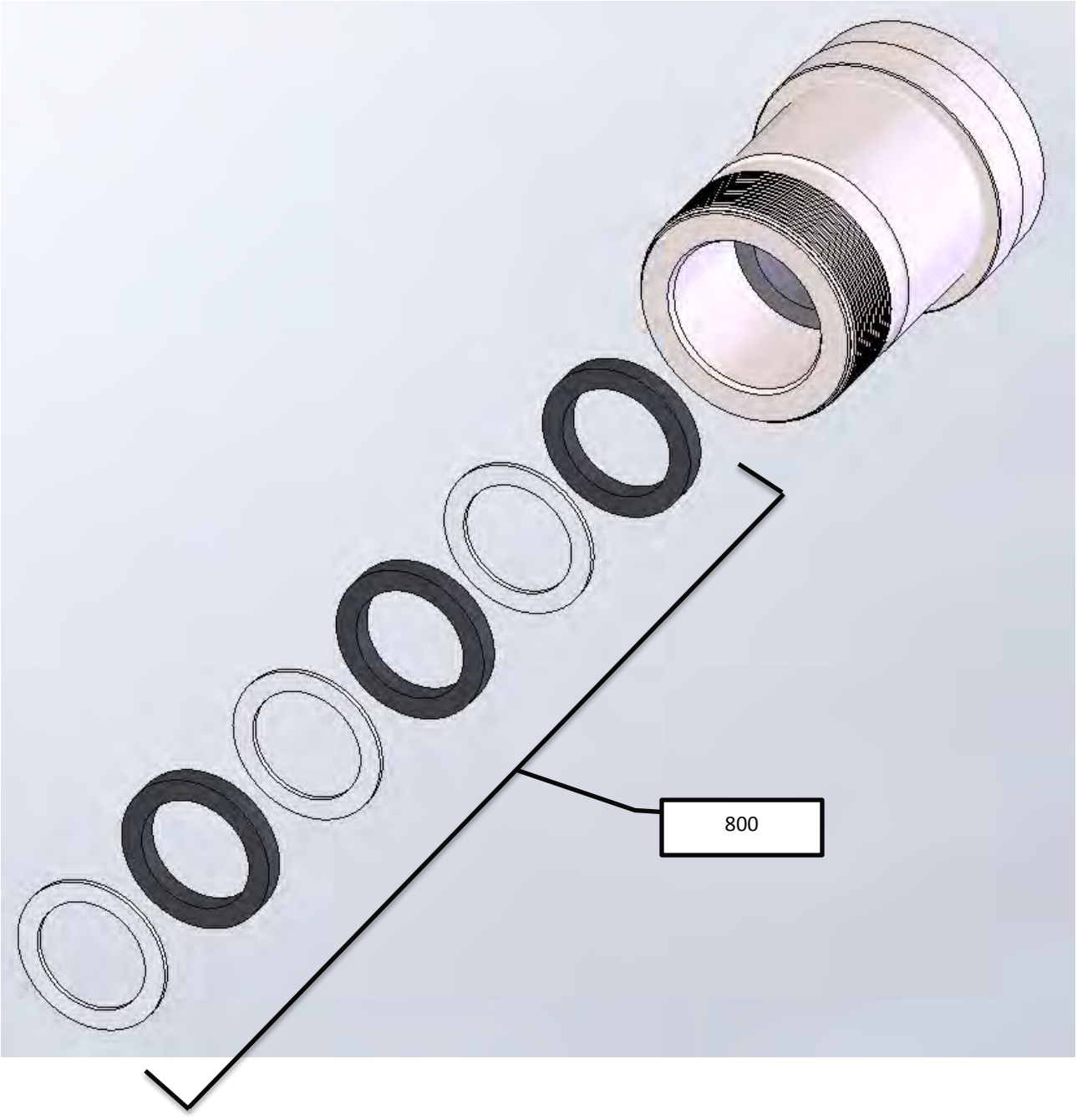


# STUFFING BOX ASSEMBLY – SPRING LOADED BRAIDED PACKING

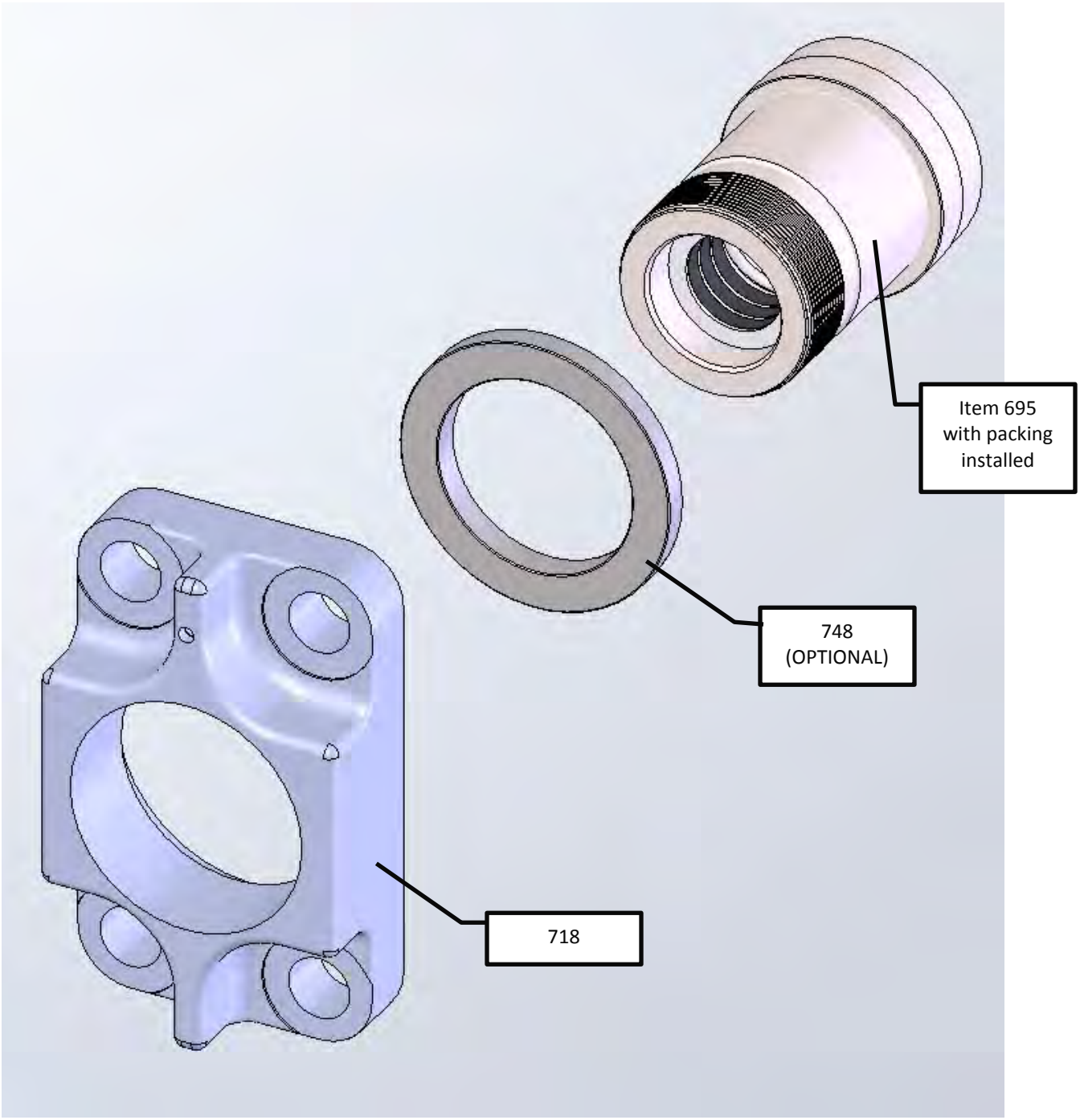
1. Insert the packing spring and the spring follower into the stuffing box (Item 695) as shown in the image below. Make sure all parts are clean and free of dirt and debris that can inhibit assembly and proper sealing. Refer to drawing 1716895 for an exploded view for reference.



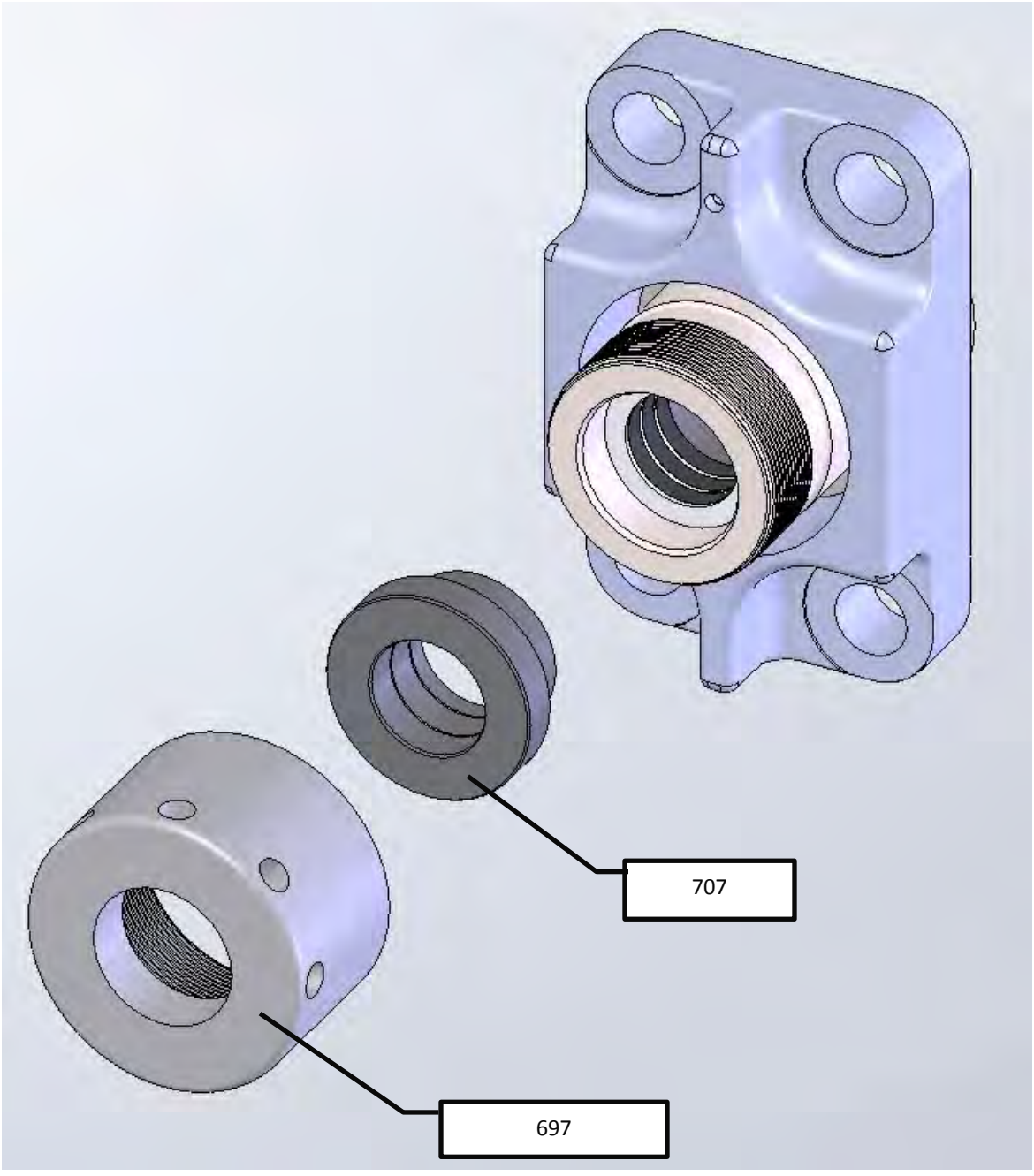
2. After lubricating packing components, insert the braided packing and packing spacers into the stuffing box and slide down to the top of the spring follower as shown. **NOTE: Pay attention to order of the parts.**



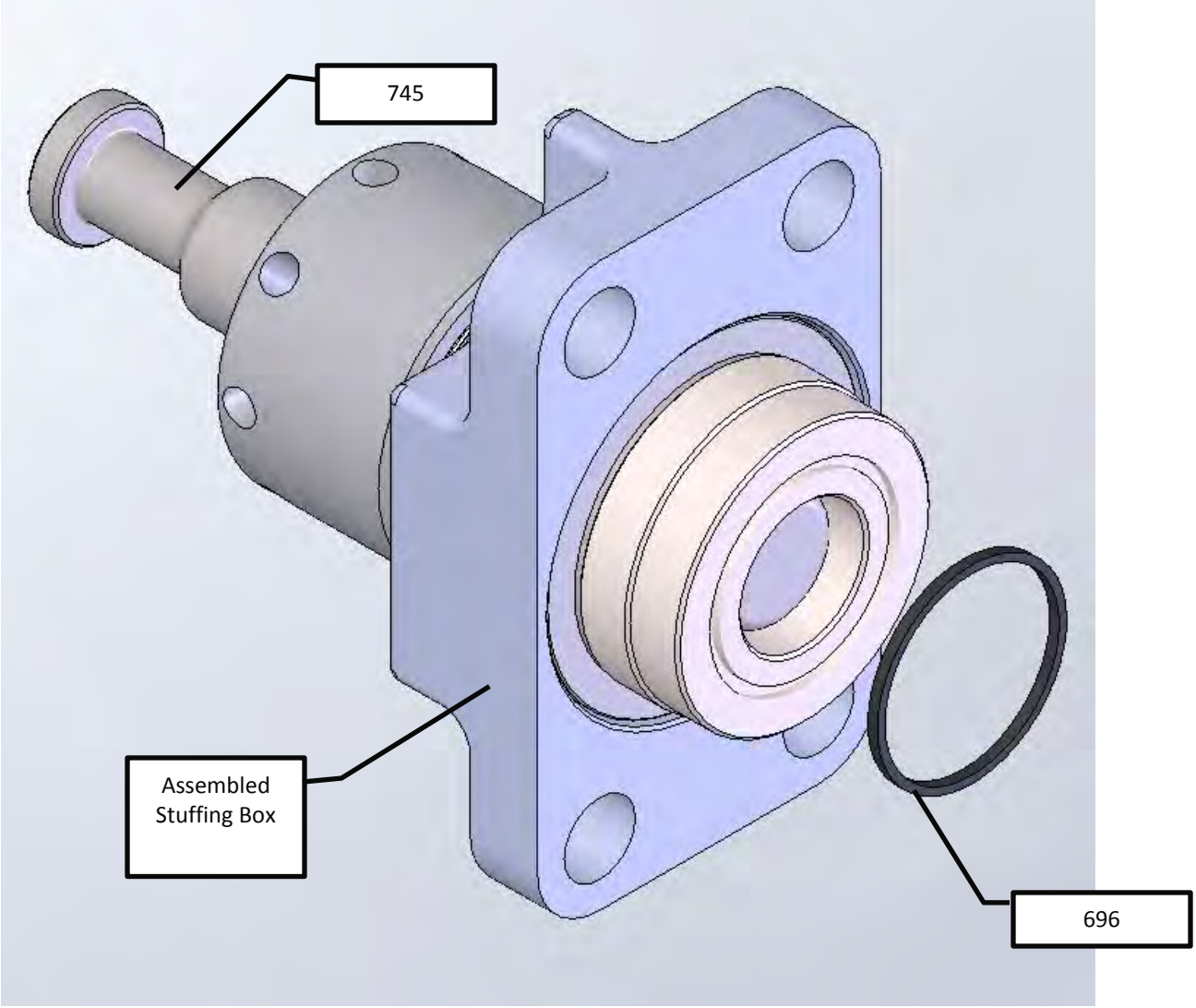
3. Slide the adapter ring (item 748) and stuffing box retainer (Item 718) over the long end of the stuffing box and push down until adapter ring (Item 748) bottoms out. Note: Not all stuffing boxes use an adapter ring.



4. Slide the gland (Item 707) into bore of stuffing box and then screw adjusting nut (Item 697) onto stuffing box. **Do NOT tighten.**

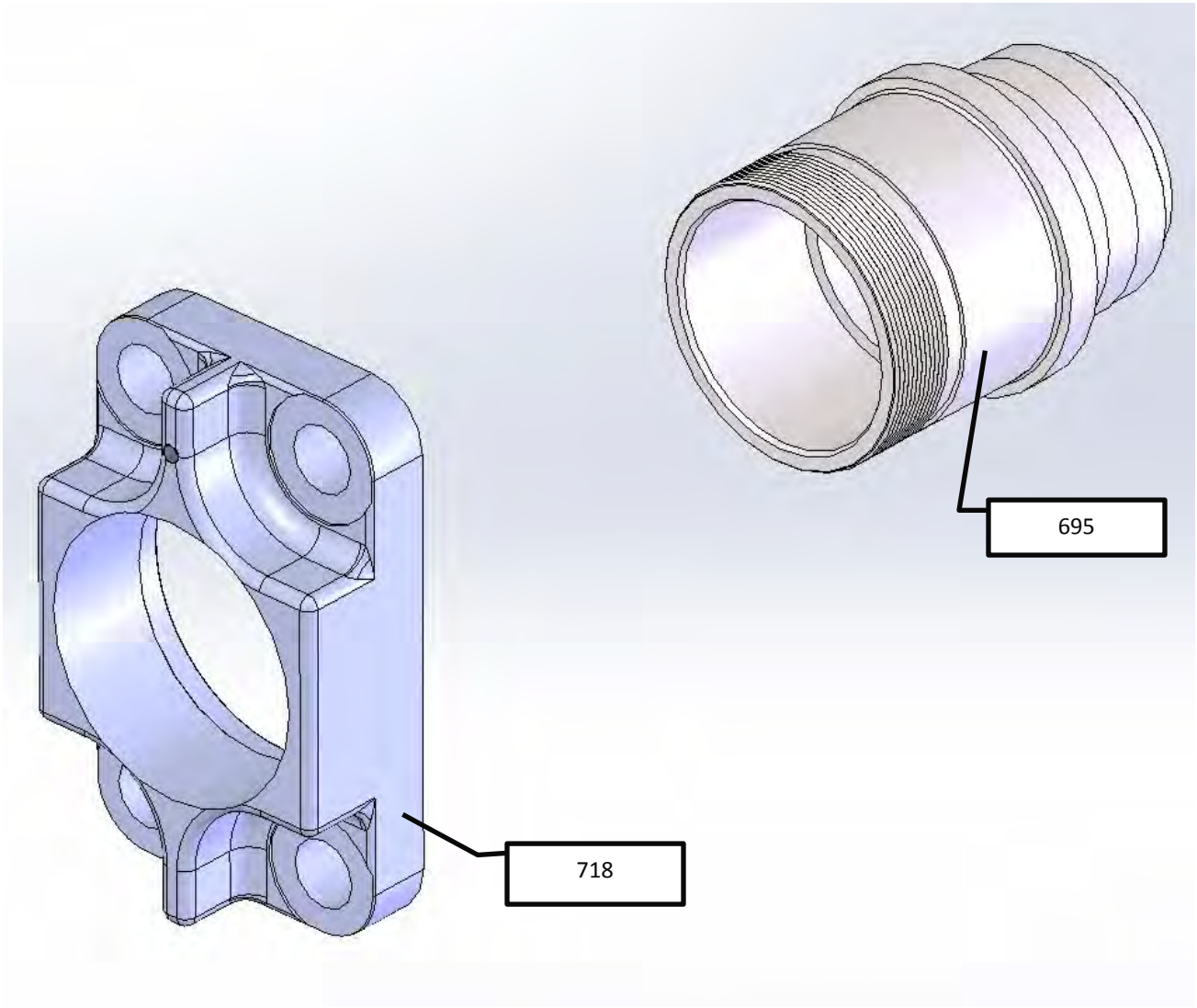


5. Using grease, place the stuffing box o-ring (Item 696) in the groove on the back of the stuffing box. Insert the plunger (Item 745) into the stuffing box as shown. The stuffing box is now ready to be installed in the power frame cradle. Complete these steps for all five (5) stuffing boxes.

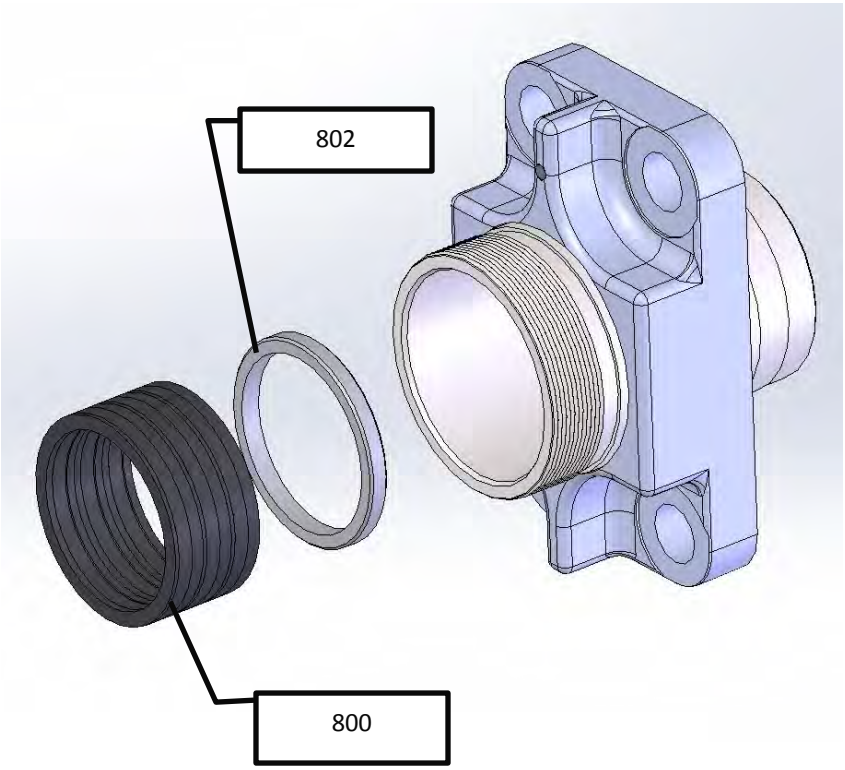


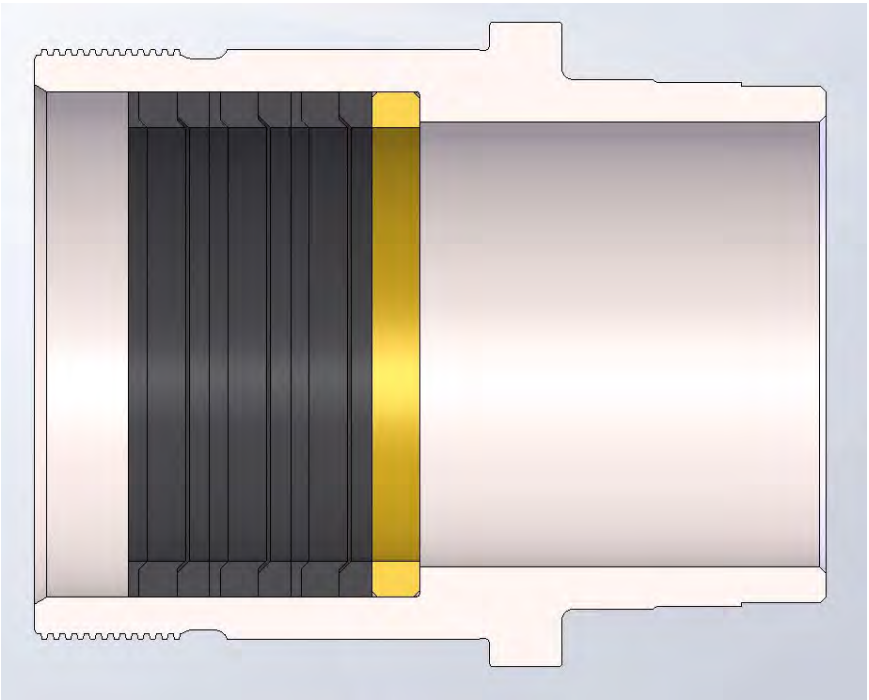
# STUFFING BOX ASSEMBLY – NON-ADJUSTABLE LIP STYLE PACKING

1. Slip the stuffing box retainer (Item 718) onto the stuffing box (Item 695).



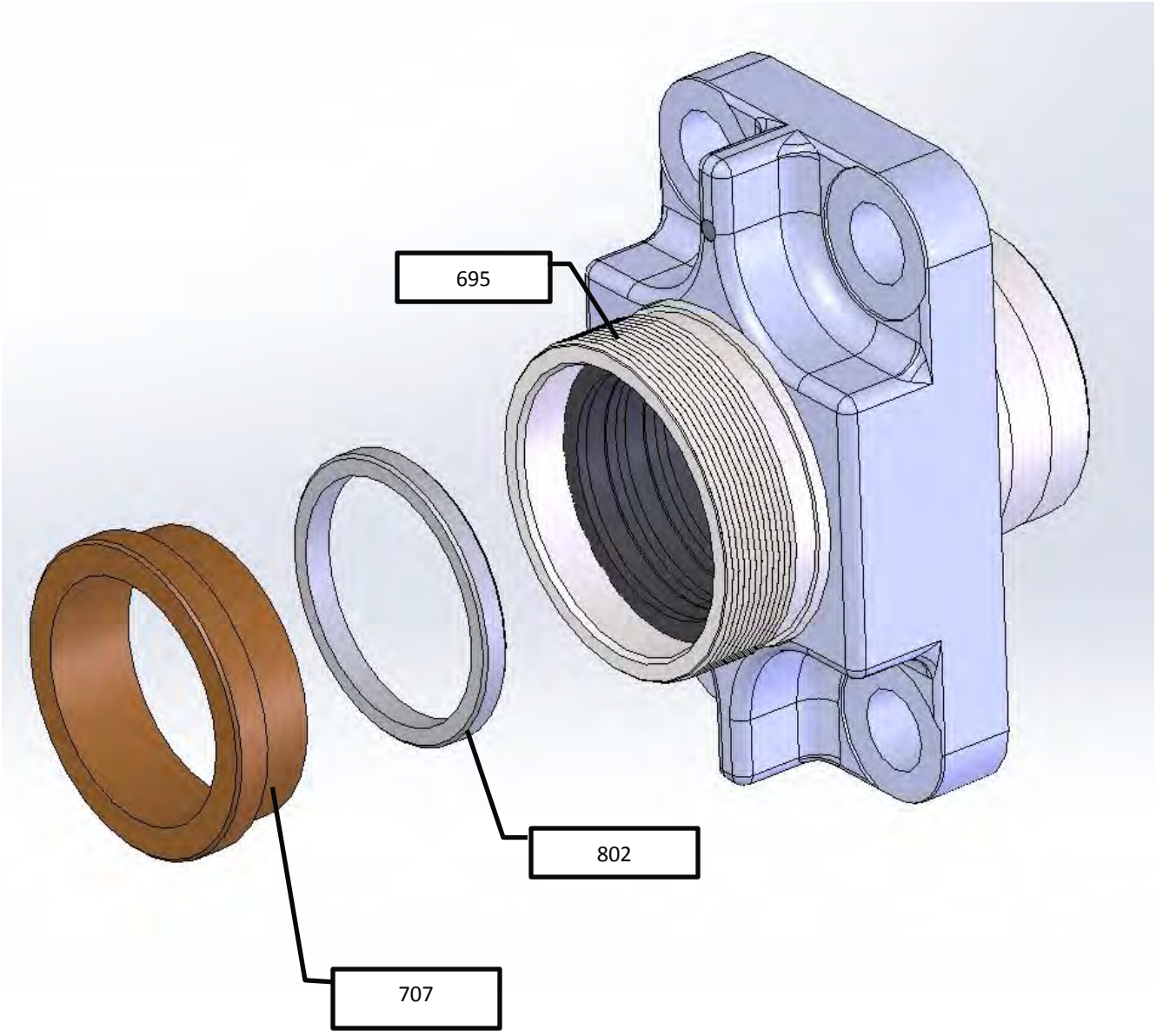
2. After lubricating packing components, insert the packing washer (Item 704) and packing into the stuffing box (Item 695) and push down to the bottom of the counterbore. **WARNING: Order of the packing rings critical to proper sealing of plunger. Refer to cross section below.**



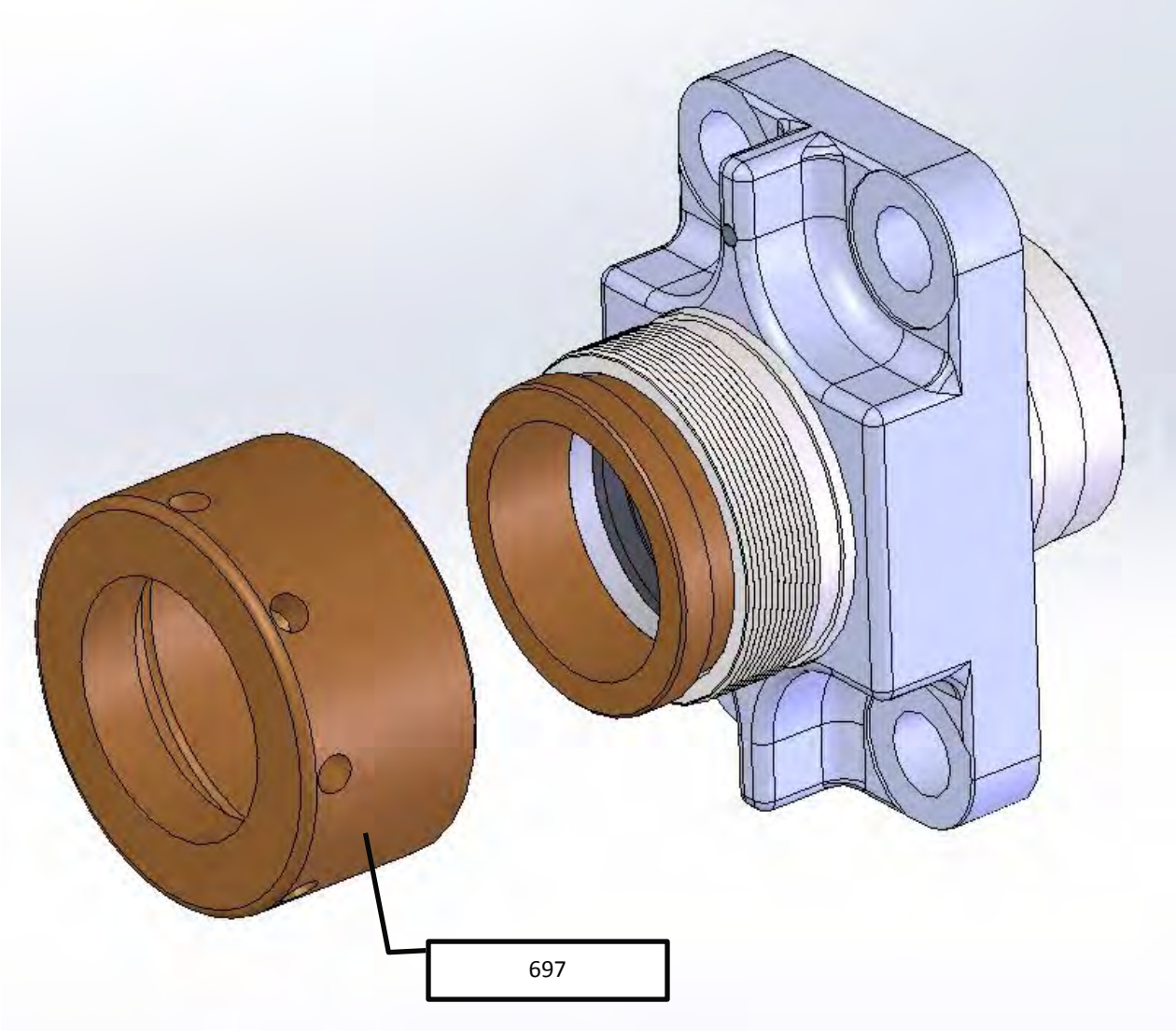



CRITICAL: NOTE ORIENTATION OF PACKING RINGS

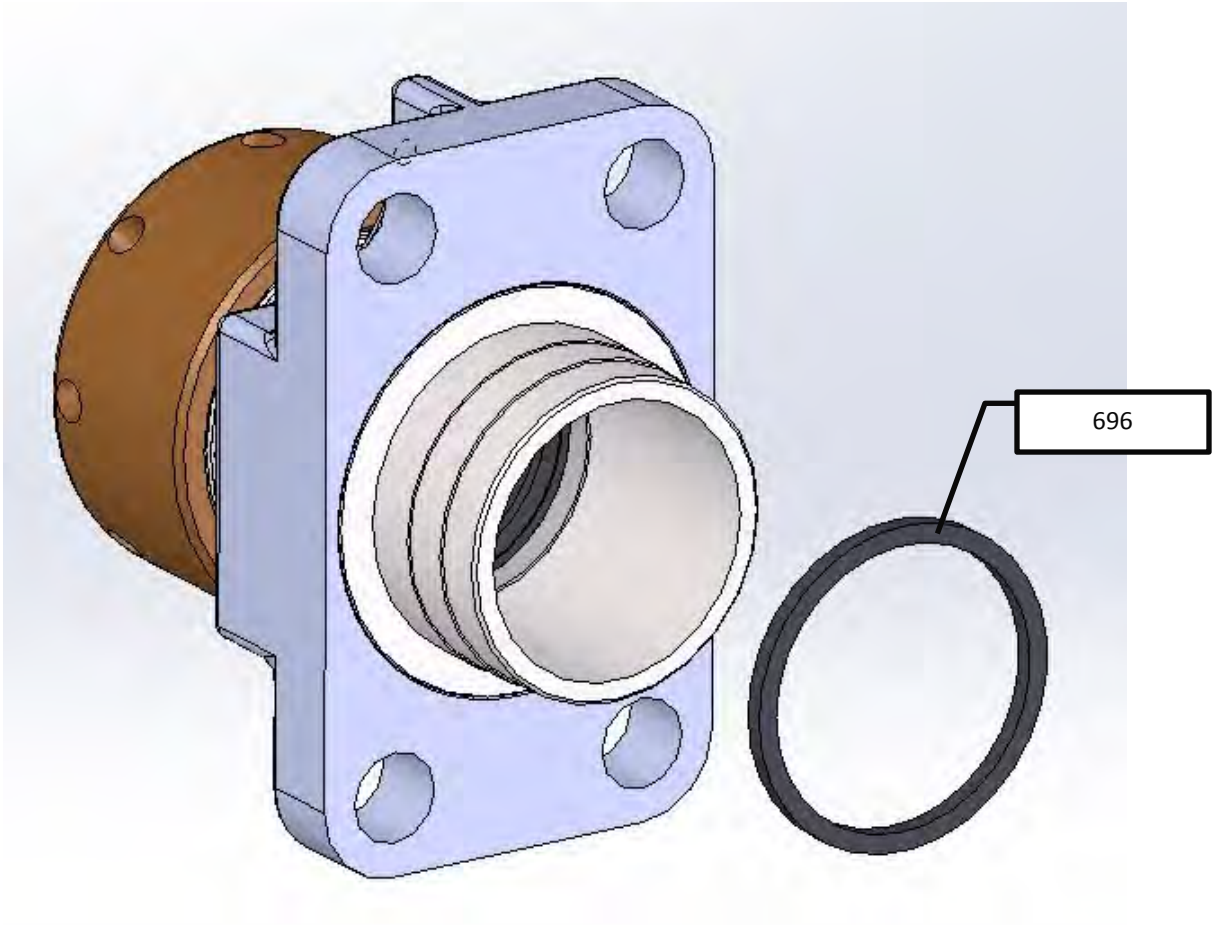
3. Slip the second packing washer (Item 802) and gland (Item 707) into the stuffing box (Item 695).



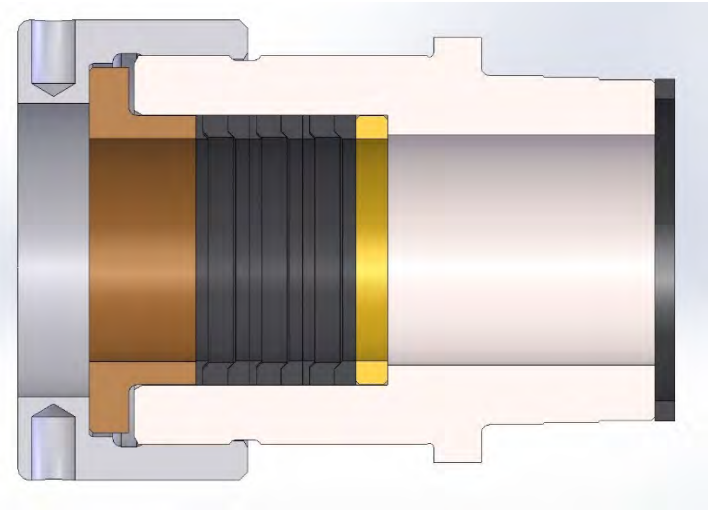
4. Hand tighten the adjusting nut (Item 697) onto the stuffing box (Item 695). Do NOT overtighten.



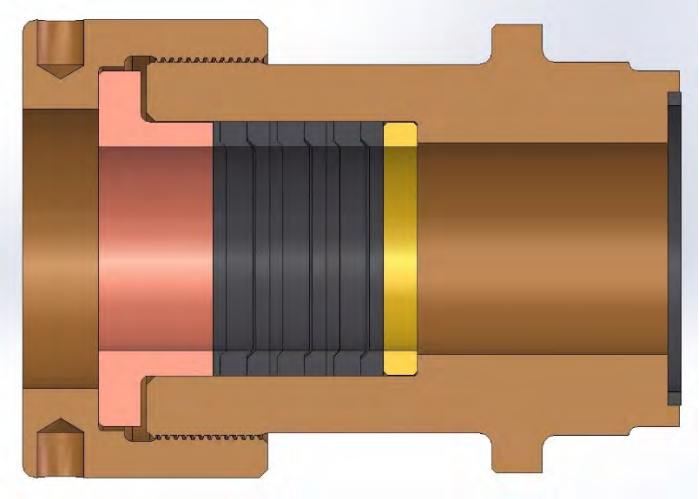
5. Keep o-ring seal (Item 696) with assembled stuffing box, it will be installed into the fluid end (item 85) when stuffing box is installed.



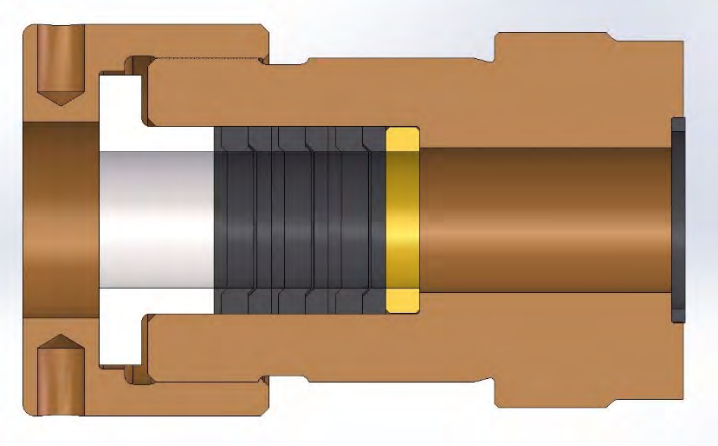
# STUFFING BOX ASSEMBLIES FOR 1045 JFD & 850-N UNIVERSAL PACKING



5” NATIONAL L CLASS STUFFING BOX ASSEMBLY

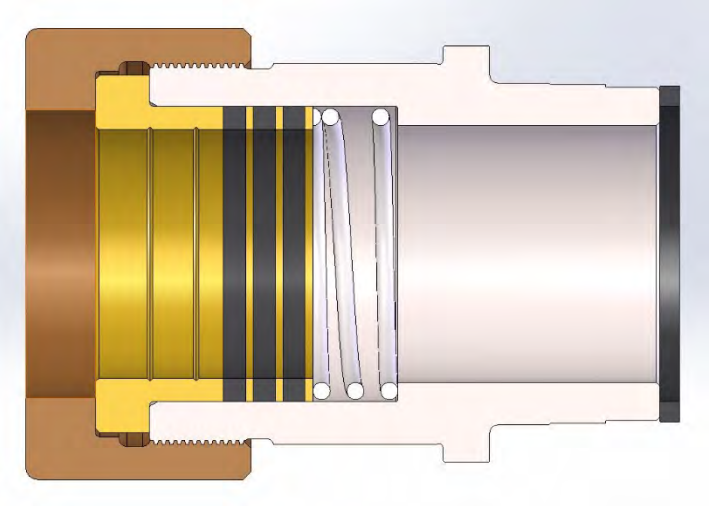


5” NATIONAL M CLASS STUFFING BOX ASSEMBLY

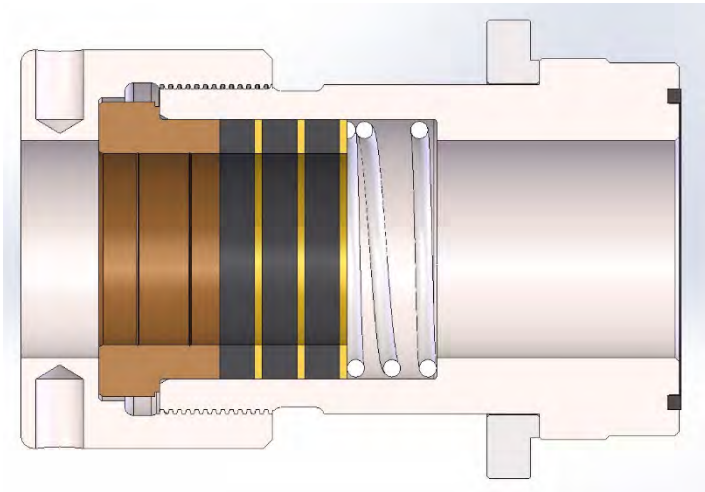


5” NATIONAL H CLASS STUFFING BOX ASSEMBLY

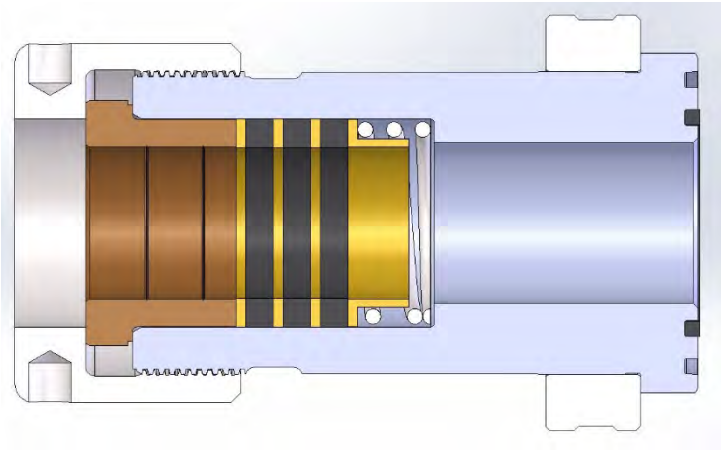
# STUFFING BOX ASSEMBLIES FOR KEVLAR PACKING



5” NATIONAL L CLASS STUFFING BOX ASSEMBLY



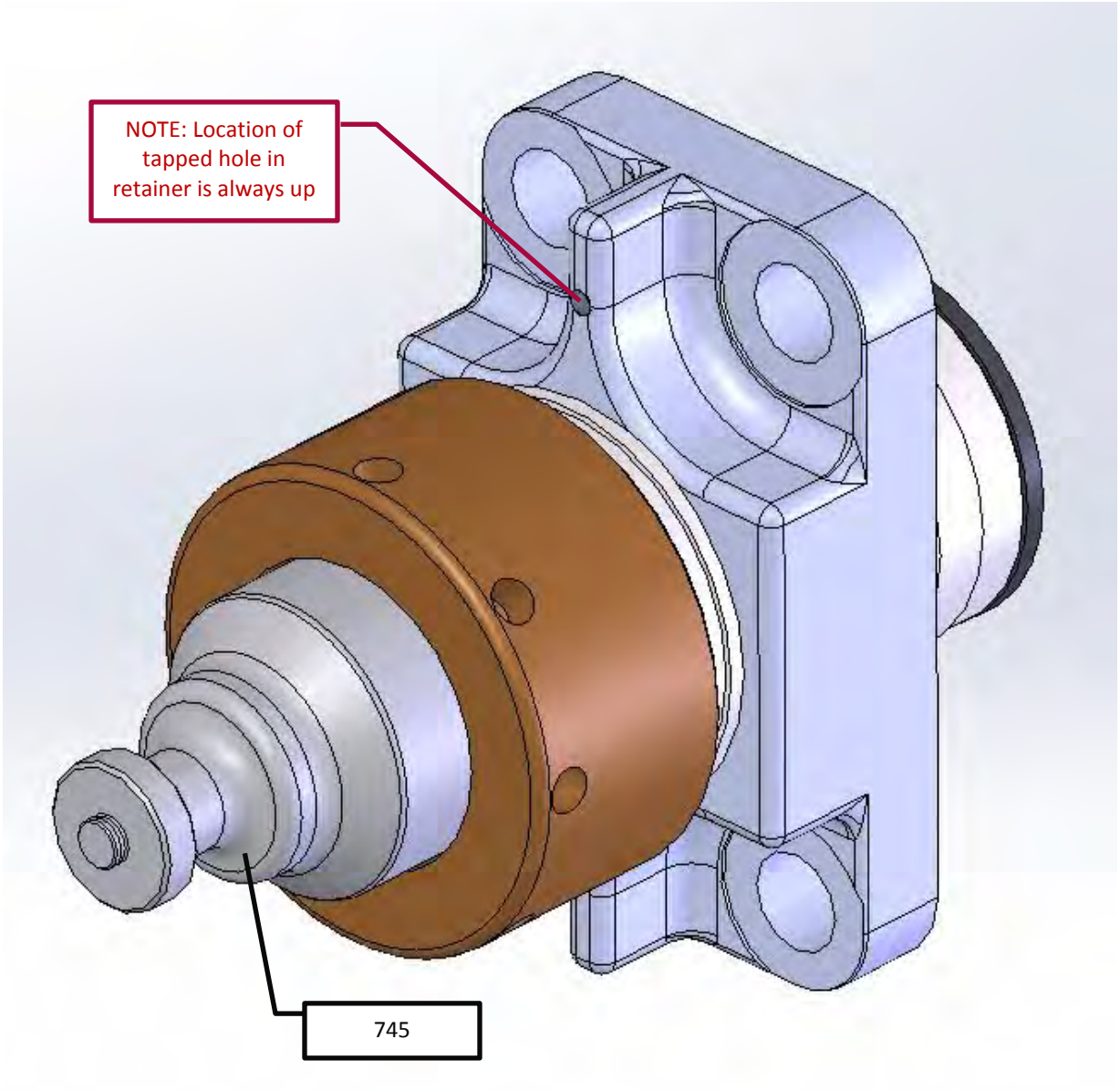
5” NATIONAL M CLASS STUFFING BOX ASSEMBLY



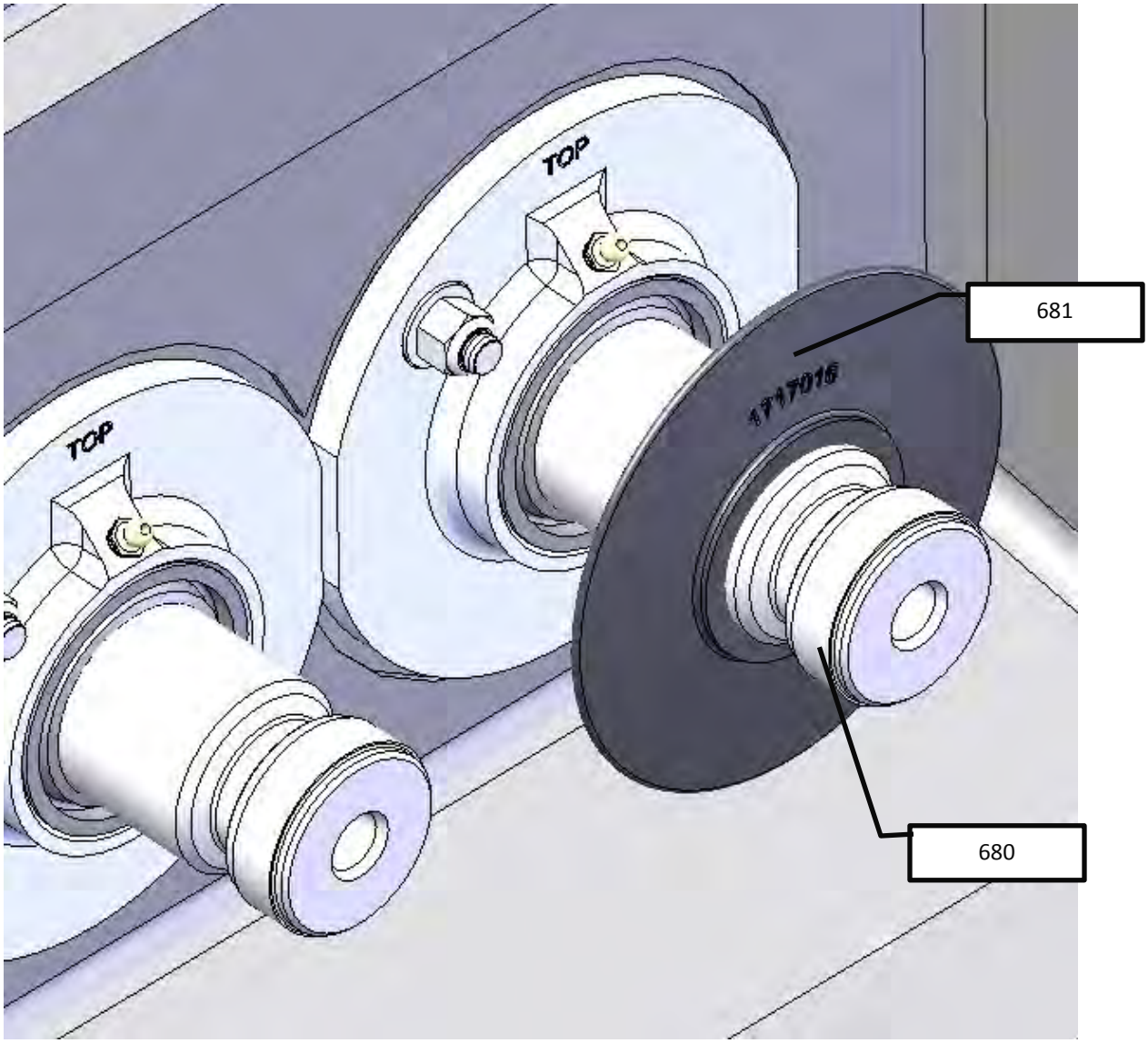
5” NATIONAL H CLASS STUFFING BOX ASSEMBLY

# STUFFING BOX ASSEMBLY WITH ASSEMBLED POWER FRAME

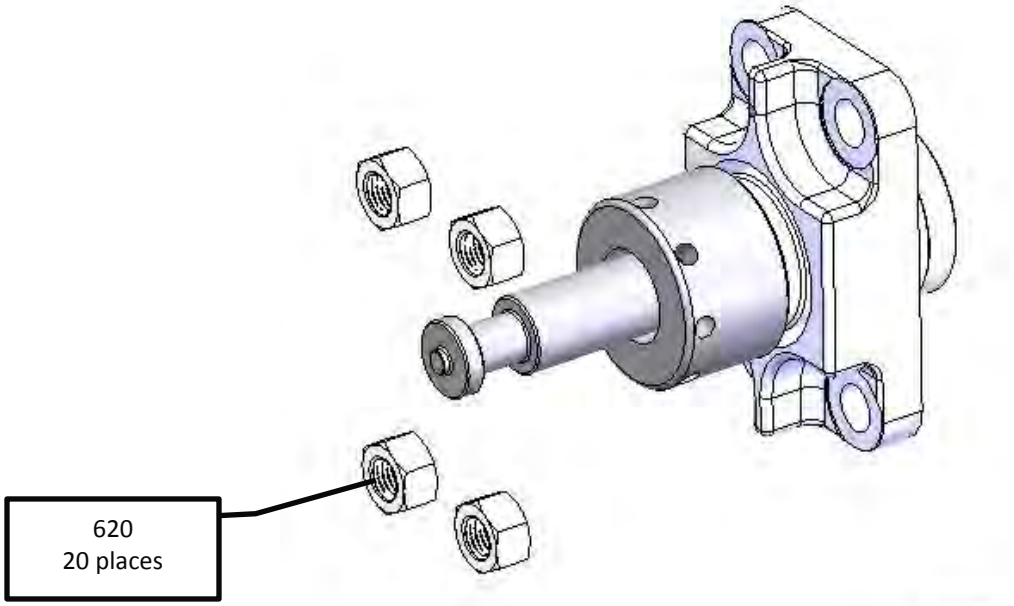
1. Coat the plunger (Item 745) with plunger lube and slip it into the packing for the stuffing box as shown below. Note the optional tapped hole is always oriented to the top of the stuffing box retainer.

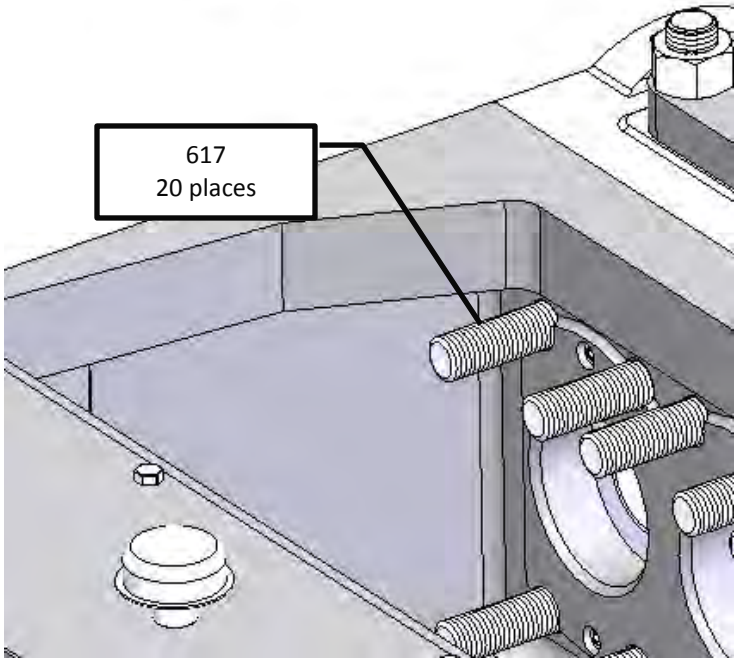


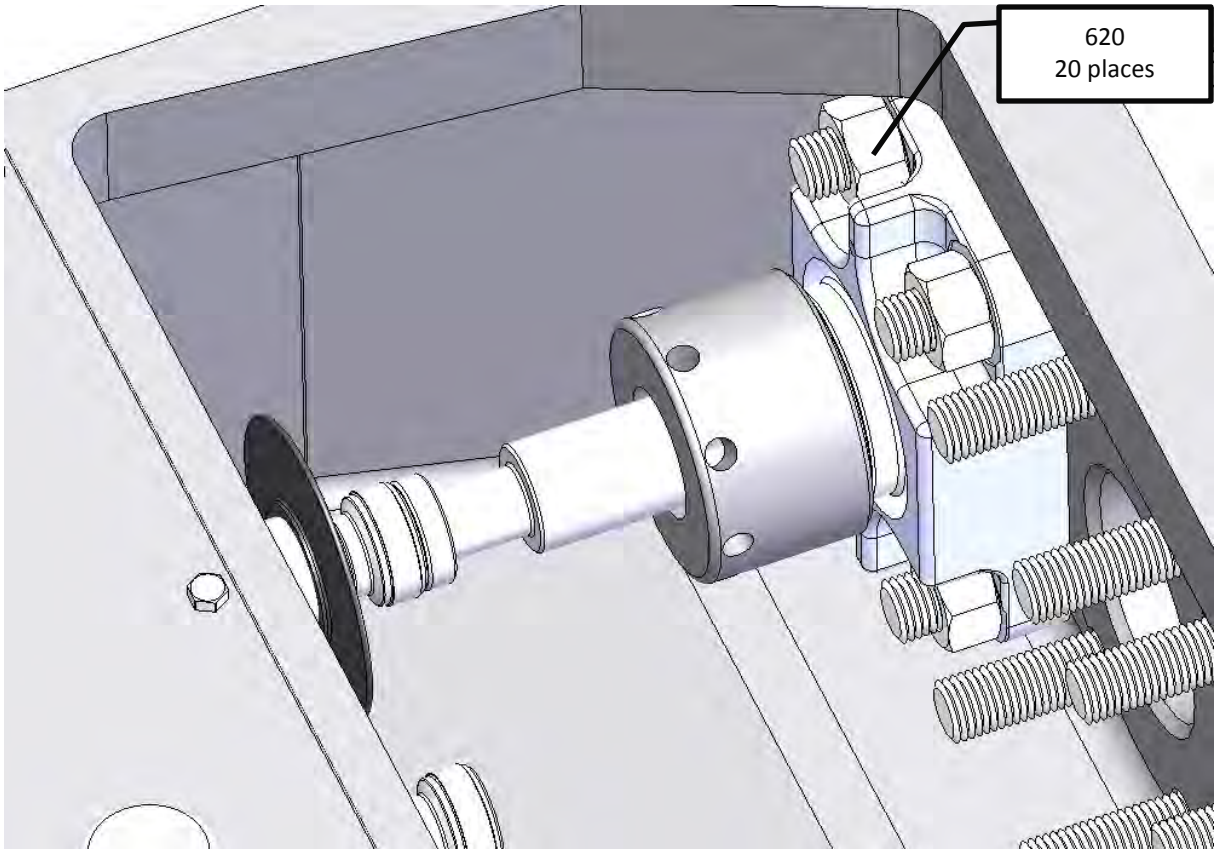
2. Slip the Intermediate rod baffle (Item 681) onto each intermediate rod (Item 680) as shown. Push them approximately ¾” onto the rod past the clamping area.



3. Lower the assembled stuffing box with plunger into the power frame cradle with fluid end mounted. Slip up onto power frame studs (Item 617) and finger tighten power frame hex nuts (Item 620). Rotate the crankshaft as needed during assembly to retract the intermediate rods (Item 680) back into the power frame to make room as needed. Repeat for all five (5) stuffing boxes. **NOTE: When inserting the stuffing box, make sure the seal (Item 696) is in the o-ring groove in the back of the stuffing box, or if the o-ring is loose, it is pushed into the counterbore on the fluid end. On L fluid ends it is critical to align the stuffing box outer diameter with counterbore of fluid end.**



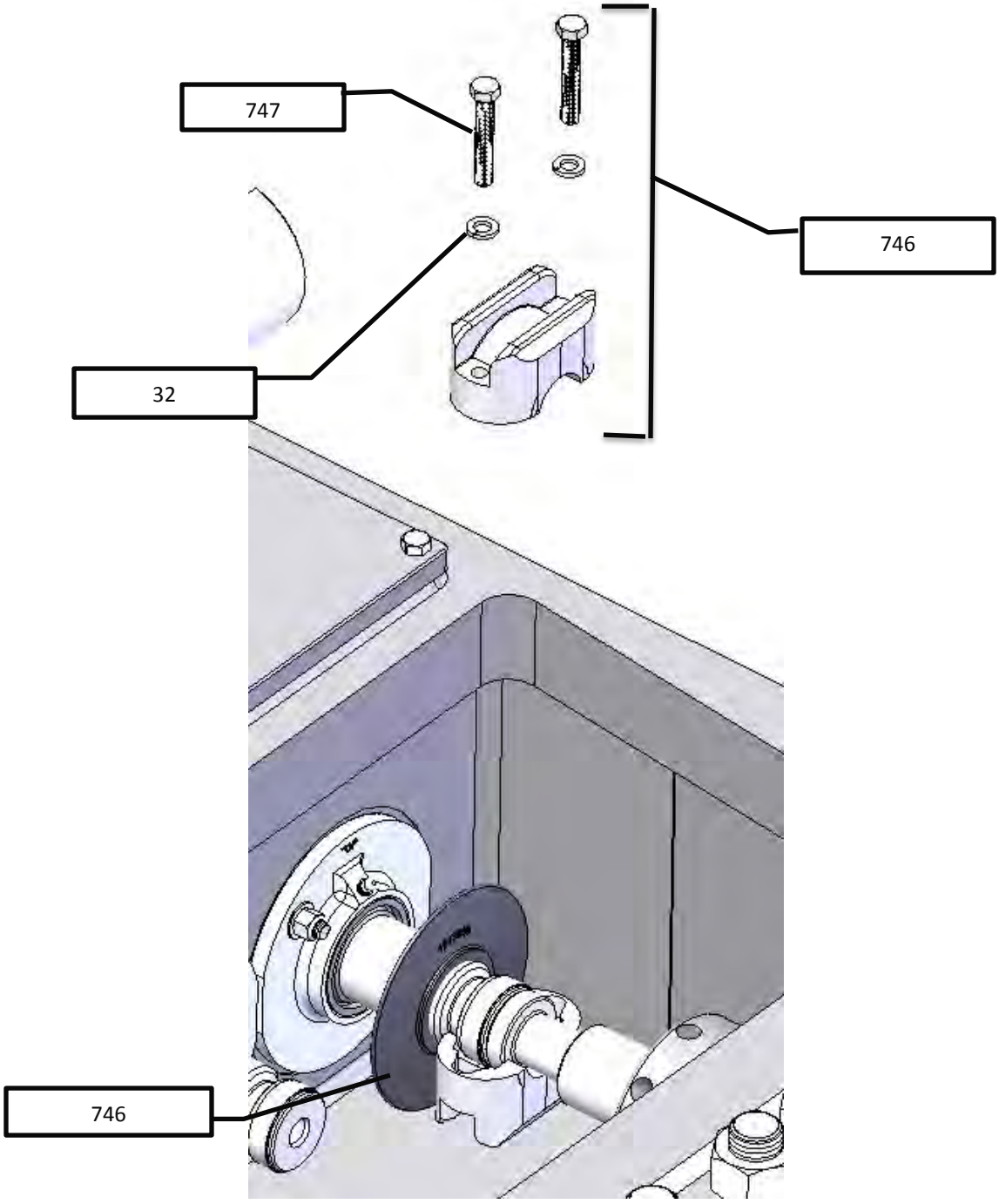


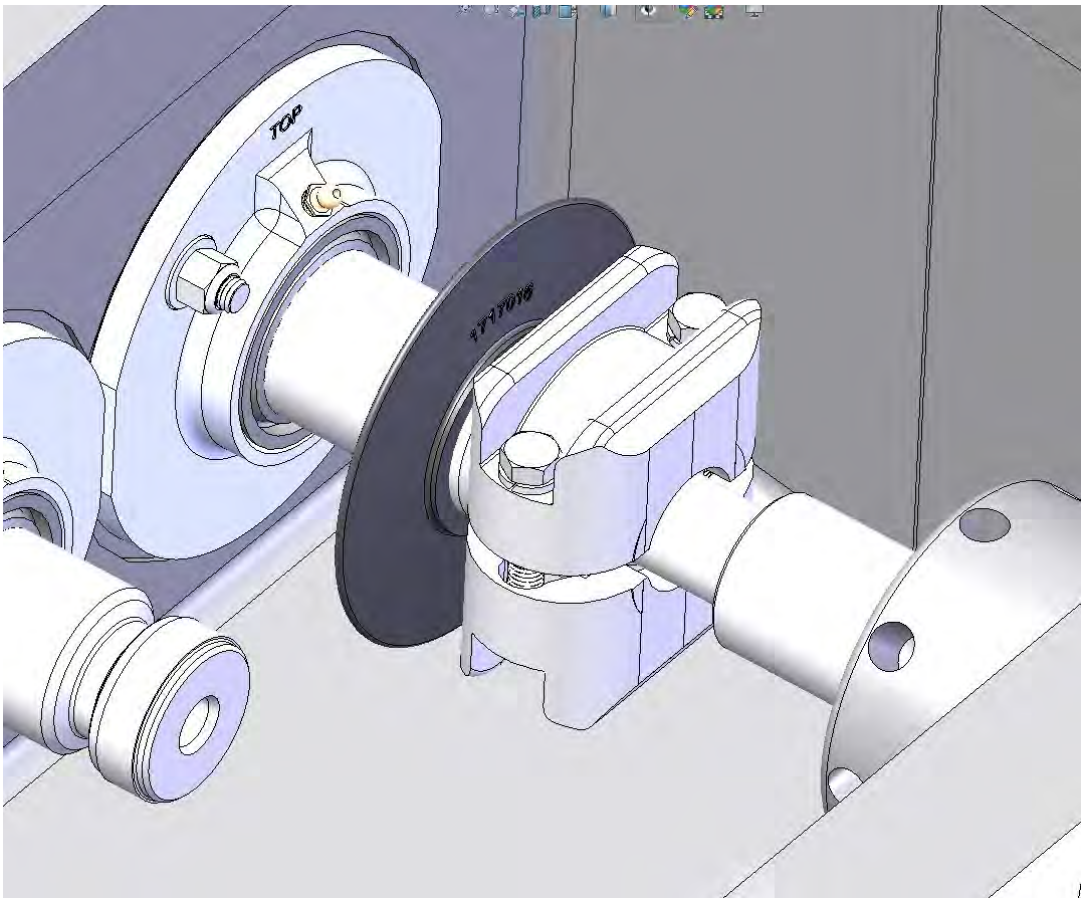

INSTALLED STUFFING BOX AND PLUNGER

4. When all five (5) stuffing boxes are completely installed, torque power frame hex nuts (item 620) to 640 ft-lbs.

# INSTALLATION OF PLUNGER CLAMP

1. Slip the lower plunger clamp half onto the bottom of the mated intermediate rod (Item 680) and plunger (Item 745). **WARNING: The Plunger has a flat side on its head and the Intermediate Rod has tapered side on its head. Align clamp half correctly.**
   Set the upper plunger clamp half on top of the mated plunger and intermediate rod. Screw the clamp halves together using the hex cap screws with lock washers. Tighten evenly. Torque plunger clamp (Item 913) bolts to 30 lb-ft (dry). **NOTE: A gap will appear between the plunger clamp halves when installed correctly. The gap should be even side to side.**

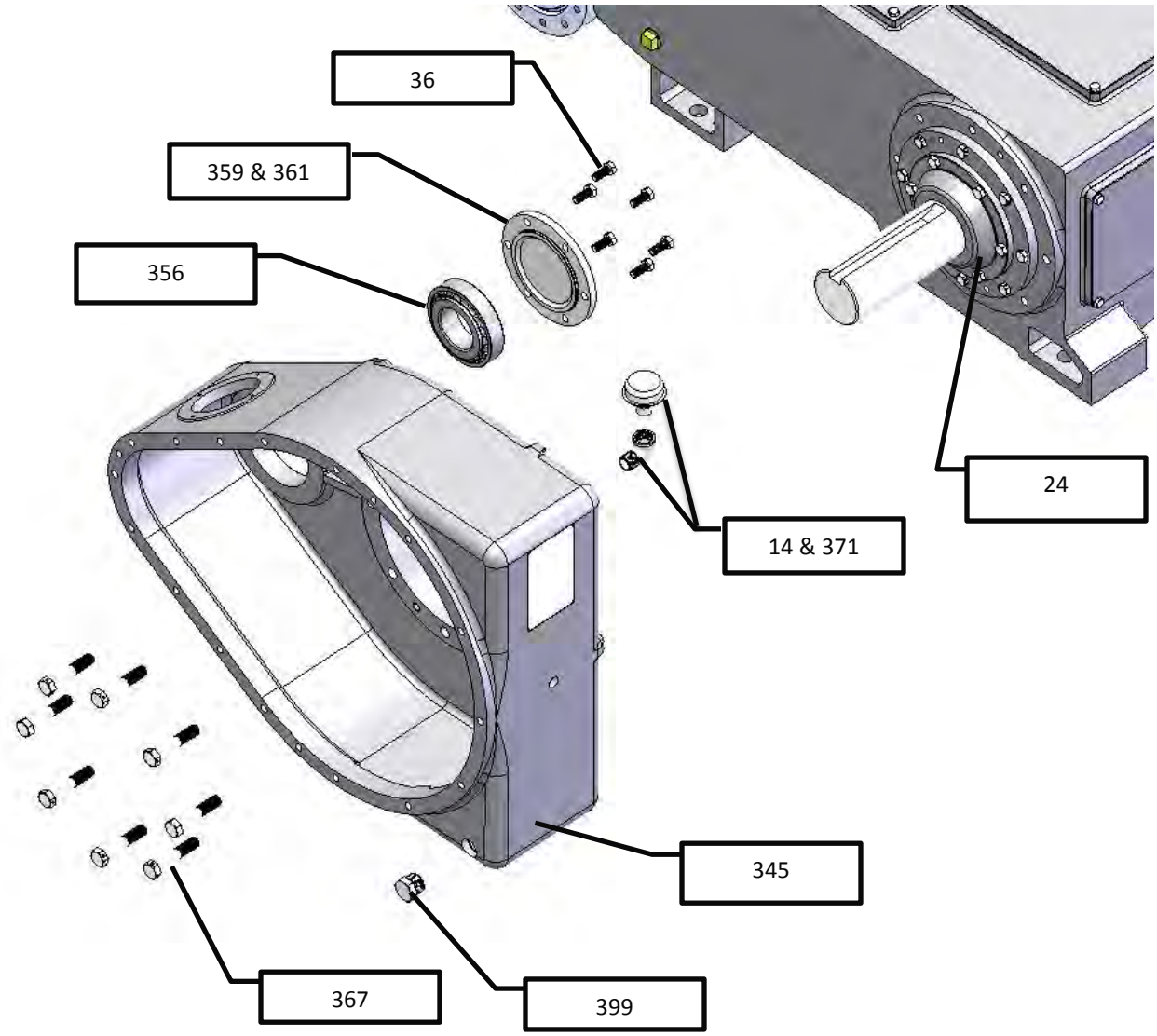




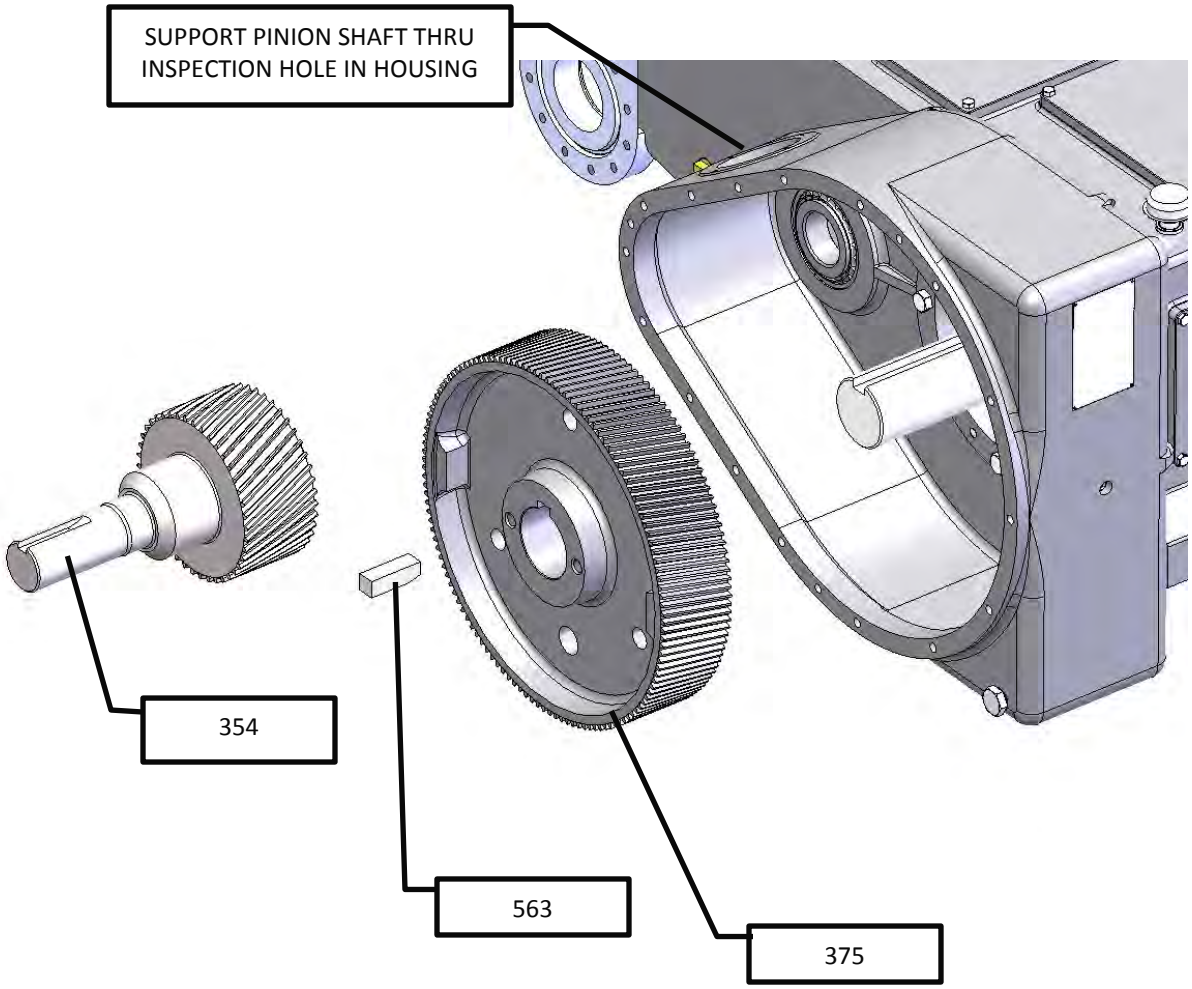

CORRECTLY INSTALLED PLUNGER CLAMP. COMPLETE FOR ALL FIVE (5) PLUNGERS

# MOUNTING GEAR REDUCER AND FINAL ASSEMBLY

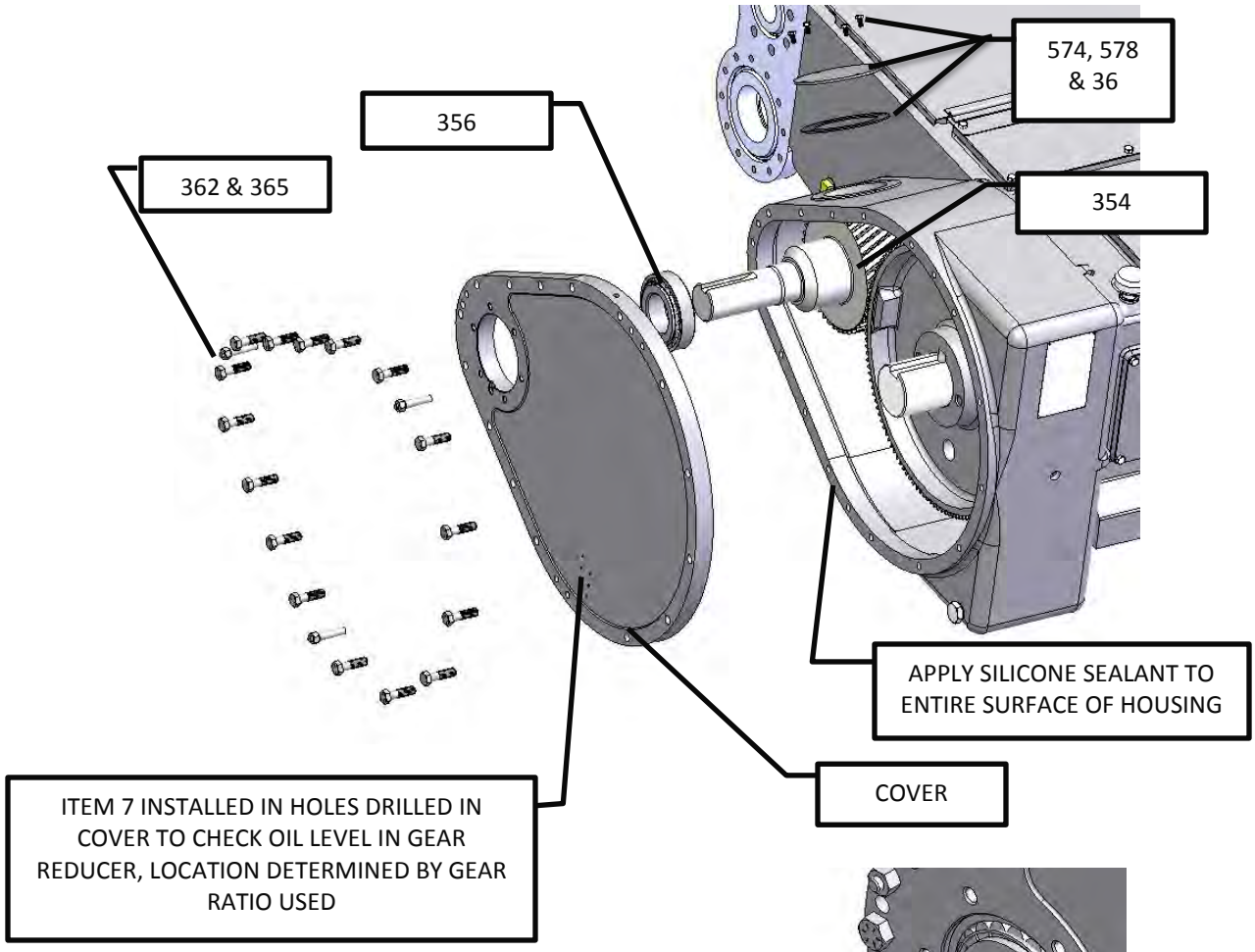
1. Slide the pinion bearing (Item 356) into the gear reducer housing and attach bearing cover (Item 359) with supplied shims (Item 361) and cap screws (Item 36). Slide the gear reducer housing (Item 345) onto the power frame and mount with eight (8) cap screws (Item 367). Torque cap screws to 375 ft-lbs. Secure the cap screws in pairs with safety wire. When using a gear reducer, no slinger ring (Item 25) is used and a different bearing retainer (Item 24) is used. If no gear reducer is installed, then skip to Step 4. Screw in the pipe elbow (Item 371) and tighten until oriented up and screw in breather cap (Item 14). Install housing oil drain plug (Item 399)

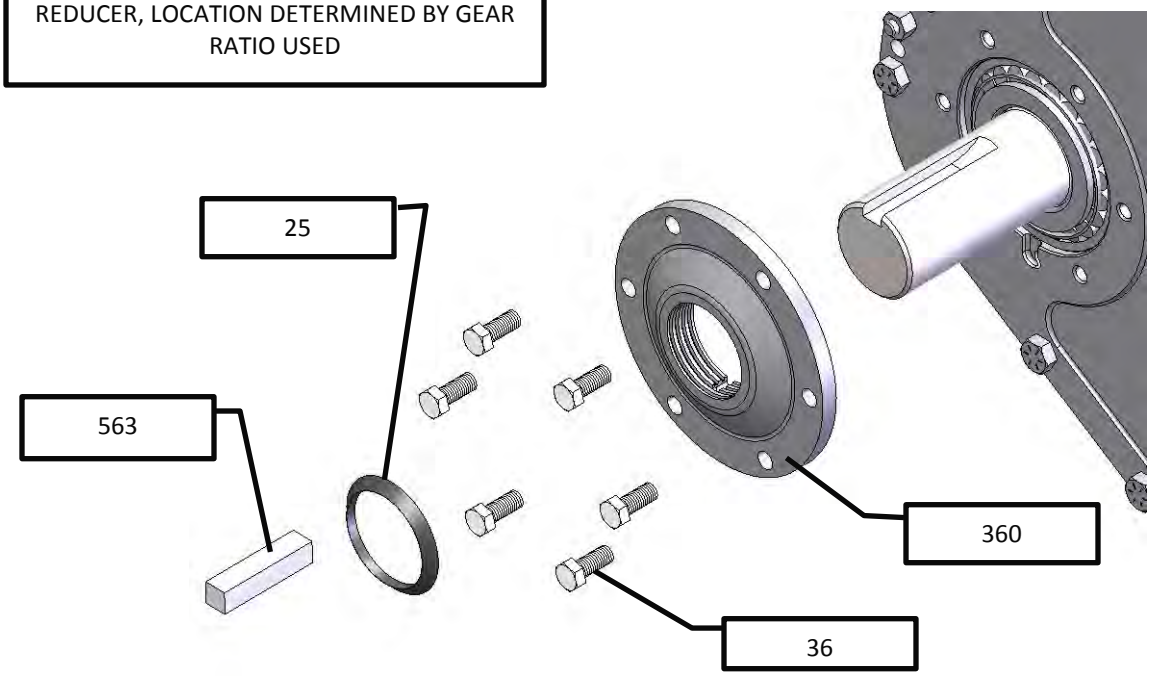


2. Slip pinion shaft (Item 354) into pinion bearing in housing and heat gear (Item 375) up to 350°F before pressing onto crankshaft (Item 105) with key (Item 563). Take care to support the pinion shaft with a strap thru the inspection hole.

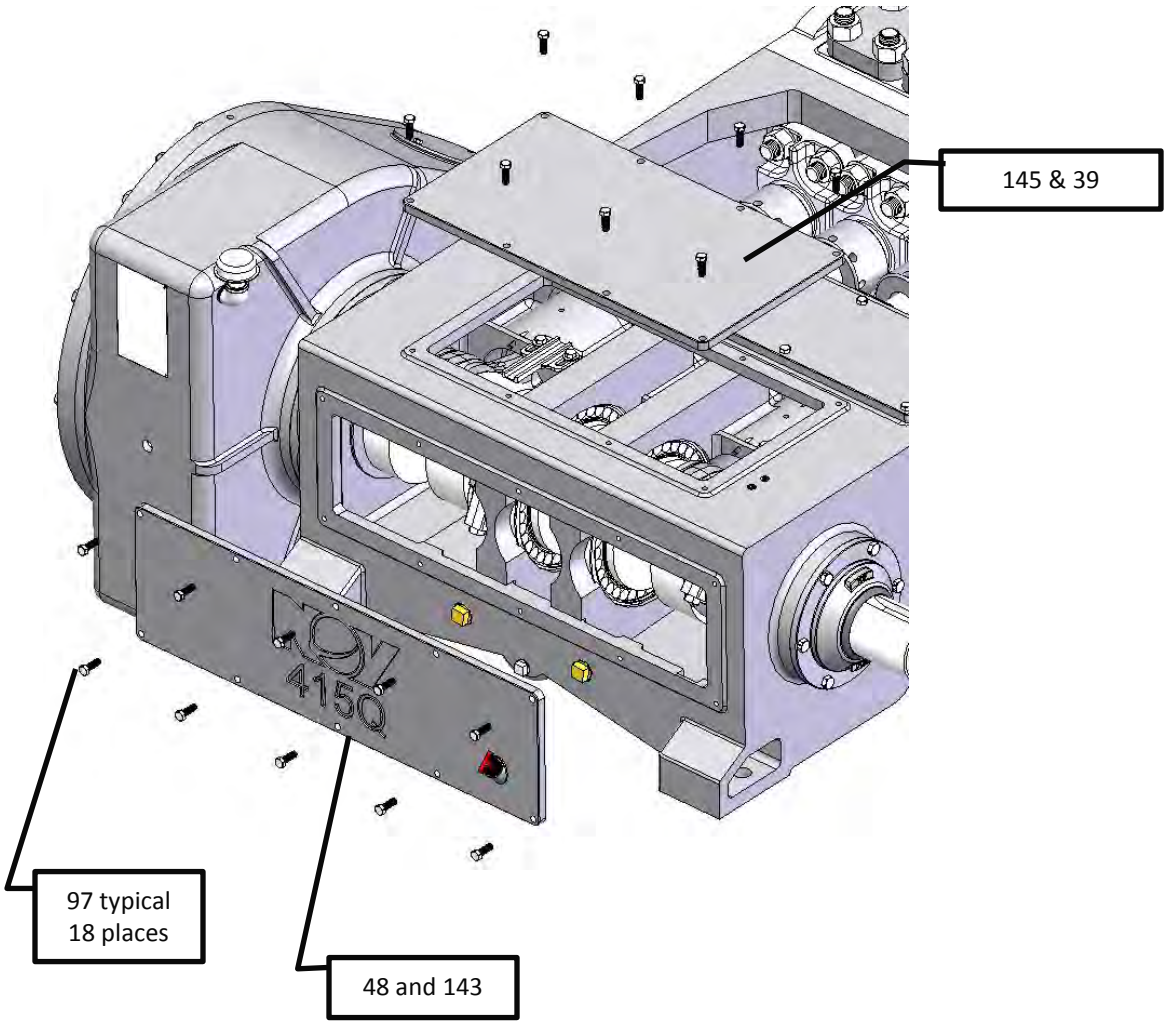


3. When gear is pressed on completely and aligned on the center of the pinion gear (Item 354), slide second pinion bearing (Item 356) onto pinion shaft (Item 354) and mount gear reducer cover and slide over pinion shaft (Item 354). Use silicone sealant to seal cover to housing. Secure with sixteen (16) cap screws (Item 362) and align with three (3) tapered dowel pins. (item 365). Install handhole cover (Item 574) with gasket (Item 578) to top of gear reducer housing with cap screws (Item 36). Install two (2) pipe plugs (Item 7) in cover.

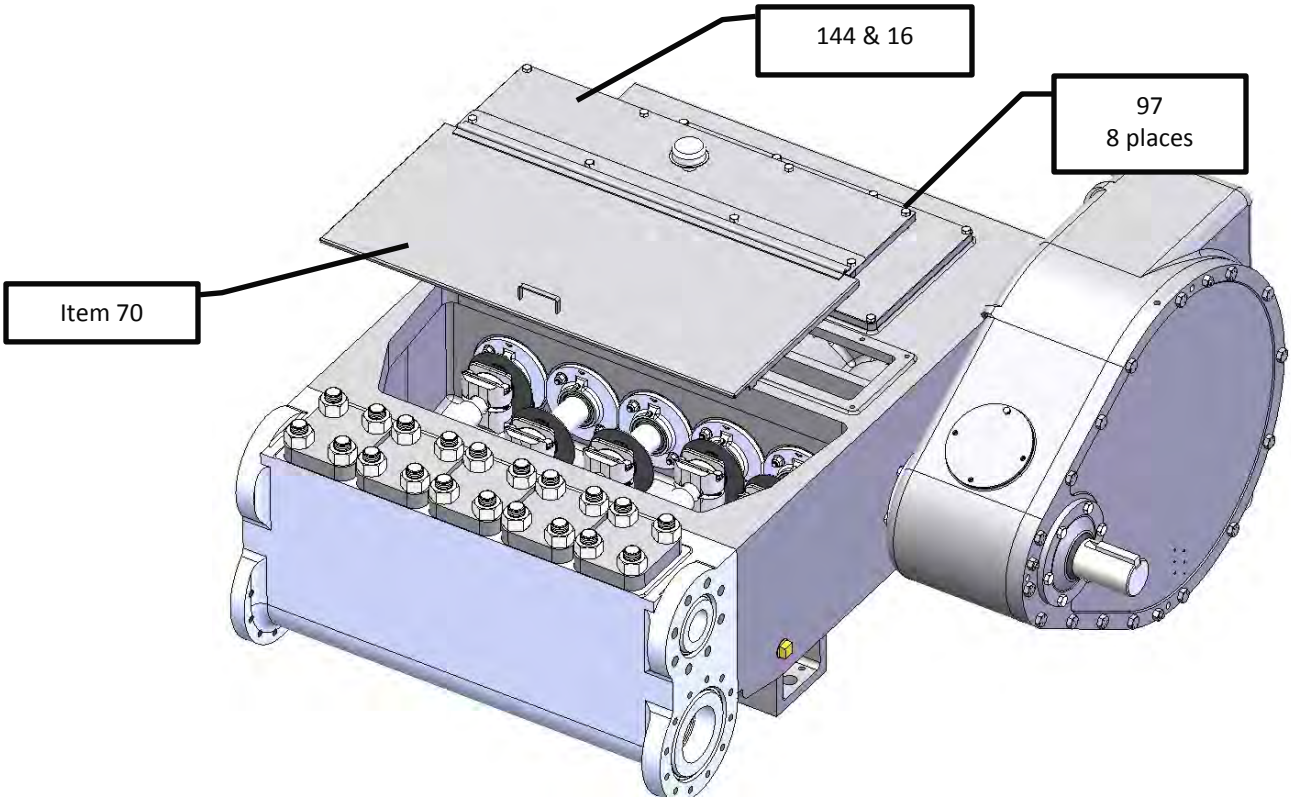


4. Mount rear cover (Item 48) with gasket (Item 143) and crankcase cover (Item 145) with gasket (Item 39) with eighteen (18) cap screws (Item 97).



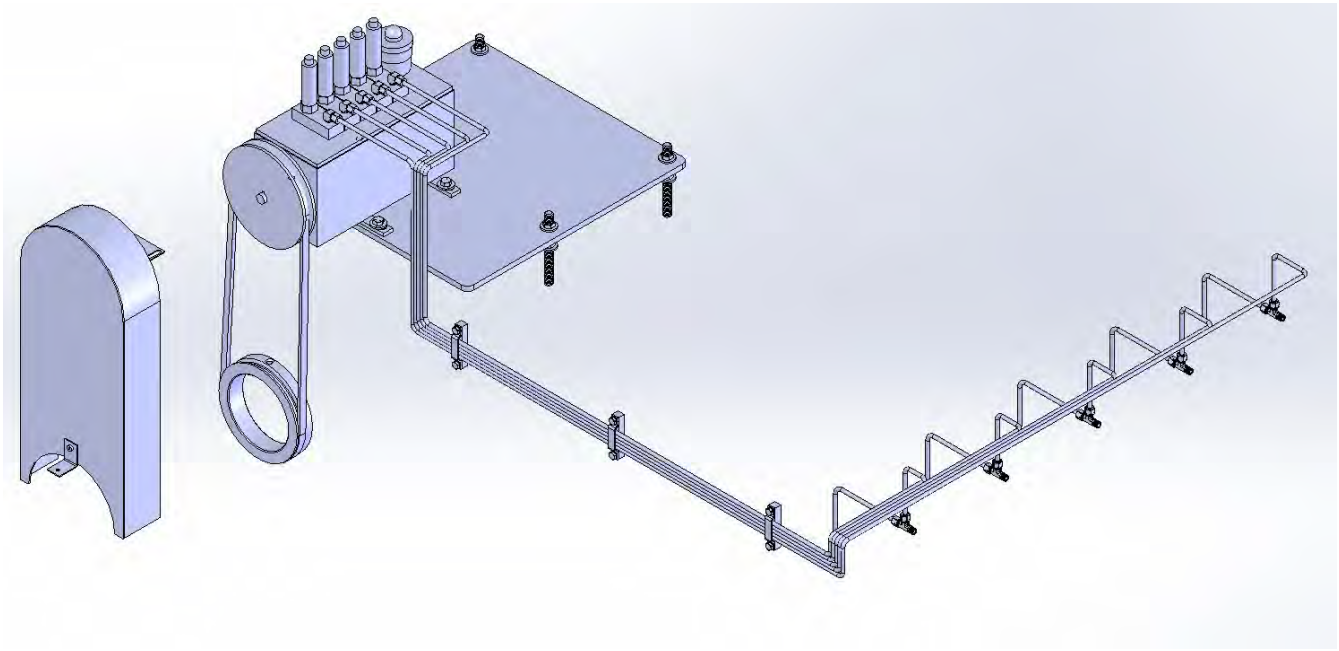
5. Mount crosshead cover (item 144) with gasket (Item 16) and cradle cover (item 70) with eight (8) cap screws (Item 45).




6. The pump is now completely assembled and ready to fill with oil before operation.

# PLUNGER LUBRICATION SYSTEM SERVICE

1. The plunger lubrication system is a belt driven drip lube system that delivers oil to the plunger and in turn lubricates the plunger packing. It is driven by the crankshaft and the oil is stored inside the lubricator's reservoir. Servicing the lubricator pump consists of adjusting the mounting plate until the v-belt is tensioned properly and the stainless steel lubrication lines are un-clogged and un-damaged. Over tightening the v-belt will cause premature failure of the lubricator bearings. Inadequate lubrication will cause premature failure of the packing and damage to the plunger. Inspect the pulleys and v-belt for excess wear and replace as needed. **See drawing 1716902 for the list of components.**



2. The plunger lubricator requires regular service to refill the oil reservoir. Use Rockdrill Oil only for the lubrication system as it is designed for long plunger and packing service life. Oil viscosity is determined by the operating temperatures for the pump, see list on following page:

# ROCK DRILL OIL LISTINGS

| | | | | OUTSIDE TEMPERATURE | | |
|---|---|---|---|---|---|---|
| PRODUCT NAME | POUR POINT °F | VISCOSITY @100 °F | (SUS) @210 °F | ABOVE 50 °F | BETWEEN 50 °-20 °F | BELOW 20 °F |
| AMOCO ROCK DRILL OIL - LIGHT | -15 | 226.1 | 49.7 | | | X |
| AMOCO ROCK DRILL OIL - MEDIUM | +10 | 517 | 65.4 | | X | |
| AMOCO ROCK DRILL OIL - HEAVY | +10 | 1026 | 88 | X | X | |
| | | | | | | |
| ARCO TRUSLIDE S-315 | -15 | 310-340 | -- | | | X |
| ARCO TRUSILDE S-700 | +15 | 600-775 | 72-79 | | X | |
| ARCO TRUSLIDE S-1000 | +5 | 920-1100 | -- | X | X | |
| | | | | | | |
| CHEVRON VISTAC OIL - GRADE 50X | 0 | 1500 | 94 | X | X | |
| CHEVRON VISTAC OIL - GRADE 36X | 0 | 1000 | 0 | | X | X |
| CHEVRON VISTAC OIL - GRADE 28X | 0 | 695 | 65 | | X | X |
| CHEVRON VISTAC OIL - GRADE 19X | -10 | 465 | 56 | | X | X |
| CHEVRON VISTAC OIL - GRADE 14X | -10 | 320 | 50 | | | X |
| CHEVRON VISTAC OIL - GRADE 9X | -10 | 160 | 54 | | | X |
| | | | | | | |
| CONOCO ROCK DRILL OIL - GRADE 32 | -5 | 170-180 | 45 | | | X |
| CONOCO ROCK DRILL OIL - GRADE 100 | +5 | 590-500 | 63 | | X | |
| CONOCO ROCK DRILL OIL - GRADE 150 | +10 | 795 | 70-80 | X | X | |
| | | | | | | |
| EXXON AROX EP 46 | -30 | 229 | 46.7 | | | X |
| EXXON AROX EP 150 | -20 | 757 | 67.2 | X | X | X |
| | | | | | | |
| GULF ROCK DRILL #44 | -35 | 227 | 48.1 | | | X |
| GULF ROCK DRILL #63 | -30 | 599 | 63.8 | | X | X |
| GULF ROCK DRILL #92 | -5 | 1321 | 89.4 | X | X | |
| | | | | | | |
| MOBIL ALAMO OIL #1 | 0 | 185-200 | 44 | | | X |
| MOBIL ALAMO OIL #3 | 0 | 490-515 | 55 | | | X |
| MOBIL ALAMO OIL #5 | 0 | 825-875 | -- | X | X | |
| MOBIL ROCK DRILL OIL RL-668B | -10 | 195-225 | -- | | | X |
| MOBIL ROCK DRILL OIL RL-668C | -10 | 470-510 | 66 | | X | X |
| MOBIL ROCK DRILL OIL RL-668D | -10 | 675-725 | 74 | | X | X |
| MOBIL ROCK DRILL OIL RL-668E | -5 | 950-1050 | 93 | X | X | X |
| | | | | | | |
| PHILLIPS ROCK D LUBE EP #500 | -10 | 550-600 | 58-61 | | X | X |
| PHILLIPS ROCK D LUBE EP #300 | -10 | 300-325 | 50-53 | | | X |
| | | | | | | |
| SHELL TONNA R 27 | -50 | 160 | 47 | | X | X |
| SHELL TONNA R 41 | -20 | 540 | 60 | | X | X |
| SHELL TONNA R 72 | 0 | 1200 | 87 | X | | X |
| | | | | | | |
| SUNOCO CODE 318760 | -5 | 540 | 56.1 | | | X |
| SUNOCO GRADE 1000 - CODE 318760 | -5 | 1000 | 72 | | X | X |
| SUNOCO DX ROCK DRILL OIL L #509 | -20 | 213 | 46.5 | | | X |
| SUNOCO DX ROCK DRILL OIL MH #510 | +5 | 615 | 67 | | X | |
| SUNOCO DX ROCK DRILL OIL H #511 | +5 | 925 | 82 | X | X | |
| | | | | | | |
| TEXACO ROCK DRILL LUBE 46 | -30 | 226 | 47 | | | X |
| TEXACO ROCK DRILL LUBE 100 | -15 | 558 | 60 | | X | X |
| TEXACO ROCK DRILL LUBE 320 | 0 | 1662 | 98 | X | X | |
| | | | | | | |
| UNION 76 DRILLUBE - GRADE 215 (SAE 10) | -25 | 221 | 48.1 | | | X |
| | | | | | | |
| UNION OIL DRILLUBE - GRADE 465 (SAE 30) | -5 | 467 | 61.8 | | X | X |
| | | | | | | |
| CASTROL RD OIL 32 | -15 | 150 | 43 | | X | X |
| CASTROL RD OIL 100 | 0 | 475 | 57 | | X | X |
| CASTROL RD OIL 150 | +10 | 660 | 66 | X | | |

# P-55U PUMP OPERATING INSTRUCTIONS

## Box Suction Pumps (Vacuum Feed)

1. Fill Reservoir with oil.
2. Loosen union nut on pump outlet.
3. Remove the vent screw and fill the sight glass with oil. Prime by manually pumping flushing unit until air free oil is observed from the drip tube and oil level drops in the sight glass.
4. Replace vent screw and tighten union nut.
5. Maintain oil level in sight glass below the drip tube so drops can be observed.

## Flow Rate Adjustment

1. Loosen locknut on pump outlet.
2. Turn flushing unit counter-clockwise to increase flow.
3. Turn flushing unit clockwise to decrease flow.
4. Tighten locknut when desired flow rate is achieved

## Sight Glass

In a vacuum type sight feed, it is not uncommon for oil level in the sight glass to drop during operation. Absence of a level indicates air is being taken in with the oil. Some oils, due to viscosity conditions, will release air faster than others. When the quality of air becomes excessive, it can eventually air lock the pump.

For this reason it is recommended that an oil level in the sight glass be maintained.

When level drops, remove the vent screw and fill sight glass to top; replace vent screw and operate flushing unit manually, observing that an oil in the sight glass is free from air. If air is not expelled, it may be necessary to loosen union nut (on pump outlet) and expel air at this point. It is desirable to maintain level below the drip tube so drops can be seen during operation.

## Over Filling of Sight Glass

In a vacuum type sight feed, it is not uncommon to see a reverse action whereas sight glass fills with oil and the drops cannot be observed. Overfilling is caused by oil absorbing air in the sight glass and normally does not affect the operation of the pump. Remove the vent screw from sight glass and allow level to drop below drip tube. Tighten vent screw and check to see that air free oil from drip tube can be observed in the sight glass. If overfilling continues, it may be caused by plunger wear and oil slippage is being drawn back to sight glass. If this is the problem, the feed setting in drops per stroke will then automatically be reduced by the amount of slippage.

## Reservoir Oil Level (Loss of Prime)

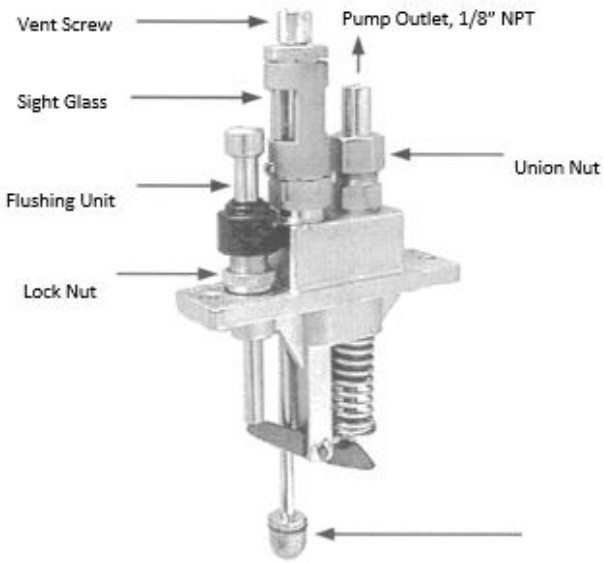
If reservoir runs low on oil (at a point below the suction inlet of the pump) it may be necessary to prime individual pumps after filling, using procedure listed above.

## Pump Displacement

Maximum output (per stroke):

1/4 Plunger = .018 Cubic Inches
3/8 Plunger = .038 Cubic Inches

The cubic volume for a pint of oil is 28.9 cubic inches and average drop size is .002 cubic inches.




TYPICAL PUMPING UNIT, ONE PER PLUNGER

# PLUNGER PACKING ADJUSTMENT

1. Gland nut should be installed hand tight in preparation for packing adjustment at assembly. Complete attachment of plunger to intermediate rod and install the plunger clamp.
2. Tighten adjustment nut as tight as possible with bar furnished with the pump. DO NOT USE A CHEATER!

## For Non-Adjustable Lip Style Packing:

1. Start pump and operate under pressure; retighten gland adjustment nut. After pump has been running for two (2) or three (3) hours under pressure, packing will be seated and the gland adjustment nut should be tightened as much as possible with bar furnished with the pump. **DO NOT USE A CHEATER!** This will remove any movement of the packing in the stuffing box.
2. The gland adjusting nuts should be checked and tightened for the first two (2) or three (3) days until the packing is fully seated and the gland adjusting nuts cannot be tightened any further. **DO NOT USE A CHEATER!**

## For Spring Loaded Braided Packing

1. After assembly, tighten packing adjustment nut. Bushing should seat against the stuffing box face. Back the nut off one-half turn using the supplied stop pin.
2. Fill the lubricator pump with rock drill oil for normal operation temperatures or steam cylinder oil for high temperature operation. Fill out the lubricator lines by manually pumping the unit. Check its operation.
3. Start pump at low speed and low pressure operation if possible, tighten stuffing box adjustment nut and insert stop pin in hole. Watch operation for a short period of time. Oil if needed.
4. Set lubricator to twice normal rate. After 24 hours, resume normal operation. Check stuffing box for excessively high temperatures and abnormal leakage.

# STORAGE

If the pump is to be idle for more than one (1) week, it should be prepared for storage as follows:

1. Drain and clean crankcase thoroughly. Leave drain open and install $90^{o}$ elbow, pointed downward, to permit air circulation and prevent condensation buildup.

2. Coat all bearings, finished surfaces and entire interior of crankcase with rust inhibiting oil.

3. Remove plungers and packing and coat with rust inhibiting oil.

4. Remove fluid end valves allowing cylinder to be thoroughly clean and drained.

5. Coat entire fluid end, valves and parts with rust inhibiting oil.

6. Thoroughly inspect and rotate crankshaft monthly. Re-coat with rust inhibiting oil as needed.

# RE-START AFTER STORAGE

Any pump that has been in storage, either after field use or as shipped from the plant, will need a thorough inspection to make sure it has not been damaged in any way and that all parts are in proper place before start up.

1. Remove all covers from Power End and Fluid End; thoroughly clean and inspect all parts and finished surfaces.
2. Check all bearings to make sure they are clean in good working order.

3. Make sure all packing, plungers and valves are installed correctly and in good condition.

4. Fill Power End to the proper level with clean oil of the proper viscosity. Make sure the oil is filled in the Crosshead Reservoir and is worked into all bearings.

5. Fill Packing Lubricator and Lubricator Lines until full. Check by breaking connection at Stuffing Box and running Lubricator Pump until fresh oil appears and then reconnect Lubricator line.

# TROUBLESHOOTING

| PROBLEM | POSSIBLE CAUSE | CORRECTION |
|---|---|---|
| KNOCKING OR POUNDING IN FLUID END AND PIPING | SUCTION LINE RESTRICTED BY: (1, 2, 3, 4) | |
| | 1. TRASH, SCALE BUILD UP, ETC. | LOCATE AND REMOVE |
| | 2. PARTIALLY CLOSED VALVE IN SUCTION LINE | LOCATE AND CORRECT |
| | 3. METERS, FILTERS, CHECK VALVES, NON-FULL-OPENING, CUT-OFF VALVE OR OTHER RESTRICTIONS. | RE-WORK SUCTION LINE TO ELIMINATE |
| | 4. SHARP 90° BENDS OR 90° BLIND TEES. | RE-WORK SUCTION LINE TO ELIMINATE. |
| | AIR ENTERING SUCTION LINE THROUGH CUT-OFF VALVE | TIGHTEN OR REPACK VALVE STEM PACKING |
| | AIR ENTERING SUCTION LINE THROUGH LOOSE CONNECTION OR FAULTY PIPE | LOCATE AND CORRECT |
| | AIR OR VAPOR TRAPPED IN SUCTION LINE | LOCATE RISE OR TRAP AND CORRECT BY STRAIGHTENING LINE, PROVIDING ENOUGH SLOPE TO PERMIT ESCAPE AND PREVENT BUILD-UP |
| | LOW FLUID LEVEL | INCREASE SUPPLY AND INSTALL AUTOMATIC LOW LEVEL SHUT-DOWN SWITCH |
| | SUCTION DAMPENER NOT OPERATING | INSPECT AND REPAIR AS REQUIRED |
| | WORN VALVES | INSPECT AND REPAIR AS REQUIRED |
| | ENTRAINED GAS IN FLUID | PROVIDE GAS BOOT OR SCRUBBER FOR FLUID |
| | POOR INLET AND OUTLET ARRANGEMENT AT SUPPLY TANK | INLET TO BE AT TOP OF TANK AND BAFFLED TO BREAK-OUT GAS AND PREVENT CHANNELING. OUTLET TO BE 12" FROM BOTTOM OF TANK AND AS FAR FROM INLET AS POSSIBLE, NEVER CLOSER THAN 90°. |
| | LOOSE PACKING ADJUSTING NUT | TIGHTEN AND/OR REPLACE PACKING |
| | INADEQUATE SIZED SUCTION LINE | REPLACE WITH INDIVIDUAL SUCTION LINE OF NEXT SIZE LARGER THAN INLET PUMP |
| | LEAKAGE PRESSURE RELIEF VALVE THAT HAS BEEN PIPED BACK INTO SUCTION LINE | REPAIR VALVE AND RE-WORK PIPING TO RETURN TO SUPPLY TANK - NOT SUCTION LINE. |
| | BY-PASS PIPED BACK TO SUCTION | REWORK TO RETURN BY-PASSED FLUID BACK TO SUPPLY TANK - NOT SUPPLY LINE |
| | BROKEN PLUNGER | INSPECT WHEN ROTATING PUMP BY HAND AND REPLACE AS REQUIRED |

| PROBLEM | POSSIBLE CAUSE | CORRECTION |
|---|---|---|
| KNOCK IN POWER END | VALVE WEAR OR DAMAGE | CHECK FLUID END FOR BAD VALVES |
| | WORN MAIN BEARINGS | REPLACE AS REQUIRED |
| | LOOSE PLUNGER - INTERMEDIATE ROD CROSSHEAD CONNECTION | INSPECT FOR DAMAGE - REPLACE AS REQUIRED AND TIGHTEN |
| | WORN CROSSHEAD PIN, OR CONNECTING ROD | LOCATE AND REPLACE AS REQUIRED |
| RAPID VALVE WEAR OR FAILURE | CORROSION | TREAT FLUID AS REQUIRED |
| | ABRASIVES IN FLUID | FILTER AS REQUIRED |
| | IMPROPER INSTALLATION | INSPECT AND INSTALL PER INSTRUCTION SHEET IN PACKING BOX |
| | IMPROPER LUBRICATION (EITHER INSUFFICIENT OR EXCESSIVE OR INCORRECT TYPE) | CHECK INSTRUCTIONS IN MANUAL AND CORRECT AS REQUIRED. |
| | LUBRICATOR NOT OPERATING | INSPECT AND CORRECT AS REQUIRED |
| | ADJUSTING NUT LOOSE | INSPECT AND REPACK PER INSTRUCTIONS |
| | SCALE OR BUILD UP ON PLUNGER | TREAT FLUID AS REQUIRED |
| SHORT PACKING LIFE | WORN OR PITTED PLUNGERS AND/OR STUFFING BOX | REPLACE AS REQUIRED |
| | ABRASIVES IN FLUID | FILTER AS REQUIRED |
| | PUMP OPERATED WITHOUT FLUID | CHECK SYSTEM FOR FAULTY LOW-LEVEL SHUT-DOWN CONTROLS OR CLOSED VALVES AND CORRECT AS REQUIRED. |
| | ABNORMALLY HIGH FLUID TEMPERATURES | CHECK WITH MANUFACTURER FOR RECOMMENDATIONS ON TYPE OF PACKING |
| | WRONG TYPE OF PACKING FOR PARTICULAR FLUID BEING HANDLED | CHECK WITH MANUFACTURER FOR RECOMMENDATIONS ON TYPE OF PACKING |
| | CAVITATION (KNOCKING AND POUNDING IN FLUID CYLINDER AND PIPING) | REFER TO CORRECTION OF "KNOCK IN POWER END" ABOVE |

| PROBLEM | POSSIBLE CAUSE | CORRECTION |
|---|---|---|
| **BROKEN OR PITTED FROM IMPLOSIONS CAUSED BY IN EXCESSIVE GAS OR AIR ENTRAINED FLUID.** | PLUNGER CRACKED AT INSTALLATION. | INSTALL NEW PLUNGER USING CARE TO AVOID ANY SHARP BLOW OR FORCE ON PLUNGER. |
| | PLUNGER CRACKED FROM THERMAL SHOCK. | CHECK SYSTEM TO ELIMINATE ANY SHARP OR SUDDEN TEMPERATURE DIFFERENCES. TEMPERATURE EXTREMES ON THE PLUNGER CAN OCCUR FROM PACKING AS DISCUSSED UNDER "SHORT PACKING LIFE" PROBLEM PR FROM TEMPERATURE CHANGES IN THE FLUID ITSELF. |
| | PLUNGER PITTED FROM IMPLOSIONS CAUSED BNY EXCESSIVE GAS OR AIR ENTRAINED IN FLUID. | CHANGE SUCTION SYSTEM TO ELIMINATE OR CHECK WITH MANUF. REGARDING USE OF SPECIAL PACKING ARRANGEMENT. |
| **RAPID WEAR OF HARD-COATED PLUNGER** | PACKING FAILURE. | CHECK AND CORRECT PER RECOMMENDATIONS UNDER "SHORT PACKING LIFE" PROBLEM. |
| | PLUNGER NOT SUITABLE FOR PARTICULAR SERVICE. | CHECK WITH MANUF. FOR RECOMMENDATION. |
| **OIL SEAL LEAKS** | PLUNGER NOT SUITABLE FOR PARTICULAR SERVICE. | CHECK AND CORRECT AS REQUIRED. |
| | PUMP NOT LEVEL. | CHECK AND CORRECT AS REQUIRED. |
| | WORN, CORRODED, PITTED, OR OTHERWISE DAMAGED SEALING SURFACE. | CHECK AND CORRECT AS REQUIRED. |
| | WORN OR DAMAGED SEALS. | CHECK AND CORRECT AS REQUIRED. |
| | OIL LEVEL TOO HIGH. | CHECK AND CORRECT AS REQUIRED. |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http://www.nov.com/contactus.aspx

**Sales/Technical Information:**
**USA:** 1 918 447 4600

**Internet:** http://www.nov.com

National Oilwell Varco is a leading manufacturer of reciprocating plunger pumps, centrifugal pumps, and fluid end replacement parts. We also offer a complete set of solutions to your fluid transfer challenges. For more Information, contact National Oilwell Varco directly at the Headquarters in Houston, Texas. All National Oilwell Varco products are available throughout the U.S. and around the world from service centers, authorized distributors, and representatives.

# 415Q MASTER FIND NUMBER ASSIGNMENT LIST 001-899

| | FIND | PART NUMBER | DESCRIPTION |
|---|---|---|---|
| | 1 | 171600141 | POWER FRAME |
| | 7 | 6874008 | PIPE PLUG |
| | 9 | 6874012 | PIPE PLUG |
| | 14 | 7802020 | BREATHER CAP |
| | 16 | 1716100 | GASKET, CROSSHEAD COVER |
| | 18 | 1713008 | GASKET, MAIN BEARING CAGE |
| | 19 | 1713010 | GASKET, MAIN BEARING CAGE RETAINER |
| | 20 | 1713009 | GASKET, MAIN BEARING RETAINER (DRIVE SIDE) |
| | 23 | 1713017 | RETAINER, CRANKSHAFT |
| | 24 | 1713022 | RETAINER, CAGE SIDE, CRANKSHAFT |
| | 25 | 7818106 | SLINGER, CRANKSHAFT |
| | 26 | 2400054 | DIP STICK, OIL LEVEL |
| | 27 | 1127523 | SLINGER, GEAR REDUCER |
| | 31 | 7618018 | WASHER, 1/2" FLAT |
| | 32 | 154-012087-405 | WASHER, 1/2" SPRING LOCK |
| | 33 | 155-100200-286 | WASHER, 1" FLAT |
| | 36 | 2400930 | SCREW, 5/8"-11UNC X 1 3/4" LG, DRILLED HEAD |
| | 37 | 2405018 | SCREW, DR HD HEX HD CAP 7/8"-9 x 4 1/2" LG - GEARBOX MOUNTING SCREWS |
| | 39 | 1716101 | GASKET, CRANKCASE COVER |
| | 40 | 1713560 | COVER, CRANKSHAFT EXTENSION |
| | 41 | 7619050 | WASHER, 1/2" SPRING LOCK |
| | 42 | 7026299 | SET SCREW, HEX SOCKET |
| | 44 | 100-034112-290 | CAP SCREW, HEX HEAD, 3/4"-10UNC X 1 1/2" LG |
| | 45 | 100-012100-290 | CAP SCREW, HX HD, 1/2"-13UNC X 1" LG |
| | 46 | 100-034100-290 | CAP SCREW, HEX HEAD, 3/4"-10UNC X 1" LG |
| | 47 | 100-014012-286 | CAP SCREW, HEX HEAD, 1/4"-20UNC X 1/2" LG |
| | 48 | 171601541 | COVER, REAR |
| | 60 | 100-058112-286 | CAP SCREW, HEX HEAD, 5/8"-11UNC X 1 1/2" LG |
| | 61 | 100-012114-286 | CAP SCREW, HEX HEAD, 1/2"-13UNC x 1 1/4" LG |
| | 70 | 1716399 | CRADLE COVER |
| | 75 | 171602341 | POWER END ASSM 415Q-5 LH L/INTERMEDIATE RODS |
| | 80 | 17131782341 | FLUID END STUDDED 415Q-5H DPSS |
| | 80 | 17162411441 | FLUID END STUDDED 415Q-5L14CF CBRZ |
| | 80 | 17162412341 | FLUID END STUDDED 415Q-5L23CF DPSS |
| | 80 | 17132182341 | FLUID END STUDDED 415Q-5M DPSS |
| | 80 | 17132181441 | FLUID END STUDDED 415Q-5M14CF CBRZ |
| | 80 | 17131781441 | FLUID END STUDDED, 415Q-5H14AF CBRZ |
| | 85 | 17131791441S | FLUID END ASSY 415Q-5H14AF CBRZ SPHERICAL VALVES |
| | 85 | 17131791441SD | FLUID END ASSY 415Q-5H14AF CBRZ SEVERE DUTY SPHERICAL VALVES |
| | 85 | 17131792341SD | FLUID END ASSY 415Q-5H14AF CBRZ SEVERE DUTY SPHERICAL VALVES |
| | 85 | 17131792341S | FLUID END ASSY 415Q-5H23AF DPSS SPHERICAL VALVES |
| | 85 | 17162421441W | FLUID END ASSY 415Q-5L14CF CBRZ SPHERICAL VALVES |
| | 85 | 17162422341W | FLUID END ASSY 415Q-5L23CF DPSS SPHERICAL VALVES |
| | 85 | 17132172341 | FLUID END ASSY 415Q-5M23CF DPSS SEVERE DUTY SPHERICAL VALVES |
| | 85 | 17132191441W | FLUID END ASSY 415Q-5M23CF DPSS SEVERE DUTY SPHERICAL VALVES |
| | 85 | 17132192341W | FLUID END ASSY 415Q-5M23CF DPSS SPHERICAL VALVES |
| | 90 | 179402025W | VALVE ASSY, SUCTION, SPHERICAL 4" (415Q-5L) |
| | 90 | 179402025SD | VALVE ASSY, SUCTION, SEVERE DUTY SPHERICAL 4" (415Q-5L) |
| | 90 | 171709025 | VALVE ASSY, SPHERICAL 1.5" (415Q-5H) |
| | 90 | 179302025W | VALVE ASSY, SPHERICAL 3" (415Q-5M) |
| | 90 | 179302025SD | VALVE ASSY, SUCTION, SEVERE DUTY SPHERICAL 3" (415Q-5M) |

| | | | |
|---|---|---|---|
| | 91 | 179402225W | VALVE ASSY, DISCHARGE, SPHERICAL 4" (415Q-5L) |
| | 91 | 179402225SD | VALVE ASSY, DISCHARGE, SEVERE DUTY SPHERICAL 4" (415Q-5L) |
| | 91 | 179302225SD | VALVE ASSY, DISCHARGE, SEVERE DUTY SPHERICAL 3" (415Q-5M) |
| | 91 | 171709025SD | VALVE ASSY, SEVERE DUTY SPHERICAL 1.5" (415Q-5H) |
| | 91 | 179302225W | VALVE ASSY, DISCHARGE, SPHERICAL 3" (415Q-5M) |
| | 97 | 100-012112-290 | CAP SCREW, HEX HD, 1/2"-13UNC x 1 1/2" LG |
| | 100 | 180104143 | PULLER ASSY (415Q-5L) |
| | 100 | 180104127 | PULLER ASSY (415Q-5M) |
| | 105 | X173412 | CRANKSHAFT W/NUTS |
| | 105 | X173412RD | CRANKSHAFT, RIFLE DRILLED |
| | 109 | 2404019 | KEY, CRANKSHAFT |
| | 117 | 7610050 | WASHER, TIMKEN |
| | 118 | 6304048 | LOCK NUT, TIMKEN |
| | 125 | ZB10500 | BEARING, CRANKSHAFT, INBOARD |
| | 134 | 1716009 | WIPER RETAINER |
| | 135 | ZT5506 | BEARING, CRANKSHAFT, OUTBOARD |
| | 141 | 1713007 | MAIN BEARING CAGE |
| | 143 | 1716102 | GASKET, REAR COVER |
| | 144 | 1713013 | PLATE, CROSSHEAD COVER |
| | 145 | 1713014 | COVER, CRANKCASE |
| | 150 | 179402125 | SEAT, SUCTION 4" |
| | 150 | 171709025SD | VALVE SEAT, 415Q-5H |
| | 150 | 179302125 | VALVE SEAT, SUCTION, 3" + 179302725 VALVE BODY (MATCHED SET) |
| | 151 | 179402325 | SEAT, DICHARGE 4" |
| | 151 | 179302725 | VALVE, DISCHARGE, 3" + 179302325 VALVE SEAT (MATCHED SET) |
| | 152 | 17930246W | RETAINER, 3" VALVE |
| | 152 | 17940246W | RETAINER, 4" VALVE |
| | 153 | 1793025 | VALVE SPRING, OUTER, 3" VALVE |
| | 153 | 1794025 | VALVE SPRING, OUTER, 4" VALVE |
| | 154 | 179402725SD | VALVE, SPHERICAL 4" |
| | 155 | 1793026 | VALVE SPRING, INNER 3" |
| | 155 | 1794026 | VALVE SPRING, INNER 4" |
| | 156 | 9707082 | WAVE RING, 3" VALVE |
| | 156 | 9707080 | WAVE RING, 4" VALVE |
| | 157 | 171709125 | VALVE SEAT, SPHERICAL + VALVE, SPHERICAL H (MATCHED SET) |
| | 158 | 179302725SD | VALVE BODY, SD, 3", 415Q-5M |
| | 158 | 179402725SD | VALVE BODY, SD, 4", 415Q-5L |
| | 158 | 171709225SD | VALVE BODY, SD, 415Q-5H |
| | 159 | 17125854 | CAGE, VALVE 415Q-5H |
| | 160 | 17134174 | RETAINER, VALVE CAGE, 17-4SS |
| | 160 | 17134172 | RETAINER, VALVE CAGE, BRZ 415Q-5H |
| | 161 | 1712486 | VALVE SPRING, CAGE 415Q-5H |
| | 164 | 9707086 | VALVE INSERT, 3" SD SPHERICAL |
| | 164 | 9707084 | VALVE INSERT, 4" SEVERE DUTY |
| | 164 | 9707094 | VALVE INSERT, SD SPHERICAL |
| | 200 | 1716104 | BEARING HALF, CONNROD |
| | 203 | 21032044 | CAP SCREW, DRILLED HEAD, CONROD |
| | 206 | 1711745 | PIN, DOWEL, 3/8 DIA X 1" |
| | 209 | H7028104 | SCREW, HEX SOC CONE PT SET 1/4 |
| | 211 | 1716030 | BUSH,CROSS J165/275 for Field Repair |
| | 211 | 1716010 | BUSH,CROSS/H PIN J165/275 Has to be HONED |
| | 212 | 1716005 | CROSSHEAD |
| | 213 | 1716008 | PIN, CROSSHEAD |

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| | 217 | 1716017 | GASKET, WIPER BOX |
| | 219 | 1713297 | WIPER, OIL |
| | 222 | 1716031 | BOLT, HO0K |
| | 223 | 6308080 | NUT, LOCK |
| | 229 | 6510604 | PIN,DOWEL STD HDN & GR,3/8X1/2 x 1 |
| | 260 | 180-161020-220 | LUBE FITTING (WIPER BOX) |
| | 269 | 105-012214-290 | CAP SCREW, SKT HEAD |
| | 270 | 1717884 | REDUCER,GEAR CPT 4.84 SPCL WID |
| | 279 | G1716004 | CONNROD ASSM, COMPLETE |
| | 299 | 1716122LSS | LUBRICATOR ASSM, LHAND |
| | 300 | 1716122RSS | LUBRICATOR ASSM, RHAND |
| | 301 | 7600032 | WASHER, 1/2" SEALING |
| | 310 | 170-038001-220 | PIPE PLUG |
| | 345 | 1713602 | HOUSING COMPLETE, GEAR REDUCER |
| | 351 | 1711606 | PLATE, NAME TAG G/R |
| | 352 | 1108210 | GASKET, HANDHOLE COVER |
| | 353 | 1108110 | COVER, HAND HOLE |
| | 354 | 1717881 | PINION,HS 6.200 PD,4.84 WIDE |
| | 356 | ZT3621 | BEARING, SINGLE ROW TAPERED |
| | 358 | 1713605 | CAP, PINION BRG OPEN |
| | 359 | 1713604 | CAP, HS, PINION BRG, BLIND |
| | 360 | 1713621 | RETAINER, G/R BRG J275 |
| | 361 | 1713628 | SHIM KIT, BEARING (GEAR REDUCER) |
| | 362 | 100-034234-290 | CAP SCREW, HEX HD, 3/4"-10UNC X 2 3/4" LG |
| | 363 | 45805430 | #10 TAPER PIN AND NUT |
| | 364 | 1713601 | COVER,G/R MACHINED,300Q |
| | 365 | 6581072 | PIN, TAPERED, GR TO PF |
| | 366 | 100-038034-290 | CAP SCREW, HEX HEAD, 3/8"-16UNC X 3/4" LG |
| | 370 | 170-114004-353 | PIPE PLUG |
| | 371 | 6829008 | ELBOW, STD 1" M.I. STREET 90 |
| | 375 | 1717882 | GEAR,30.0 PD WIDE F/ |
| | 377 | 1713625 | SHIM, BRG RETAINER .005 |
| | 378 | 1713627 | SHIM, BRG RETAINER .007 |
| | 379 | 1713620 | SHIM, BRG RETAINER .020 |
| | 399 | 7815059 | PLUG, MAGNETIC DRAIN 1-1/4 405 |
| | 401 | 1713016P | OIL TROUGH, CRANKSHAFT |
| | 509 | 1716019 | RING, SNAP, MAIN BEARING |
| | 510 | 1716018 | RING, SNAP, |
| | 520 | 1790080 | BUMPER, VALVE PULLER |
| | 521 | 1790082 | WRENCH VALVE SPRING RETAINER |
| | 522 | 705509101 | SCREW, FILLISTER HEAD, #10-24UNC |
| | 523 | 1790044 | MAGNET |
| | 526 | 1790033 | RETRIEVER |
| | 527 | 7817130 | ROD, THREADED, 1"-8UNC |
| | 528 | 1790035 | HANDLE, SEAT REMOVAL & INSTALL TOOL |
| | 530 | 1790038 | HEAD, SEAT INSTALL AND REMOVAL TOOL |
| | 531 | 1710250 | BAR, ONLY BUMPING |
| | 540 | 1716911 | PLT,PUMP MTG,PLGR LUBE,5" PUMP |
| | 541 | 7811075 | LUBRICATOR, 5 FEED LH |
| | 541 | 7811073 | LUBRICATOR, 5 FEED |
| | 543 | 64226988 | MALE ELBOW |
| | 544 | 104-038400-286 | STUD, ALL THREAD |
| | 545 | 154-038068-286 | WASHER, LOCK, ZINC PLTD (CFS) |

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| | 546 | 155-038100-286 | WASHER,PLAIN (CFS) |
| | 547 | 133-038016-286 | NUT, ZINC PLTD (CFS) |
| | 548 | 100-012200-290 | CAP SCREW x 4 |
| | 549 | 1716912 | GUARD,BELT,PLGR LUB, 5"PUMP |
| | 550 | 100-058100-290 | CAP SCREW x 2 |
| | 551 | 7200020 | SHEAVE, 6.2 PD 1 A GRV W/ 5/8 |
| | 552 | 7027208 | SCREW, HEX SOCKET HD CUP PT SE |
| | 553 | 1713021 | SHEAVE, 6 IN PD CRANKSHAFT (View) |
| | 554 | 4712530 | V-BELT |
| | 555 | 1716914 | GUARD,C'SHAFT,PLGR LUBE,5"PUMP |
| | 556 | 100-058612-290 | CAP SCREW |
| | 557 | 330-002003-365 | TUBING 1/4 OD STNLS STL 035 WA x 504 |
| | 558 | 7802201 | CLIP, ADEL |
| | 560 | 49011837 | TEE |
| | 561 | 2402990 | KEY, 7/8 X 7/8 X 4 PLAIN |
| | 562 | 133-138006-286 | NUT, HEAVY HEX, 1 3/8"-6UNC |
| | 565 | 2404048 | KEY, 1-1/4 X 1-1/4 X 5-1/2 PLA |
| | 617 | 104-138712-286 | STUD, 1-3/8"-6 UNC X 7 1/2" LG |
| | 620 | 133-138006-286 | NUT, HVY HEX, 1-3/8-6UNC |
| | 625 | 1712033 | COVER, CYL TOP 415Q-5M |
| | 625 | 171207323 | VALVE COVER, DSS (415Q-5L) |
| | 625 | 170948423 | VALVE COVER, DSS 4A (415Q-5H) |
| | 625 | 171203323 | VALVE COVER, DSS 4A (415Q-5M) |
| | 625 | 17094842 | VALVE COVER, NAB (415Q-5H) |
| | 625 | 1712073 | VALVE COVER, NAB (415Q-5L) |
| | 626 | 1712373 | VALVE COVER SEAL (415Q-5H) |
| | 626 | 2410031429 | VALVE COVER SEAL (415Q-5L) |
| | 626 | 2410031345 | VALVE COVER SEAL (415Q-5M) |
| | 631 | 104-100334-286 | STUD |
| | 631 | 104-112512-186 | STUD |
| | 632 | 133-112006-286 | NUT, HVY HEX, 1 1/2-6UNC |
| | 632 | 133-100008-286 | NUT, HVY HEX, 1-8UNC |
| | 659 | 204-000063-214 | GASKET (415Q-5L) |
| | 659 | 200-045002-405 | RTJ GASKET, R45 (415Q-5M & 5H) |
| | 660 | 100-034200-290 | CAPSCREW, HEX HD (415Q-5L) |
| | 660 | 100-034312-290 | CAPSCREW, HEX HD (415Q-5M & 5H) |
| | 663 | 1713410 | SCREW, HX HEAD, CAGE LOADING 415Q-5H |
| | 673 | 200-026002-405 | R26 RING JOINT SEAL (415Q-5H) |
| | 673 | 200-035002-405 | R35 RING JOINT SEAL (415Q-5M) |
| | 673 | 200-037002-405 | R37 RING JOINT SEAL (415Q-5L) |
| | 674 | 100-100400-290 | CAP SCREW, HEX HD (415Q-5H) |
| | 674 | 100-078312-290 | CAP SCREW, HEX HD (415Q-5L) |
| | 674 | 100-118400-290 | CAP SCREW, HEX HD (415Q-5M) |
| | 680 | 340-019 | INTERMEDIATE ROD, CLMP |
| | 680 | 340-023 | INTERMEDIATE ROD, THD |
| | 681 | 1717016 | BAFFLE |
| | 685 | AAB-119199-405 | NAME PLATE |
| | 686 | 126-006516-405 | DRIVE SCREW, #6 X 5/16" (PFS) |
| | 689 | 6578016 | PIN, SPRING 1/8" (ANTI-ROTATION) |
| | 690 | 6572420 | PIN, SPRING 3/8" (CROSSHEAD LUBE) |
| | 691 | 6572016 | PIN, SPRING, 5/16" |
| | 692 | 6571216 | PIN, SPRING 3/16" |
| | 693 | 6541612 | PIN, USA TYPE "C" GROOVE 1/4 |

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| | 695 | L342-908 | STUFFING BOX, 1.88 - 2.00 PLGR (415Q-5H) |
| | 695 | 342-948 | STUFFING BOX, 2.13 PLGR (415Q-5H) |
| | 695 | 342-915 | STUFFING BOX, 2.25 - 2.50 PLGR (415Q-5H) |
| | 695 | 342-952 | STUFFING BOX, 2.63 PLGR (415Q-5M) |
| | 695 | 342-924 | STUFFING BOX, 2.75 - 3.00 PLGR (415Q-5M) |
| | 695 | 343-042 | STUFFING BOX, 3.13 - 3.25 PLGR (415Q-5M) |
| | 695 | 343-012 | STUFFING BOX, 3.38 - 3.50 PLGR (415Q-5L) |
| | 695 | 343-011 | STUFFING BOX, 3.63 - 3.75 PLGR (415Q-5L) |
| | 695 | 343-010 | STUFFING BOX, 3.88 - 4.00 PLGR (415Q-5L) |
| | 695 | 343-009 | STUFFING BOX, 4.13 - 4.25 PLGR (415Q-5L) |
| | 695 | 343-008 | STUFFING BOX, 4.38 - 4.50 PLGR (415Q-5L) |
| | 696 | 2410031342 | PACKING, RECT. 3.60X4.006X.20 (415Q-5M & 5H) |
| | 696 | 2410031347 | PACKING, RECT. 4.225X4.63X.20 (415Q-5L & 5M) |
| | 696 | 2410031334 | PACKING, RECT. 2.60X 3.00 X.20 (415Q-5H) |
| | 696 | 08423022 | STUFFING BOX GASKET (415Q-5L) |
| | 697 | L342-913 | NUT, ADJUSTING, 17-4, 1.50 - 2.13 PLUNGERS (415Q-5H) |
| | 697 | 342-916 | NUT, ADJUSTING, 17-4, 2.25 - 2.63 PLUNGERS (415Q-5M & 5H) |
| | 697 | 342-928 | NUT, ADJUSTING, 17-4, 2.63 - 3.00 PLUNGERS (415Q-5M) |
| | 697 | 342-927 | NUT, ADJUSTING, 17-4, 3.13 - 3.50 PLUNGERS (415Q-5L) |
| | 697 | 343-013 | NUT, ADJUSTING, 17-4, 3.38 - 4.50 PLUNGERS (415Q-5L) |
| | 697 | 343-091 | NUT, ADJUSTING, DPSS, 1.50-2.13 PLUNGERS (415Q-5H) |
| | 698 | 1710270 | BAR, STBX ADJUSTING NUT |
| | 699 | 1712326 | BAR, STBX ADJUSTING NUT |
| | 707 | L342-167 | GLAND,OUTER 1.88 PKG (415Q-5H) |
| | 707 | L342-168 | GLAND,OUTER 2.00 PKG (415Q-5H) |
| | 707 | 342-121 | GLAND,OUTER 2.12 PKG (415Q-5H) |
| | 707 | 342-005 | GLAND,OUTER 2.25 PKG (415Q-5M) |
| | 707 | 342-122 | GLAND,OUTER 2.38 PKG (415Q-5M) |
| | 707 | 342-006 | GLAND,OUTER 2.50 PKG (415Q-5M) |
| | 707 | 342-123 | GLAND,OUTER 2.62 PKG (415Q-5M) |
| | 707 | 342-022 | GLAND,OUTER 2.75 PKG (415Q-5M) |
| | 707 | 342-124 | GLAND,OUTER 2.88 PKG (415Q-5M) |
| | 707 | 342-023 | GLAND,OUTER 3.00 PKG (415Q-5M) |
| | 707 | 342-125 | GLAND,OUTER 3.13 PKG (415Q-5L & 5M) |
| | 707 | 343-044 | GLAND,OUTER 3.25 PKG (415Q-5L & 5M) |
| | 707 | 343-023 | GLAND,OUTER 3.38 PKG (415Q-5L) |
| | 707 | 343-022 | GLAND,OUTER 3.50 PKG (415Q-5L) |
| | 707 | 343-021 | GLAND,OUTER 3.63 PKG (415Q-5L) |
| | 707 | 343-020 | GLAND,OUTER 3.75 PKG (415Q-5L) |
| | 707 | 343-019 | GLAND,OUTER 3.88 PKG (415Q-5L) |
| | 707 | 343-018 | GLAND,OUTER 4.00 PKG (415Q-5L) |
| | 707 | 343-017 | GLAND,OUTER 4.13 PKG (415Q-5L) |
| | 707 | 343-016 | GLAND,OUTER 4.25 PKG (415Q-5L) |
| | 707 | 343-015 | GLAND,OUTER 4.38 PKG (415Q-5L) |
| | 707 | 342-174 | GLAND,OUTER 4.50 PKG (415Q-5L) |
| | 712 | 342-930 | PIN H LOCK STBX J100/165 |
| | 712 | 342-914 | PIN H LOCK STBX J30/60/100/165 |
| | 715 | 342-002 | SPRING FOLLOWER 2.50 X 3.25 BRS (415Q-5M) |
| | 715 | 342-014 | SPRING FOLLOWER 2.75 x 3.75 H PKGN (415Q-5M) |
| | 715 | 342-356 | SPRING FOLLOWER 2.88 H OUTR BRASS (415Q-5M) |
| | 715 | 342-015 | SPRING FOLLOWER 3.00 X 3.75 H PKGN (415Q-5M) |
| | 715 | 342-357 | SPRING FOLLOWER 3.13 X 4.13 KV (415Q-5L & 5M) |
| | 715 | 343-045 | SPRING FOLLOWER 3.25 X 4.13 (415Q-5L & 5M) |

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| | 715 | 343-039 | SPRING FOLLOWER 3.38 X 4.25 (415Q-5L) |
| | 715 | 342-028 | SPRING FOLLOWER 3.50 X 4.25 KV (415Q-5L) |
| | 715 | 343-038 | SPRING FOLLOWER 3.63 X 4.50 (415Q-5L) |
| | 715 | 343-041 | SPRING FOLLOWER 3.75 X 4.50 (415Q-5L) |
| | 715 | 343-037 | SPRING FOLLOWER 3.88 X 4.75 (415Q-5L) |
| | 715 | 342-360 | SPRING FOLLOWER 4.00 H OUTR BRASS (415Q-5L) |
| | 715 | 343-036 | SPRING FOLLOWER 4.13 X 5 (415Q-5L) |
| | 715 | 343-035 | SPRING FOLLOWER 4.25 X 5 (415Q-5L) |
| | 715 | 343-034 | SPRING FOLLOWER 4.38 X 5-1/4 (415Q-5L) |
| | 715 | 342-392 | SPRING FOLLOWER 4.50 H BRS360 (415Q-5L) |
| | 715 | 342-353 | SPRING FOLLOWER H 1.12 BRS360 (415Q-5H) |
| | 715 | L342-367 | SPRING FOLLOWER H 1.88 x 2.75 PKGN (415Q-5H) |
| | 715 | L342-368 | SPRING FOLLOWER H 2.00 x 2.75 PKGN (415Q-5H) |
| | 715 | 342-001/26 | SPRING FOLLOWER H 2.25 x 3.25 PKGN (415Q-5M & 5H) |
| | 715 | 342-354 | SPRING FOLLOWER H 2.38 BRS360 (415Q-5M) |
| | 715 | 342-355 | SPRING FOLLOWER H 2.62 BRS360 (415Q-5M) |
| | 718 | 1713834 | RETAINER, STUFFING BOX (415Q-5L & 5M) |
| | 718 | 1716034 | RETAINER, STUFFING BOX (415Q-5M) |
| | 718 | 17133041 | RETAINER, STUFFING BOX (415Q-5H) |
| | 719 | L342-260 | SPRING 1.88/2.00 PKG (415Q-5H) |
| | 719 | 342-000/26 | SPRING 2.25/2.50 PKG (415Q-5M & 5H) |
| | 719 | 342-270 | SPRING 2.63/2.88 PKG (415Q-5M) |
| | 719 | 342-008/26 | SPRING 2.75/3.00 PKG (415Q-5M) |
| | 719 | 342-268 | SPRING 3.13/3.38 PKG (415Q-5L & 5M) |
| | 719 | 342-007 | SPRING 3.25/3.50 PKG (415Q-5L) |
| | 719 | 343-025 | SPRING 3.63/3.75 PKG (415Q-5L) |
| | 719 | 342-269 | SPRING 3.75/4.00 PKG (415Q-5L) |
| | 719 | 343-024 | SPRING 4.13/4.25 PKG (415Q-5L) |
| | 719 | 342-272 | SPRING 4.25/4.50 PKG (415Q-5L) |
| | 745 | L340-147 | PLUNGER 1.88 TC CP NT 5.00 STK |
| | 745 | 1716054 | PLUNGER 2.00 CR CP NT 5.00 STK |
| | 745 | 1712039 | PLUNGER 2.00 CR TD NT 5.00 STK |
| | 745 | L340-148 | PLUNGER 2.00 TC CP NT 5.00 STK |
| | 745 | L340-188 | PLUNGER 2.00 TC TD NT 5.00 STK |
| | 745 | 340-200 | PLUNGER 2.13 TC CP NT 5.00 STK |
| | 745 | 340-149 | PLUNGER 2.25 TC CP NT 5.00 STK |
| | 745 | 340-201 | PLUNGER 2.38 TC CP NT 5.00 STK |
| | 745 | 340-150 | PLUNGER 2.50 TC CP NT 5.00 STK |
| | 745 | 340-202 | PLUNGER 2.63 TC CP NT 5.00 STK |
| | 745 | 340-011 | PLUNGER 2.75 TC CP NT 5.00 STK |
| | 745 | 340-296 | PLUNGER 2.88 TC CP NT 5.00 STK |
| | 745 | 340-012 | PLUNGER 3.00 TC CP NT 5.00 STK |
| | 745 | 340-295 | PLUNGER 3.12 TC CP NT 5.00 STK |
| | 745 | 1716063 | PLUNGER 3.25 CR CP NT 5.00 STK |
| | 745 | 340-004 | PLUNGER 3.25 TC CP NT 5.00 STK |
| | 745 | 340-281 | PLUNGER 3.38 TC CP NT 5.00 STK |
| | 745 | 1716064 | PLUNGER 3.50 CR CP NT 5.00 STK |
| | 745 | 340-197 | PLUNGER 3.50 TC TD NT 5.00 STK |
| | 745 | 340-010 | PLUNGER 3.50 TC CP NT 5.00 STK |
| | 745 | 340-282 | PLUNGER 3.63 TC CP NT 5.00 STK |
| | 745 | 340-203 | PLUNGER 3.75 TC CP NT 5.00 STK |
| | 745 | 340-283 | PLUNGER 3.88 TC CP NT 5.00 STK |
| | 745 | 340-204 | PLUNGER 4.00 TC CP NT 5.00 STK |

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| | 745 | 340-284 | PLUNGER 4.13 TC CP NT 5.00 STK |
| | 745 | 340-285 | PLUNGER 4.25 TC CP NT 5.00 STK |
| | 745 | 340-286 | PLUNGER 4.38 TC CP NT 5.00 STK |
| | 745 | 340-287 | PLUNGER 4.50 TC CP NT 5.00 STK |
| | 746 | 1716037 | CLAMP CPT PLGR |
| | 747 | 100-012300-290 | CAP SCREW, HEX HD, 1/2-13UNC X 3" LG (PLUNGER CLAMP) |
| | 748 | L342-907 | RETAINER ADAPTER, 2.50-2.75 SBX (415Q-5H) |
| | 748 | 342-958 | RETAINER ADAPTER, H RING (415Q-5H) |
| | 748 | 342-933 | RETAINER ADAPTER, H RING (415Q-5M & 5H) |
| | 800 | 6422322N858 | PKG SET 0858 2.00X2.75X2.25X1.44 (415Q-5H) |
| | 800 | 171619941 | PKG SET 1058-4 415Q-5 2.00 X 1 (415Q-5H) |
| | 800 | 6422343 | PKG SET 850N 3.50 X 4.25 X 1 (838) (415Q-5L) |
| | 800 | L342-767 | PKG SET H 1.88 X 2.75 J PUMPS (415Q-5H) |
| | 800 | 342-768 | PKG SET KEV/BRS 2.00X2.75X1.44 (415Q-5H) |
| | 800 | 342-751 | PKG SET KEV/BRS 2.13X2.88X1.44 (415Q-5H) |
| | 800 | 342-003 | PKG SET KEV/BRS 2.25X3.25X1.83 (415Q-5M & 5H) |
| | 800 | 342-752 | PKG SET KEV/BRS 2.38X3.25X1.65 (415Q-5M) |
| | 800 | 342-004 | PKG SET KEV/BRS 2.50X3.25X1.44 (415Q-5M) |
| | 800 | 342-753 | PKG SET KEV/BRS 2.63X3.63X1.83 (415Q-5M) |
| | 800 | 342-018 | PKG SET KEV/BRS 2.75X3.75X1.83 (415Q-5M) |
| | 800 | 342-754 | PKG SET KEV/BRS 2.88X3.75X1.64 (415Q-5M) |
| | 800 | 342-019 | PKG SET KEV/BRS 3.00X3.75X1.44 (415Q-5M) |
| | 800 | 342-755 | PKG SET KEV/BRS 3.13X4.13X1.83 (415Q-5L) |
| | 800 | 342-755 | PKG SET KEV/BRS 3.13X4.13X1.83 (415Q-5M) |
| | 800 | 342-843 | PKG SET KEV/BRS 3.25X4.13X1.65 (415Q-5L & 5M) |
| | 800 | 342-017 | PKG SET KEV/BRS 3.50X4.25X1.44 (415Q-5L) |
| | 800 | 343-032 | PKG SET KEV/BRS 3.63X4.25X1.65 (415Q-5L) |
| | 800 | 343-031 | PKG SET KEV/BRS 3.63X4.50X1.65 (415Q-5L) |
| | 800 | 343-040 | PKG SET KEV/BRS 3.75X4.50X1.44 (415Q-5L) |
| | 800 | 343-030 | PKG SET KEV/BRS 3.88X4.75X1.65 (415Q-5L) |
| | 800 | 342-758 | PKG SET KEV/BRS 4.00X4.75X1.44 (415Q-5L) |
| | 800 | 343-029 | PKG SET KEV/BRS 4.13X5.00X1.65 (415Q-5L) |
| | 800 | 343-028 | PKG SET KEV/BRS 4.25X5.00X1.44 (415Q-5L) |
| | 800 | 343-027 | PKG SET KEV/BRS 4.38X525X1.65 (415Q-5L) |
| | 800 | L342-790 | PKG SET KEV/BRS 4.50X5.25X1.44 (415Q-5L) |
| | 802 | 1712098 | WASHER, STD 3.50 X 4-1/4 850N x 2 (838) |
| | 850 | 345-067 | PK 1.88 TC TD KEVL 17-4 165T (415Q-5H) |
| | 850 | 345-031 | PK 1.88 TC CP KEVL 17-4 165T (415Q-5H) |
| | 850 | 345-114 | PK 2.00 TC CP KEVL 17-4 165T (415Q-5H) |
| | 850 | 347-125 | PK 2.00 TC CP KEVL DPSS 415Q (415Q-5H) |
| | 850 | 342-109 | PK 2.13 TC CP KEVL 17-4 165T (415Q-5H) |
| | 850 | 345-033 | PK 2.25 TC CP KEVL 17-4 165T (415Q-5M & 5H) |
| | 850 | 345-110 | PK 2.38 TC CP KEVL 17-4 165T (415Q-5M) |
| | 850 | 345-034 | PK 2.50 TC CP KEVL 17-4 165T (415Q-5M) |
| | 850 | 345-111 | PK 2.63 TC CP KEVL 17-4 165T (415Q-5M) |
| | 850 | 345-035 | PK 2.75 TC CP KEVL 17-4 165T (415Q-5M) |
| | 850 | 345-333 | PK 2.88 TC CP KEVL 17-4 165T (415Q-5M) |
| | 850 | 345-036 | PK 3.00 TC CP KEVL 17-4 165T (415Q-5M) |
| | 850 | 345-332 | PK 3.13 TC CP KEVL 17-4 415Q (415Q-5M) |
| | 850 | 345-351 | PK 3.25 CR CL KEVL 17-4 415Q (415Q-5M) |
| | 850 | 345-331 | PK 3.25 TC CL KEVL 17-4 250T (415Q-5M) |
| | 850 | 345-219 | PK 3.38 TC CP KEVL 17-4 415Q (415Q-5L) |
| | 850 | 347-038 | PK 3.50 CR CP KEVL 17-4 415Q (415Q-5L) |

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| | 850 | 345-218 | PK 3.50 TC CP KEVL 17-4 415Q (415Q-5L) |
| | 850 | 345-107 | PK 3.50 TC TD KEVL 17-4 415Q (415Q-5L) |
| | 850 | 345-217 | PK 3.63 TC CP KEVL 17-4 415Q (415Q-5L) |
| | 850 | 347-046 | PK 3.75 CR TD KEVL 17-4 415Q (415Q-5L) |
| | 850 | 345-216 | PK 3.75 TC CP KEVL 17-4 415Q (415Q-5L) |
| | 850 | 345-215 | PK 3.88 TC CP KEVL 17-4 415Q (415Q-5L) |
| | 850 | 345-214 | PK 4.00 TC CP KELV 17-4 415Q (415Q-5L) |
| | 850 | 345-213 | PK 4.13 TC CP KEVL 17-4 415Q (415Q-5L) |
| | 850 | 345-212 | PK 4.25 TC CP KEVL 17-4 415Q (415Q-5L) |
| | 850 | 345-211 | PK 4.38 TC CP KELV 17-4 415Q (415Q-5L) |
| | 850 | 345-210 | PK 4.50 TC CP KEVL 17-4 415Q (415Q-5L) |
| | 887 | 181205709 | SPACER, VALVE TOOL, L FLUID ENDS |
| | 888 | 1790034 | RETRIEVER, CPT BALL & DISC |
| | 890 | 1793007 | KIT, 3" VALVE SEAT PULLER |
| | 890 | 1794007 | KIT, 4" SEAT PULLER, 415Q-5L & 5M |
| | 890 | 1712342 | KIT, VALVE SERVICE TOOL,CAGE TYPE, 415Q-5H |
| | 891 | 1713109 | SUPPORT, VALVE PULLER |
| | 892 | 1790042 | TOOL, SEAT INST & REM |
| | 893 | 20220194 | WASHER |
| | 895 | 1790081 | BAR, VALVE PULLER BUMPER |
| | 895 | 20220159 | BOLT-PULLER 1"-8 TPI 33" LONG |
| | 896 | 1794006 | 4" VALVE SEAT PULLER |
| | 896 | 181259300 | HEAD, 2.00" ID SEAT PULLER |
| | 896 | 1794006 | HEAD, 4" VALVE SEAT PULLER |
| | 896 | 181259409 | PULLER HEAD, F/SPHER. VALVE |
| | 897 | 1712242 | BAR, CPT BUMPING CAGE TYPE |
| | 898 | 1712263 | PLATE, BUMPING BAR INSERT PO-H |
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