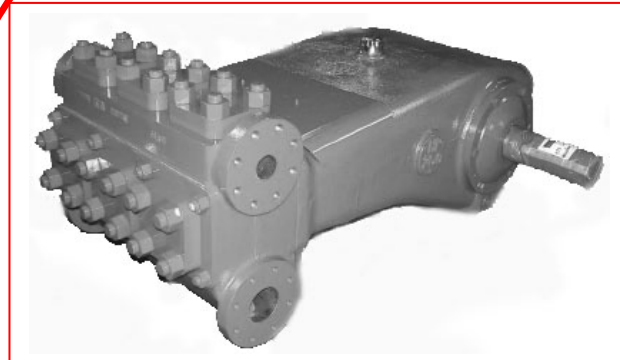
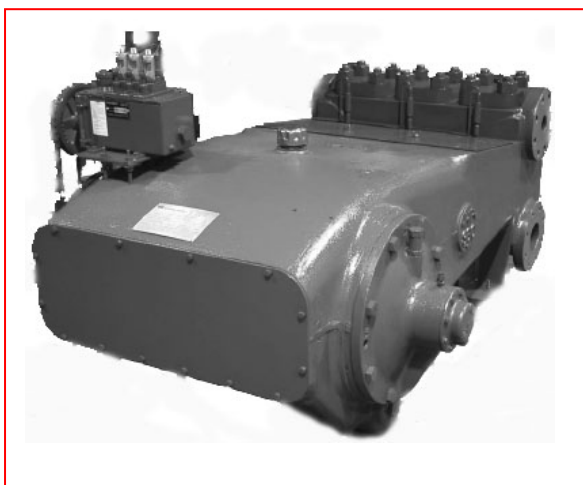


Multiplex Plunger Pumps

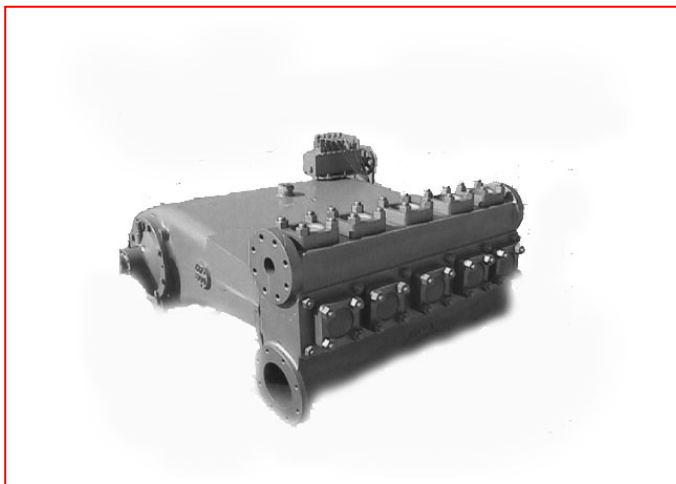
Installation, Care and Operation Manual



184T-7



308T-7



543Q-7

Covering the following pumps:

**184T-7
308T-7
543Q-7**

Sales / Technical Information

**USA Tollfree: 1 (800) 324-4706
Phone: 1 (918) 447-4600
Fax: 1 (918) 447-4677
Internet: <http://www.nov.com>**



NATIONAL OILWELL VARCO

**SUPPLEMENT FOR
ALL PUMP MANUALS**

! WARNING !

PRESSURE

RELIEF

VALVES

! NOTICE !

Our technical publications relative to reciprocating pumps state that pressure relief valves must be installed in the discharge systems from these units. This supplement is issued to emphasize the importance of relieving the discharge system of all pressure which exceeds the rated working pressure applied by the manufacturer to the specific pistons and liners (or plungers and packing) in any particular unit.



For the protection of persons and property the discharge system from each Reciprocating Pump must be equipped with a device which relieves the system of all pressures which exceed the pressure rating applied by the manufacturer to each particular piston or plunger diameter. Allowances will be made for pressure surges which are inherent with the reciprocating action of piston and plunger pumps. The percentage of pressure allowance appears later in this publication and in the "Standards of the Hydraulic Institute" (13th edition).

The relieving device must provide for instantaneous pressure relief, it may be a valve designed for automatic or manual resetting; however, if preferred, rupture discs or burst discs may be installed.

FAILURE to comply with the procedures outlined in the Warning may result in damage to the pump and related equipment and more importantly may cause serious bodily injury or death!

THE PRESSURE RELIEF VALVE:

1. This valve must be a full opening type.
2. It must have a working pressure rating, equal to or greater than, the maximum working pressure of the pump.
3. The through capacity of the valve, when fully opened, must be sufficient to relieve the full capacity of the pump without excessive overpressure.
3. The relief valve must be between the pump fluid end and any valve in the discharge system.
4. There must be no restricting device(s) between the relief valve and the pump fluid end.

RUPTURE DISC OR BURST DISC:

1. These discs must have a diameter which is not less than the pipe size of the pressure relief flange.
2. These discs must have a rupture or burst pressure rating consistent with the specifications tabulated later in this publication.
1. The relief valve discharge line should not terminate in the pump suction line.
2. The line should terminate in the supply tank, if possible.
3. The line must be securely anchored.
4. The line must be the same pipe size as, or may be larger than, the discharge connection on the relief valve.
5. If the line is of great length, this must be taken into consideration in sizing the relief valve.
6. There must be no restrictions or valves in the relief valve discharge line.

LOCATION OF THE RELIEF VALVE:

1. The relief valve must be placed in the discharge line as close as possible to the pump fluid end or it may be mounted on the pump discharge manifold.
2. The relief valve must be on the pump side of any discharge strainer.

NOTE: Follow the foregoing instructions if rupture discs or burst discs are installed.

SUGGESTED SET PRESSURES FOR THE PUMP RELIEF VALVES:

PUMP TYPE:

Double Acting – Duplex
Double Acting – Triplex
Double Acting – Quintuplex
Single Acting – Triplex
Single Acting – Simplex
Single Acting – Duplex
Single Acting – Triplex
Single Acting – Quintuplex
Single Acting – Septuplex

Note: The above set pressures are to be observed when installing rupture discs or burst discs.

OPERATING PUMP PRESSURE:

Piston Pressure Rating – Plus 25%
Piston Pressure Rating – Plus 10%
Piston Pressure Rating – Plus 10%
Piston Pressure Rating – Plus 10%
Plunger Pressure Rating – Plus 25%
Plunger Pressure Rating – Plus 20%
Plunger Pressure Rating – Plus 10%
Plunger Pressure Rating – Plus 10%

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 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, beginning at the left side of the pump.

! 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.

 **! ATTENTION !** **PUMP NOMENCLATURE:**

ALL PUMP SIZES WITHIN THIS MANUAL WILL BE DESCRIBED WITH THE NEW OR CURRENT NOMENCLATURE. THE OLD PUMP NOMENCLATURES DESCRIBED ON THE FRONT COVER, BUT NOT INCLUDED IN THIS MANUAL EXCEPT AS NEEDED, ARE TO BE UNDERSTOOD AS BEING INCLUDED WITH THE NEW NOMENCLATURES.

 **! WARNING ! WARNING ! WARNING !** **BEFORE SERVICING PUMPS:**

1. SHUT DOWN AND LOCK OUT 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.

! WARNING!

For the protection of persons and property, the discharge system from each Reciprocating Pump must be equipped with a device which relieves the system of all pressures which exceed the pressure rating applied by the manufacturer to each particular piston or plunger diameter. Allowances will be made for pressure surges which are inherent with the reciprocating action of piston and plunger pumps. The percentage of pressure allowance appears later in this publication and in the "Standards of the Hydraulic Institute" (13th edition).

The relieving device must provide for instantaneous pressure relief, it may be a valve designed for automatic or manual resetting; however, if preferred, rupture discs or burst discs may be installed.

FAILURE to comply with the procedures outlined in the Warning may result in damage to the pump and related equipment and more importantly may cause serious bodily injury or death!

THE PRESSURE RELIEF VALVE:

1. This valve must be a full opening type.
2. It must have a working pressure rating, equal to or greater than, the maximum working pressure of the pump.
3. The through capacity of the valve, when fully opened, must be sufficient to relieve the full capacity of the pump without excessive overpressure.
3. The relief valve must be between the pump fluid end and any valve in the discharge system.
4. There must be no restricting device(s) between the relief valve and the pump fluid end.

THE RELIEF VALVE DISCHARGE LINE:

1. The relief valve discharge line should not terminate in the pump suction line.
2. The line should terminate in the supply tank, if possible.
3. The line must be securely anchored.
4. The line must be the same pipe size as, or may be larger than, the discharge connection on the relief valve.
5. If the line is of great length, this must be taken into consideration in sizing the relief valve.
6. There must be no restrictions or valves in the relief valve discharge line.

RUPTURE DISC OR BURST DISC:

1. These discs must have a diameter which is not less than the pipe size of the pressure relief flange.
2. These discs must have a rupture or burst pressure rating consistent with the specifications tabulated later in this publication.

LOCATION OF THE RELIEF VALVE:

1. The relief valve must be placed in the discharge line as close as possible to the pump fluid end or it may be mounted on the pump discharge manifold.
2. The relief valve must be on the pump side of any discharge strainer.

NOTE: Follow the foregoing instructions if rupture discs or burst discs are installed.

SUGGESTED SET PRESSURES FOR THE PUMP RELIEF VALVES:**PUMP TYPE**

Double Acting – Duplex
Double Acting – Triplex
Double Acting – Quintuplex
Single Acting – Triplex
Single Acting – Simplex
Single Acting – Duplex
Single Acting - Triplex
Single Acting – Quintuplex
Single Acting – Septuplex

PUMP OPERATING PRESSURE:

Piston Pressure Rating – Plus 25%
Piston Pressure Rating – Plus 10%
Piston Pressure Rating – Pulse 10%
Piston Pressure Rating – Plus 10%
Plunger Pressure Rating – Plus 25%
Plunger Pressure Rating – Plus 20%
Plunger Pressure Rating – Plus 10%
Plunger Pressure Rating – Plus 10%
Plunger Pressure Rating – Plus 10%

Note: The above set pressures are to be observed when installing rupture discs or burst discs.

Plunger Pump Nomenclature Example....

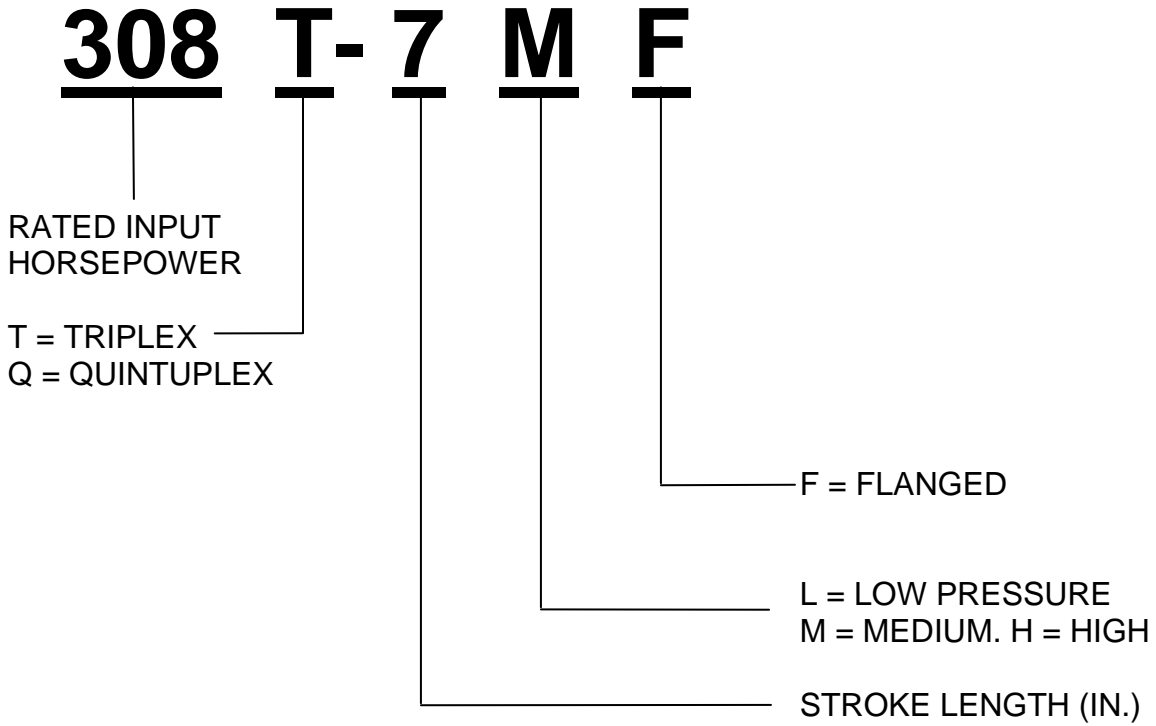


Table of Contents...

INSTALLATION

	<u>PAGE</u>
I. GENERAL	
A. Suction Line	11
B. Discharge Line	11-12
C. Power End	12
D. Fluid End.....	12
E. Plunger Packing.....	13
F. Plunger Packing Lubrication	13

LUBRICATION

I. GENERAL	
A. Oil.....	13

OPERATION

I. GENERAL	
A. Operation Check List	14

MAINTENANCE

I. GENERAL	
A. Daily Maintenance	15
B. Monthly Maintenance.....	15
C. Storage	16
D. Start-Up After Storage	16
II. TROUBLE SHOOTING GUIDE.....	17-18

OVERHAUL AND REPAIR

I. GENERAL	
A. Tools Required.....	19
B. Check Points and Adjustments	19-20
C. Dimensional Checks and Clearances.....	20-21
D. Fastener Torque	22

Table of Contents (Continued)...

DISASSEMBLY

	<u>PAGE</u>
I. POWER END	
A. Plunger/Intermediate Rods and Power End Stuffing Boxes	
"XL", "L", and "M" Fluid End	23-24
"H" Fluid End.....	24
B. Crankshaft Assembly	
184T-7 & 308T-7.....	25-26
543Q-7	26
C. Crankshaft Bearings (All Pumps)	27-31
D. Lubrication Oil Pump (All Pumps).....	32-33
II. FLUID END	
A. Fluid Cylinder Removal	
All Pumps	34
B. Plunger Removal	
All Pumps	35
C. Stuffing Box Removal	
All Pumps	36
D. Fluid End Valve Removal	36

ASSEMBLY

I. POWER END	
A. Connecting Rod and Crosshead Assembly	
Bronze Wrist Pin Bushing	37
Roller Bearing Wrist Pin Bearing	38
B. Crankshaft Main Bearings and Center Support Bearings	
184T-7, 308T-7.....	39-40
543Q-7	40-42
C. Connecting Rod to Crankshaft Assembly	
All Pumps	42-43
D. Intermediate Rods and Power End Stuffing Boxes	
All Pumps	43-44

Table of Contents...

ASSEMBLY (Continued)...

	<u>PAGE</u>
II. FLUID END	
A. Stuffing Boxes and Plungers	
“XL” Fluid End	45
“L” and “M” Fluid End cylinder	46
“H” Fluid End	47
Stuffing Box Torques	47
B. Fluid Cylinders	
“XL” Fluid Cylinder	48
“L” and “M” Fluid Cylinders	49
“H” Fluid Cylinders	50
All Pumps	51
C. Fluid Valves – Tapered Seat Type	
All Pumps	51
D. Piping Installation	
All Pumps	51
E. Plunger Packing Installation	
1. 838 Packing	52-53
2. Braid Packing	54-55
3. 1068-4 Spring Loaded Packing	56-57

PLUNGER PUMP VALVES

I. OPERATIONAL MAINTENANCE

A. Suction and discharge	58
B. Valve Covers	58
C. Valve Cover and Cylinder Head Cover Seals	58
D. Valve Springs	58
E. Valve and Seat	58

Table of Contents...

PLUNGER PUMP VALVES (Continued)...

	<u>PAGE</u>
II. TAPERED SEAT VALVES	
A. Severe Duty Type Valves	
1. Nomenclature	59
2. Valve Removal Procedures	60
3. Valve Parts Inspection	61-62
4. Valve Installation Procedures	62-63
B. Disc Tapered Seat Valves	
1. Nomenclature	64
2. Valve Removal Procedures	65
3. Valve Parts Inspection	66
4. Valve Installation Procedure	66-67
C. Spherical Valves	
1. Nomenclature	68
2. Valve Removal Procedure	69
3. Valve Parts Inspection	70
4. Valve Installation Procedure	71
D. Spherical Valves – Severe Duty	
1. Nomenclature	72
2. Valve Removal Procedure	73
3. Valve Parts Inspection	74
4. Valve Installation Procedure	75

P-55U LUBRICATOR

I. PUMP OPERATING INSTRUCTIONS

A. Operating Instructions	76
1. Box Suction Pumps	76
2. Flow Rate Adjustment.....	76
3. Sight Glass	76
4. Overfilling of Sight Glass	76
5. Reservoir Oil Level	76
6. Pump Displacement.....	76

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 plant. 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° ells 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. SUCTION LINE

1. The suction line must not be smaller than the suction intake of the fluid cylinder 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.
2. When bends are required, they should be made with long radius 45° ells. Do not use a bend directly adjacent to the fluid cylinder. Avoid using any 90° bends 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.

B. 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 cylinder 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° ell. Do not use a bend directly adjacent to the fluid cylinder, particularly a 90° bend.

Installation...

I. GENERAL

B. DISCHARGE LINE (Continued)...

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 25% 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.

C. POWER END

1. The pump must be mounted level, grouted in, and 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, place the pump in a strain, 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 Thomas Flexible 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 proper oil (see page 13) 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.

D. FLUID END

1. The fluid cylinder is shipped assembled to the pump complete with valves and cover plates. 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.

Installation...

I. GENERAL (Continued)...

E. 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 "Assembly, Fluid End, Plunger Packing Installation" in this manual for correct procedure of packing used.

F. PLUNGER PACKING LUBRICATION

1. Automatic packing lubricators are beneficial on all installations and are required on pumps operating at high pressure (1200 psi [85kg/cm²] 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 feed 5 to 7 drops per minute.

Lubrication...

I. GENERAL

NATIONAL OILWELL VARCO model 184T-7, 308T-7, and 543Q-7 multiplex pumps are pressure lubricated via a gear pump direct driven by the crankshaft. The gear pump provides oil to the crankshaft, connecting rod bearings and crosshead pin bushings. The main bearings and crossheads are splash lubricated from the main oil reservoir and crosshead oil reservoir.

A. OIL

Use "extreme pressure" gear oil. The chart below shows the recommended grades for various ambient temperatures.

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 - Gallons: 184T-7 - 17 308T-7 - 19 543Q-7 - 25

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: 184T-7 – 64.3 308T-7 – 71.9 543Q-7 – 94.6

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

Operation...

I. GENERAL



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

A. 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 page 13).
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 by-pass 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 (refer to "Assembly, Fluid End, Plunger Packing Installation" in this manual).
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 fasteners holding the cylinder in place are tight.

Maintenance...

I. GENERAL

The following points are intended as a guide to be used in setting up a maintenance program. Good preventive maintenance will pay big dividends in the form of reliable service with a minimum of trouble.

A. DAILY MAINTENANCE

1. Check power end oil level daily. Do not attempt to check the oil with the pump running. Inspect the oil for dirt or contamination and change if necessary. An increase in oil level indicates fluid leakage into power end. Change oil immediately and check intermediate rod wipers and surface smoothness of rod.
2. Lubricate 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 at pressures above 1200 psi. Use an alternate packing lubricator to drip the proper oil on the plunger for lubrication.
3. Check lubricator for proper level and operation.
4. Check plunger packing for excessive leakage. Replace packing as required.
5. Check stuffing box adjusting nuts for tightness.
6. Drain plunger leakage sump tanks if required.
7. Flush plunger chamber drain lines with kerosene on power oil pumps and fresh water on salt pumps. This may be done weekly unless salt and paraffin accumulation is severe.
8. Make sure suction and discharge line valves are fully open.
9. Check for leakage between the fluid cylinder and frame or stuffing box to fluid cylinder packing if required.
10. Check all seals for leakage.
11. Check belts or clutch for slippage. If either condition exists, correct immediately.

B. MONTHLY MAINTENANCE

1. Drain and refill crankcase every six (6) months or as often as required to maintain a clean, sludge-free oil of the proper viscosity.
2. Clean crankcase air breather with a non-explosive solvent.
3. Check all studs, nuts and capscrews for tightness. Inspect gaskets for leaks. Tighten or replace as required.
4. Clean pump. Good housekeeping is a prerequisite to good maintenance.

Maintenance...

I. GENERAL (Continued)...

C. STORAGE

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

1. Drain and clean crankcase thoroughly. Leave drain open and install 90° elbow, pointing downward, to permit air circulation and prevent condensation build-up.
2. Coat all bearings, finished surfaces, and entire inside surface of crankcase with a rust inhibiting oil.
3. Remove plungers and packing, clean and coat with rust inhibiting oil.
4. Remove fluid cylinder valves allowing cylinder to be thoroughly cleaned and drained.
5. Coat entire cylinder, valves and parts, with a rust inhibiting oil.
6. Thoroughly inspect pump and rotate crankcase once each month. Re-coat with rust inhibiting oil where necessary.

D. START-UP 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 properly in place.



FAILURE TO OBSERVE THE FOLLOWING POINTS CAN RESULT IN SERIOUS DAMAGE.

1. Remove all covers on both power end and fluid end; thoroughly clean and inspect all parts and finished surfaces.
2. Check all bearings to make sure they are clean and in good condition.
3. Make sure valves, plungers and packing are properly installed and in good condition.
4. Carefully tighten all bolts, nuts, studs and working connections.
5. Fill power end to the proper level with clean oil of the proper viscosity. Make sure oil is poured into the crosshead reservoir and is worked into all bearings.
6. Fill packing lubricator and pump lines full. Check by breaking connection at stuffing box, working lubricator plunger until oil appears.

Maintenance (Continued)...

II. TROUBLE SHOOTING GUIDE

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 DAMPENOR 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 BREAKOUT 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.
	KNOCK IN POWER END	LEAKAGE PRESSURE RELIEF VALVE THAT HAS BEEN PIPED BACK INTO 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.
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.

Maintenance...

II. TROUBLE SHOOTING GUIDE (Continued)...

PROBLEM	POSSIBLE CAUSE	CORRECTION
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 SHUTDOWN 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.	
BROKEN OR PITTED FROM IMPLOSIONS CAUSED BY EXCESSIVE GAS OR AIR ENTRAINMENT IN 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 ANY EXCESSIVE GAS OR AIR ENTRAINMENT IN FLUID.	CHANGE SUCTION SYSTEM TO ELIMINATE OR CHECK WITH MANUFACTURER 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 MANUFACTURER 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.

Overhaul and Repair...

I. GENERAL

The bearings and other working parts in the power end have been designed for continuous duty, and if properly lubricated, will provide years of trouble-free service. However, after the pump has been in service for a long period of time, the bearings and other working parts will gradually loosen, and if not corrected, will lead to more serious trouble. The time to overhaul the pump will vary depending on the operating conditions and is therefore a matter that must be left to the good judgment of the operator. Complete disassembly and assembly procedures are discussed in their respective sections.

A. TOOLS REQUIRED

Most of the tools required to overhaul the pump will be found in an ordinary set of mechanics hand tools. The special tools and equipment required and not furnished with the pump include a torque wrench, bearing puller, and a valve servicing kit. Also, a hot oil bath capable of reaching a temperature of 300° F (149° C) will be needed.

B. CHECK POINTS AND ADJUSTMENTS

1. 184T-7 and 308T-7:

The 184T-7 and 308T-7 have two single row, shim adjusted, tapered roller end bearings. They have been assembled and adjusted at the factory with proper clearance and will give long trouble-free service. The proper crankshaft end clearance is found by adjusting the amount of shims on the end bearing housing until the crankshaft has .005" to .007" (.127 mm to .178 mm) endplay and will rotate freely.

2. 543Q-7:

The 543Q-7 has two single row, shim adjusted, tapered roller end bearings and two cylindrical roller center main bearings. The internal clearance of the bearings has been set at the factory and there is no adjustment needed. The crankshaft end clearance is found by adjusting the amount of shims on the end bearing housing until the crankshaft has .008" to .010" (.203 mm to .254 mm) endplay and will rotate freely.

3. 184T-7:

- a. The connecting rod shell bearings or inserts are precision made and adjustable by use of shims. Tolerances are listed on the following page.
- b. The normal clearance between the crosshead and crosshead bore is .006" (.152 mm) to .012" (.305 mm). The maximum allowable clearance, including wear, is .018" (.457 mm).
- c. The wrist pin bushings must be pressed into the connecting rods and reamed to size. The allowable clearance between the pin and bushing is listed on the following page.

4. 308T-7 and 573Q-7:

- a. The connecting rod shell bearings or inserts are precision made and adjustable by use of shims. Tolerances are listed on the following page.
- b. The normal clearance between the crosshead and crosshead bore is .006" (.152 mm) to .014" (.356 mm). The maximum allowable clearance, including wear, is .020" (.508 mm).

Overhaul and Repair...

I. GENERAL

B. CHECK POINTS AND ADJUSTMENTS (Continued)...

- c. The wrist pin bushings must be pressed into the connecting rods and reamed to size. The allowable clearance between the pin and bushing is listed in the following tables.

C. DIMENSIONAL CHECKS AND CLEARANCES

SHELL BEARING CLEARANCE						
PUMP	CRANKSHAFT PIN O.D.		MAXIMUM CLEARANCE		MINIMUM CLEARANCE	
	in	mm	in	mm	in	mm
184T-7	<u>4.502</u>	<u>114.351</u>	.007	.178	.005	.127
	4.499	114.275				
308T-7	<u>5.500</u>	<u>139.700</u>	.008	.203	.006	.152
	5.499	139.675				
543Q-7	<u>5.500</u>	<u>139.700</u>	.008	.203	.006	.152
	5.499	139.675				

WRIST PIN CLEARANCE						
PUMP	CROSSHEAD PIN O.D.		MAXIMUM CLEARANCE		MINIMUM CLEARANCE	
	in	mm	in	mm	in	mm
184T-7	<u>2.7500</u>	<u>69.850</u>	.004	.102	.002	.051
	2.7495	69.837				
308T-7	<u>3.2500</u>	<u>82.550</u>	.006	.152	.003	.076
	3.2495	82.537				
543Q-7	<u>3.2500</u>	<u>82.550</u>	.006	.152	.003	.076
	3.2495	82.537				

PUMP	CRANKSHAFT END BEARING O.D.	
	in	mm
184T-7	<u>5.0045</u>	<u>127.114</u>
	5.0025	127.064
308T-7	<u>6.8795</u>	<u>174.739</u>
	6.8770	174.676

PUMP	CRANKSHAFT END BEARING O.D.		CRANKSHAFT CENTER MAIN O.D.	
	in	mm	in	mm
543Q-7	<u>6.8795</u>	<u>174.739</u>	<u>13.003</u>	<u>330.276</u>
	6.8770	174.676	13.002	330.251

Overhaul and Repair...

I. GENERAL

C. DIMENSIONAL CHECKS AND CLEARANCES (Continued)...

CROSSHEAD/POWER FRAME CLEARANCE						
PUMP	POWER FRAME CROSSHEAD BORE I.D.		CROSSHEAD/POWER FRAME MAXIMUM CLEARANCE		CROSSHEAD/POWER FRAME MINIMUM CLEARANCE	
	in	mm	in	mm	in	mm
184T-7	<u>7.503</u> 7.500	<u>190.576</u> 190.500	.012	.305	.006	.152
308T-7	<u>8.755</u> 8.750	<u>222.377</u> 222.250	.014	.356	.006	.152
543Q-7	<u>8.755</u> 8.750	<u>222.377</u> 222.250	.014	.356	.006	.152

PUMP	POWER FRAME OUTER MAIN BEARING BORE I.D.		POWER FRAME INNER MAIN BEARING BORE I.D.	
	in	mm	in	mm
184T-7	<u>12.500</u> 12.502	<u>317.500</u> 317.551	NA	NA
308T-7	<u>14.500</u> 14.502	<u>368.300</u> 368.351	NA	NA
543Q-7	<u>14.500</u> 14.502	<u>368.300</u> 368.351	<u>17.246</u> 17.248	<u>438.048</u> 438.099

PUMP	CROSSHEAD O.D.		CROSSHEAD PIN BORE I.D.	
	in	mm	in	mm
184T-7	<u>7.494</u> 7.491	<u>190.348</u> 190.271	<u>2.748</u> 2.749	<u>69.799</u> 69.825
308T-7	<u>8.744</u> 8.741	<u>222.098</u> 222.021	<u>3.248</u> 3.249	<u>82.499</u> 82.525
543Q-7	<u>8.744</u> 8.741	<u>222.098</u> 222.021	<u>3.248</u> 3.249	<u>82.499</u> 82.525

CRANKSHAFT END PLAY				
PUMP	CRANKSHAFT END PLAY MINIMUM		CRANKSHAFT END PLAY MAXIMUM	
	in	mm	in	mm
184T-7	.005	.127	.007	.178
308T-7	.005	.127	.007	.178
543Q-7	.008	.203	.010	.254

Overhaul and Repair...

I. GENERAL (Continued)...

D. FASTENER TORQUE

POWER END FASTENER TORQUES				
MODEL	FASTENER	SIZE	TORQUE (ft.-lbs.)	TORQUE (N-M)
184T-7	Connecting Rod	5/8"-11 UNC	120-145	163-197
184T-7	Main Bearing Housing	3/4"-10 UNC	150	203
308T-7, 543Q-7	Connecting Rod	3/4"-16 UNF	190-210	258-285
308T-7, 543Q-7	Main Bearing Housing	7/8"-9 UNC	200	271
ALL "H" Class	Power Frame Adapter	1"-8 UNC	250	339
ALL	Intermediate Rod to Crosshead	1-1/8"-7 UNC	275	373
ALL	Tuthill Lube Pump	5/16"-18 UNC	17	23
ALL	Power End Stuffing Box	3/8"-16 UNC	45	61
ALL	Others	3/8"-16 UNC	30	41

FLUID END FASTENER TORQUES				
MODEL	FASTENER	SIZE	TORQUE (ft.-lbs.)	TORQUE (N-M)
XL	Fluid End to Power End Attaching Stud	1"-8 UNC	250	339
XL	Valve Cover and Cylinder Cover	1"-8 UNC	250	339
XL	Stuffing Box To Fluid End	3/8"-16 UNC	45	61
XL	Disc Valve Retainer	3/4"-10 UNC	100	136
L and M	Fluid End to Power End Attaching Stud	1"-8 UNC	300	410
L	Valve Cover and Cylinder Cover	1-1/8"-7 UNC	475	644
L	Stuffing Box To Fluid End	5/8"-11 UNC	95	130
L	Disc Valve Retainer	5/8"-11 UNC	55	75
L	Suction Manifold (Block Fluid End)	5/8"-11 UNC	130	176
M	Valve Cover and Cylinder Cover	1-1/2"-6 UNC	1060	1437
M	Stuffing Box To Fluid End	7/8"-9 UNC	200	270
M	Disc Valve Retainer	1/2"-13 UNC	30	41
M	Suction Manifold (Block Fluid End)	3/4"-10 UNC	150	203
H	Power Frame to Fluid End	1/2"-13 UNC	60	80
H	Clamp Ring To Fluid End	7/8"-9 UNC	200	270
H	Valve Cover	1-1/4"-7 UNC	660	895
H	Disc Valve Retainer	1/2"-13 UNC	30	41
H	Power Frame Adapter	1"-8 UNC	250	339
H	Suction Manifold	3/4"-10 UNC	150	203
ALL	Plunger to Intermediate Rod	1"-8 UNC	250	339

Disassembly...

I. POWER END

It is not necessary to remove the fluid end when disassembling the power end. However, the plungers should be removed.



POWER END DISASSEMBLY AND OVERHAUL IS BEST PERFORMED IN A WELL EQUIPPED SHOP ENVIRONMENT. IF THE PUMP IS DISASSEMBLED AT LOCATION ENSURE THE PRESSURE HAS BEEN REMOVED FROM THE FLUID END AND THE PUMP BLOCKED OUT WITH APPROPRIATE BLOCK VALVES. ENSURE THE FLUID END IS DRAINED AND ANY POWER SOURCE OR DRIVER IS LOCKED OUT BEFORE PROCEEDING!

A. PLUNGER/INTERMEDIATE RODS AND POWER END STUFFING BOXES

- **“XL”, “L”, and “M” Model**
 1. Remove the fluid end cylinder head.
 2. Remove the cradle cover.
 3. Loosen the packing gland nuts.

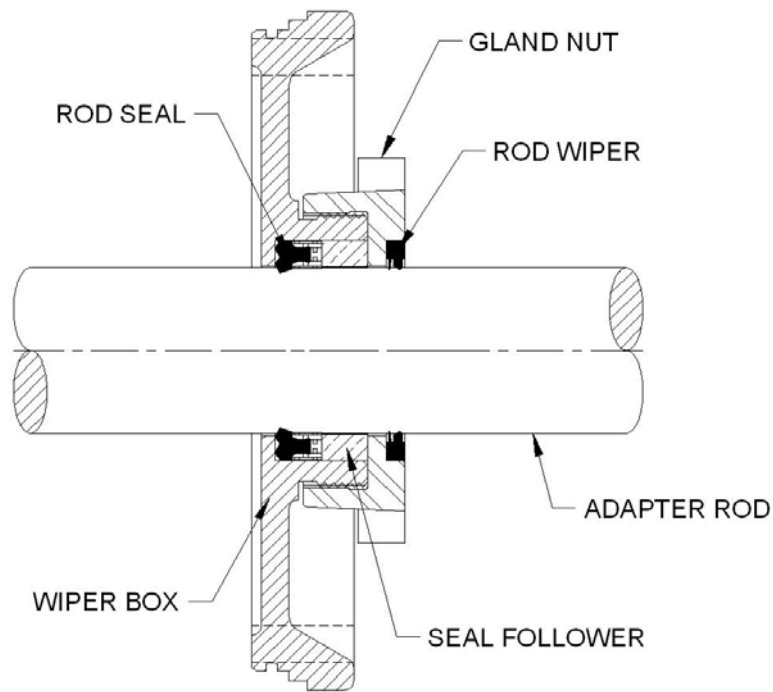


Figure 1

Disassembly...

I. POWER END

A. PLUNGER/INTERMEDIATE RODS AND POWER END STUFFING BOXES

- **“XL”, “L”, and “M” Model (Continued)...**
 4. The plunger and intermediate rod separate at the knurl area interface. Use a back-up wrench and break the plunger loose. Unscrew from the intermediate rod. Remove the plunger through the fluid cylinder opening.
 5. Using a pipe wrench on the knurled area of the intermediate rod, remove it from the crosshead and power end.
 6. Remove the wiper box gland nut. (See Figure 1)
 7. Remove the four (4) capscrews holding the power end stuffing box.
 8. Slide the wiper box and seal assembly out of the power end.
- **“H” Model**
 1. Remove the cradle cover.
 2. Loosen the packing gland nut.
 3. The plunger and intermediate rod separate at the knurl area interface. Use a back-up wrench and break the plunger loose. Unscrew from the intermediate rod.
 4. Rotate the pump until the intermediate rod is at bottom dead center.
 5. Remove the fluid end stuffing box gland nut.
 6. Remove the plunger through the cradle opening.
 7. Use a pipe wrench on the knurled area of the intermediate rod and remove it from the crosshead and power end.
 8. Remove the wiper box gland nut.
 9. Remove the four (4) cap screws holding the power end stuffing box.
 10. Slide the wiper box and seal assembly out of the power end.

Disassembly...

I. POWER END (Continued)...

B. CRANKSHAFT ASSEMBLY

- **184T-7 & 308T-7**

1. Remove the plungers as described above.
2. Remove the rear power end crankcase cover.
3. Remove connecting rod bolts and cap.

NOTE: Connecting rods and caps are matched marked and must be kept together. Do not mix caps and rods.

4. Connecting rod and crosshead must be moved all the way forward to clear crankshaft.
5. Remove the eight (8) 5/16 capscrews holding the lube pump in the off drive side bearing housing and carefully remove the pump from the bearing housing.
6. Place a large wooden block in the power end under the crankshaft. This will support the crankshaft once the bearing housings are removed. See Figure 2.
7. Remove the bearing housing retainer capscrews.
8. Thread bearing retainer capscrews into the two (2) tapped holes of each bearing retainer and use them to push the bearing retainers out of their bores.
9. Remove crankshaft bearing retainers, seals, and shims. These parts should be tied together and marked for reassembly at their original location.
10. Using a hoist and non marring strap, carefully remove the crankshaft out either side of the frame. If reusing end bearings remember, the crankshaft end bearing cones and cups are matched sets. Do not mix cones and cups.

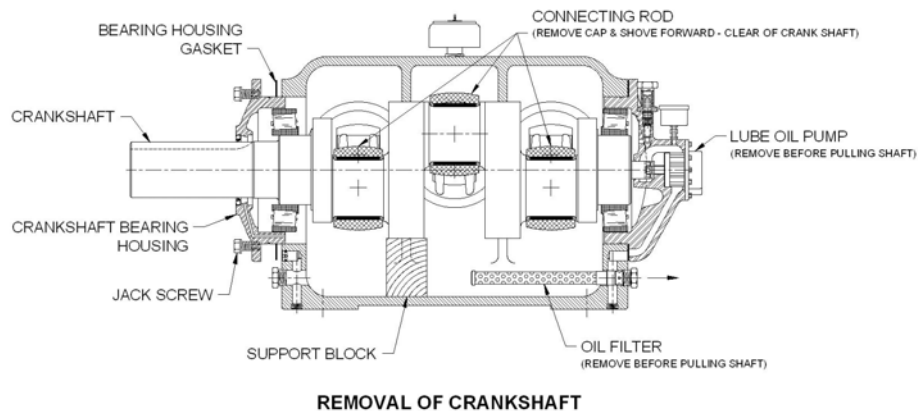


Figure 2

Disassembly...

I. POWER END

B. CRANKSHAFT ASSEMBLY

- 184T-7 & 308T-7 (Continued)...

! ATTENTION !

COVER KEYWAYS TO PROTECT OIL SEALS DURING REMOVAL.

- 543Q-7

The 543Q-7 crankshaft is removed similarly to the 184T-7 and 308T-7. The primary difference is the set of center main bearings on the 543Q-7. Refer to Figure 2 for general nomenclature and use the following instructions.

1. Remove the plungers as previously described.
2. Remove the rear power end crankcase cover.
3. Remove connecting rod bolts and cap.

NOTE: Connecting rods and caps are matched marked and must be kept together. Do not mix caps and rods.

4. Connecting rod and crosshead must be moved all the way forward to clear crankshaft.
5. Remove the eight (8) 5/16 capscrews holding the lube pump in the off drive side bearing housing and carefully remove the pump from the bearing housing.
6. Remove the bearing housing retainer capscrews.
7. Thread bearing retainer capscrews into the two (2) tapped holes of each bearing retainer and use them to push the bearing retainers out of their bores.
8. Remove crankshaft bearing retainers, seals, and shims. These parts should be tied together and marked for reassembly at their original location.
9. Using a hoist and non marring strap, carefully remove the crankshaft out either side of the frame of the frame. If reusing the main bearings remember to keep the bearings and races together. Do not mix races and roller elements.

Disassembly...

I. POWER END (Continued)...

C. CRANKSHAFT BEARINGS

- 184T-7, 308T-7, & 543Q-7

The crankshaft main bearings may be inspected while on the crankshaft and should not be removed unless necessary. A puller is required when replacement is necessary.

NOTE: Keep the component parts of the bearings together if they are to be re-installed. They are matched sets and must be correctly assembled as a unit.

If new bearings are going to be installed, remove the old bearings as shown in Figure 3.

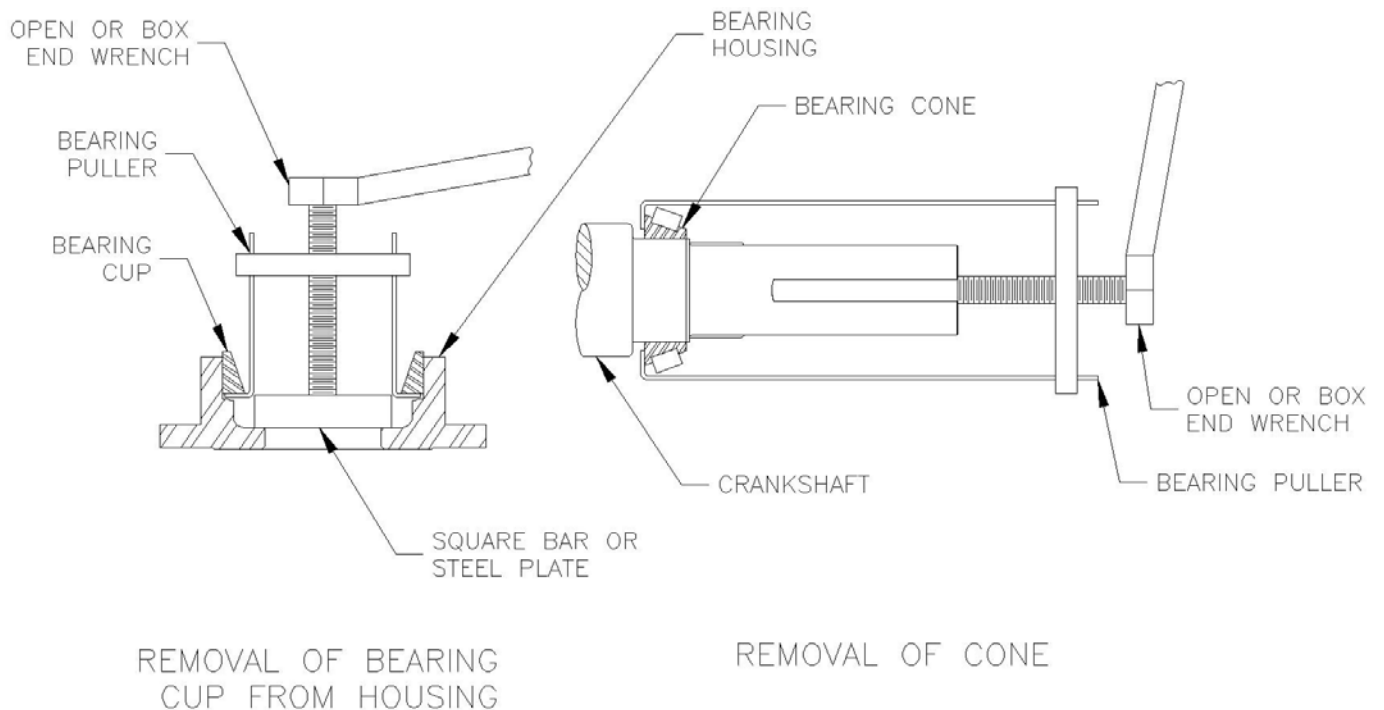


Figure 3

Disassembly...

I. POWER END

C. CRANKSHAFT BEARINGS (Continued)...

- 543Q-7

The 543Q-7 has two (2) cylindrical roller center main bearings. These bearings come pre-adjusted from the factory and require no adjustment. The roller assembly consists of a thin inner race that is press fitted onto the crankshaft and retained by snap rings and a roller bearing complement that is a tap fit into the power frame housing and retained by four (4) bolts, washers, and nuts. If new bearings are required, remove the old bearings as follows. Removal will likely destroy the old bearings, so be sure you are not going to reuse them before proceeding.

1. Remove the two (2) snap rings that hold the inner bearing races in place.
2. Safely and securely position the crankshaft in a vertical position.
3. Use a rosebud tip torch and heat the race around the circumference.
4. While the race is hot, hit the race sharply with a heavy brass drift. The race should fall off of the crankshaft.
5. Using insulated gloves carefully lift and remove the race.
6. Flip the crankshaft 180° and repeat the above procedure for the second race.

To remove the outer roller complements follow these steps.

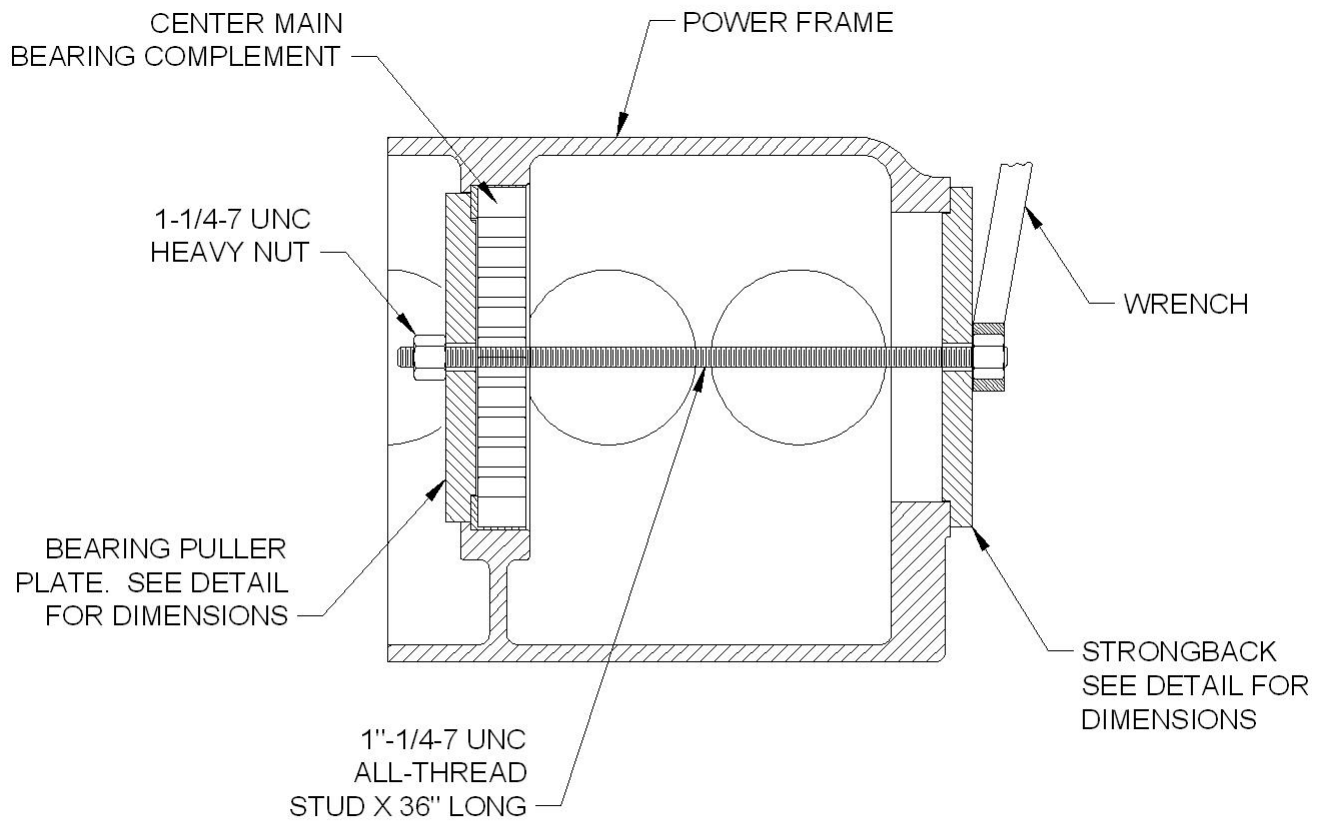
1. Remove the retaining bolts, nuts, and washers retaining the outer roller complement in the power frame.
2. Use a heavy drift and hammer to alternately hit the complement at the top and bottom until it is out of its bore.
3. As an alternative, a tool can be made to jack the bearing complement out of the power frame. The puller tool is especially useful if you are planning to reuse the bearings. See Figures 4, 5, and 6 for a typical puller and components.

Disassembly...

I. POWER END

C. CRANKSHAFT BEARINGS

- 543Q-7 (Continued)...



REMOVAL OF CENTER BEARING COMPLEMENT

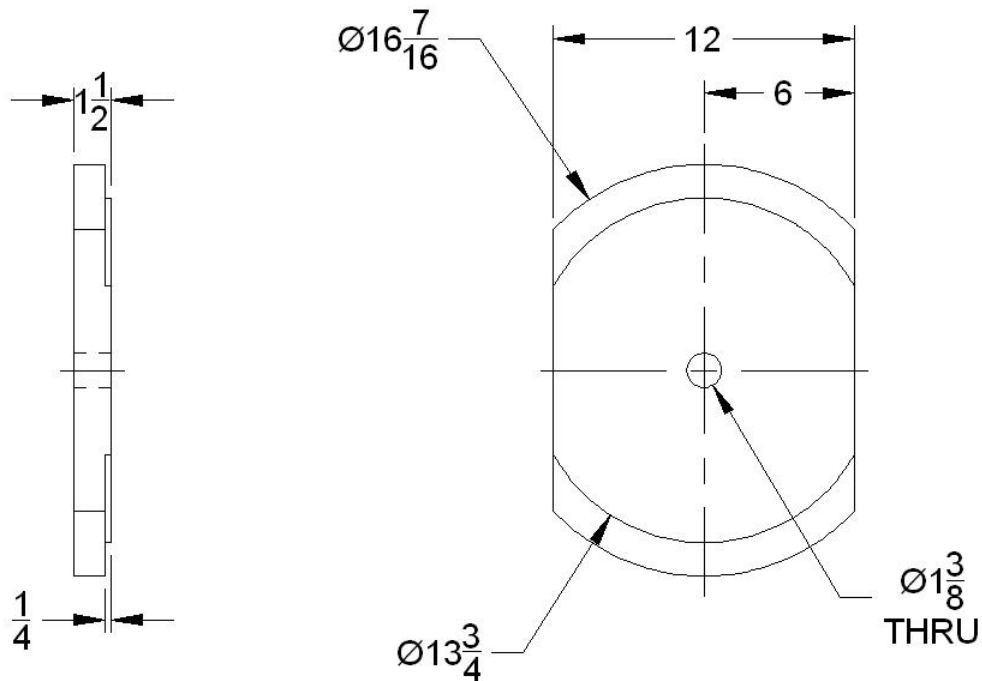
Figure 4

Disassembly...

I. POWER END

C. CRANKSHAFT BEARINGS

- 543Q-7 (Continued)...



BEARING PULLER PLATE

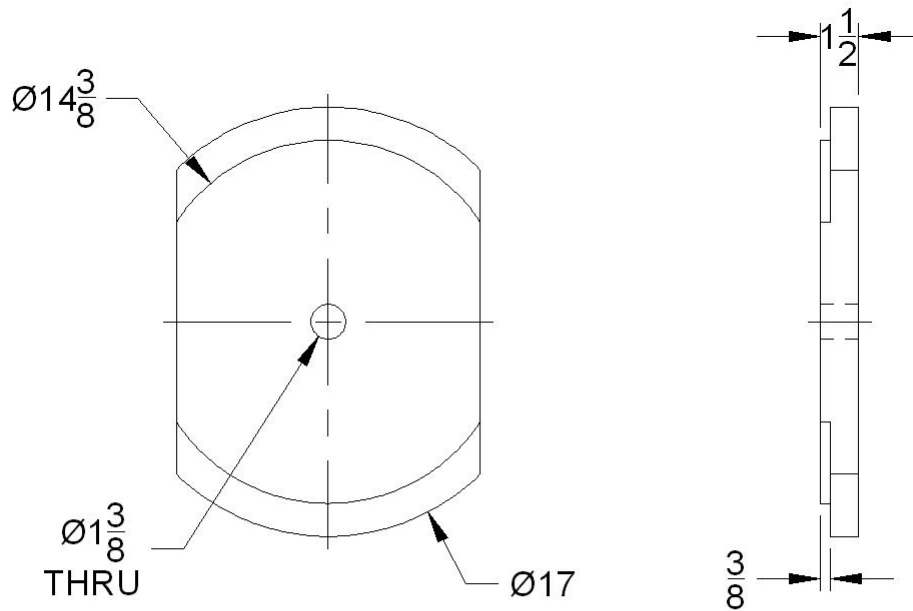
Figure 5

Disassembly...

I. POWER END

C. CRANKSHAFT BEARINGS

- 543Q-7 (Continued)...



STRONGBACK

Figure 6

Disassembly...

I. POWER END (Continued)...

D. LUBRICATION OIL PUMP

- **ALL MODELS**

This series of pumps have a lubrication pump that is an integral part of the power frame assembly. It is driven by a slotted shaft which is driven via the crankshaft. It has its own strainer/filter, oil pressure gauge, and relief valve. The pump draws oil through the strainer/filter located in the crankcase reservoir and discharges into the crankshaft, where it lubricates all connecting rod and wrist pin bearings. See Figure 7.

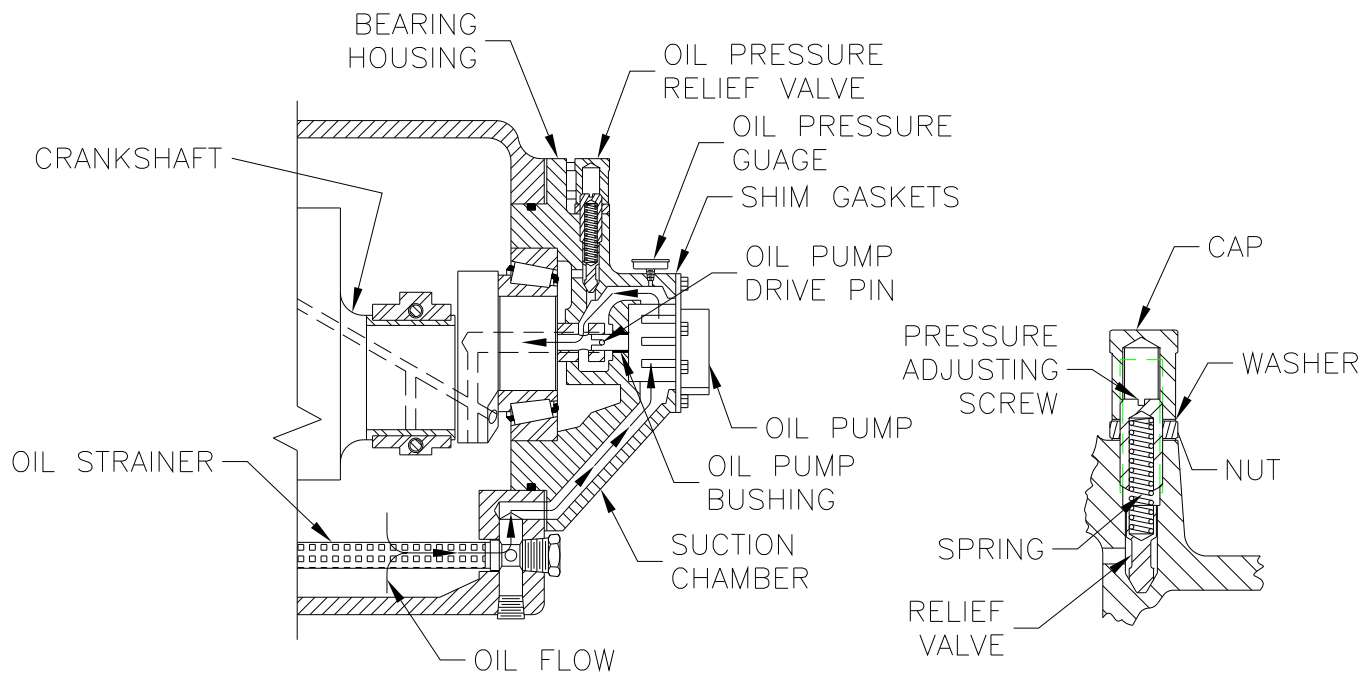


Figure 7

The lube oil pump may be removed by removing the six (6) capscrews holding the lube pump to the bearing housing. After removing the capscrews, the complete unit may be slipped out. It is not necessary to disturb either the crankshaft or bearing housing.

Disassembly...

I. POWER END

D. LUBRICATION OIL PUMP (Continued)...

- ALL MODELS**

The relief valve, located on top of the housing is adjustable and prevents excessive lube pressure during cold starts. It is adjusted at the factory for normal operating conditions. However, since operating conditions do vary, it may be necessary to adjust after installation. Crankshaft speed, type of oil and oil temperature directly affect the oil operating pressure. To adjust the oil pressure, operate pump until normal operating temperature is reached. Remove the cap and loosen the jam nut. Turn the adjusting screw in or out until the desired pressure is reached. Retighten the jam nut and replace the cap. Under normal speeds and temperatures the oil pressure should be adjusted somewhere between 30 and 40 psi. However, because of the variable factors affecting the oil pressure the pump has been designed to operate safely from 15 psi or more.

Sometimes the drive side of the pump must be reversed. When swapping the drive from right hand to left hand or opposite, care must be taken to correctly swap the lube side bearing housing and oil pump. The power frame is machined to be driven from either the right or left side. In order to do this, the power frame is machined symmetrically. This means the port for the oil suction must be plugged on the drive side to prevent oil leakage. When swapping drives, this plug must also change sides. See Figure 8 for details of the plug and strainer/filter changes.

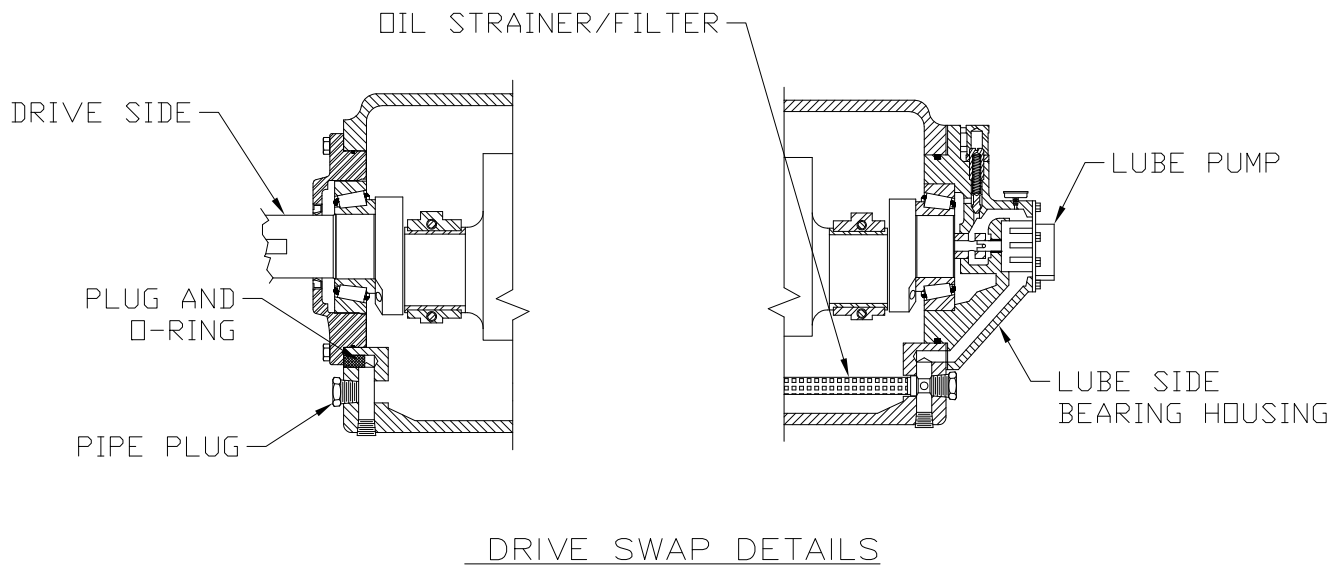


Figure 8

When changing drive side, the lube side bearing housing, oil pump, oil strainer/filter and components from the lube side are swapped to the drive side. The pipe plug, port plug, and O-ring from the drive side are switched to the opposite side. If the port plug is not removed it will block the oil suction port and the pump will starve for oil when started. If the port plug is not installed on the opposite side, oil will leak from under the bearing housing.

Disassembly (Continued)...

II. FLUID END



BEFORE WORKING ON THE FLUID END ENSURE THE PRESSURE HAS BEEN REMOVED FROM THE FLUID END AND THE PUMP BLOCKED OUT WITH APPROPRIATE BLOCK VALVES. ENSURE THE FLUID END IS DRAINED AND ANY POWER SOURCE OR DRIVER IS LOCKED OUT BEFORE PROCEEDING!

A. FLUID CYLINDER REMOVAL

- **“XL”, “L”, AND “M” MODEL PUMPS**

1. Disconnect piping and any lube fittings etc.
2. Remove the plungers as described below for the XL, L, and M model pumps.
3. Connect a properly rated lifting strap or chain to the fluid end.
4. Remove the hex nuts holding the fluid end to the power end. See Figures 12 and 13.
5. Use a hoist and carefully slide the fluid end forward until free.
6. Note, unless previously removed, the stuffing boxes on the L and M models are directly attached to the fluid end and will come out with the fluid end. The XL model stuffing boxes cannot be removed prior to removing the fluid end.

- **“H” MODEL PUMPS**

1. Disconnect piping and any lube fittings, etc.
2. Remove the plungers as described below for the H model pumps.
3. Connect a properly rated lifting strap or chain to the fluid end.
4. Remove the 7/8" diameter capscrews holding the stuffing box clamp ring to the pump. See Figure 14.
5. Remove the 1/2" diameter capscrews holding the fluid end to the power end. See Figure 14.
6. Use a hoist and carefully remove the fluid end.
7. Note, the stuffing boxes will stay with the power end.

Disassembly...

II. FLUID END (Continued)...

B. PLUNGER REMOVAL

- **“XL”, “L”, AND “M” MODEL PUMPS**

1. Remove the fluid end cylinder head.
2. Remove the cradle cover.
3. Loosen the packing gland nuts.
4. Rotate the crankshaft until the knurl area of the plunger/intermediate rod is accessible in the cradle area of the pump.
5. The plunger and intermediate rod separate at the knurl area interface. Use two (2) pipe wrenches (use one (1) as a back-up wrench) and break the plunger loose from the intermediate rod. Unscrew the plunger and remove through the fluid cylinder opening.
6. If replacing the intermediate rod, use a pipe wrench on the knurled area of the intermediate rod and remove it from the crosshead and power end.
7. Repeat steps 3 through 6 until all plungers and intermediate rods are removed.

- **“H” MODEL PUMPS**

1. Remove the cradle cover.
2. Loosen the packing gland nuts.
3. Rotate the crankshaft until the knurl area of the plunger/intermediate rod is accessible in the cradle area of the pump.
4. The plunger and intermediate rod separate at the knurl area interface. Use two (2) pipe wrenches (use one (1) as a back-up wrench) and break the plunger loose from the intermediate rod. Unscrew the plunger.
5. Rotate the pump until the intermediate rod you are working on is at bottom dead center.
6. Remove the gland nut and plunger through the cradle opening.
7. If replacing the intermediate rod, use a pipe wrench on the knurled area of the intermediate rod and remove it from the crosshead and power end.
8. Repeat steps 3 through 7 until all plungers and intermediate rods are removed.

Disassembly...

II. FLUID END (Continued)...

C. STUFFING BOX REMOVAL

- **“XL” MODEL PUMPS**

The “XL” series pumps capture the stuffing box between the fluid end and power end. To remove the stuffing box, the fluid end has to be removed.

1. Remove the fluid end as explained in section “A. Fluid Cylinder Removal” above. The stuffing boxes will come out with the fluid end.
2. Remove the 3/8” capscrews holding the stuffing box to the fluid end.
3. Carefully pull the stuffing box away from the fluid end.
4. Repeat for the remaining stuffing boxes.

- **“L”, AND “M” MODEL PUMPS**

This series of pumps all have separate stuffing boxes that bolt to the back side of the fluid end. To remove the stuffing boxes without removing the fluid end follow this procedure.

1. Remove the plungers as previously described.
2. Remove any lube fittings, etc.
3. Remove the capscrews holding the stuffing box to the fluid end.
4. Use a properly rated lifting strap and carefully remove the stuffing box by pulling back and up out of the cradle area.
5. Repeat for the remaining stuffing boxes.

- **“H” MODEL PUMPS**

The stuffing boxes on the “H” model fluid end are removed without removing the fluid end. See following instructions.

1. Remove the plungers as previously described for the “H” model pump.
2. Remove any lube fittings, etc.
3. Remove the 7/8” diameter capscrews holding the clamp ring to the stuffing box.
4. Use a properly rated lifting strap and carefully remove the stuffing box by pulling back and up out of the cradle area.
5. Repeat for the remaining stuffing boxes.

D. FLUID END VALVE REMOVAL

Refer to valve section of this manual.

Assembly...

I. POWER END

A. CONNECTING ROD AND CROSSHEAD ASSEMBLY

- **184T-7, 308T-7, & 543Q-7 – BRONZE WRIST PIN BUSHING**

The standard connecting rod and crosshead assembly for the 184T-7, 308T-7, and 543Q-7 uses a bronze wrist pin bearing (see Figure 9). Installing new wrist pin bearings is best done in a fully equipped shop containing a hydraulic press. To install new bearings and assemble the connecting rod/crosshead sub assembly, follow these instructions.

1. Lubricate the connecting rod pin bore and carefully press the crosshead pin bushing into the connecting rod.
2. Ream bushing to obtain the clearance listed on page 20. (If service bushings are used, reaming will not be necessary in most cases).
3. Assemble the connecting rod to the crosshead by pressing the crosshead pin into the crosshead or, to facilitate assembly, the crosshead may be heated to no more than 300° F (149° C) in an electric oven or bath.

NOTE: The 308T-7 and 543Q-7 models have a woodruff key that will need to be installed before the new pin is fully seated. The 184T-7 does not use a woodruff key.

4. Lubricate the crosshead bore and slide the connecting rod crosshead assembly into the power frame. Push the assemblies all the way forward.

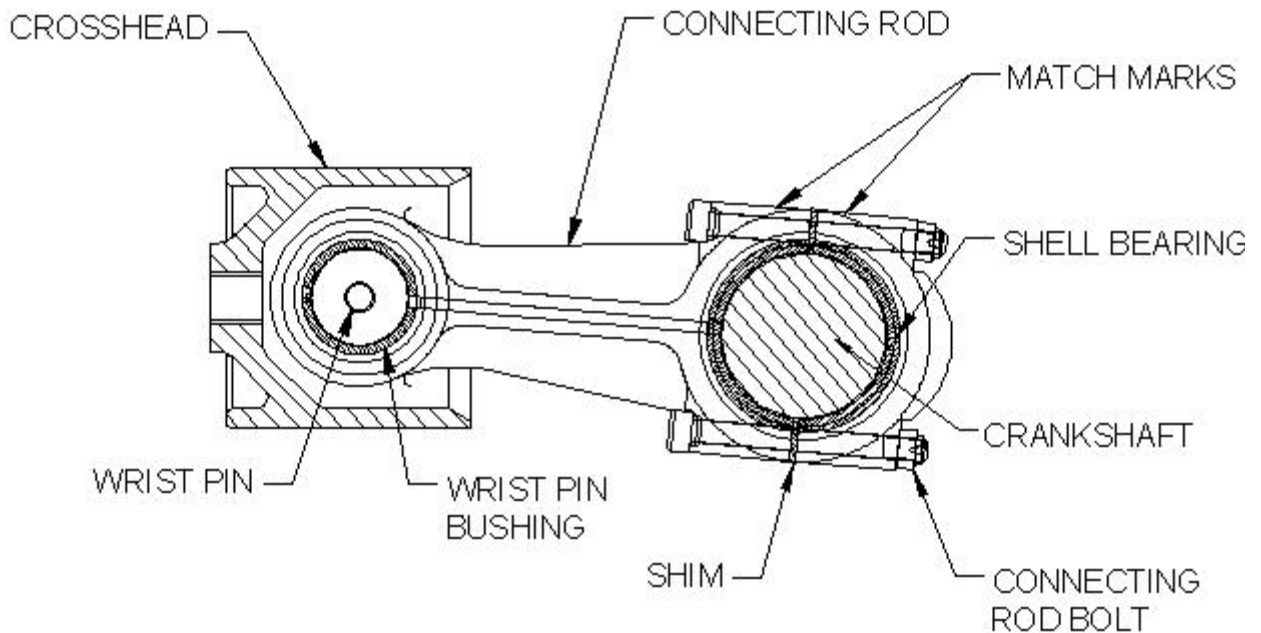


Figure 9

Assembly...

I. POWER END

A. CONNECTING ROD AND CROSSHEAD ASSEMBLY (Continued)...

- **308T-7, 543Q-7 - ROLLER BEARING WRIST PIN BEARING**

The 308T-7 and 543Q-7 with roller bearing wrist pins use a slightly different wrist pin arrangement (see Figure 10). Installing new wrist pin bearings is best done in a fully equipped shop containing a hydraulic press. To install wrist pin bearings in these models see the following instructions.

1. Lubricate the connecting rod pin bore and carefully press the roller bearing into the connecting rod.
2. Assemble the connecting rod to the crosshead by pressing the crosshead pin into the crosshead or, to facilitate assembly, the crosshead may be heated to no more than 300° F (149° C) in an electric oven or bath.
3. Install the snap rings in the crosshead on each side of the wrist pin.
4. Lubricate the crosshead bore and slide the connecting rod crosshead assembly into the power frame. Push the assemblies all the way forward.

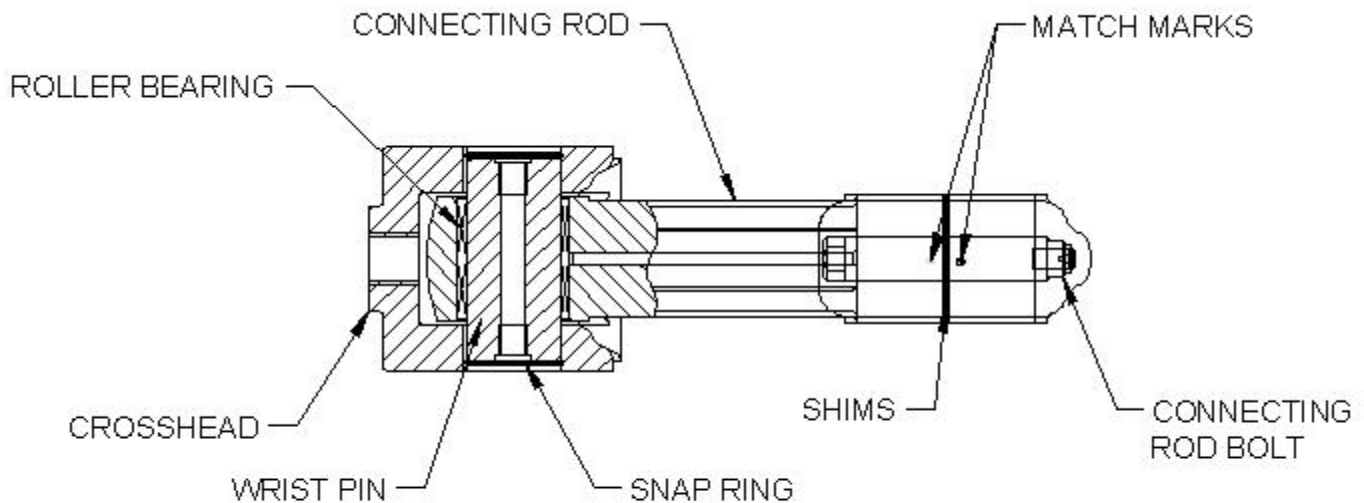


Figure 10

Assembly...

I. POWER END (Continued)...

B. CRANKSHAFT MAIN BEARINGS AND CENTER SUPPORT BEARINGS

- **184T-7 & 308T-7**

1. Thoroughly clean and remove all burrs from the I.D. of the cone and roller assembly and from the bearing seating surfaces on the crankshaft.
2. Heat the cone and roller assembly in an electric oven or oil bath to 300° F (149° C). It is recommended that a thermometer be used to prevent overheating.
3. After the bearings have been brought up to temperature and with the crankshaft firmly supported, install the cone and roller assemblies on the crankshaft. *Make sure the cone and roller assemblies are firmly against the shoulders on the crankshaft.*
4. Allow the crankshaft and bearing assembly to cool before installing in the power end.
5. Make sure the main bearing openings in the frame are clean and free of burrs.

NOTE: The crossheads and connecting rods must be installed prior to replacing the crankshaft assembly.

6. Install the crankshaft main bearing outer races or cups in the main bearing housing. These races can be carefully driven into the housing with a brass rod. An alternative and easier way is to chill the races in a freezer or with CO₂ and place them in their respective bearing housings. Ensure the races are completely seated.
7. Place the crankcase main bearing standard shim pack, approximately .079" (2.0 mm) to .104" (2.6 mm) thickness, on the crankshaft-bearing housing/retainers. *If the **old** bearings and retainers are being re-installed, use the same amount of shims as before.*
8. Install the off drive side bearing housing with shims in the power frame and tighten in place with the proper capscrews. See required torque in table at the end of this section.
9. With the cone and roller assemblies of the main bearings in place on the crankshaft, slide the crankshaft through the main bearing openings in the power end frame with No. 1 throw forward. Slide the off drive side bearing into its bore.
10. Assemble the drive side crankshaft-bearing housing/retainer and shims to the main frame and tighten in place with the proper capscrews.

NOTE: The following steps (11a and 11b) are necessary only if new bearings are being installed. When the same crankshaft main bearings are being reassembled, use the same amount of shims as were previously used and use the steps as a check for adjustment.

11. To determine the correct amount of shims when installing new bearings, follow these steps.
 - a. When first installing shims, use only enough shims to produce a slight drag when the crankshaft is rotated. Tap shaft on each end sufficient to ensure that the bearing outer race is tightly against the retainer.

Assembly...

I. POWER END

B. CRANKSHAFT AND MAIN BEARINGS

- **184T-7 & 308T-7 (Continued)...**

- Add enough shims to remove the slight drag or pre-load (approximately .005" [.127 mm] to .007" [.178 mm]), depending on the amount of pre-load). *The bearings are correctly adjusted when the endplay of the crankshaft is per the specifications and the crankshaft will rotate freely. Do not pre-load bearings.*

CRANKSHAFT END PLAY				
PUMP	MAXIMUM END PLAY		MINIMUM END PLAY	
	in	mm	in	mm
184T-7	.007	.178	.005	.127
308T-7	.007	.178	.005	.127
543Q-7	.010	.254	.008	.203

- **543Q-7**

The main bearing set for the 543Q-7 and 543QE-7 is comprised of two (2) tapered roller end bearings and two cylindrical roller center mains. To install the two (2) tapered roller end bearings follow these instructions.

- Thoroughly clean and remove all burrs from the I.D. of the cone and roller assembly and from the bearing seating surfaces on the crankshaft.
- Heat the cone and roller assembly in an electric oven or oil bath to 300° F (149° C). It is recommended that a thermometer be used to prevent overheating.
- After the bearings have been brought up to temperature and with the crankshaft firmly supported, install the cone and roller assemblies on the crankshaft. *Make sure the cone and roller assemblies are firmly against the shoulders on the crankshaft.*
- Allow the crankshaft and bearing assembly to cool before installing in the power end.

The cylindrical bearing inner mains consist of a thin inner race that is a press fit onto the crankshaft and retained by snap rings and a roller bearing complement that is a tap fit into the power frame housing and retained by four (4) bolts, washers, and nuts. These bearings have a built in clearance and no adjustment is necessary. To install new inner mains carefully follow these instructions.

- Heat the inner race in an electric oven or oil bath to 300° F (149° C). It is recommended that a thermometer be used to prevent overheating.
- Carefully slide one of the inner races over the crankshaft and position over the appropriate inner bearing surface.
- Install the snap rings on the crankshaft to retain the bearing.
- Carefully slide the second inner race over the crankshaft to the appropriate location.

Assembly...

I. POWER END

B. CRANKSHAFT AND MAIN BEARINGS

- **543Q-7 (Continued)...**

9. Install the remaining snap rings.
10. Make sure the main bearing openings in the frame are clean and free of burrs.
11. Take one of the bearing roller complements and using a brass bar carefully tap it into the power frame center main location. If a freezer is available you can freeze the complement before installing to make installation easier.
12. Install the four (4) bolts, flat washers, and nuts to retain the outer complement.
13. Take the remaining complement and repeat steps 7 and 8.
14. Allow the crankshaft and bearing assembly to cool before installing in the power frame.

To install the completed crankshaft sub-assembly, ensure the crossheads and connecting rods have been installed first and have been pushed as far forward as possible.

15. Install the crankshaft main bearing outer races or cups in the main bearing housing. These races can be carefully driven into the housing with a brass rod. An alternative and easier way is to chill the races in a freezer or with CO₂ and place them in their respective bearing housings. Ensure the races are completely seated.
16. Place the crankcase main bearing standard shim pack, approximately .079" (2.0 mm) to .104" (2.6 mm) thickness, on the crankshaft-bearing housing/retainers. *If the **old** bearings and retainers are being re-installed, use the same amount of shims as before.*
17. Install the off drive side bearing housing with shims in the power frame and tighten in place with the proper capscrews. See required torque in the following table.
18. With the cone and roller assemblies of the main bearings in place on the crankshaft, carefully slide the crankshaft through the main bearing openings in the power end frame with No. 1 throw forward.
19. Assemble the drive side crankshaft-bearing housing/retainer and shims to the main frame and tighten in place with the proper cap screws.

NOTE: The following steps are necessary only if new bearings are being installed. When the same crankshaft main bearings are being reassembled, use the same amount of shims as were previously used and use the steps as a check for adjustment.

Assembly...

I. POWER END

B. CRANKSHAFT AND MAIN BEARINGS

- 543Q-7 (Continued)...

20. To determine the correct amount of shims when installing new bearings, follow these steps.

- When first installing shims, use only enough shims to produce a slight drag when the crankshaft is rotated. Tap shaft on each end sufficient to ensure that the bearing outer race is tightly against the retainer.
- Add enough shims to remove the slight drag or pre-load (approximately .005" [.127 mm] to .007" [.178 mm]), depending on the amount of pre-load). *The bearings are correctly adjusted when the endplay of the crankshaft is per the specifications and the crankshaft will rotate freely. Do not pre-load bearings. See table on page 40 for correct end play.*

MAIN BEARING HOUSING TORQUE			
MODEL	FASTENER SIZE	TORQUE (ft.-lbs.)	TORQUE (N-M)
184T-7	3/4"-10 UNC	150	203
308T-7 and 543Q-7	7/8"-9 UNC	200	271

C. CONNECTING ROD TO CRANKSHAFT ASSEMBLY (ALL PUMPS)

- Thoroughly clean and remove all burrs and nicks from connecting rod and crankshaft journals.
- Position the number 1 crankshaft throw to the rear.
- Take a shell bearing half and carefully locate it in the rod half of the connecting rod assembly.
- Lubricate the connecting rod pin and rod bearing.
- Slide the connecting rod back over the crankshaft throw using caution so the outer surface of the insert is not damaged. Note the match numbers of the cap and rod to be certain the rod is assembled correctly.
- Take the other half of the shell bearing and carefully place it in the rod cap. Lubricate the shell bearing.
- Install a standard shim pack along with the rod bolts and nuts.

The standard shim is a brass laminated stack 3/16" thick. The shim is composed of multiple 0.003" thick shims which can be peeled off one at a time. Use a sharp edged tool (knife) to start each peeled layer.

- Torque the rod bolt as specified in the table below.
- Take a heavy brass drift and sharply hit the cap end of the connecting rod. This particular rod design does not use any type of machined alignment pin and by striking it sharply on the cap end after installation on the crankshaft will align the cap and rod halves. Without this step the rod will likely lock up and there is no way to determine the correct clearance.

Assembly...

I. POWER END

C. CONNECTING ROD TO CRANKSHAFT ASSEMBLY (ALL PUMPS) (Continued)...

10. Place a wrench on the rod cap nut and shake side to side. There should be slight movement back and forth.
11. Rotate the pump by hand. It should rotate freely.
12. Remove the rod cap and peel layers from the shims.
13. Install the rod cap and repeat steps 8 through 11.
14. Continue this process until there is a slight drag or the rod locks up.
15. Remove the cap and add a small amount of shims back until the pump will rotate freely and the rod has a slight amount of side to side movement.
16. At this point use *plasti-gauge* (available from most auto parts stores or your local supply house) and check for the proper running clearance per the table on page 20.
17. Add or remove shims as required to get the correct running clearance.

CONNECTING ROD TORQUE		
MODEL	TORQUE (ft-lbs.)	TORQUE (N-M)
184T-7	120-145	163-197
308T-7 and 543Q-7	190-210	258-285

D. INTERMEDIATE RODS AND POWER END STUFFING BOXES

- **ALL PUMPS**

The standard power end wiper box is composed of a special molded seal, a seal follower and a rod wiper (see Figure 11). To replace the assembly follow the instructions below.

1. Clean the stuffing box and gland.
2. Lubricate the I.D. of the stuffing box.
3. Lubricate the rod seal and carefully install as shown in Figure 11. Ensure the seal is all the way to the bottom of the box.
4. Install the follower.
5. Take the rod wiper and carefully press it into the gland nut.
6. Loosely install the gland nut.

Assembly...

I. POWER END

D. INTERMEDIATE RODS AND POWER END STUFFING BOXES

- ALL PUMPS (Continued)...

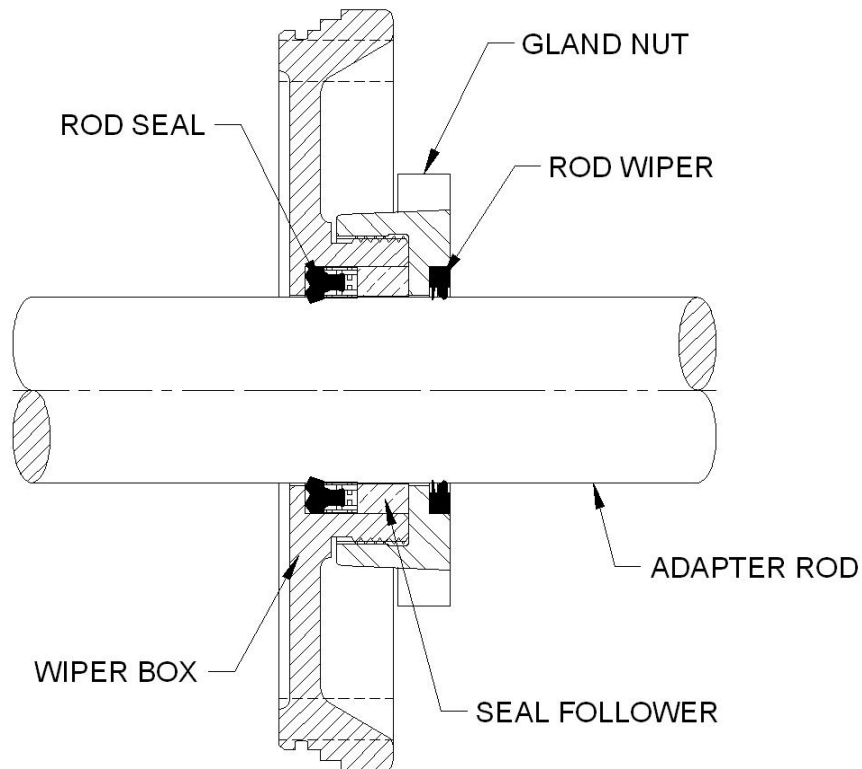


Figure 11

7. Lubricate the adapter rod and carefully slide through the seals.
8. Using a pipe wrench on the knurled area of the adapter rod, securely tighten the adapter rod (275 ft-lbs or 373 N-M).
9. Rotate the pump by hand and repeat for all rods.
10. After all the rods have been installed, tighten the gland nuts metal to metal.

Assembly (Continued)...

II. FLUID END

A. STUFFING BOXES AND PLUNGERS

! ATTENTION !

NATIONAL-OILWELL VARCO DOES **NOT** RECOMMEND THE USE OF CERAMIC PLUNGERS FOR PUMPING FLAMMABLE OR HAZARDOUS LIQUIDS.

- **“XL” PUMPS**

The stuffing boxes on the “XL” fluid ends have to be attached to the fluid end prior to mounting the fluid end. See Figure 12 for “XL” mounting diagram.

1. Lay the fluid end flat on a pallet or firm surface with the stuffing box side up.
2. Ensure the stuffing box side of the fluid end is clean and seal bevels on the bores are clean and free of any burrs.
3. Ensure the stuffing box guide boss is clean and free of any burrs.
4. Install the O-ring seal on the stuffing box boss and coat with a layer of grease.
5. Carefully slip the stuffing box boss into the bore on the fluid end.
6. Align the stuffing box mounting holes and torque the 3/8” capscrews to 45 ft.-lbs. (61 N-M).
7. Carefully install the fluid end to the power end as detailed in section “B”.
8. Assemble packing in the stuffing box bore per instructions included with each set of packing, or as described later in this section of the manual.
9. Loosely install the gland nut.
10. Lubricate a plunger and carefully install it through the packing.
11. Using the knurled area of the plunger, thread it into the adapter rod.
12. Torque the plungers to 250 ft.-lbs. (339 N-M).
13. Repeat for the remaining plungers.

Assembly...

II. FLUID END

A. STUFFING BOXES AND PLUNGERS (Continued)...

- **“L” and “M” PUMPS**

On the “L” and “M” model pumps the stuffing boxes can be installed prior to installing the fluid end or afterwards. This section assumes the fluid end is already mounted to the power end. See Figure 13.

1. Thoroughly clean and remove any nicks or burrs from all mating surfaces of the main frame, fluid cylinder and stuffing boxes.
2. Assemble packing in stuffing box bore per instructions included with each set of packing, or as described later in this section of the manual.
3. Loosely install the gland nut.
4. Install the O-ring seal in the face of the stuffing box. Apply a coat of grease to hold it in place.
5. Carefully slide the stuffing box into place and secure with the appropriate fastener. See the following table for correct torque for the various fluid ends. Torque the stuffing box in steps and alternate around the box to ensure the box is pulled up squarely.
6. Lubricate a plunger and carefully install it through the packing.
7. Using the knurled area of the plunger, thread it into the adapter rod.
8. Torque the plungers to 250 ft.-lbs (339 N-M).
9. Repeat for the remaining plungers.

Assembly...

II. FLUID END

A. STUFFING BOXES AND PLUNGERS (Continued)...

- **“H” PUMPS**

“H” model fluid ends have a special adapter plate between the fluid end and power end. Stuffing boxes for “H” model pumps are installed after the fluid end is mounted to the power frame. See Figure 14.

1. Thoroughly clean and remove any nicks or burrs from all mating surfaces of the main frame, fluid cylinder and stuffing boxes.
2. Assemble packing in stuffing box bores per instructions included with each set of packing, or as described later in this section of the manual.
3. Loosely install the gland nut.
4. Install the O-ring seal in the face of the stuffing box. Apply a coat of grease to hold the seal in place.
5. Carefully slide the stuffing box into place.
6. Slide the retaining ring over the stuffing box. See Figure 14.
7. Install the 7/8 inch fasteners and alternately torque them as specified in the following table. Ensure the stuffing box is pulled up square.
8. Lubricate a plunger and carefully install it through the packing.
9. Using the knurled area of the plunger, thread it into the adapter rod.
10. Torque plungers to 250 ft.-lbs. (339 N-M).
11. Repeat for remaining plungers.

STUFFING BOX FASTENER TORQUE			
FE MODEL	FASTENER THREAD	TORQUE FT.-LBS.	TORQUE N-M
“XL”	3/8-16 UNC	45	61
“L”	5/8-11 UNC	95	130
“M”	7/8-9 UNC	200	270
“H”	7/8-9 UNC	200	270

Assembly...

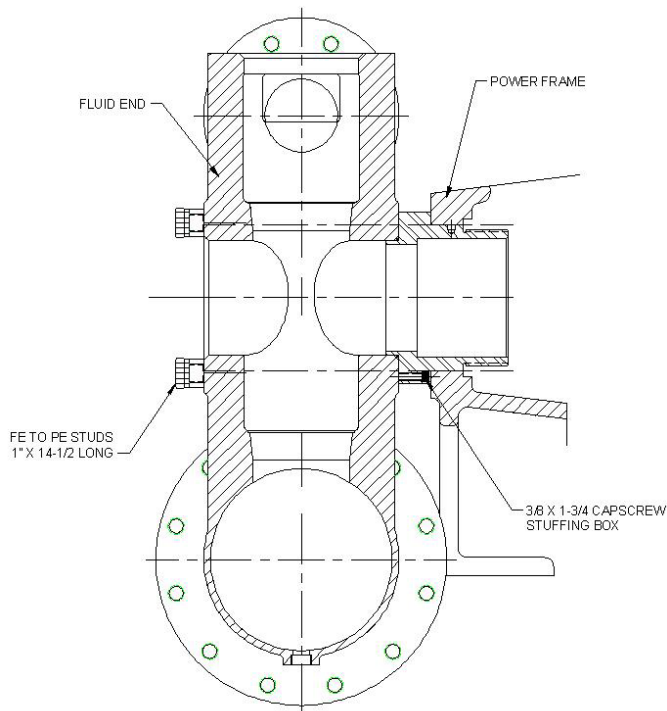
II. FLUID END (Continued)...

B. FLUID CYLINDER

- **"XL" PUMPS**

The "XL" class fluid ends clamp the stuffing box between the fluid end and the power end. The small 3/8" capscrews which hold the stuffing box to the fluid end are there to keep the stuffing box and fluid end attached while mounting. They do not actually retain the stuffing box. To mount the "XL" class fluid end refer to Figure 12 and follow the steps below.

1. Install the stuffing boxes per the instructions in section "A" above.
2. Using a proper lifting strap and hoist carefully pick up the fluid end/stuffing box sub-assembly and carefully slide them over the fluid end to power end attaching studs. Take care that the stuffing boxes align with the power end bores. Push the fluid end/stuffing box assembly back until the shoulder on the stuffing box stops at the power frame.
3. Torque the fluid end to power end attaching stud nuts to 250 ft.-lbs. (339 N-M) in a stepped alternating pattern.



"XL" CLASS FLUID END MOUNTING DIAGRAM

Figure 12

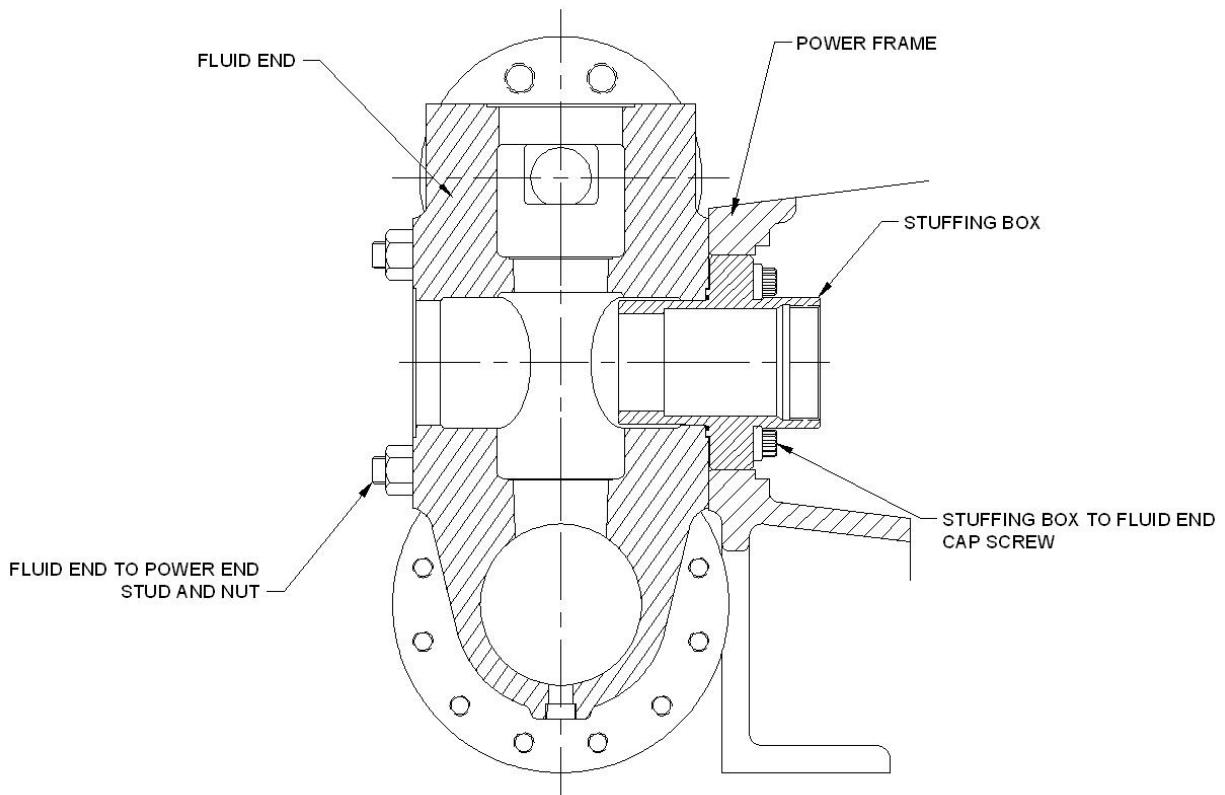
Assembly...

II. FLUID END

B. FLUID CYLINDER (Continued)...

- **"L" and "M" PUMPS**

1. To mount an "L" or "M" class fluid end use a proper lifting strap and hoist to pick up the fluid end body and carefully slide it over the fluid end to power end attaching studs. The fluid end stuffing boxes can be attached to the fluid end body prior to installing the fluid end body or they can be installed afterward. See "Stuffing Boxes and Plungers – "L" and "M" Class Fluid Ends" in this manual to install plungers after installing the fluid end. Refer to Figure 13.
2. Install the heavy hex nuts on the fluid end to power studs and, using an alternating pattern, torque the fluid end fasteners to 300 ft.-lbs. (410 N-M).



"L" AND "M" CLASS FLUID END MOUNTING DIAGRAM

Figure 13

Assembly...

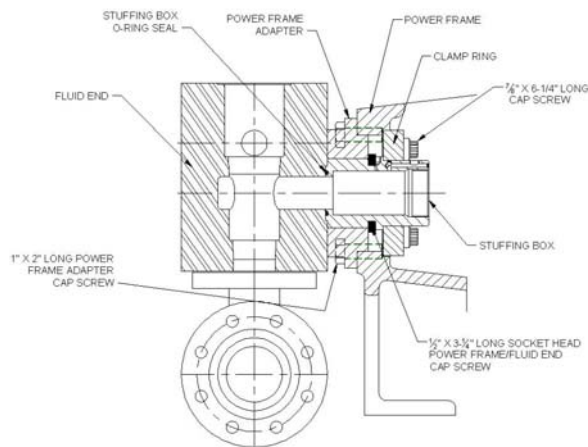
II. FLUID END

B. FLUID CYLINDER (Continued)...

- **"H" PUMPS**

The "H" class fluid end is different in that an adapter plate is used between the fluid end and power end. The adapter plates have to be installed first, and then the fluid end can be mounted. To attach the "H" class fluid end to the pump follow these steps. Refer to Figure 14.

1. Slide the smaller O.D. of power end adapter plate into the power frame face bore. Note, there is a difference between the adapters for the center bore and outer bores.
2. Fasten the adapter plates to the power end with the 1" X 2" long capscrews.
3. Torque the adapter plates to 250 ft.-lbs. (339 N-M).
4. Use a proper lifting strap and carefully place the fluid end next to the power frame adapters. The two (2) alignment pins in the power frame should align with the alignment holes in the fluid end. *Note, on the "H" model fluid end the stuffing box cannot be attached to the fluid end at this point. It will be added after hanging the fluid end.*
5. Place the 1/2" X 3-1/4" socket head capscrew through the power frame and into the fluid end. Torque to 60 ft.-lbs. (80 N-M).
6. Install the fluid end stuffing box O-ring and coat with grease to hold in place.
7. Carefully slide the stuffing box through the power end opening and up against the fluid end.
8. Slide the clamp ring over the stuffing box and install the 7/8" capscrews.
9. Torque the capscrews in steps to 200 ft.-lbs. (270 N-M). Use an alternating pattern to help ensure the stuffing boxes pull up square and torque evenly.



"H" CLASS FLUID END MOUNTING DIAGRAM

Figure 14

Assembly...

II. FLUID END

B. FLUID CYLINDER (Continued)...

- **ALL PUMPS**

See table below for a summary of fluid end fastener torques.

FLUID END FASTENER TORQUES				
MODEL	FASTENER	SIZE	TORQUE (ft.-lbs.)	TORQUE (N-M)
XL	Fluid End to Power End Attaching Stud	1"-8 UNC	250	339
XL	Valve Cover and Cylinder Cover	1"-8 UNC	250	339
XL	Stuffing Box To Fluid End	3/8"-16 UNC	45	61
XL	Disc Valve Retainer	3/4"-10 UNC	100	136
L and M	Fluid End to Power End Attaching Stud	1"-8 UNC	300	410
L	Valve Cover and Cylinder Cover	1-1/8"-7 UNC	475	644
L	Stuffing Box To Fluid End	5/8"-11 UNC	95	130
L	Disc Valve Retainer	5/8"-11 UNC	55	75
L	Suction Manifold (Block Fluid End)	5/8"-11 UNC	130	176
M	Valve Cover and Cylinder Cover	1-1/2"-6 UNC	1060	1437
M	Stuffing Box To Fluid End	7/8"-9 UNC	200	270
M	Disc Valve Retainer	1/2"-13 UNC	30	41
M	Suction Manifold (Block Fluid End)	3/4"-10 UNC	150	203
H	Power Frame to Fluid End	1/2"-13 UNC	60	80
H	Clamp Ring To Fluid End	7/8"-9 UNC	200	270
H	Valve Cover	1-1/4"-7 UNC	660	895
H	Disc Valve Retainer	1/2"-13 UNC	30	41
H	Power Frame Adapter	1"-8 UNC	250	339
H	Suction Manifold	3/4"-10 UNC	150	203
ALL	Plunger to Intermediate Rod	1"-8 UNC	250	339

C. FLUID VALVES - TAPERED SEAT TYPE (ALL PUMPS)

See Valve section of this manual.

D. PIPING INSTALLATION (ALL PUMPS)

1. Install flanges on fluid cylinder with special high carbon heat-treated capscrews or studs and nuts available from National Oilwell Varco.
2. Install suction and discharge lines to flanges.

Assembly...

II. FLUID END (Continued)...

E. PLUNGER PACKING INSTALLATION

1. 838 Packing

It is important that the following procedure be observed when replacing old packing to prevent rapid packing wear. Style 838 packing is assembled in units consisting of a pressure ring along with a top and bottom adapter. Each set will have two (2) or three (3) units. Pay attention to the arrangement of the old packing sets to ensure the new sets are installed correctly. Another check is that the units are installed so the lantern ring is positioned under the lubrication port. If the lantern ring does not align with the lubrication port, the pump is not correctly packed.

- a. Remove cradle cover and rotate pump to bring the first plunger to the forward position.
- b. Back off gland nut one (1) or two (2) rounds.
- c. The plunger and intermediate rod separate at the knurl area interface. Using a back-up wrench break the plunger loose and unscrew from the intermediate rod. Remove the plunger.

Now is also a good time to inspect the adapter rods and power end packing. If the rods are worn or the power end packing has been leaking, refer to section D of the power end assembly in this manual to replace the appropriate components.

- d. Remove the gland nut, old packing, and packing adapters. Note the order of the packing and adapters. Clean the stuffing box and inspect for any damage.
- e. Rotate the pump to bring the next plunger forward.
- f. Repeat steps "b" through "e" until all the plungers and packing have been removed.
- g. Check the stuffing box bore, throat bushing, lantern ring, and follower for excessive wear. These items can often be reused, but if they are worn, replace them. Reusing worn trim will cause premature packing failure.
- h. Lightly lubricate the stuffing box bore and install the throat bushing.
- i. Lightly lubricate a packing unit and install each component separately ensuring each component is fully seated at the bottom of the box before installing the next component. Repeat and install the second unit. **(DO NOT GREASE)**
- j. Install the lantern ring. Check to ensure the lubrication port is aligned with the lantern ring. If not, too few or too many units have been installed ahead of the lantern ring.
- k. Install the last unit of packing.
- l. Install the follower ring and start the gland nut. Adjust the gland nut hand tight only.
- m. Lightly oil the plunger and install it through the fluid cylinder. Do not use worn plungers on new packing, as this will shorten packing life.

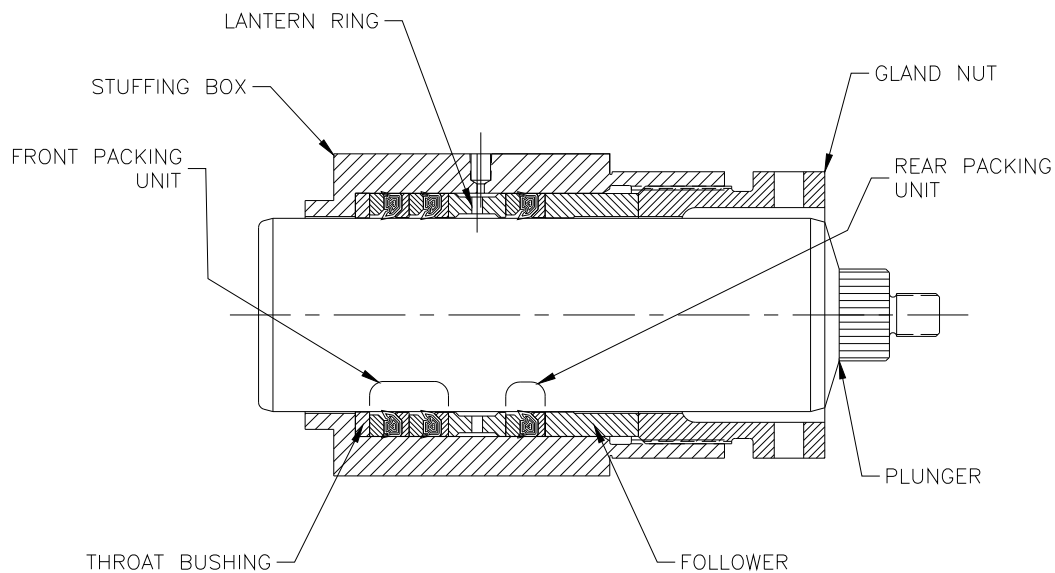
Assembly...

II. FLUID END

E. PLUNGER PACKING INSTALLATION

1. 838 Packing (Continued)...

- n. Carefully start the plunger thread on the adapter rod. Use a back-up wrench and tighten the plunger to 250 ft.-lbs. (339 N-M).
- o. Repeat steps “h” through “n” until all cylinders have been repacked.
- p. Tighten gland nut with the wrench provided. Pull snug by hand, but **DO NOT USE A CHEATER.**
- q. Start the pump and operate at pressure for two (2) to three (3) hours while observing for excessive leakage. If leakage is excessive, stop the pump and readjust. After the two (2) or three (3) hours, stop the pump and readjust. Again, **DO NOT USE A CHEATER.**
- r. This style packing is considered non-adjustable and should be ready to go at this point. However, it may take as much as one (1) or two (2) days to fully seat. After a couple of days, stop the pump and check the packing again. After this adjustment the pump should be ready to run without further adjustment.



838 STYLE PACKING

Figure 15

Assembly...

II. FLUID END

E. PLUNGER PACKING INSTALLATION (Continued)...

2. BRAID PACKING

It is important that the following procedure be observed when replacing old packing to prevent rapid packing wear. Braided packing sets consist of braided packing rings, spacer rings, and end rings. The composition and number of rings vary depending on the fluid compatibility and stuffing box depth.

- a. Remove cradle cover and rotate pump to bring the first plunger to the forward position.
- b. Back off gland nut one (1) or two (2) rounds.
- c. The plunger and intermediate rod separate at the knurl area interface. Using a back-up wrench break the plunger loose and unscrew from the intermediate rod. Remove the plunger.

Now is also a good time to inspect the adapter rods and power end packing. If the rods are worn or the power end packing has been leaking, refer to section D of the power end assembly in this manual to replace the appropriate components.

- d. Remove the gland nut, old packing, and packing adapters. Note the order of the packing and adapters. Clean the stuffing box and inspect for any damage.
- e. Rotate the pump to bring the next plunger forward.
- f. Repeat steps "b" through "e" until all the plungers and packing have been removed.
- g. Check the stuffing box bore, throat bushing and follower for excessive wear. These items can often be reused, but if they are worn, replace them. Reusing worn trim will cause premature packing failure.
- h. Ensure the stuffing box lube port is plugged or has not been drilled completely through. Braided packing does not use a lantern ring and the port must be plugged or the packing can extrude through the port.
- i. Lightly lubricate the stuffing box bore and install the throat bushing.
- j. Install the first end ring into the box. Ensure it is fully seated against the bottom of the box and not cocked.
- k. Install the first pressure ring into the box and ensure it is fully seated.
- l. Install the spacer and ensure it is fully seated.
- m. Repeat this procedure until all the packing is installed and fully seated. **ENSURE THE SPLITS ON EACH PACKING RING ARE STAGGERED FROM THE PREVIOUS RING. DO NOT ALIGN THE SPLITS.**
- n. Install the follower ring and loosely install the gland nut.
- o. Lightly oil the plunger and install it through the fluid cylinder. Do not use worn plungers on new packing, as this will shorten packing life.

Assembly...

II. FLUID END

E. PLUNGER PACKING INSTALLATION

2. BRAID PACKING (Continued)...

- p. Carefully start the plunger thread on the adapter rod. Use a back-up wrench and tighten the plunger to 250 ft.-lbs. (339 N-M).
- q. Repeat steps “i” through “p” until all cylinders have been repacked.
- r. Tighten gland nuts finger tight. Some braided packing is very sensitive to gland tightening. Do not over tighten.
- s. Start the pump and bring up to pressure. Watch the packing carefully for signs of excessive heat. If the packing starts to smoke back the gland off a little. Braided packing does normally drip a small amount. This is by design and helps keep the packing from overheating.
- t. Continue to slowly tighten the nut to reduce the leakage to an acceptable level. Remember this type of packing does leak a small amount and tightening the gland until all leakage has stopped will usually result in excessive heat and failed packing. This style packing is adjustable packing and will have to be inspected regularly to keep the nut tight and leakage to a minimum. If the pump is allowed to operate with too loose packing, the packing will prematurely fail and you run the risk of damaging the stuffing box.

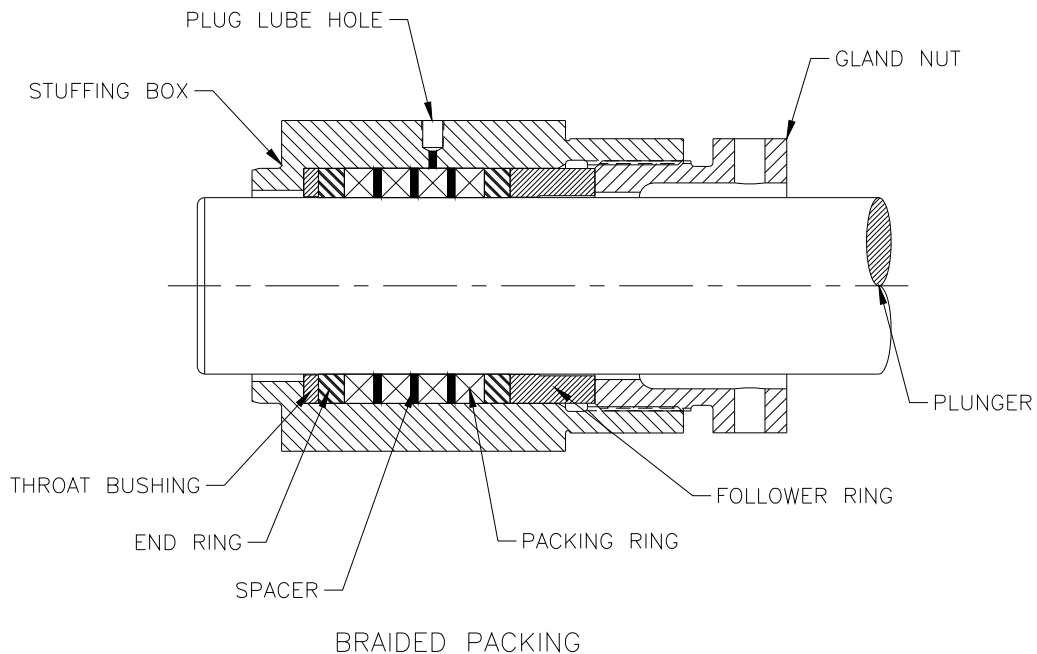


Figure 16

Assembly...

II. FLUID END

E. PLUNGER PACKING INSTALLATION (Continued)...

3. 1068-4 PACKING

1068-4 packing is spring loaded, molded V-ring style packing. It is normally used in reverse osmosis services, but may be used in other selected applications. This is non-adjustable packing.

- a. Remove cradle cover and rotate pump to bring the first plunger to the forward position.
- b. Back off gland nut one (1) or two (2) rounds.
- c. The plunger and intermediate rod separate at the knurl area interface. Using a back-up wrench break the plunger loose and unscrew from the intermediate rod. Remove the plunger.

Now is also a good time to inspect the adapter rods and power end packing. If the rods are worn or the power end packing has been leaking, refer to section D of the power end assembly in this manual to replace the appropriate components.

- d. Remove the gland nut, old packing, and packing adapters. Note the order of the packing and adapters. Clean the stuffing box and inspect for any damage.
- e. Rotate the pump to bring the next plunger forward.
- f. Repeat steps "b" through "e" until all the plungers and packing has been removed.
- g. Check the stuffing box bore, throat bushing and follower for excessive wear. These items can often be reused, but if they are worn, replace them. Reusing worn trim will cause premature packing failure.
- h. Ensure the stuffing box lube port is plugged or has not been drilled completely through. 1068-4 packing does not use a lantern ring and the port must be plugged or the packing can extrude through the port.
- i. Lightly lubricate the stuffing box bore and install the throat bushing, if used.
- j. Install the packing spring.
- k. Lubricate and install the packing set and adapters.
- l. Install the follower ring (if used) and gland nut. Do not fully tighten the gland nut at this time.
- m. Lightly oil the plunger and install it through the fluid cylinder. Do not use worn plungers on new packing, as this will shorten packing life.
- n. Carefully start the plunger thread on the adapter rod. Use a back-up wrench and tighten the plunger to 250 ft.-lbs. (339 N-M).
- o. Repeat steps "g" through "n" until all cylinders have been repacked.

Assembly...

II. FLUID END

E. PLUNGER PACKING INSTALLATION

3. 1068-4 PACKING (Continued)...

- p. Using the standard gland wrench tighten all glands completely. The glands will pull completely up. Again, this packing is spring-loaded and non-adjustable so once the glands are properly pulled up there is no more adjustment.
- q. Start the pump and bring up to pressure.

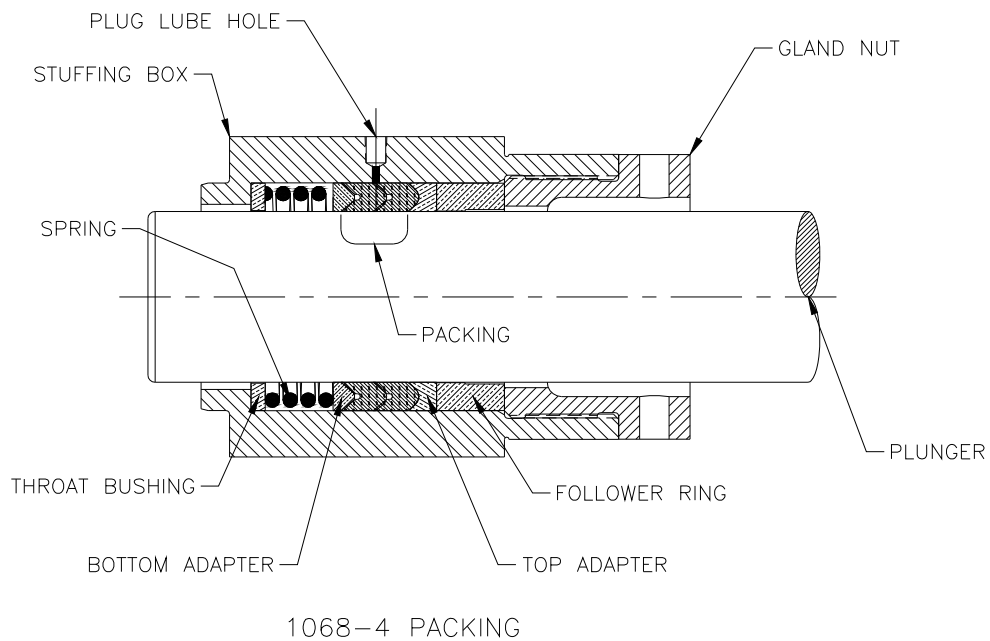


Figure 17

Plunger Pump Valves...

I. OPERATIONAL MAINTENANCE

A. SUCTION AND DISCHARGE

As with any plunger pump, the necessity for having an adequate suction head and proper piping design of both suction and discharge cannot be over emphasized.

! ATTENTION !

NOISY VALVES, DUE TO IMPROPER FILLING, CAN LEAD TO SHORT LIFE AND RAPID MECHANICAL WEAR OF THE POWER END PARTS.

B. VALVE COVERS



THE VALVE COVERS AND CYLINDER HEAD COVERS AS USED WITH THE NATIONAL OILWELL VARCO PLUNGER PUMPS, **MUST** BE KEPT TIGHT AT ALL TIMES. DUE TO THE DISCHARGE PRESSURE APPLYING A CONSTANT LOAD TO THE COVERS, IT IS **NOT** POSSIBLE TO CHECK THEIR TIGHTNESS WITH THE PUMP RUNNING OR WITH PRESSURE IN THE CYLINDER.

Bleed off the discharge pressure and check the tightness of the covers as outlined under the assembly procedure for the type of cover used.

C. VALVE COVER AND CYLINDER HEAD COVER SEALS

Tapered Seat Valves: The cover seals should be replaced as required.

D. VALVE SPRINGS

The springs used with the NATIONAL OILWELL VARCO valves are made of inconel alloy or other stainless steel.

! ATTENTION !

THESE SPRINGS SHOULD BE CHANGED APPROXIMATELY ONCE A YEAR IN ORDER TO ASSURE PROPER VALVE ACTION AND ELIMINATE THE POSSIBILITY OF A SPRING BREAK.

E. VALVE AND SEAT

Tapered Seat Valves: There are four basic valve & seat assemblies available, depending on the type of service. They are the severe duty (abrasion resistant) tapered seat valves, the disc tapered seat valves, the spherical tapered seats, and the spherical severe duty tapered seat valves.

Plunger Pump Valves (Continued)...

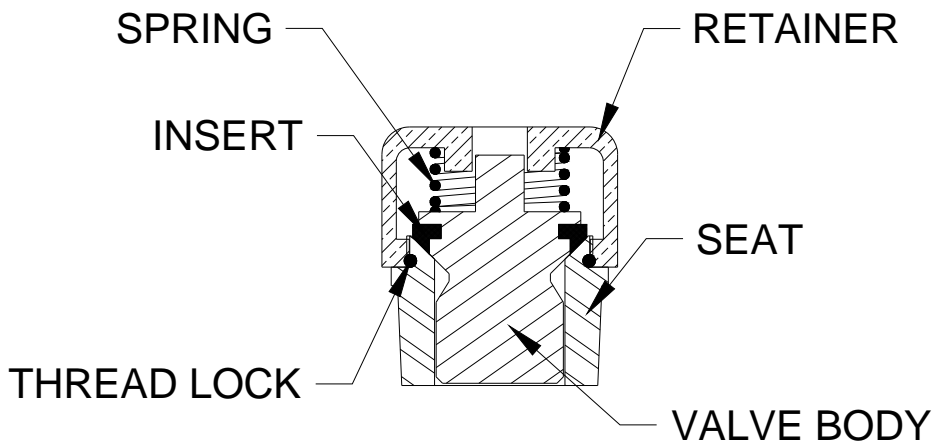
II. TAPERED SEAT VALVES

A. SEVERE DUTY TYPE VALVES

This section will assist in servicing the severe duty (abrasion resistant) valve in your National Oilwell Varco multiplex pump.

1. NOMENCLATURE.

NOMENCLATURE



SEVERE DUTY VALVE ASSEMBLY

For part numbers and pullers see the following table.

SEVERE DUTY VALVE			
Pump Model	Suction Valve Assembly	Discharge Valve Assembly	Valve Puller Assembly
184T-7H, 308T-7H, 543Q-7H	100SD8924T	100SD8913T	998-816008-091
184T-7M, 308T-7M, 543Q-7M	100SD9831	100SD9831	998-816013-091
184T-7L, 308T-7L, 543Q-7L	100SD1231	100SD1231	998-816012-092

Plunger Pump Valves...

II. TAPERED SEAT VALVES

A. SEVERE DUTY TYPE VALVES (Continued)...

2. VALVE REMOVAL PROCEDURES

- Ensure pressure is removed from the fluid end and pump is **“LOCKED OUT”**.
- The discharge valve is removed through the valve cover and the suction valve is removed through the cylinder head on all but the “H” model. On the “H” model the suction seat is smaller than the discharge and both seats come out through the valve cover area. Remove the appropriate covers.
- Rotate the pump so the plunger for the cylinder you are working on is all the way back.
- Starting with the discharge valve assembly use the cage wrench (see tools section of parts list for special tools and numbers) and remove the valve retainer by turning the wrench counter-clockwise.
- Remove the valve spring.
- Remove the valve body.
- Use the special valve seat puller and remove the valve seat. See Figure 18.
- Repeat steps “c” through “g” for the suction valve assembly.

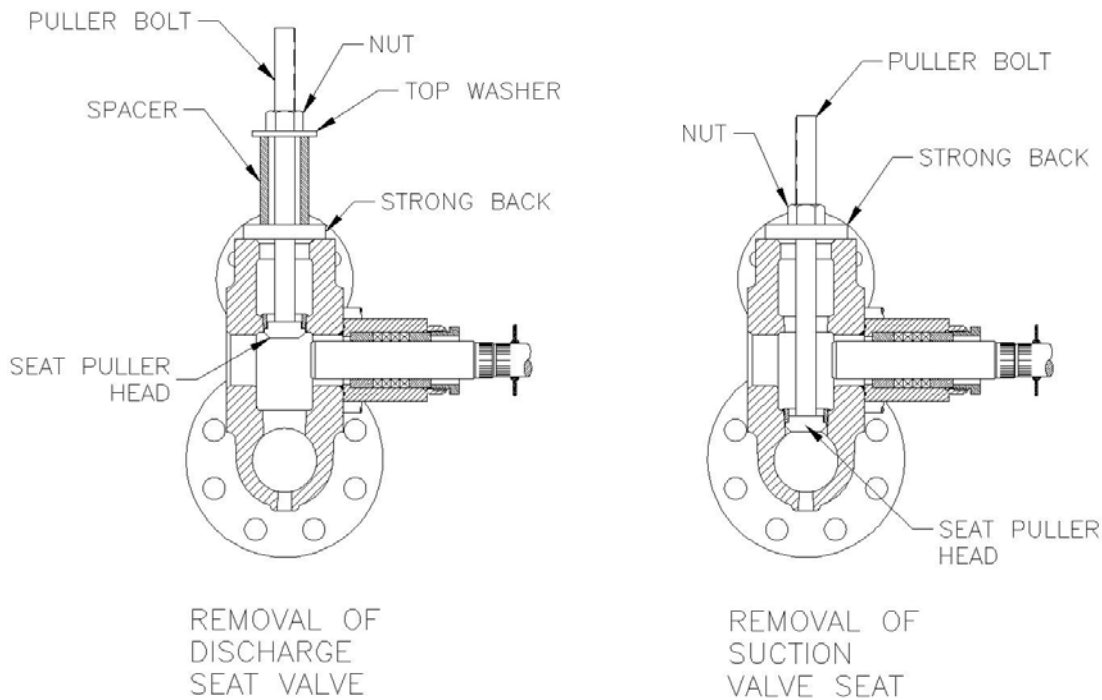


Figure 18

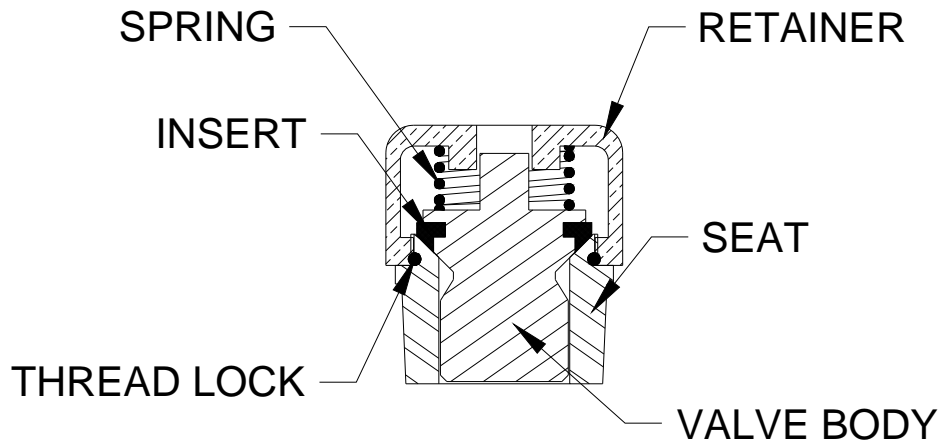
Plunger Pump Valves...

II. TAPERED SEAT VALVES

A. SEVERE DUTY TYPE VALVES (Continued)...

3. VALVE PARTS INSPECTION

NOMENCLATURE



SEVERE DUTY VALVE ASSEMBLY

a. RETAINER

The retainer will not need to be replaced very often. It should be inspected for corrosion or to see if it has been warped or bent. If this is the case, replace the retainer because this can cause undue wear on the spring and improper valve action.

b. SPRING

The spring is made from inconel or other stainless steel and will work in most corrosive environments. It should be inspected for wear and/or nicks. If such evidence is apparent, the spring should be replaced.

Plunger Pump Valves...

II. TAPERED SEAT VALVES

A. SEVERE DUTY TYPE VALVES

3. VALVE PARTS INSPECTION (Continued)...

c. INSERT

The valve insert is made from polyurethane. A good insert is vital for good sealing in slurries or dirty fluids. Inspect the insert for tears, nibbling, and extrusion. If the insert is worn, replace it. Generally you can replace the insert a couple of times before having to replace the valve body.

d. THREAD LOCK

The thread lock is a nitrile rubber. It is used to lock the retainer and prevent it from backing off during pump operation. If the thread lock is torn or damaged, replace it.

e. VALVE BODY

The valve body is heat-treated 17-4 PH stainless. Inspect the body for excessive wear, cracks, or washing. The guides should also be inspected for proper fit in the seat and any cracks or excessive wear. Replace the valve body when these conditions are present. If replacing the valve body, a new insert should also be used.

f. SEAT

The seat is also a heat-treated 17-4 PH stainless steel. It should be inspected for excessive wear and/or wash on the seating surface. Also check the taper for signs of wash or wear. If any of these conditions exist, the seat should be replaced. Do not use an old valve body with a new seat.

With the seat out of the pump also inspect the fluid end seating area for washing or excessive wear. The seats should fit in the fluid end with a small amount of stand off. If the fluid end seating area is washed or there is no stand off on the seats, the fluid end will have to be repaired. This type of repair will require the services of a machine shop.

4. VALVE INSTALLATION PROCEDURES

- a. Thoroughly clean the fluid cylinder seat area with a cleaner that will not leave an oily residue. **Do not oil the taper area of the seat or fluid cylinder seating area. This will cause the seat to “jump out” of the bore and could cause major damage to the pump.**
- b. Clean the taper on the suction seat using the same precautions as with the fluid cylinder bore. The two surfaces must be clean and dry before assembly.
- c. Insert the suction seat into the fluid cylinder suction bore.
- d. Using a metal plate or old worn valve body, drive the seat into place with several sharp blows from a hammer and bar. See Figure 19.
- e. Install the new valve body with insert.

Plunger Pump Valves...

II. TAPERED SEAT VALVES

A. SEVERE DUTY TYPE VALVES

4. VALVE INSTALLATION PROCEDURES (Continued)...

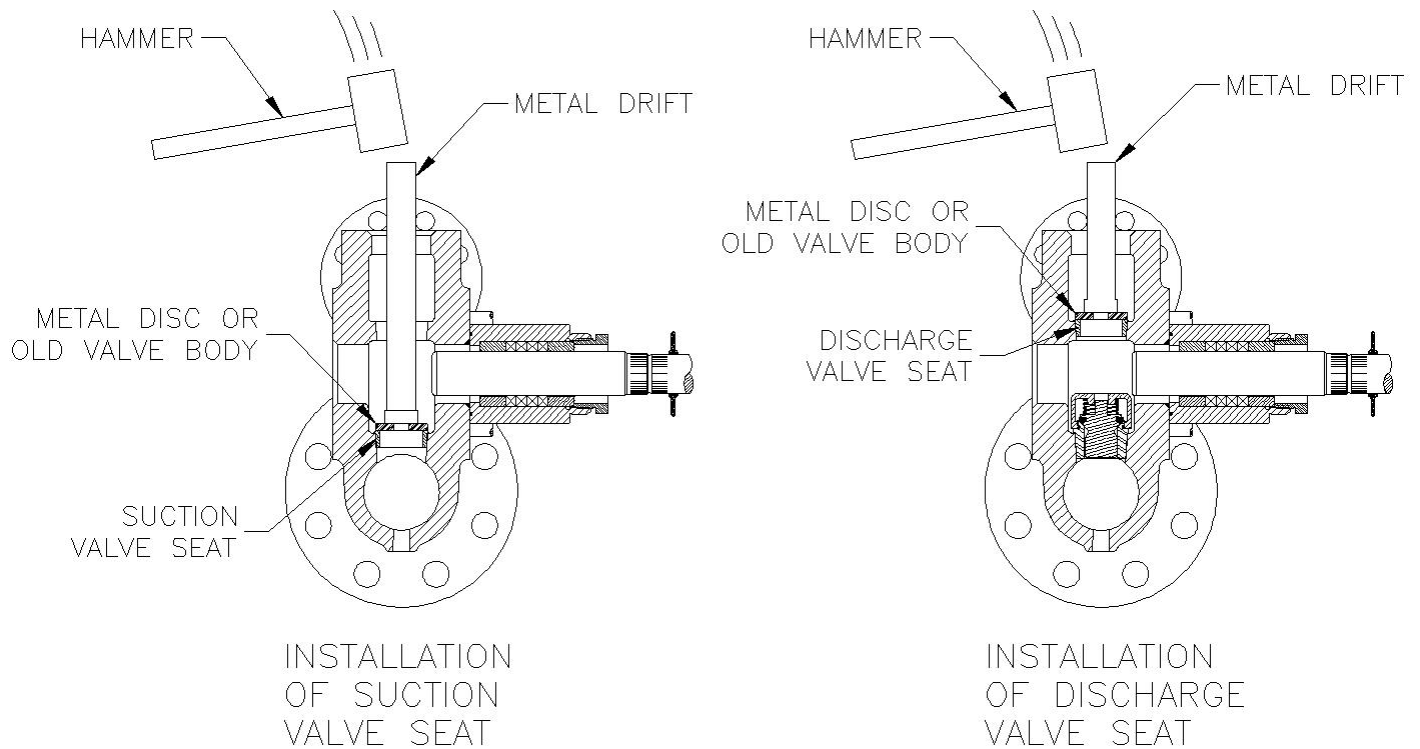


Figure 19

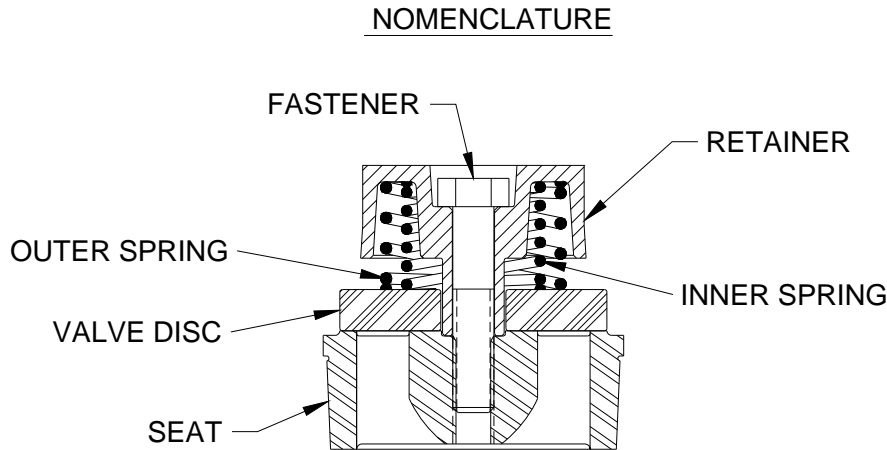
- f. Install the spring.
- g. Using the cage wrench (see parts list for special tools) install the retainer cage.
- h. Repeat this procedure for the discharge valve.
- i. Repeat until all valve assemblies have been installed.

Plunger Pump Valves...

II. TAPERED SEAT VALVES (Continued)...

B. DISC TAPERED SEAT VALVES

1. NOMENCLATURE



For part numbers and pullers see the following table. *(Pressure Limited)

DISC STYLE VALVE			
Pump Model	Suction Valve Assembly	Discharge Valve Assembly	Valve Puller Assembly
184T-7H, 308T-7H, 543Q-7H	*(Delrin Disc) 001DP8924	*(Delrin Disc) 001DP8913	998-816008-045
184T-7H, 308T-7H, 543Q-7H	(Titanium Disc) 001TP8924	(Titanium Disc) 001TP8913	998-816008-045
184T-7M, 308T-7M, 543Q-7M	(Delrin Disc) 001DP9831	(Delrin Disc) 001DP9831	998-816013-092
184T-7M, 308T-7M, 543Q-7M	(Titanium Disc) 001TP9831	(Titanium Disc) 001TP9831	998-816013-092
184T-7L, 308T-7L, 543Q-7L	(Delrin Disc) 001DP1231	(Delrin Disc) 001DP1231	998-816012-022
184T-7L, 308T-7L, 543Q-7L	(Titanium Disc) 001TP1231	(Titanium Disc) 001TP1231	998-816012-022
184T-7XL, 308T-7XL, 543Q-7XL	(Delrin Disc) 998-Q600XL-054	(Delrin Disc) 998-Q600XL-054	998-Q600XL-090
184T-7XL, 308T-7XL, 543Q-7XL	(Titanium Disc) 998-Q600XL-051	(Titanium Disc) 998-Q600XL-051	998-Q600XL-090

Plunger Pump Valves...

II. TAPERED SEAT VALVES

B. DISC TAPERED SEAT VALVES (Continued)...

2. VALVE REMOVAL PROCEDURES

- a. Ensure pressure is removed from the fluid end and pump is “**Locked out**”.
- b. The discharge valve is removed through the valve cover and the suction valve is removed through the cylinder head on all but the “H” model. On the “H” model the suction seat is smaller than the discharge and both seats come out through the valve cover area. Remove the appropriate covers.
- c. Rotate the pump so the plunger for the cylinder you are working on is all the way back.
- d. Starting with the discharge valve assembly remove the capscrew holding the retainer in place.
- e. Remove the retainer and valve springs.
- f. Remove the valve disc.
- g. Use the special valve puller and remove the seat. See Figure 20.
- h. Repeat steps “c” through “g” for the suction valve assembly.

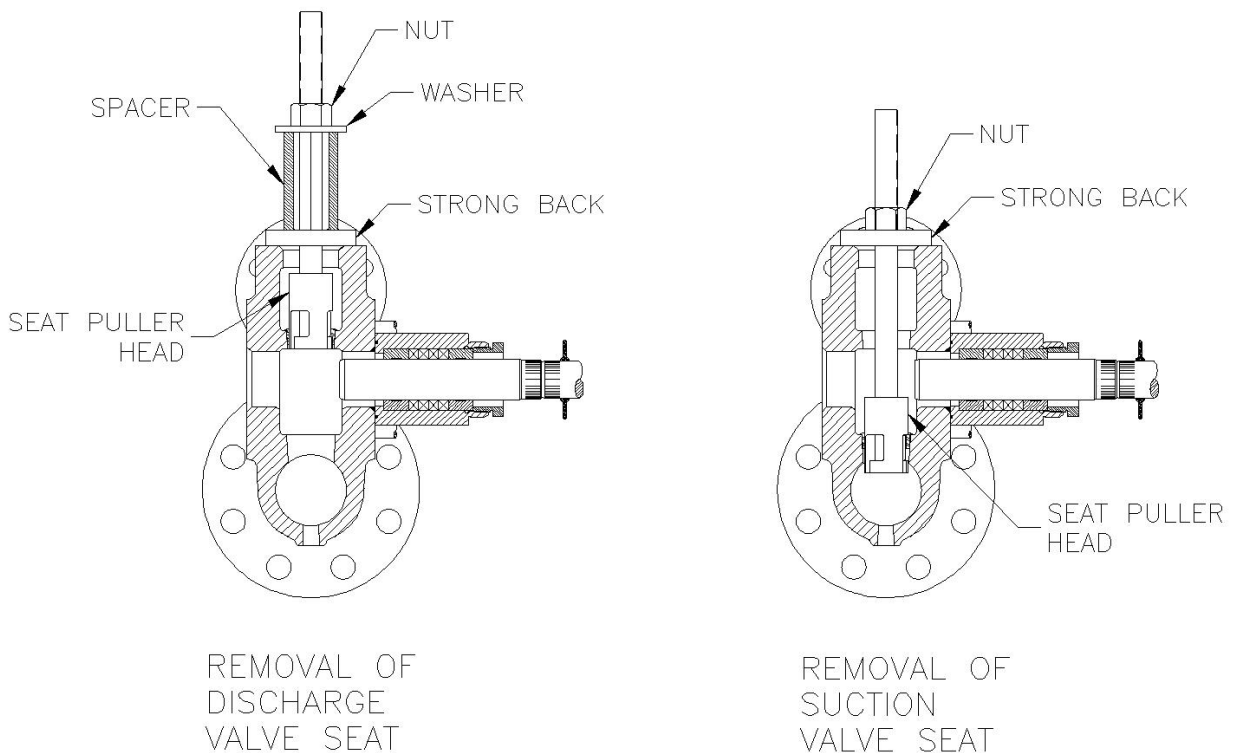


Figure 20

Plunger Pump Valves...

II. TAPERED SEAT VALVES

B. DISC TAPERED SEAT VALVES (Continued)...

3. VALVE PARTS INSPECTION

a. FASTENER

The fastener has a nylon lock tab or a lock patch. Inspect the fastener for corrosion, damaged threads, straightness, and condition of the locking tab. If the fastener is damaged, replace it. The locking tab can be used more than once. However, if the resistance when the tab engages the thread is minimal, replace it.

b. RETAINER

The retainer will not need to be replaced very often. It should be inspected for corrosion or to see if it has been warped or bent. If this is the case, replace the retainer because this can cause undue wear on the springs and improper valve action.

c. SPRINGS

The springs are made from inconel or other stainless steel and will work in most corrosive environments. It should be inspected for wear and/or nicks. If such evidence is apparent, the springs should be replaced.

d. VALVE DISC

The valve disc is either "Delrin" or Titanium. Inspect the disc for excessive wear, cracks, or washing. If any of these conditions exist, replace the disc.

e. SEAT

The seat should be inspected for excessive wear and/or wash on the seating surface. Also check the webs for any cracks and the thread for any tears or damaged threads. Check the taper for any signs of wash. Replace the seat if these conditions exist.

4. VALVE INSTALLATION PROCEDURES

- a. Thoroughly clean the fluid cylinder seat area with a cleaner that will not leave an oily residue. **Do not oil the taper area of the seat or fluid cylinder seating area. This will cause the seat to "jump out" of the bore and could cause major damage to the pump.**
- b. Clean the taper on the suction seat using the same precautions as with the fluid cylinder bore. The two surfaces must be clean and dry before assembly.
- c. Insert the suction seat into the fluid cylinder suction bore.
- d. Using a metal plate or old worn valve body, drive the seat into place with several sharp blows from a hammer and bar. See Figure 21.
- e. Install the valve disc.
- f. Install the valve springs.

Plunger Pump Valves...

II. TAPERED SEAT VALVES

B. DISC TAPERED SEAT VALVES

4. VALVE INSTALLATION PROCEDURES (Continued...)

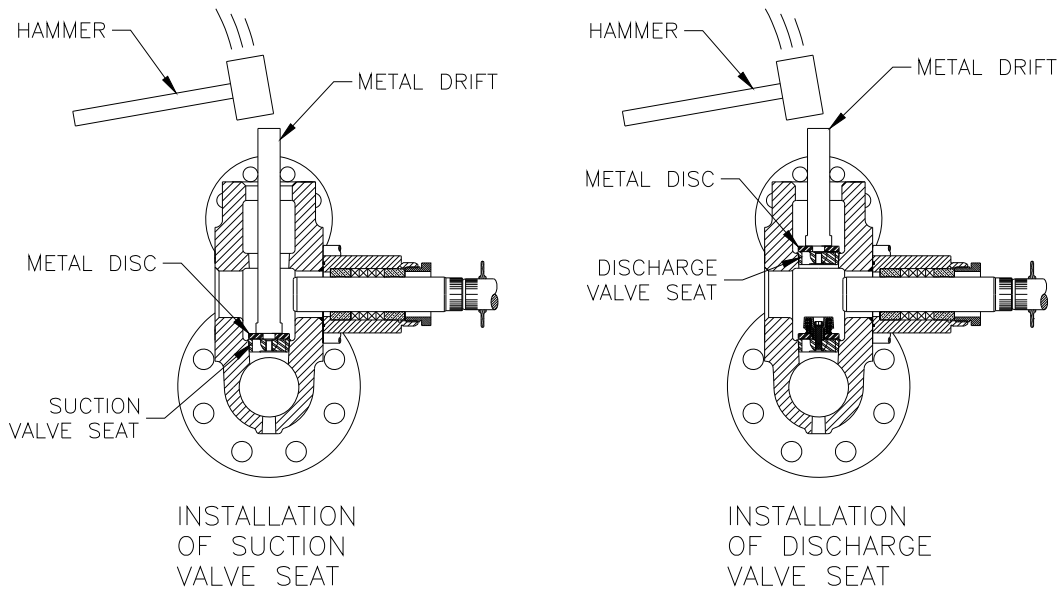


Figure 21

- g. Install the retainer by pushing down the retainer with one hand to compress the springs and start the neck of the retainer through the valve disc. Hand start the fastener.
- h. Tighten the fastener while ensuring the retainer pulls down against the seat and does not clamp the disc down. The disc has to move up and down on the retainer neck. See following table for fastener torque.
- i. Repeat this procedure for the discharge valve.

DISK VALVE RETAINER TORQUE			
Pump Model	Fastener Size	Torque (ft.-lbs.)	Torque (N-M.)
184T-7H, 308T-7H, 543Q-7H	1/2"-13 UNC	30	41
184T-7M, 308T-7M, 543Q-7M	1/2"-13 UNC	30	41
184T-7L, 308T-7L, 543Q-7L	5/8"-11 UNC	55	75
184T-7XL, 308T-7XL, 543Q-7XL	3/4"-10 UNC	100	136

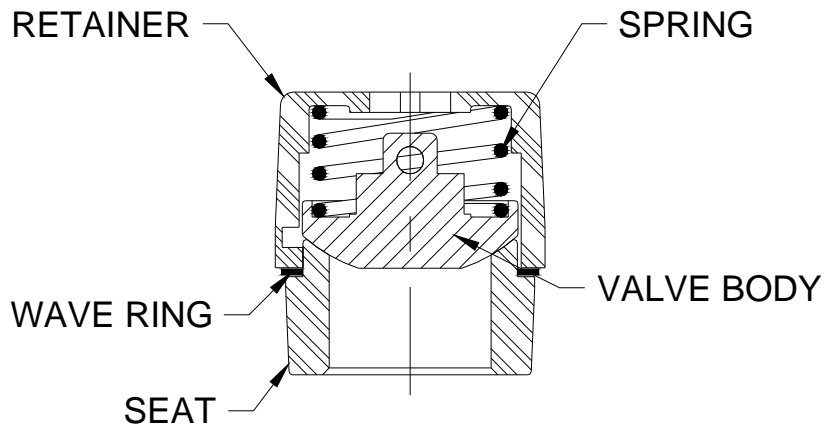
Plunger Pump Valves...

II. TAPERED SEAT VALVES (Continued)...

C. SPHERICAL VALVES

1. NOMENCLATURE

NOMENCLATURE



SPHERICAL VALVE ASSEMBLY

For part numbers and pullers see the following table.

SPHERICAL VALVES			
Pump Model	Suction Valve Assembly	Discharge Valve Assembly	Valve Puller Assembly
184T-7H, 308T-7H, 543Q-7H	179304225	179304425	998-543Q7H-046
184T-7M, 308T-7M, 543Q-7M	179303425W	179303425W	998-543Q7M-095
184T-7L, 308T-7L, 543Q-7L	179403625W	179403625W	998-543Q7L-095
184T-7XL, 308T-7XL, 543Q-7XL	179504025W	179504025W	998-Q600XL-095

Plunger Pump Valves...

II. TAPERED SEAT VALVES

C. SPHERICAL VALVES (Continued)...

2. VALVE REMOVAL PROCEDURE

- a. Ensure pressure is removed from fluid end and pump is **“LOCKED OUT”**.
- b. The discharge valve is removed through the valve cover and the suction valve is removed through the cylinder head on all but the “H” model. On the “H” model the suction seat is smaller than the discharge and both seats come out through the valve cover area. Remove the appropriate covers.
- c. Rotate the pump so the plunger for the cylinder you are working on is all the way back.
- d. Remove the spring retainer by pressing downward on the puller head and turn counter clockwise about 1/8 of a turn or until retainer stops. Remove the retainer with the retriever. See Figures 22 - 25.
- e. Remove spring(s) and valve with the retriever. See Figures 22 - 25.
- f. Remove seat by placing the puller head through the seat opening and engage lugs to the underside of the seat. Pull seat or bump seat loose and remove. See Figures 22 - 25.
- g. Repeat steps “c” through “f” for the suction valve assembly.



Figure 22

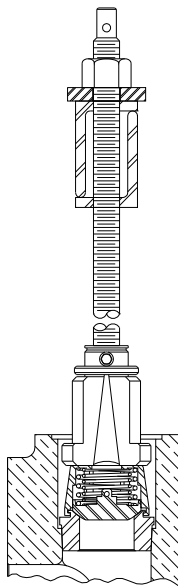


Figure 23

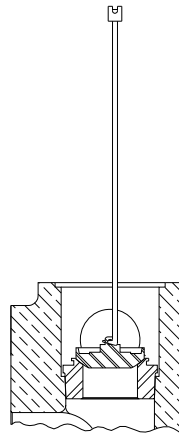


Figure 24

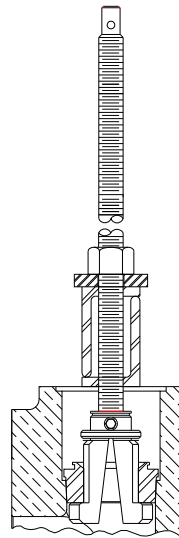


Figure 25

Plunger Pump Valves...

II. TAPERED SEAT VALVES

C. SPHERICAL VALVES (Continued)...

3. VALVE PARTS INSPECTION

a. RETAINER

The retainer will not need to be replaced very often. It should be inspected for corrosion or to see if it has been warped or bent. If this is the case, replace the retainer because this can cause undue wear on the springs and improper valve action.

b. SPRING(S)

The springs are made from inconel or other stainless steel and will work in most corrosive environments. It/they should be inspected for wear and/or nicks. If such evidence is apparent, the spring should be replaced.

c. VALVE BODY

The valve body is a stainless steel spherical disc. Inspect the valve for excessive wear, cracks, or washing. If any of these conditions exist, replace the valve.

d. SEAT

The seat is stainless steel and should be inspected for excessive wear and/or wash on the seating surface. Also check the lugs, which engage the retainer for any damage. Check the taper for any signs of wash. Replace if these conditions exist.

e. WAVE RING

The wave ring protects the valve integrity and is a safety device to prevent the cage from coming loose in the rare event a spring breaks. Check the wave ring for cracks or damage. Replace if necessary.

Plunger Pump Valves...

II. TAPERED SEAT VALVES

C. SPHERICAL VALVES (Continued)...

4. VALVE INSTALLATION PROCEDURE

- a. Thoroughly clean the cylinder taper with a cleaner that will not leave an oily residue. **Do not oil the taper area of the seat or fluid cylinder seating area. This will cause the seat to “jump out”.**
- b. Clean the taper on the suction seat using the same precautions as with the fluid cylinder bore. The two surfaces must be clean and dry before assembly.
- c. Inspect for corrosion or damaged areas. Repair or replace as required.
- d. Place seat in the suction bore making certain it is straight.
- e. With a bar and a driver, drive seat in place with two or three sharp blows. **NOTE!!** Seat does not have to be completely seated. Pump start-up pressure will drive seat home. See Figures 26 - 27.
- f. Install valve, spring(s), and spring retainer. See Figures 26 - 27.

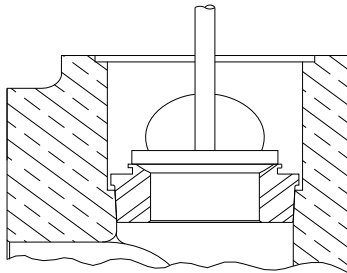


Figure 26

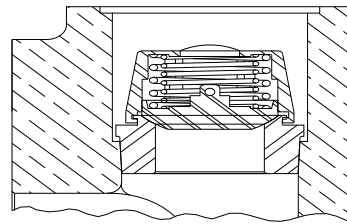


Figure 27

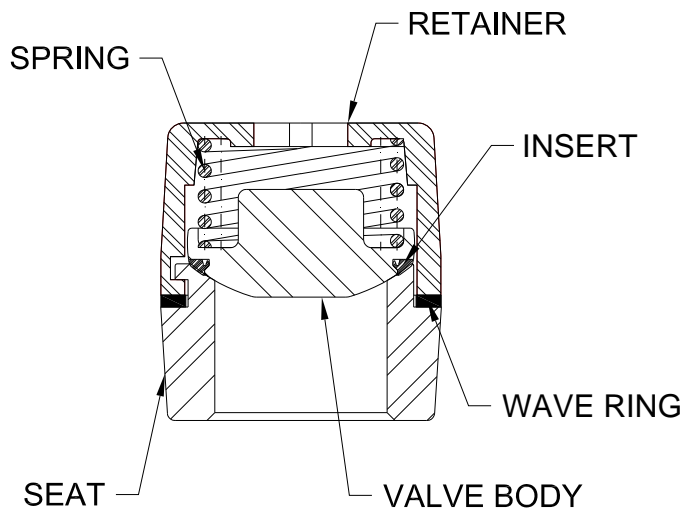
Plunger Pump Valves...

II. TAPERED SEAT VALVES (Continued)...

D. SPHERICAL VALVES – SEVERE DUTY

1. NOMENCLATURE

NOMENCLATURE



SPHERICAL - SEVERE DUTY ASSEMBLY

For part numbers and pullers see the following table.

SPHERICAL VALVE – SEVERE DUTY			
Pump Model	Suction Valve Assembly	Discharge Valve Assembly	Valve Puller Assembly
184T-7H, 308T-7H, 543Q-7H	Not Available	Not Available	Not Available
184T-7M, 308T-7M, 543Q-7M	179303425SD	179303425SD	998-543Q7M-095
184T-7L, 308T-7L, 543Q-7L	179403625SD	179403625SD	998-543Q7L-095
184T-7XL, 308T-7XL, 543Q-7XL	179504025SD	179504025SD	998-Q600XL-095

Plunger Pump Valves...

II. TAPERED SEAT VALVES

D. SPHERICAL VALVES – SEVERE DUTY (Continued)...

2. VALVE REMOVAL PROCEDURE

- a. Ensure pressure is removed from fluid end and pump is “**LOCKED OUT**”.
- b. The discharge valve is removed through the valve cover and the suction valve is removed through the cylinder head. Remove both covers.
- c. Rotate the pump so the plunger for the cylinder you are working on is all the way back.
- d. Remove the spring retainer by pressing downward on the puller head and turn counter clockwise about 1/8 of a turn or until retainer stops. Remove the retainer with the retriever. See Figures 28 - 31.
- e. Remove spring(s) and valve with the retriever. See Figures 28 - 31.
- f. Remove seat by placing the puller head through the seat opening and engage lugs to the underside of the seat. Pull seat or bump seat loose and remove. See Figures 28 - 31.
- g. Repeat steps “c” through “f” for the suction valve assembly.



Figure 28

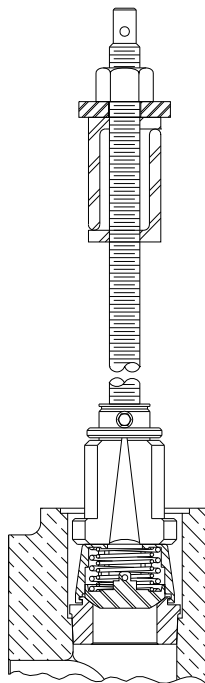


Figure 29

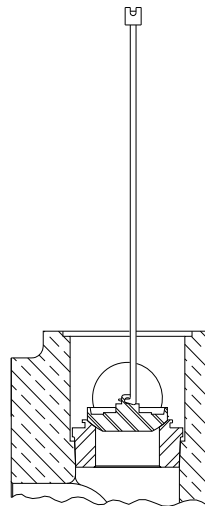


Figure 30

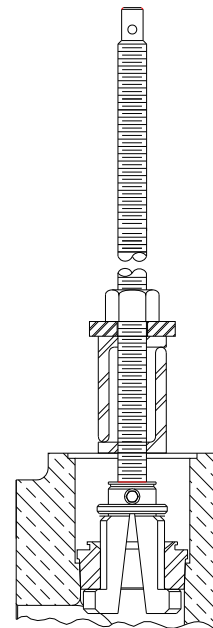


Figure 31

Plunger Pump Valves...

II. TAPERED SEAT VALVES)

D. SPHERICAL VALVES – SEVERE DUTY (Continued)...

3. VALVE PARTS INSPECTION

a. RETAINER

The retainer will not need to be replaced very often. It should be inspected for corrosion or to see if it has been warped or bent. If this is the case, replace the retainer because this can cause undue wear on the springs and improper valve action.

b. SPRINGS

The springs are made from inconel or other stainless steel and will work in most corrosive environments. They should be inspected for wear and/or nicks. If such evidence is apparent, the spring should be replaced.

c. VALVE BODY

The valve body is a stainless steel spherical disc. Inspect the valve for excessive wear, cracks, or washing. If any of these conditions exist, replace the valve.

d. INSERT

The standard insert is poly urethane and is used when solids are present in the fluid. Inspect the insert for cracks or tears. If damaged replace.

e. SEAT

The seat is stainless steel and should be inspected for excessive wear and/or wash on the seating surface. Also check the lugs, which engage the retainer for any damage. Check the taper for any signs of wash. Replace if these conditions exist.

f. WAVE RING

The wave ring protects the valve integrity and is a safety device to prevent the cage from coming loose in the rare event a spring breaks. Check the wave ring for cracks or damage. Replace if necessary.

Plunger Pump Valves...

II. TAPERED SEAT VALVES

D. SPHERICAL VALVES – SEVERE DUTY (Continued)...

4. VALVE INSTALLATION PROCEDURE

- a. Thoroughly clean the cylinder taper with a cleaner that will not leave an oily residue. **Do not oil the taper area of the seat or fluid cylinder seating area. This will cause the seat to “jump out”.**
- b. Clean the taper on the suction seat using the same precautions as with the fluid cylinder bore. The two surfaces must be clean and dry before assembly.
- c. Inspect for corrosion or damaged areas. Repair or replace as required.
- d. Place seat in the suction bore making certain it is straight.
- e. With a bar and a driver, drive the seat in place with two or three sharp blows. **NOTE!!** Seat does not have to be completely seated. Pump start-up pressure will drive seat home. See Figures 32 - 33.
- f. Install valve, spring(s), and spring retainer. See Figures 32 - 33.

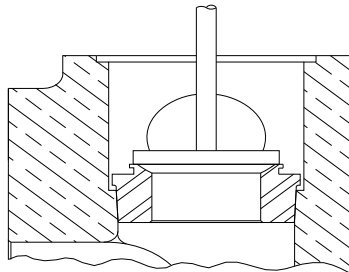


Figure 32

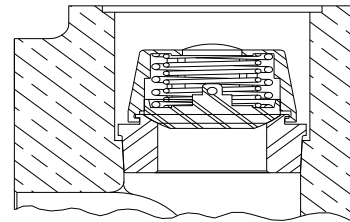


Figure 33

P-55U Pump...

A. OPERATING INSTRUCTIONS

1. BOX SUCTION PUMPS (VACUUM FEED)

- Fill reservoir with oil.
- Loosen union nut on pump outlet.
- 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.
- Replace vent screw and tighten union nut.
- Maintain oil level in sight glass below the drip tube so drops can be observed.

2. FLOW RATE ADJUSTMENT

- Loosen locknut on flushing unit.
- Turn flushing unit counter-clockwise to increase flow.
- Turn flushing unit clockwise to decrease flow.
- Tighten locknut when desired flow rate is achieved.

3. 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 and 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.

4. OVERFILLING 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.

5. RESERVOIR OIL LEVEL (LOSS OF PRIME)

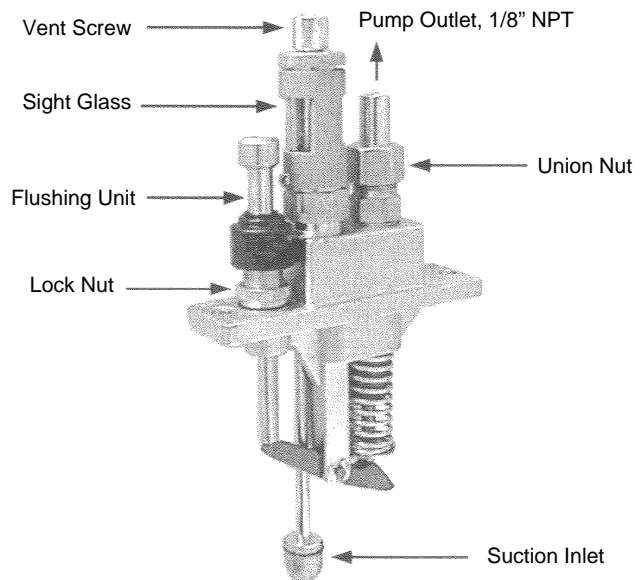
If reservoir runs low on oil (at a point below the suction inlet of the pump) it may be necessary to prime individual pumps after filling, using procedure listed above.

6. PUMP DISPLACEMENT

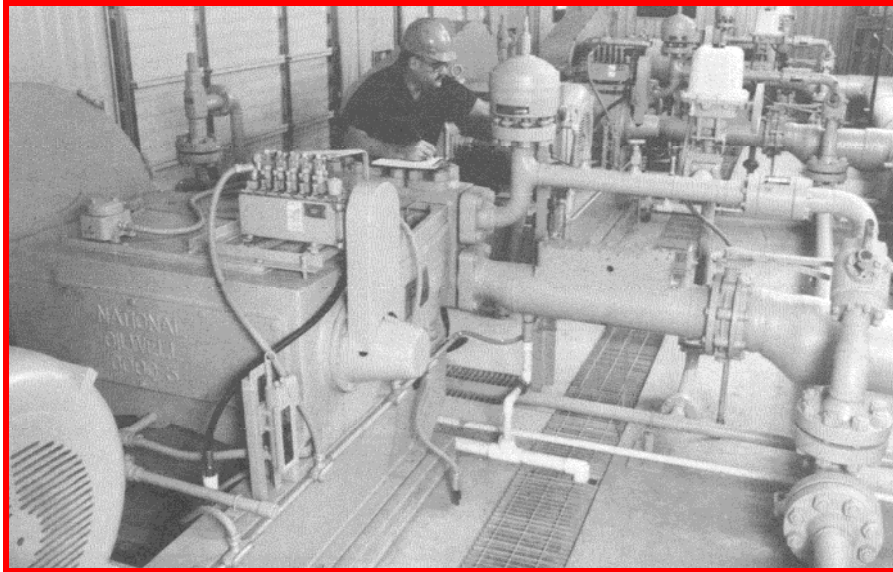
Maximum output (per stroke):

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.



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