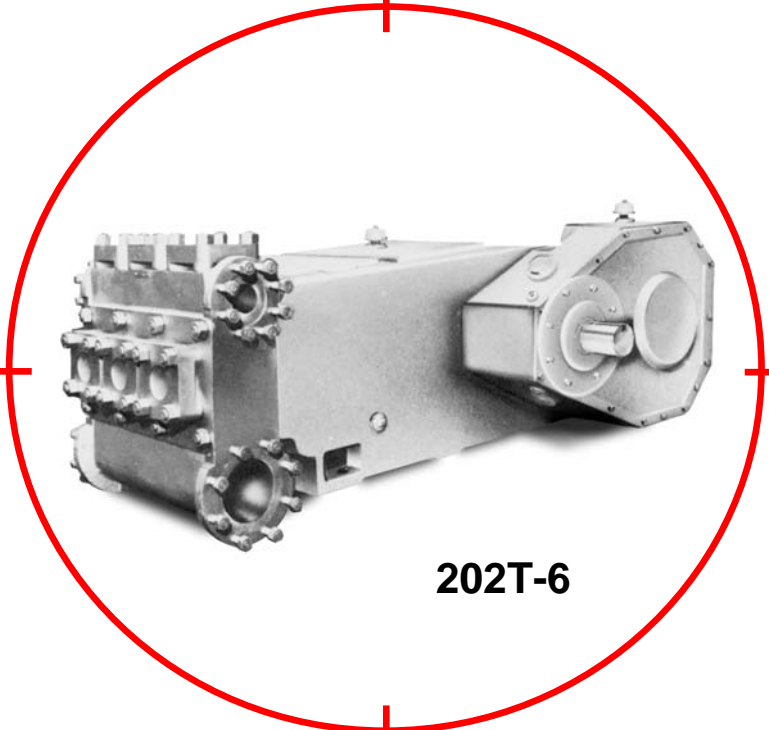


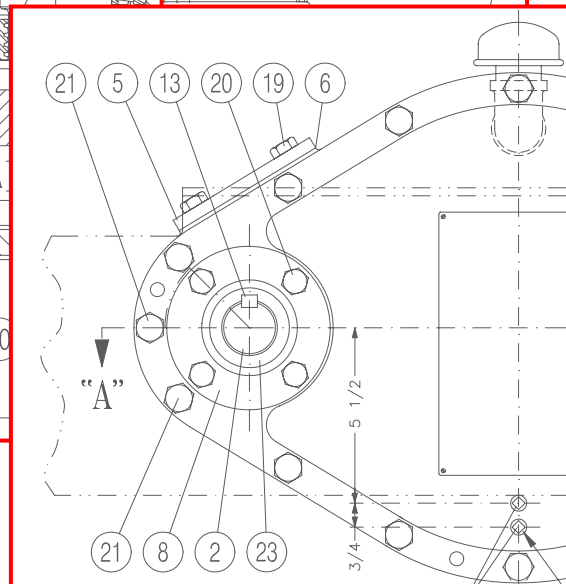
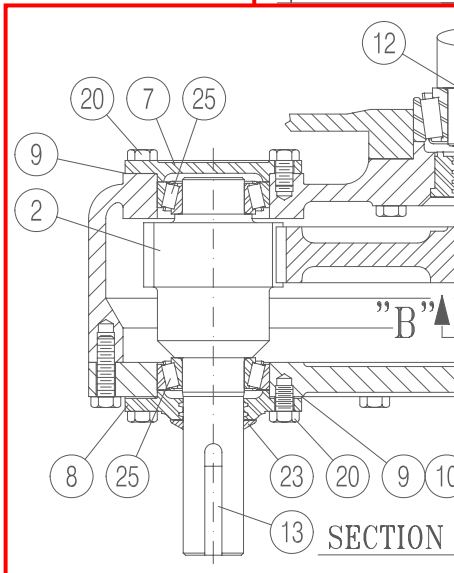
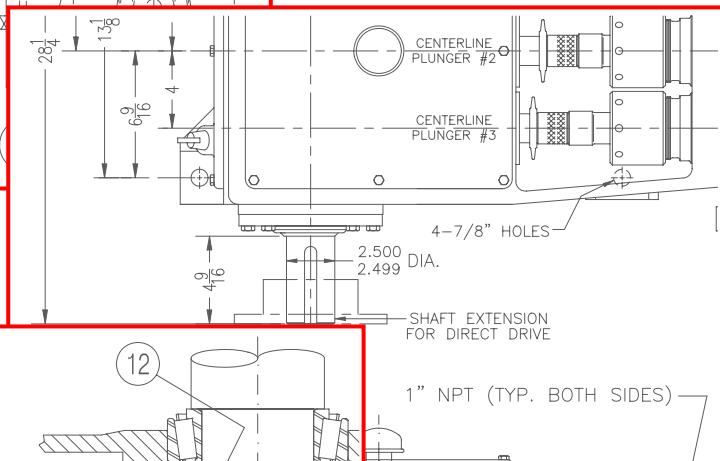
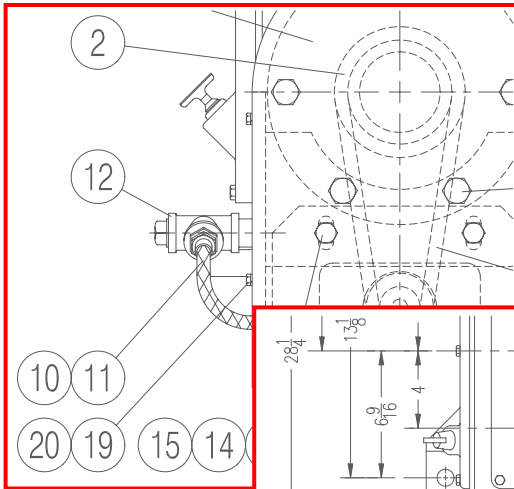
202T-6 Triplex Plunger Pump

Installation, Care and Operation Manual



202T-6

Types:
202T-6L
202T-6M
202T-6H





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%
Plunger Pressure Rating – Plus 10%

Foreword...

This manual is published as a guide for the normal operations 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 dimensions 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 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 stipulated in the purchase contract.

ATTENTION

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

CAUTION

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.

ATTENTION

FAILURE TO OBSERVE THE WARNINGS, CAUTIONS AND NOTES IN THIS PUBLICATION CAN RESULT IN PROPERTY DAMAGE, SERIOUS BODILY INJURY OR EVEN DEATH!

Introduction...

This manual is published as a guide for normal Installation, Care and Operations of your unit. Because of the wide range of applications, it is not possible to detail all facets of these subjects and it is requested that when situations encountered are outside the scope of this presentation they be referred to the manufacturer. PLEASE TRY IT OUR WAY FIRST.

Table of Contents...

INSTALLATION

PAGE

I. GENERAL

A. General	6
B. Alignment and Rotation.....	6-7
C. Pump Suction.....	7-8
D. Pump Discharge	8

PREPARING FOR OPERATION

I. GENERAL

A. General	9
B. Fluid End.....	9
C. Power End	9

PLACING IN OPERATION

I. GENERAL.....	10
-----------------	----

LUBRICATION

I. GENERAL

A. Crankcase.....	11
B. Plunger Packing.....	12
C. Lubricant Selection	12

TECHNICAL INFORMATION

I. GENERAL.....	13
-----------------	----

Table of Contents...

FLUID END REPLACEMENTS 202T-6M & 202T-6L

PAGE

I. GENERAL

A. Fluid Valve	14
B. Plunger.....	15
C. Packing and Stuffing Box	16

FLUID END REPLACEMENTS 202T-6H

I. GENERAL

A. Fluid Valve	17
B. Plunger.....	18
C. Packing and Stuffing Box	19

POWER END REPLACEMENTS

I. GENERAL

A. Diaphragm Packing.....	20
B. Extension Rod.....	21
C. Connecting Rod Bearings.....	22
D. Crossheads, Crosshead Pins and Bushings	23
E. Main Bearings	24-25

LUBRICATOR INSTALLATION

I. GENERAL	26
------------------	----

DRIVE REVERSAL

I. GENERAL	27
------------------	----

Table of Contents...

MAINTENANCE

PAGE

I. GENERAL

A. Daily Maintenance	28
B. Weekly Maintenance.....	28
C. Monthly Maintenance.....	28
D. Six Months Maintenance	28

TROUBLE SYMPTOMS

I. GENERAL.....	29-30
-----------------	-------

TORQUING VALUES and SEQUENCE

I. GENERAL.....	31
A. Torquing Values For Fasteners	31
B. Material and Specifications	31

SHEAR BLOCKS

I. GENERAL

A. General	32
B. Installation	32

STORAGE OF PUMPS

I. GENERAL

A. General	33
B. Recommended Protection Initial Storage	33
C. Six Month Servicing	34
D. Pre-Installation Check After Storage	34

OWNERS RECORD	35
---------------------	----

TYPICAL WATERFLOOD PUMP INSTALLATION SUCTION and DISCHARGE PIPING ARRANGEMENT	36
---	----

VISCOSITY EQUIVALENTS	37
-----------------------------	----

Installation...

I. GENERAL

The installation of the equipment, if carefully planned and adequately performed, is the first most important step in providing for long, trouble free service from the pump as well as the associated equipment. Review the specifications and performance data on the preceding pages and be sure that the flow system is of sufficient design to insure safety at elevated pressures and that it provides a safe pressure relief in the event of flow interruption as well as immediate shut-down should line failure occur. Safety guards for all reciprocating and rotating elements should be mandatory at the time of installation. Hand rails, supports, tie-down, shields, deck plating, etc., must be considered in your program.

It is suggested that the guards and other safety devices be fitted with interlocking devices or relays which will, if any of these are opened or removed, cause complete power interruption and force the unit(s) out of service. The power should remain "locked out" until the guards or safety devices are properly reinstalled, inspected and approval given for continued operations.

Make it a safe installation.

The following are considered basic installation requirements:

A. GENERAL

1. The foundation must be level. Angular installation and operation may be detrimental to the lubrication of the equipment and may impose high stresses causing equipment failure.
2. The foundation must be of sufficient strength to prevent flexing of the equipment.
3. The foundation must be of sufficient size and design to maintain the equipment free of strain.
4. The equipment must be adequately secured to the foundation. High strength bolts or capscrews with locking devices should be employed.
5. Consideration should be given to the location of the equipment with its proximity to the associated equipment, fluid supply, fuel supply, environmental contamination, etc.
6. Avoid environmental contamination by providing for the proper disposition of drainage from the crankcase, gear case, chain case, sludge sump and any other lubrication reservoirs as well as from the flushing media reservoir, the flushing media sump, the pump cradle, the suction line and the discharge line.

B. ALIGNMENT and ROTATION

1. It is most important that the pump be accurately aligned with the prime mover.
2. If flexible couplings are used, follow the alignment recommended by the coupling manufacturer.
3. When alignment is achieved it should be reinforced by shear blocks or dowel pins.
4. These pumps are designed for CLOCKWISE rotation of the crankshaft when viewing the crankshaft from the right hand side of the pump.

The laterality of the pump is determined by standing at the power end and looking toward the fluid end.

Installation...

I. GENERAL

B. ALIGNMENT and ROTATION (Continued)

! WARNING ! ! WARNING ! ! WARNING!

COUNTER CLOCKWISE ROTATION (ROTATION REVERSE TO THAT INDICATED ABOVE) WILL BE DETRIMENTAL TO THE UNIT.

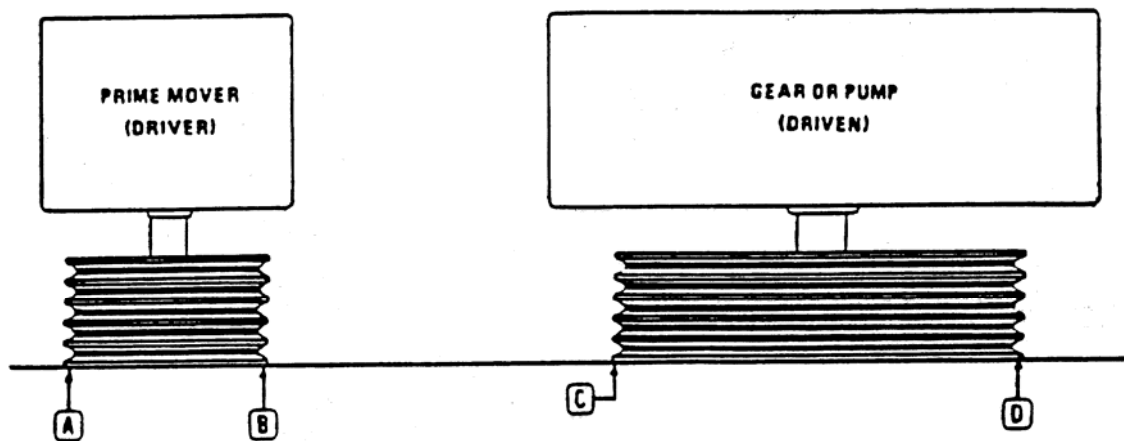


Figure 1 – Alignment

With the pump and prime mover on the skid or foundation, use a straight-edge or chalk line to determine the relative position of these two components. When close alignment is achieved, install the belts or chain and adjust for proper tension then reposition the prime mover to obtain full surface contact between the straight-edge or chalk line and the sheaves or sprockets at points (A), (B), (C) and (D). Retain this alignment and readjust the belts or chain for tension. Secure the components to their mounting.

C. PUMP SUCTION

1. Single acting pumps require a flooded or charged suction for proper performance. A net positive suction pressure, as provided by an adequate centrifugal charging pump, will aid in the filling of the fluid cylinders and reduce the erratic operation caused by cavitation. Generally, the charging pump should have a capacity equal to 1½ times that of the triplex pump.
2. The suction flow should be streamlined through gradual turns with friction not greater than those caused by 45 degree long radius elbows. Do not install any bend directly adjacent to the pump intake.
3. The suction line must not be smaller than the pump suction, preferably the line should be at least one pipe size larger. The line should be as short as possible and the fluid velocity should not exceed 3 feet/second. In the pumping of solids it may be necessary to exceed this velocity to prevent the product from settling out of the carrier fluid. In this service, maintain the lowest possible velocity and the lowest possible pump speed to provide for maximum pump performance.

Installation...

I. GENERAL

C. PUMP SUCTION (Continued)

4. A suction stabilizer is recommended installed as close as possible to the pump suction.
5. Install a full-opening gate valve or butterfly at the supply tank to permit the suction line to be closed and drained when necessary. Do not use a valve with any flow restriction.
6. Install a drain valve at the lowest point in the suction system.
7. Install a pressure gauge at the pump suction.
8. Install a low suction pressure alarm system.
9. Install a thermometer well at the pump suction.
10. Do not introduce meters or any restricting device into the suction line.
11. It is not recommended, but if it should be necessary to manifold a number of pumps to a common suction, the suction pipe from the supply tank and the manifold must have a cross-sectional area equal to or greater than the total cross-sectional areas of all the pump suction connections connected to the manifold.
12. Support the suction line at the pump and at the supply tank to remove any imposed stresses or strains. Additional supports, dependent upon the length and configuration of the suction line, may be necessary to reduce fatigue and vibration.

D. PUMP DISCHARGE

1. The discharge line must not be smaller than the discharge at the pump.
2. The discharge from the pump should be streamlined through gradual turns with friction not greater than those caused by 45 degree long radius elbows. Do not install any bend directly adjacent to the pump discharge.
3. Install a discharge pulsation dampener as close to the pump as possible.
4. Any valves in the discharge line must be full opening type.
5. Install a pressure relief valve ahead of any valve in the discharge line. It must be set at a pressure not greater than 10% above the rated working pressure of the plunger being used. The discharge from the relief valve should be directed through a securely positioned line back to the supply tank (not to the pump suction).
6. Install a by-pass line to permit the unit to be operated without load. This permits servicing of the equipment and circulation of lubrication prior to loading the pump.
7. Install a pressure gauge at the pump discharge.
8. Install a high-low pressure alarm system. This may be supplemented with a time delay shut-down.

Preparing for Operation...

I. GENERAL

Certain preparations are necessary before the pump can be placed in operation. It is suggested that all check points in the MAINTENANCE section of this publication be observed and executed prior to releasing the pump for service. The following is a guide for general operation.

A. GENERAL

1. Inspect the unit for any damage or defects.
2. Check sheaves/sprockets/couplings for proper alignment.
3. Check belts or chain for proper tension.
4. Check fuel, water, suction, discharge and drainage piping.
5. Check safety guards for maximum protection.
6. Check safety devices for malfunction.

B. FLUID END

1. The fluid end is normally shipped complete with the valves and seats installed. The plungers and packing will, if delayed start-up is indicated, be shipped unassembled.
2. Remove valve covers – inspect the valve service and the interior of the fluid end for defects or foreign materials.

C. POWER END

1. Check rotation. The pump is designed for clockwise rotation of the crankshaft when viewed from the right hand side. Right or left hand side is determined by standing at the power end and looking toward the fluid end. REVERSE ROTATION MAY BE DETRIMENTAL TO THE UNIT (check with manufacturer if reverse rotation is necessary).
2. Remove inspection doors and covers – check the interior of the pump for dirt, rust, water and foreign objects, particularly if the pump has been in storage. If necessary, clean and wash out the power end with non-toxic, non-explosive solvent.
 - a. Replace the inspection doors and covers.
 - b. Check and be sure the drains are closed.
3. Fill the crankcase with correct amount of the proper lubricant as indicated in the LUBRICATION section of this manual.
 - a. The filling may be accomplished by removing the breather on top of the crankcase and introducing the lubricant at this point.
 - b. Replace the breather.

Placing in Operation...

I. GENERAL

If the unit has been prepared for operation as outlined in the foregoing, proceed to place the unit in service. The following is a guide for initial start-up.

1. If the pump is equipped with an externally driven lubricating oil system, energize the system five minutes in advance of start-up.
2. If the pump is equipped with an integral lubricating oil system or has a combination splash/cascade oiling system, remove the inspection doors and covers from the power end, introduce an adequate quantity of the lubricating media into the bearing troughs, etc. Replace the doors and covers.
3. Check the temperature of the lubricant in the crankcase. This must be within the limits specified in the LUBRICANT TABLE which appears subsequently in this publication.

If the lubricant is below the minimum specified degree it can possibly be increased in temperature by circulating it through the lubrication system. If this action does not bring the temperature up to the minimum level, introduce hot water into the heat exchanger or use emersion type heaters.

DO NOT PLACE THE PUMP IN OPERATION OR MAINTAIN IT IN OPERATION WHEN THE TEMPERATURE OF THE LUBRICANT IS ABOVE OR BELOW THE LIMITS STATED IN THE LUBRICANT TABLE APPEARING IN THIS PUBLICATION.

4. If the pump is equipped with a flushing system energize the flushing system.
5. Rotate the pump one full revolution by hand to be certain all moving parts are free and can move unrestricted.
6. Open by-pass valve.
7. Open valve at suction tank.
8. Apply power slowly, check direction of rotation and control at low rpm to prime the pump fluid chambers.
9. Open the valve in the discharge line, increase power, close by-pass valve and observe the following:

- Check lubricant pump to be certain of flow in the lubrication system.
- Check flushing system for proper distribution.
- Check for lubrication leaks at diaphragm.
- Check suction pressure.
- Check discharge pressure.
- Check lubricant temperature.
- Check suction stabilizer for proper operational level.
- Check discharge pulsation dampener for charge pressure.
- Check for lubricant leaks in external piping.
- Check for fluid leaks in suction and discharge piping.
- Check all external bolting for proper torquing.

10. If operations are below 50 rpm consult manufacturer for lubrication instructions.*

* Not applicable to pumps with separately driven lubricating oil pumps which provides positive lubrication at all times.

Lubrication...

I. GENERAL

The maintenance of a regular lubrication check schedule with the use of the proper grades of oil and grease is probably the most important factor to be observed in securing the utmost performance from your pump. The oil must be kept clean. Bearing and other parts require more frequent adjustment and wear out quickly when run in dirty oil.

1. Use only the quantity and grades of lubricant listed below.
2. Maintain the lubricant free of all contamination (fluids and solids).
3. Change lubricant at the end of the service periods listed below.
4. If contaminated, change lubricant immediately.
5. Maintain the temperature of the lubricant within the ranges listed above.
6. Maintain continuous lubricant flow under all operating conditions.
7. Provide a low lubricant level alarm system.*
8. Provide alarm system for high lubricant temperature (set at 180°F. to 190°F.)*
9. Drain sludge sump when draining crankcase lubricant.
10. Consult the manufacturer if additional information is required regarding the lubrication of this equipment.

A. CRANKCASE

SERVICE PERIOD	CAPACITY U.S. GAL	TYPE	TEMPERATURE	AGMAN ^o	ISON ^o
1 Month (Break-In Period)	34	Heavy Duty, High Temperature, Extreme Pressure Gear Oil	10°F. & Above -20°F. +80°F. -50°F. +32°F.	5 EP 2 EP 1 EP	220 EP 68 EP 32 EP
Every 6 Months	34	Heavy Duty, High Temperature, Extreme Pressure Gear Oil	10°F. & Above -20°F. +80°F. -50°F. +32°F.	5 EP 2 EP 1 EP	220 EP 68 EP 32 EP

The loading and operating conditions of these units dictate that an EXTREME PRESSURE, HEAVY DUTY, and INDUSTRIAL GEAR LUBRICANT should be introduced into the lubrication system and distributed to the moving parts. This lubricant must qualify under AGMA (American Gear Manufacturers Association) specification 250.04 (Sept. 1981) and have a Timken Load Arm Test with the results being okay at not less than 60 pounds (27.2 kg). The pour point of the selected lubricant should be 15°F. (-9°C.) below the starting ambient temperature.

* To protect this valuable equipment it is recommended that shut-down switches be provided to function when destructive conditions exist, e.g., the absence of sufficient lubricant, excessive lubricant temperatures, etc.

Lubrication...

I. GENERAL (Continued)

B. PLUNGER PACKING

Pump Fluid Ends	Type
Pumps Equipped with Grease Fittings	Multi-purpose Lithium Base Grease
Pumps Equipped with Mechanical Lubricator	Rock Drill Oil

C. LUBRICANT SELECTION

Proper lubrication is essential to the performance of all machinery. The basic principle in the selection of lubricants is to choose the least viscous that will retain a film coverage or barrier between the moving parts. The film of lubricant must be of sufficient strength to withstand localized contact pressures at all points of moving contact. The absence of proper lubricant will result in accelerated wear and failure of the moving parts.

Technical Information...

I. GENERAL

NATIONAL OILWELL VARCO 202T-6M, 202T-6L and 202T-6H TRIPLEX PLUNGER PUMPS

The following details are presented to permit identification of the valve service plungers and the packing under industry standards, as a guide to the proper setting of clearance of rotating and reciprocating parts and includes data pertinent to the unit or its function.

ROTATING and RECIPROCATING PARTS

Pinion Shaft Bearings:

Type Tapered Roller
 Clearance..... Adjustable
 Lateral Clearance of Shaft003" to .005" End Play

Crankshaft Bearings:

Type Tapered Roller
 Clearance..... Adjustable
 Lateral Clearance of Shaft Zero End Play and No Preload

Connecting Rod (or Crank Pin) Bearing:

Type Precision Type
 Clearance..... .003" to .007"

Crosshead Pin Bearing (or Bushing):

Type Bronze Bushing
 Clearance – Crosshead Pin in Crosshead000 to .002"
 Clearance – Bearing or Bushing to Crosshead Pin002" to .005"

Crosshead:

Clearance – (Diometrical) Crosshead to Crosshead Guide010" to .014"

VALVE SERVICE

Type Plate Type
 Disc Material Delrin
 Seat Material..... Spherical

PLUNGER

Function Single Acting
 Material Tungsten Carbide or Ceramic

PACKING

Designation General Service
 Function Flexible Lip
 Material Non-Adjustable

MISCELLANEOUS

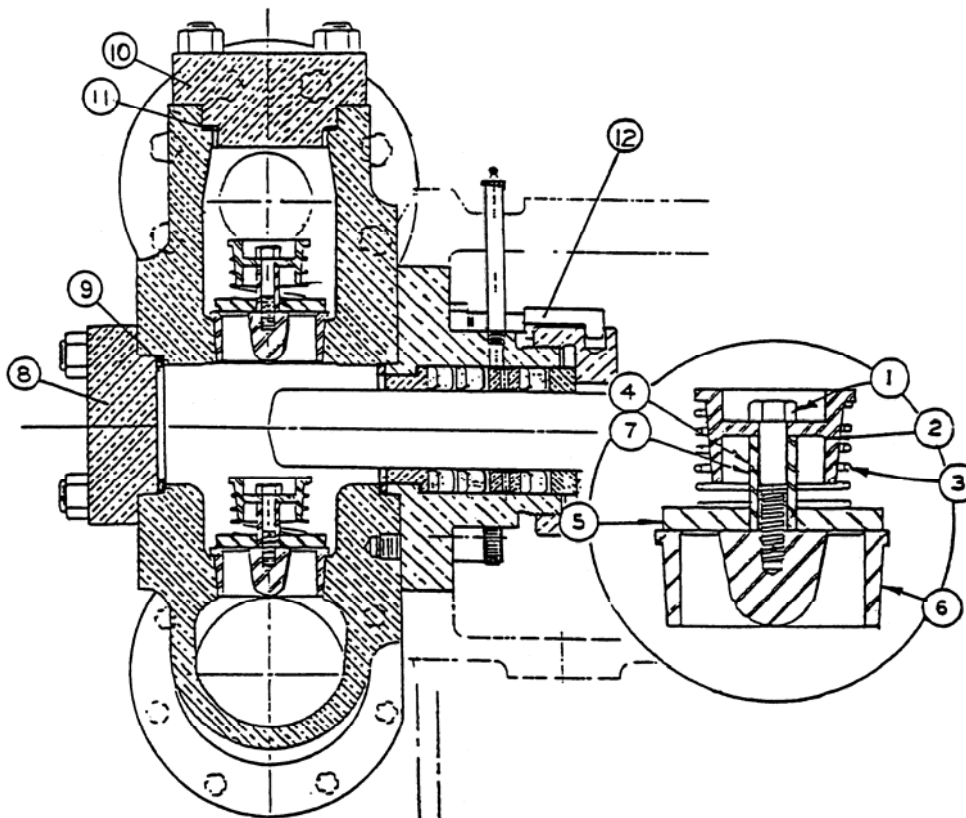
Tools: (Optional Except as Shown)
 Valve Seat Puller Mechanical or Hydraulic*

*May be purchased separately from pump manufacturer.

Fluid End Replacements 202T-6M and 202T-6L...

I. GENERAL

A. PLATE TYPE FLUID VALVE



TO REMOVE

1. Close and drain suction line.
2. Close discharge line.
3. Remove cylinder heads (8) and gaskets (9).
4. Remove valve covers (10) and gaskets (11).
5. Rotate pump until plunger (12) retracts exposing suction (lower) valve assembly.
6. Remove capscrew (1) from discharge (upper) valve assembly.
7. Lift out valve guard (2), valve spring (3), valve sleeve (4), valve sleeve bushing* (7) and valve disc (5).
8. Using manufacturer's valve seat puller, remove valve seat (6).
9. Repeat items 6, 7 and 8 above to remove the suction (lower) valve assemblies.

* All valve assemblies do not require the valve sleeve bushing. Consult your specific parts list to determine requirement.

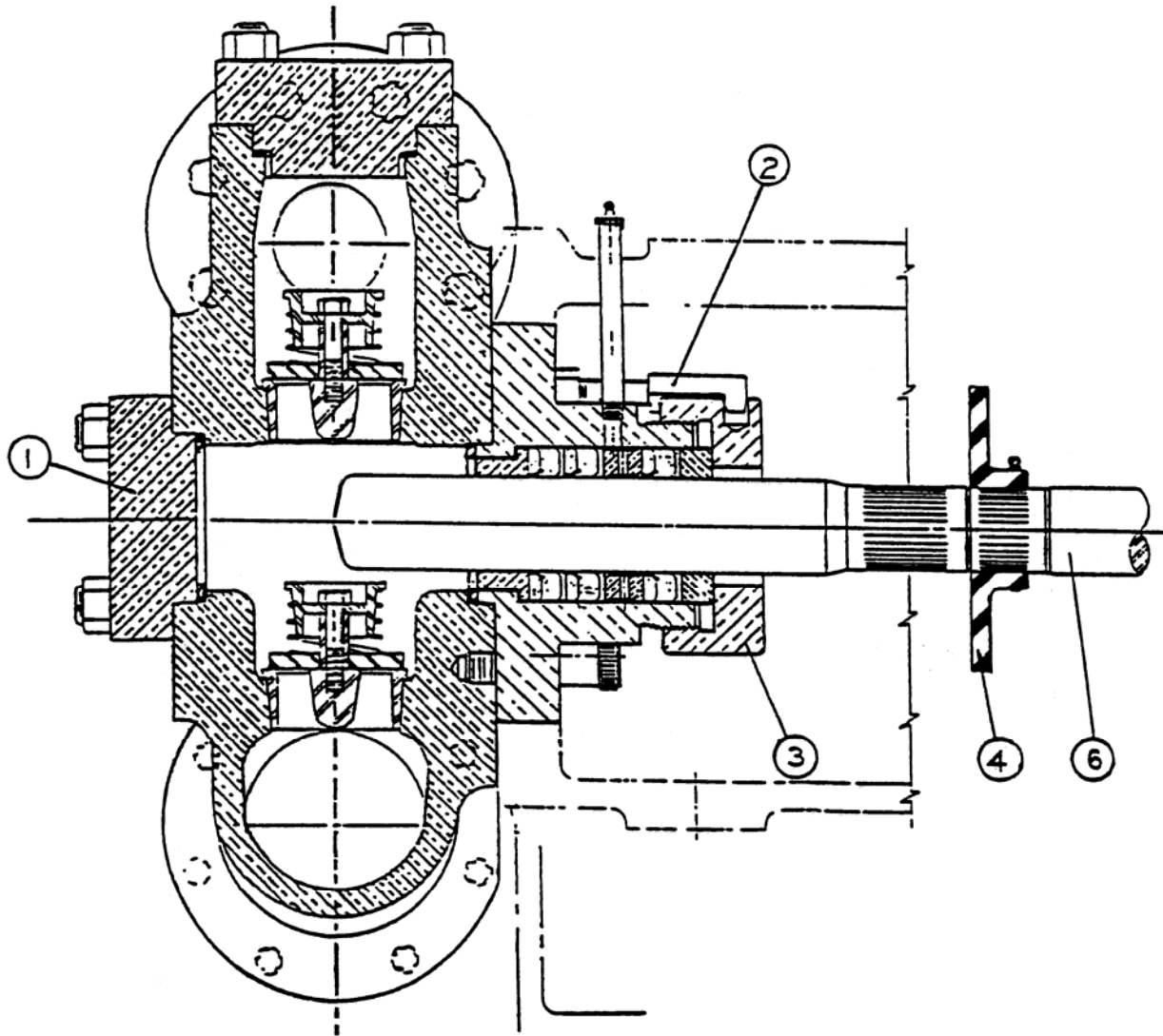
TO INSTALL

1. Using spirits or commercial solvent, clean the valve seats and the valve seat bores in the fluid end (these must be clean, free of grease and free of burrs). Dry the seats and the bores (do not touch the mating surfaces with bare hands).
2. Insert clean seats in suction (lower) bores and drive squarely in place using a smooth, thick metal plate across the top of the seat.
NOTE: The tapered seat will become tight in the bore before the flange on the outer portion of the seat reaches the valve seat counter-bore – excessive driving will distort the valve seat.
3. Insert valve disc (5), valve sleeve (4), valve sleeve bushing* (7), valve spring (3), valve guard (2) and capscrew (1). Tighten capscrew.
4. Repeat steps 2 and 3 to install discharge (upper) valve assemblies.
5. Replace valve cover gaskets (11), valve covers (10), cylinder gaskets (9) and cylinder heads (8).
6. Tighten cylinder head and valve cover nuts.
7. Open discharge line.
8. Close drain valve and open suction line.

Fluid End Replacements 202T-6M and 202T-6L...

I. GENERAL (Continued)

B. PLUNGER



TO REMOVE

1. Close and drain suction line.
2. Close discharge line.
3. Remove cylinder head (1).
4. Unlatch gland pawl (2) and loosen packing gland (3).
5. Slide water baffle (4) back toward power end.
6. Hold the extension rod from turning and unscrew the plunger (6).
7. Remove the plunger through the cylinder head opening. If the plunger does not move freely, place a block between the extension rod and the plunger and carefully rotate the pump forward to force the plunger through the stuffing box.

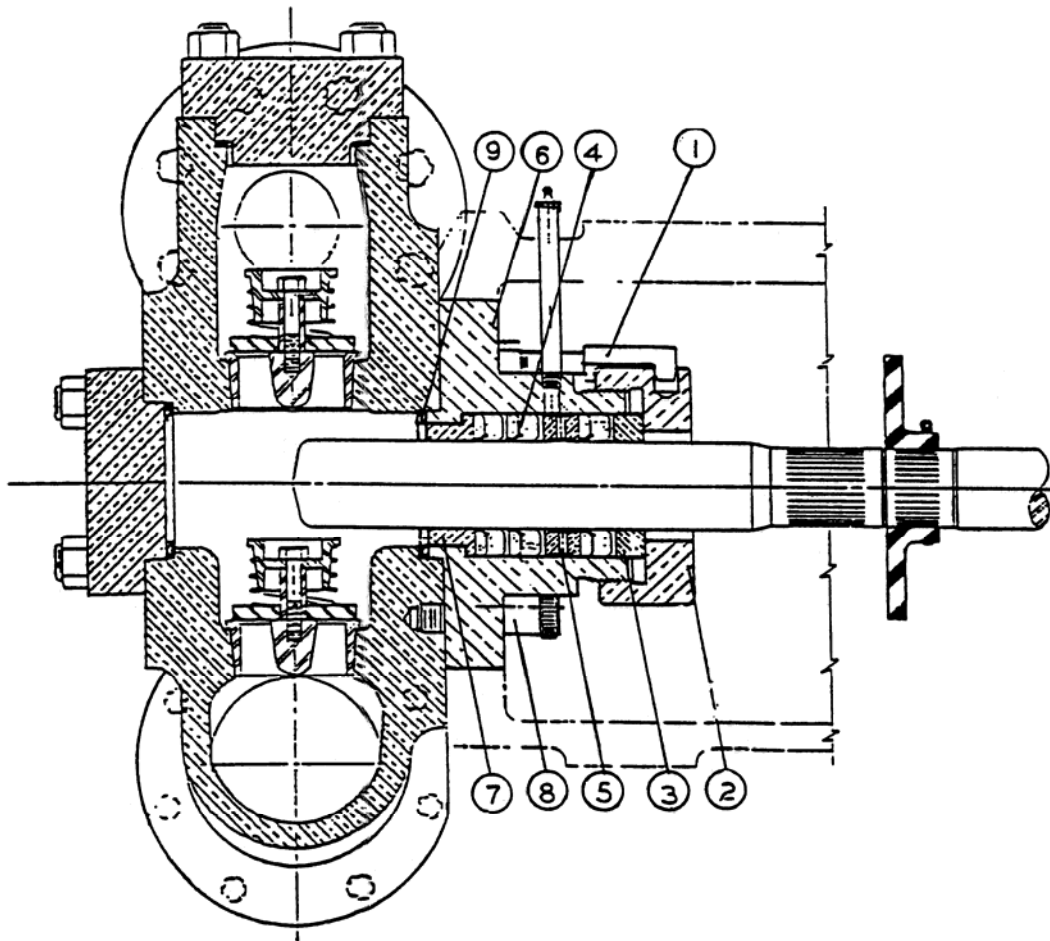
TO INSTALL

1. Insert plunger carefully through the packing.
2. Tighten packing gland snugly to center the plunger in packing.
3. With the fluid baffle on the extension rod, hold the extension rod from turning and screw the plunger into the extension rod.
4. Slide fluid baffle into place and tighten clamp.
5. Adjust packing and latch gland pawl.
6. Replace cylinder head.
7. Open discharge line.
8. Close drain valve and open suction line.

Fluid End Replacements 202T-6M and 202T-6L...

I. GENERAL (Continued)

C. PACKING and STUFFING BOX



TO REMOVE

1. Close and drain suction line.
2. Close discharge line.
3. Remove plunger. Refer to "Plunger Replacement".
4. With gland pawl (1) already unlatched, remove packing gland (2).
5. Remove gland follower (3), packing rings (4), lantern ring (5), and more packing (4).
6. Thoroughly clean stuffing box (6) with solvent, and inspect stuffing box and stuffing box bushing (7) for washouts and wear. If stuffing box replacement is needed at this time, continue to remove as follows. Otherwise, proceed with "To Install" steps 4 through 10.
7. Remove Allen nuts (8).
8. Remove stuffing box (6) and gasket (9) (do not re-use this gasket).
9. Remove stuffing box bushing (7) from stuffing box.

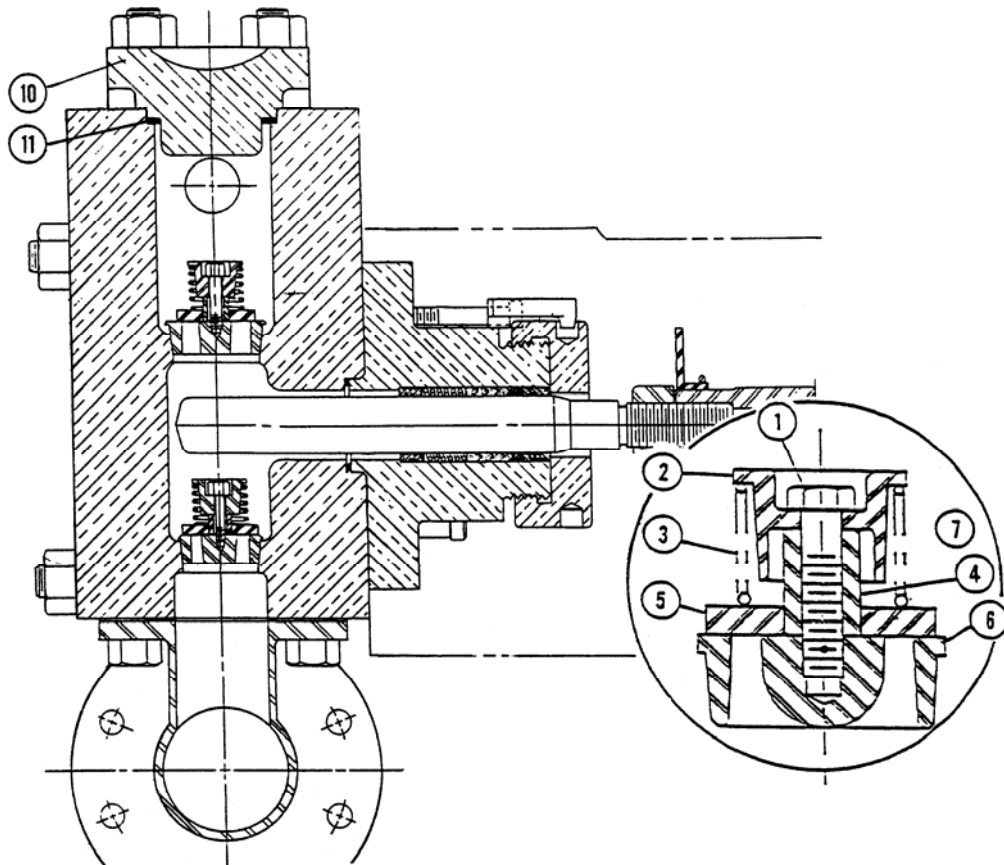
TO INSTALL

1. Clean gasket recess and install new gasket.
2. Install stuffing box bushing in the stuffing box.
3. Install stuffing box and secure Allen nuts.
4. Lightly oil each of the new packing rings to facilitate installation.
5. Install packing according to instructions furnished with packing; install lantern ring and gland follower.
6. Screw on packing gland and tighten just enough to hold the packing in place without exerting pressure on it.
7. Install plungers. Refer to "Plunger Replacement".
8. Tighten the packing gland in accordance with instructions furnished with packing. Latch gland pawl into gland.
9. Grease lubricate packing if mechanical oil lubricator is not used.
10. With oil lubrication use manual plunger buttons on lubricator to supply a generous amount of oil when starting up.
11. Open discharge line.
12. Close drain valve and open suction line.

Fluid End Replacements 202T-6H...

I. GENERAL

A. PLATE TYPE FLUID VALVE



TO REMOVE

1. Close and drain suction line.
2. Close discharge line.
3. Remove valve covers (10) and gaskets (11).
4. Rotate pump until plunger (12) retracts exposing suction (lower) valve assembly.
5. Remove capscrew (1) from discharge (upper) valve assembly.
6. Lift out valve guard (2), valve spring (3), valve sleeve (4), valve sleeve bushing* (7) and valve disc (5).
7. Using manufacturer's valve seat puller, remove valve seat (6).
8. Repeat items 5, 6 and 7 above to remove the suction (lower) valve assemblies.

* All valve assemblies do not require the valve sleeve bushing. Consult your specific parts list to determine requirement.

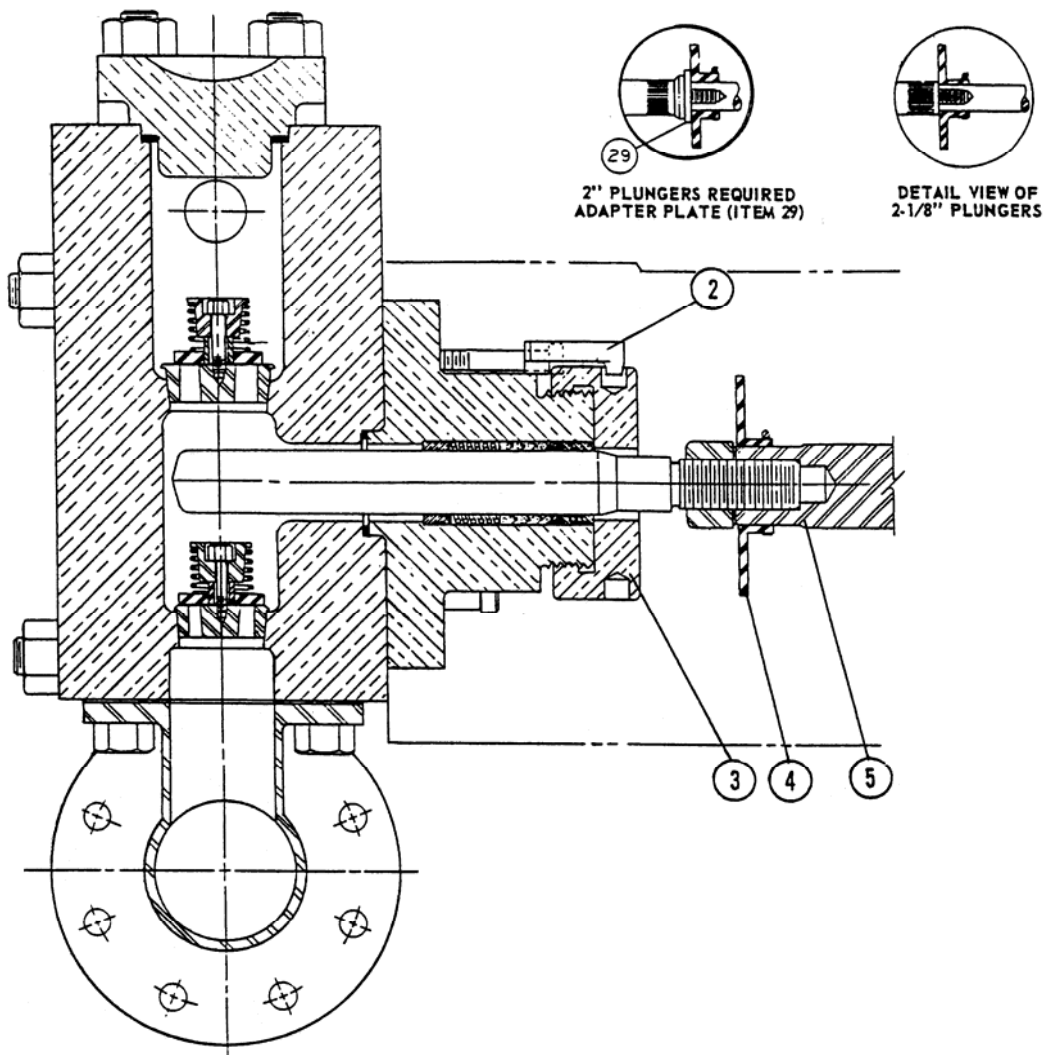
TO INSTALL

1. Using spirits or commercial solvent, clean the valve seats and the valve seat bores in the fluid end (these must be clean, free of grease and free of burrs). Dry the seats and the bores (do not touch the mating surfaces with bare hands).
2. Insert clean seats in suction (lower) bores and drive squarely in place using a smooth, thick metal plate across the top of the seat. NOTE: The tapered seat will become tight in the bore before the flange on the outer portion of the seat reaches the valve seat counter-bore – excessive driving will distort the valve seat.
3. Insert valve disc (5), valve sleeve (4), valve sleeve bushing* (7), valve spring (3), valve guard (2) and capscrew (1). Tighten capscrew.
4. Repeat steps 2 and 3 to install discharge (upper) valve assemblies.
5. Replace valve cover gaskets (11) and valve covers (10).
6. Tighten valve cover nuts.
7. Open discharge line.
8. Close drain valve and open suction line.

Fluid End Replacements 202T-6H...

I. GENERAL (Continued)

B. PLUNGER



TO REMOVE

1. Unlatch gland pawl (2) and loosen the packing gland (3).
2. Slide water baffle (4) back toward power end.
3. Hold the extension rod from turning and unscrew the plunger (6).
4. Remove capscrews from diaphragm assembly.
5. Unscrew plunger extension (5) from crosshead and lift extension rod and diaphragm assembly from pump.
6. Slip the plunger back through diaphragm assembly opening.
7. Remove the plunger up and out through the frame opening.

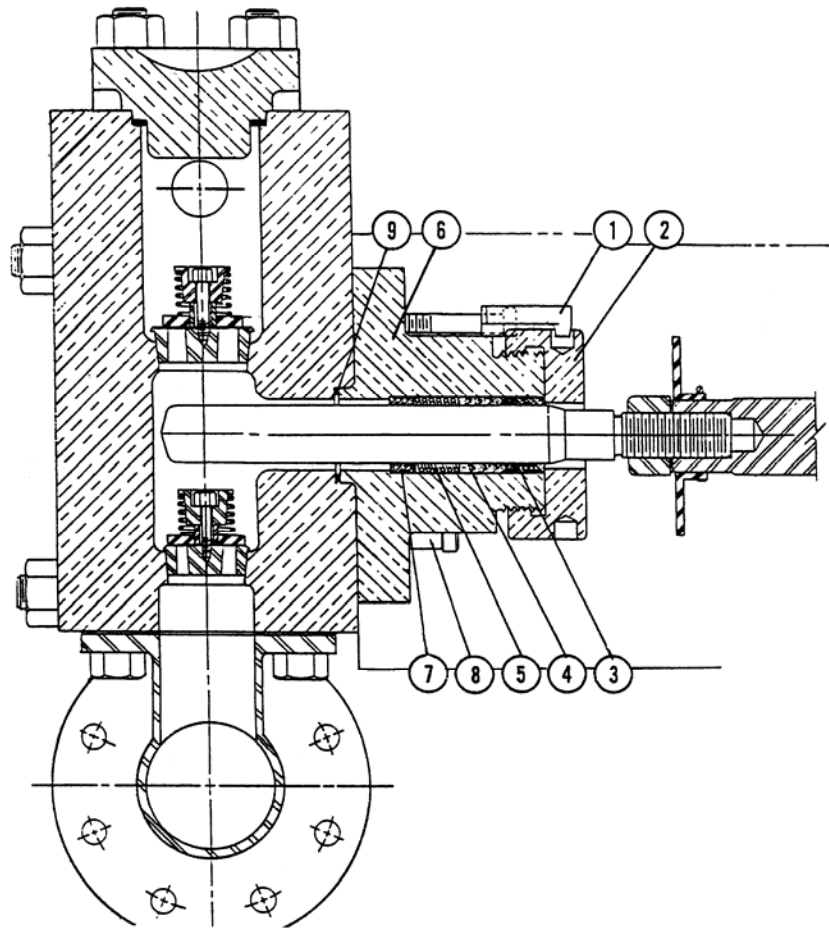
TO INSTALL

1. Slide plunger carefully through the frame opening.
2. Tighten packing gland snugly to center the plunger in the packing.
3. With the fluid baffle and diaphragm assembly on the extension rod set diaphragm in place with the capscrews.
4. Screw extension rod firmly into crosshead.
5. Screw plunger into extension rod.
6. Slide fluid baffle into place.
7. Adjust packing and latch gland pawl.

Fluid End Replacements 202T-6H...

I. GENERAL (Continued)

C. PACKING and STUFFING BOX



TO REMOVE

1. Remove plunger. Refer to "Plunger Replacement".
2. With gland pawl (1) already unlatched remove packing gland (2).
3. Remove gland follower (3), packing rings (4), packing spring (5) and more packing.
4. Thoroughly clean stuffing box (6) with solvent and inspect stuffing box and stuffing box bushing (7) for washouts and wear. If stuffing box replacement is needed at this time continue to remove as follows. Otherwise, proceed with "To Install" steps 4 through 10.
5. Remove Allenhead capscrew.
6. Remove stuffing box (6) and gasket (9) (do not reuse this gasket).
7. Remove stuffing box bushing (7) from stuffing box.

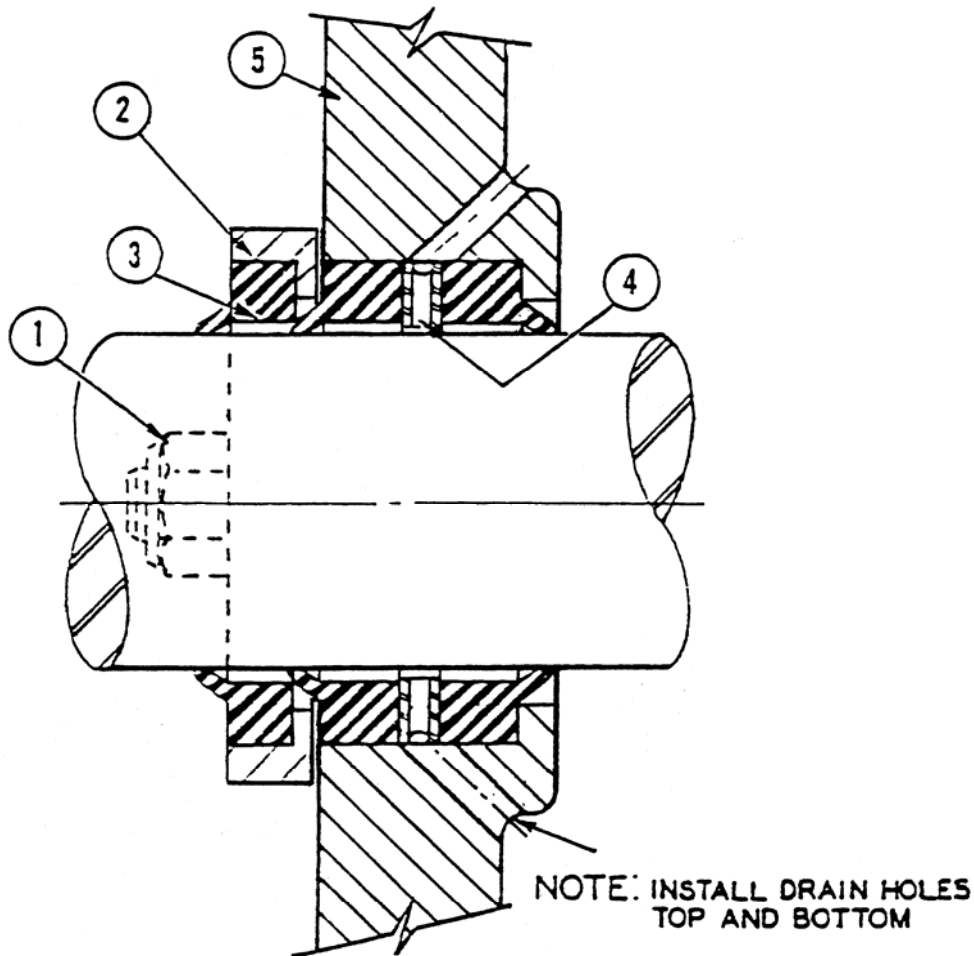
TO INSTALL

1. Clean gasket recess and install new gasket.
2. Install stuffing box bushing in the stuffing box.
3. Install stuffing box and secure with Allenhead capscrews.
4. Lightly oil each of the new packing rings to facilitate installation.
5. Install packing according to instructions furnished with the packing; install lantern ring and gland follower.
6. Screw on packing gland and tighten just enough to hold packing in place without exerting pressure on it.
7. Install plungers. Refer to "Plunger Replacement".
8. Tighten packing gland according to packing instructions. Latch gland pawl into gland.
9. Grease lubricate packing if mechanical oil lubricator is not used.
10. With oil lubrication use manual plunger buttons on lubricator to supply a generous amount of oil when starting up.

Power End Replacements...

I. GENERAL

A. DIAPHRAGM PACKING



TO REMOVE

1. Remove gland nut (1) and gland (2).
2. Remove rod wipers (3) and lantern ring (4).

TO INSTALL

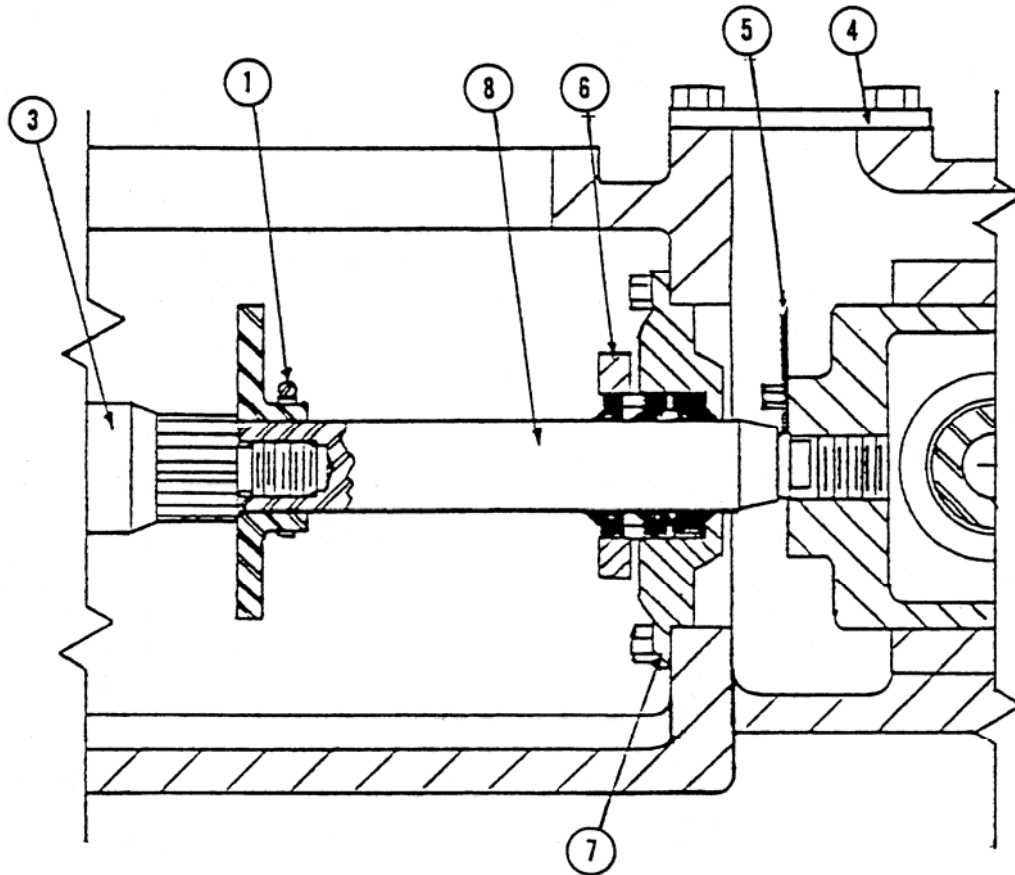
1. Clean and dry diaphragm (5) bore.
2. Install first wiper with lip facing power end as shown.
3. Install lantern ring.
4. Install remaining two wipers as shown.
5. Reinstall gland and gland nuts.

NOTE: If diaphragm is removed it is important that it be installed with the drain holes located at the top and bottom.

Power End Replacements...

I. GENERAL (Continued)

B. EXTENSION ROD



TO REMOVE

1. Slide fluid baffle (1) toward power end.
2. Unscrew Plunger (3) from extension rod.
3. Remove frame and top cover (4).
4. Remove baffle plate (5) from front of crosshead
5. Loosen diaphragm gland (6).
6. Remove capscrews from diaphragm assembly (7).
7. Unscrew plunger extension (8) from crosshead and lift extension rod and diaphragm assembly from pump.

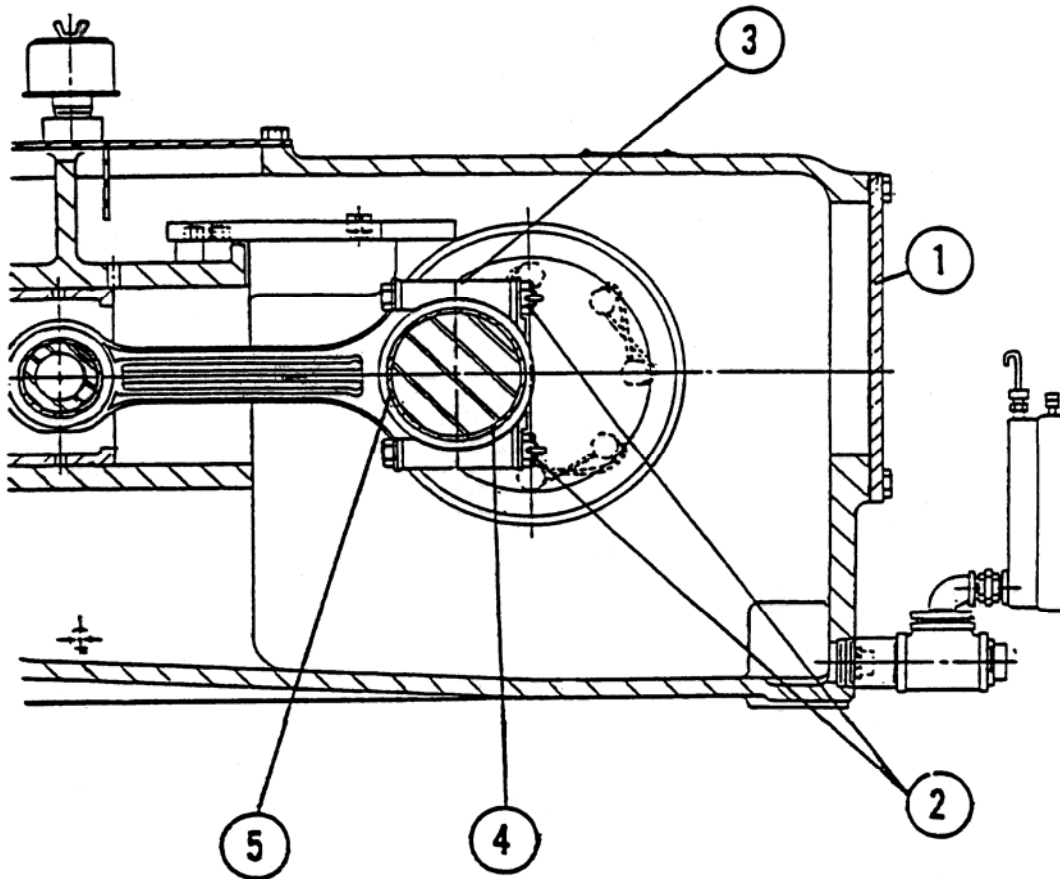
TO INSTALL

1. Clean and lubricate new extension rod.
2. Slide extension rod gently through diaphragm assembly, and set diaphragm in place with the capscrews.
3. Screw extension rod firmly into crosshead.
4. Replace baffle plate on crosshead.
5. Replace frame end top cover.
6. Screw plunger into extension rod.
7. Slide fluid baffle into place and tighten clamp.
8. Adjust diaphragm gland.

Power End Replacements...

I. GENERAL (Continued)

C. CONNECTING ROD BEARINGS



REPLACEMENT AND ADJUSTMENT

These bearings are precision fitted with normal running clearance of .004" built in. If replacement should become necessary the following procedure will apply.

1. Remove frame end plate (1).
2. Remove cotter pins and nuts from connecting rod bolts (2).
3. Remove the connecting rod cap (3).
4. Remove the bearing insert (4) out of the cap and replace with a new one.
5. Rotate crankshaft until other bearing insert (5) in the connecting rod is accessible.

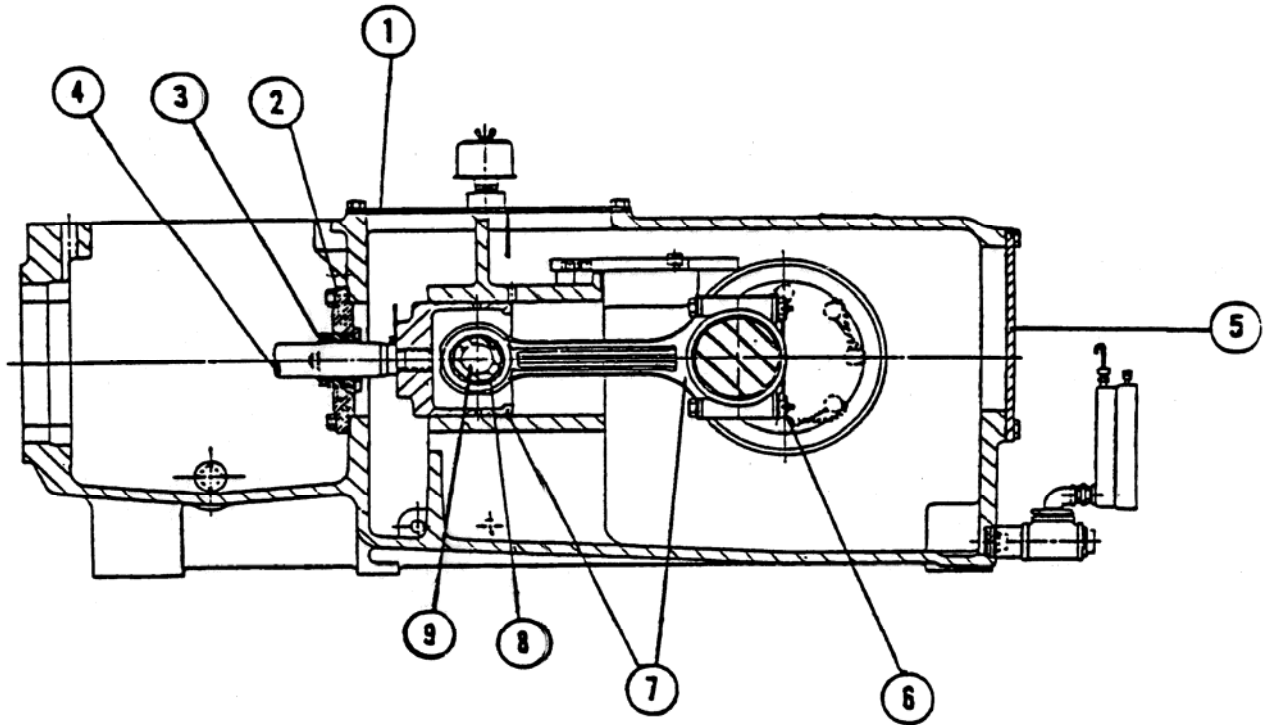
6. Remove the insert and replace with new one.
7. Lubricate bearing and crankshaft journal.
8. Replace cap securely and replace cotter pins.
9. Replace frame end plate.

CAUTION: Do not mix the caps and connecting rods. The connecting rods and caps are matched and marked with identical numbers.

Power End Replacements...

I. GENERAL (Continued)

D. CROSSHEADS, CROSSHEAD PINS AND BUSHINGS



CROSSHEADS, CROSSHEAD PIN AND BUSHING REPLACEMENT

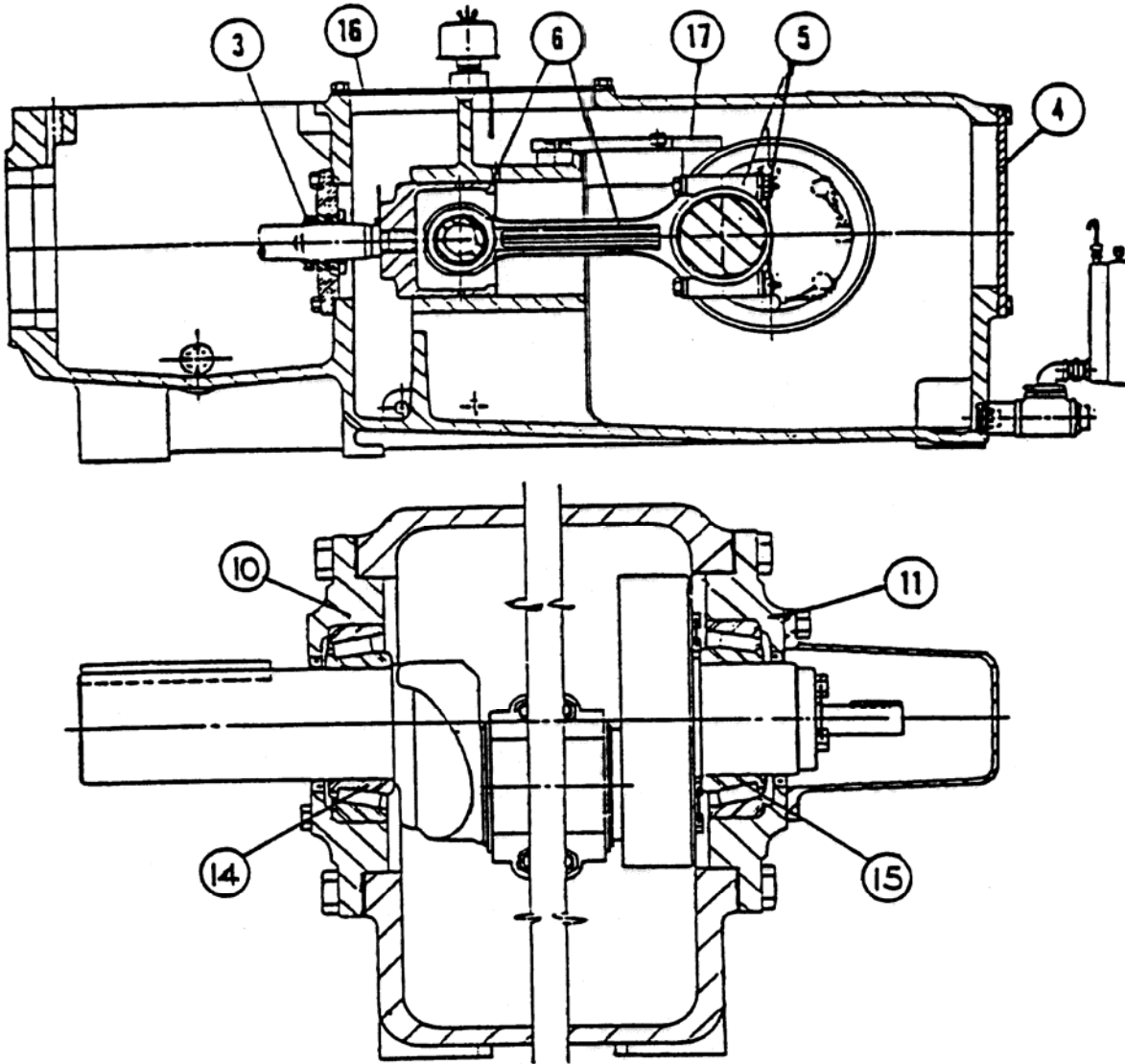
1. Remove plunger (refer to "Plunger Replacement" in this manual).
2. Remove top cover (1).
3. Remove baffle plate (2) from front of crosshead.
4. Loosen diaphragm packing gland (3).
5. Unscrew and remove extension rod (4).
6. Remove rear door (5), and remove the caps from the connecting rods (6).
7. Rotate crankshaft to facilitate removal of connecting rod and crosshead assembly.
8. Carefully remove the connecting rod and crosshead assembly (7) out the rear door opening.
9. Release crosshead pin retaining ring (8).
10. Push crosshead pin (9) from the crosshead and connecting rod.
11. Separate crosshead from the connecting rod and inspect all parts for scoring or wear – replace if necessary.
12. If crosshead pin bushing is to be replaced, drive it from the connecting rod and press new bushing into the connecting rod (be sure to try the crosshead pin in the newly installed bushing to be certain that it has not been distorted during assembly – hone if necessary).
13. Reassemble unit by reversing this procedure.

IMPORTANT: Note that the connecting rod caps and the connecting rod on which it is fitted are marked with identical numbers – when the unit is reassembled the caps must be returned in the same relative position to its respective connecting rod.

Power End Replacements...

I. GENERAL (Continued)

E. MAIN BEARINGS



Power End Replacements...

I. GENERAL

E. MAIN BEARINGS (Continued)

REPLACEMENT

1. Ease off plunger packing gland (2) and diaphragm packing gland (3) to facilitate forward travel of the plunger that occurs with step 4.
2. Remove rear door (4) and disconnect the connecting rods from the crankshaft by removing bolts, nuts and connecting rod caps (5).

NOTE: Notice that the connecting rods and caps are match marked with identical numbers. Be sure that these parts are not mixed and that they are assembled in the same relative position as when they were removed from the pump.
3. Push the connecting rod and crosshead assemblies (6) as far forward in the guides as they will go. This will provide clearance to remove crankshaft.
4. Block up the crankshaft to prevent it falling when bearing covers are removed.
5. Remove capscrews and bearing cover (10). (Be careful not to damage oil seals.)
6. Remove capscrews and main bearing cover (11).
7. Drive one cup out of the frame when removing the crankshaft through side of pump.
8. Pull bearing cones (14) (15) off the crankshaft.
9. Remove the other cup from the frame and replace with new one.
10. Lightly oil the shaft and shrink the new bearing cones onto the crankshaft.
11. Replace crankshaft. Drive the new bearing cup into the frame.
12. Install bearing cover (10) and (11) with an equal thickness of shims behind each, tighten securely and check end play with dial indicator.
13. Bearings are properly adjusted when .000" end play is obtained.

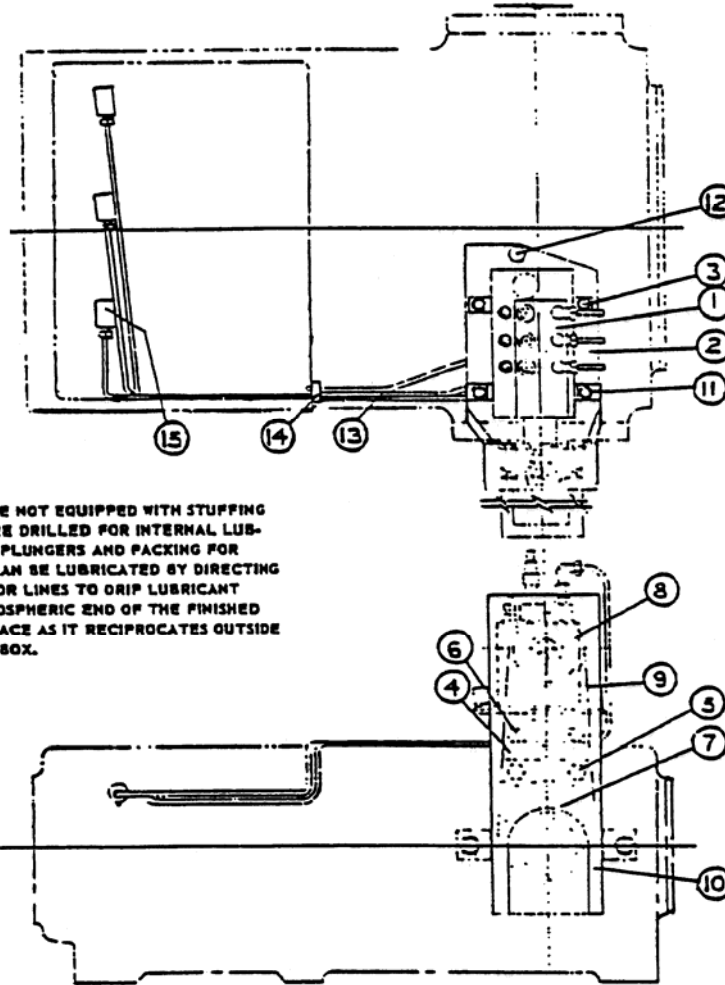
ADJUSTMENT

1. Remove cylinder heads, top cover (16) and scraper (17).
2. Ease off plunger packing glands (2) and diaphragm packing glands (3) to facilitate forward travel of the plunger that occurs with step 4.
3. Remove rear door (4) and disconnect the connecting rods from the crankshaft by removing cotteners, nuts and connecting rod caps (5).

NOTE: Notice that the connecting rods and caps are match marked with identical numbers. Be sure that these parts are not mixed and that they are assembled in the same relative position as when they were removed from the pump.
4. Push the connecting rod and crosshead assemblies (6) as far forward in the guides as they will go. This will provide clearance to rotate the crankshaft for main bearing adjustment.
5. Check bearing adjustment by jacking the crankshaft back and forth against a dial indicator. If end play measures in excess of .000" proceed to adjust.
6. Remove main bearing housing cover (11) and take out an estimated number of shims.
7. Replace housing, tighten securely and check end play again with dial indicator. Bearings are properly adjusted when .000" end play is obtained.
8. Install and secure remaining parts by reversing removal procedure.

Lubricator Installation...

I. GENERAL



NOTE: SOME PUMPS ARE NOT EQUIPPED WITH STUFFING BOXES THAT ARE DRILLED FOR INTERNAL LUBRICATION, THE PLUNGERS AND PACKING FOR THESE PUMPS CAN BE LUBRICATED BY DIRECTING THE LUBRICATOR LINES TO DRIP LUBRICANT ONTO THE ATMOSPHERIC END OF THE FINISHED PLUNGER SURFACE AS IT RECIPROCATES OUTSIDE THE STUFFING BOX.

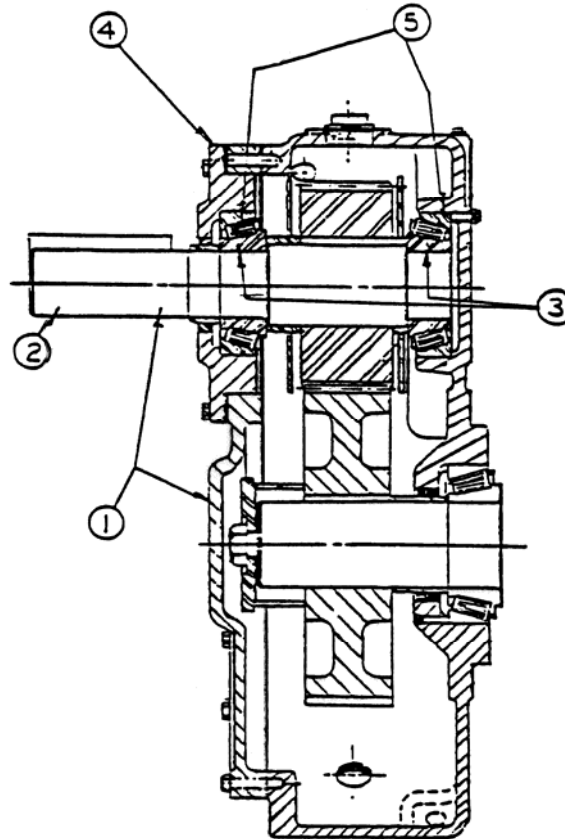
TO INSTALL A MECHANICAL LUBRICATOR ON THE PUMP, THE FOLLOWING SEQUENCE SHOULD BE FOLLOWED:

1. Mount Lubricator (1) on mounting plate (2) with four 3/8" x 1 1/4" long bolts (3) with platewasher, lockwasher and hex nut.
2. Install support (4) to frame using two 7/8" x 2 1/4" long cap screws (5) and lockwasher.
3. Attach the lubricator and mounting plate to support using two 1/2" x 1 1/4" long cap screws (6) platewashers and lockwashers.
4. Mount and align sheaves (7) and (8) on their respective shafts and tighten setscrews securely.
5. Install and adjust V-belt (9).
6. Secure belt guard (10) to support using two 3/8" x 3/4" long cap screws (11) and lockwashers.
7. Use 1/2" x 3" long setscrew (12) and jam nut as an adjustment to remove tension from the lubricator and mounting plate assembly.
8. Remove the alomite fittings from the stuffing box nipples and replace with the angle check valves (15) that are supplied with the lubricator.
9. Bend copper tubing (13) to suit and fasten in place with the tubing clips (14), then connect tubing to the lubricator discharge and to the stuffing box fittings.

Reduction Gear...

I. GENERAL

GEAR REDUCTION PINION SHAFT BEARING



DRIVE REVERSAL

These pumps are equipped with a double extended crankshaft, therefore it is only necessary to reverse main bearing housing cover and reduction gear on opposite side of pump.

REPLACEMENT and ADJUSTMENT

1. Remove gear case cover and pinion shaft assembly (1) as a unit.
2. Remove pinion shaft (2) with bearing cones (3) from housing.
3. Pull bearing cones (3) off pinion shaft.
4. Remove pinion bearing housing (4).
5. Pull bearing cup (5) out of gear case; drive in new cup.
6. Drive out bearing cup (5) from bearing housing; drive in new cup.
7. Lightly oil pinion shaft and shrink on new bearing cones.
8. Using full set of shims, mount pinion bearing housing on gear case cover and capscrew tight.
9. Install pinion shaft in pinion bearing housing.
10. Replace oil baffle on gear case cover if removed.
11. Mount pinion shaft assembly and cover as a unit to the gear and capscrew tight.
12. Adjust pinion shaft bearings by removing shims from housing (4) until .003" end play is obtained.

Maintenance...

I. GENERAL

This is a listing of observations suggested to be considered when performing maintenance on standard pumps. Each operating company should prepare their own specific forms for this purpose and insist that an established program be followed and recorded.

DAILY	CHK'D	RCR'D	CHK'D	RCR'D	CHK'D	RCR'D
1. Check oil level in Crankcase						
2. Check oil temperature						
3. Check oil for contamination						
4. Check oil level in Lubricator						
5. Check and adjust Plunger/Packing						
6. Lubricate Plunger/Packing						
7. Lubricate Flushing Pump						
8. Lubricate Charging Pump						
9. Drain plunger leakage from Power End						
10. Check suction pressure						
11. Check discharge Pressure						
12. Check for oil leaks						
13. Check for fluid leaks						
14. Check Suction Stabilizer for proper pressure or fluid level						
15. Check Discharge Pulsation Dampener for proper pressure						
16. Check Flushing System						
17. Check for Diaphragm leakage						
18. Check Oil Seal for leakage						
19. Check Pump for cleanliness						
20. Check work area for cleanliness						
WEEKLY						
1. Flush Cradle Drain lines						
2. Check Plunger Crosshead Coupling						
3. Check all safety controls for malfunction						
MONTHLY						
1. Check all Fluid End and Power End Bolting						
2. Check Plunger wear						
3. Check Crosshead Extension Rod for wear						
4. Clean Flushing Pump Strainer						
5. Clean Crankcase Breather						
6. Check Valves, Seats and Springs						
7. Check availability and condition of tools						
SIX MONTHS						
1. Check Crosshead clearance						
2. Check Crosshead Pin clearance						
3. Check Main Bearing clearance						
4. Check Crankpin Bearing clearance						
5. Check Foundation and/or Hold-Down Bolts						
6. Check Suction Flange Bolting						
7. Check Discharge Flange Bolting						
8. Check Pump Sheave or Coupling						
9. Change oil (also change Air Breather)						
10. Change Flushing Media						

Trouble Symptoms...

I. GENERAL

OBSERVATION	PROBABLE SOURCE	ADJUSTMENT
Low Suction Pressure	Low Head	Increase Level of Fluid Supply
	Charging Pump Head Low	Increase Charging Pump Speed
	Restricted Fuel Flow	Remove Restrictions from Suction Line
	Erroneous Gauge Reading	Recalibrate or Replace Gauge
Fluid Knock or Hammer	Air Entering Suction Line	Repair Suction Line
	Air Entering Charging Pump	Tighten or Replace Shaft Packing or Seal
	Air Entering Suction Stabilizer	Repair and Rebalance
	Air/Gas in Pump Fluid	Impose Vacuum on Supply Tank
		Allow More Settling Time
		Reduce Pump Speed
Adjust Suction Stabilizer		
Same as Low Discharge Pressure	Same as Low Discharge Pressure	
Discharge Line Vibration	Discharge Pulsation Dampener	Repair and Recharge or Replace
	Unsupported Discharge Line	Provide Supports or Hangers
	Same as Low Discharge Pressure	Same as Low Discharge Pressure
	Same as Low Suction Pressure	Same as Low Suction Pressure
	Same as Fluid Knock or Hammer	Same as Fluid Knock or Hammer
Short Valve Life	Abrasives in Fluid	Filter Pumped Product
	Large Particles in Fluid	Screen Pumped Product
		Broken Valve Spring – Replace
	Valve Not Sealing	Worn Valve Spring – Replace
		Worn Valve/Seat – Replace
	Pump Not Filling	Same as Low Suction Pressure
	Pulsation Dampener Malfunction	Repair or Replace
	Corrosion	Treat Pumped Fluid
Use Different Materials for Valves/Seats		
Short Plunger/Packing Life	Abrasives in Fluid	Filter Pumped Product & Flushing Fluid
	Friction Wear	Lubricate with Rock Drill Oil
		Do Not Overtighten Adjustable Packing
		Use Ceramic Plungers if Fluid is Clean
	Wear or Scoring	Check Stuffing Box Alignment
		Check Gland Alignment
		Check Plunger Alignment
		Check Packing for Foreign Particles
		Replace Stuffing Box Bushing
		Replace Packing Follower
		Replace Lantern Ring
Use Recommended Packing		
No Liquid Discharge, Erratic Discharge or Cavitation	Pump not Primed	Prime Pump
	Insufficient NPSH	Increase System NPSH
	Suction Line Plugged	Unplug Suction Line
	Air Pocket or Air Leak in Suction	Eliminate Air Pocket/Air Leak
	Foreign Matter Causing Valves to Bypass	Remove Foreign Matter

Trouble Symptoms...

I. GENERAL (Continued)

OBSERVATION	PROBABLE SOURCE	ADJUSTMENT
Leakage	Loose Valve Cover/Cylinder Head	Tighten Valve Cover/Cylinder Head
	Worn or Damaged Gasket	Replace Gasket
	Damaged Gasket Surface	Replace Valve Cover/Cylinder Head Repair Fluid End
Low Discharge Pressure	Worn or Fluid Cut Valve Assembly	Replace Valve Assembly
	Valve Propped Open	Remove Restriction
	Improper Filling	Remove Restrictions from Suction Line
		Increase Level of Fluid Supply
		Increase Charging Pump Speed
Decrease Charging Pump Speed		
Prime Fluid Chambers		
High Oil Temperature	Improper Bending Adjustment	Check and Adjust Clearances
	Improper Crosshead Adjustment	
Knock in Power End	Incorrect Pump Rotation	Check Installation Directions
	Loose Plunger	Check and Tighten
	Loose Bearing Housings/Covers	
	Worn Crosshead Pin	Replace
	Worn Crosshead	
	Worn Crank Pin Bearing	
	Worn Crankshaft	Chrome Plate and Grind or Replace
	Worn Main Bearing	Adjust or Replace
Diaphragm Leakage	Worn or Damaged Extension Rod	Replace Rod
	Worn Wiper Rings	Replace Wiper Rings
	Worn Lantern Ring	Replace Lantern Ring
	Wiper Rings Improperly Sealing	Check Installation Directions
		Clean and Polish Diaphragm Bore
	Oil Baffle Misplaced	Check Installation Directions
	Reservoir in Diaphragm Housing	Install Drain Hole at Bottom
		Clean Drain Hole
Pressure in Crankcase	Clean or Replace Air Breather	
Oil Seal Leakage	Worn Sealing Lip	Replace Seal
	Damaged Sealing Lip	
	O. D. Not Seated	Clean and Polish Bore of Oil Seal Housing
	Foreign Material at Seal Point	Clean and Polish Shaft
		Clean and Polish or Replace Sleeve
	Pressure in Crankcase	Replace Air Breather

Torquing Values and Sequence...

I. GENERAL

A. TORQUING VALUES FOR FASTENERS

The proper torquing of all bolts, studs, capscrews and nuts is **IMPORTANT**. Improper torquing will cause failure by fatigue or yield and result in serious damage.

1. Thoroughly clean all threads, internal and external at the time of installation.
2. Lubricate the threads and the inside face of the head on the capscrew or bolt as well as the inside face of the nut, with a good quality anti-seize compound.
3. Be certain tightening progresses uniformly to prevent misalignment or damage to the components.
4. The following values are to be observed in the final tightening of the fasteners.

B. MATERIAL and SPECIFICATIONS

GROUP 1: Low carbon steel bolts, capscrews and studs. SAE grade 1 or ASTM A-307.

GROUP 2: Heat treated carbon steel bolts and capscrews. SAE grade 5 or ASTM A-325.

GROUP 3: Alloy steel studs. SAE grade 7 or ASTM A-193 (B-7).

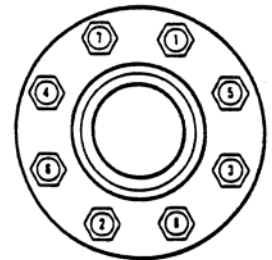
Diameter (Inches)	Threads (Per Inch)	Torque Required (Lbs/Ft)		
		Group 1	Group 2	Group 3
1/4	20	1.95	5.06	6.22
5/16	18	4.05	10.4	12.9
3/8	16	7.2	16.5	23.9
7/16	14	11.5	29.6	36.6
1/2	13	17.6	45.2	55.8
5/8	11	34.9	90.0	111.
3/4	10	62.	159.	196.
7/8	9	100.	236.	318.
1	8	150.	354.	477.
1-1/8	7	211.	475.	675.
1¼	7	300.	675.	955.
1*	6		877.	1245.
1½	6		1508.	2105.
1¾	5		2456.	3440.

* These torquing values are for lubricated threads (Dry threads require different torquing values).

A pattern or sequence for the torquing of fasteners is necessary for the proper installation of many machinery components.

Bearing housings, flanges, covers, etc., retained with multiple fasteners, should have equal "stand-off" and clamping force in all areas.

The sketch to the right reflects the "cross over" pattern for the torquing of the fasteners. It is suggested that all fasteners be installed "hand tight" and that the torquing be applied in two steps. First, apply half torque to fastener number 1, then number 2, then number 3, etc. When half torque has been applied to all the fasteners, apply full torque to fastener number 1, then number 2, etc., until all the fasteners have been fully torqued.



Shear Blocks...

I. GENERAL

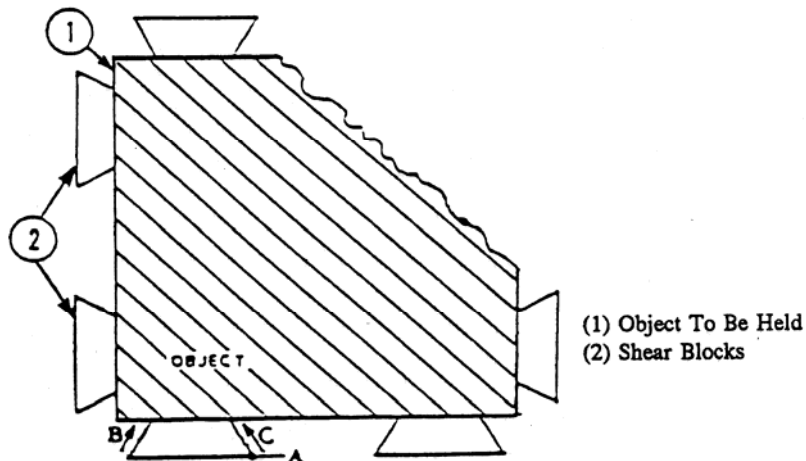
A. GENERAL

Machinery items are generally mounted on machined pads, "H" beams or bed-plates and retained with capscrews or hold-down bolts. The flexing of loaded machinery will cause these capscrews or hold-down bolts to become loose and ineffective for the retention of alignment of the machine with its associated equipment. When the equipment is being made ready for operations it should be carefully aligned, secured with the capscrews or hold-down bolts then its position reinforced with dowel pins or shear blocks (this is applicable to items which need not be moved, i.e., pumps, rotary tables, etc., however, engines or other prime movers which must be moved for belt or chain drive adjustments should be equipped with slide rails and in these installations the slide rails should be "doweled" or "blocked").

Also, the shear blocks serve a dual purpose. They are guides for the reinstallation of a machinery item once it has been removed from its base for servicing or any other reason.

B. INSTALLATION

1. As indicated above, be certain that the equipment is in alignment and that the capscrews or hold-down bolts are properly tightened.
2. Hold the shear block firmly in place and tack-weld it at point "A".
3. Continue to hold the shear block in place and weld side "B" – start at the outside corner and weld continuously toward the retained object.
4. Weld side "C" – again, start at the outside corner and weld continuously toward the retained object.
5. Shear blocks should be installed opposite to each other – this placement with this outlined welding procedure will then place the retained object in compression.
6. Recheck the alignment of the equipment. If it has been distorted, remove the shear blocks, re-align the equipment and proceed with these same instructions to install new shear blocks.



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. 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)

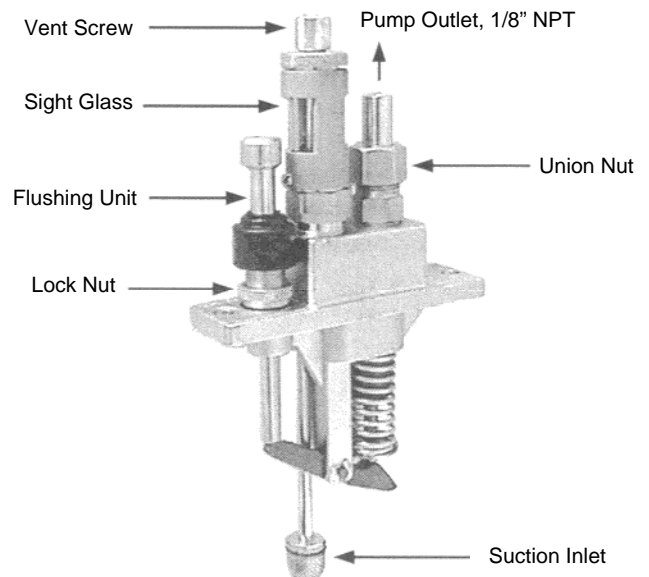
If reservoir runs low on oil (at a point below the suction inlet of the pump) it may be necessary to prime individual pumps after filling, using procedure listed above.

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.



Storage of Pumps...

I. GENERAL

All machinery units require protection from corrosion erosion, natural attrition which causes deterioration of the surface as well as the working parts. Generally, units in operation are frequently inspected, cleaned, painted and lubricated while idle units are often more or less neglected. Any degree of neglect is costly, especially if continued over a sufficient period of time to make restoration of the equipment impossible. It is recommended that preventive measures of protection be established and the following will guide you in the minimum requirement.

A. GENERAL

Preferably, units should be stored in clean, climatically controlled buildings. This would require the minimum inspection, but, since storage in older environments is sometimes necessary, more frequent inspections and additional protection is necessary. The schedule for inspection and protection can be determined only at the point of storage. A protection and storage log is recommended. Tropical areas require the maximum protection; arid regions require the least amount of protection. The frequency of inspection is determined after noting the rate of deterioration. Take positive action immediately when corrosion/erosion appears, do not wait until large areas are covered because usually the larger the area, the deeper the penetration.

B. RECOMMENDED PROTECTION INITIAL STORAGE

1. Drain all oil and thoroughly clean inside of Power Frame.
2. Coat pinion shaft oil seals with grease.
3. Remove breathers for later installation on pump. Seal all breather holes with greased solid pipe plugs. Remove extension rods and diaphragm sealing housing; be sure to protect the rods and housings, storing them separately for later installation on the pump. Seal diaphragms with wooden covers. "Mate" the wood cover and diaphragm faces together, thoroughly coating with Rust Veto 342 or its equivalent.
4. Spray two gallons of Shell VSI 100 vapor phase inhibitor or equivalent into power end of pump.
5. Remove valves and valve springs. Clean and wrap in corrosion inhibiting paper. Remove liners and pistons. Clean and wrap in corrosion inhibiting paper. Clean and dry fluid end bores and thoroughly coat all internal surfaces with Tectyl 506 or equivalent.
6. Thoroughly coat all threads and end of valve cover and screw into fluid end.
7. Protect all external machine surfaces using Rust Veto 342 or equivalent including pump pads.
8. Inspect complete pump and record all details on the Protection and Storage Log.

Storage of Pumps...

I. GENERAL (Continued)...

C. SIX MONTH SERVICING

1. Rotate pump.
2. Renew internal rust inhibitors to specifications and quantities previously stated under the "Initial Storage" section.
3. Before replacing top and side covers, inspect for any internal corrosion.
4. Inspect for soundness of external protection, i.e., rust preventative and paint. Renew as necessary.
5. Enter and record all details on the "Protection and Storage Log".

D. PRE-INSTALLATION CHECK AFTER STORAGE

1. Repeat six month servicing procedure as stated above.
2. Ensure all necessary parts are complete and in a satisfactory condition for installation on pump.
3. Enter all records and close out the "Protection and Storage Log".

Owners Record...

NAME _____

LOCATION _____

DATE OF DELIVERY _____ DATE PLACED IN OPERATION _____

PUMP MODEL _____

PUMP SIZE _____ SERIAL NO. _____

PRIME MOVER _____ SERIAL NO. _____

GEAR UNIT _____ SERIAL NO. _____

DRIVE:

DRIVE SHEAVE P.D. _____ DRIVEN SHEAVE P.D. _____ NO. OF GROOVES _____

BELT LENGTH _____ DRIVE SPROCKET _____ CHAIN SIZE _____

CHAIN LENGTH _____ COUPLING (MAKE) _____ COUPLING SIZE _____

PRESSURE _____ VOLUME _____ PUMP SPEED _____ DRIVE SPEED _____

PLUNGERS _____

PACKING _____

PISTONS _____

LINERS _____

VALVES _____

SEATS _____

LUBRICANTS:

CRANK CASE _____

FLUSHING SYSTEM _____

GEAR UNIT _____

LUBRICATOR _____

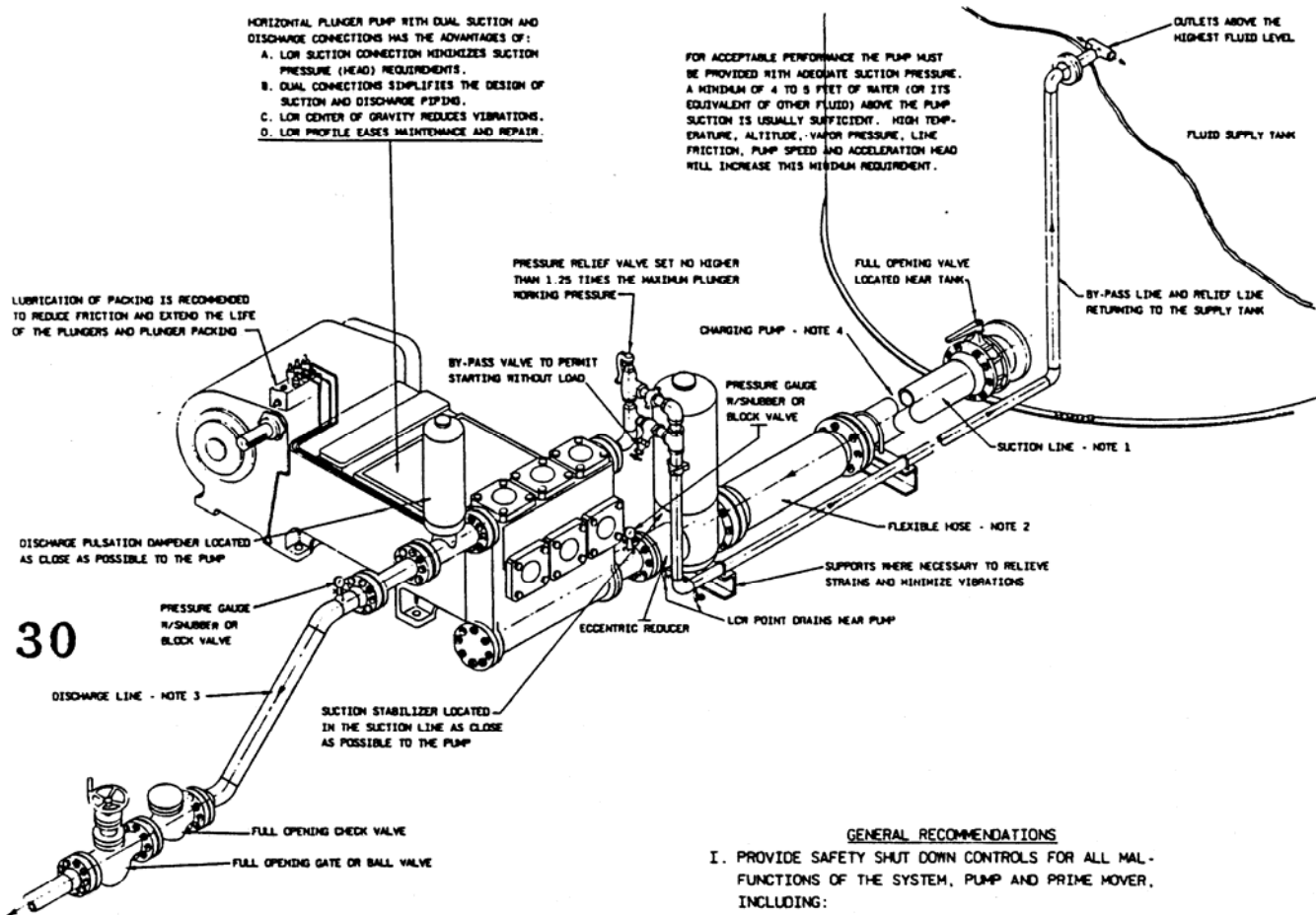
PRIME MOVER _____

COUPLING _____

NOTES _____

All of the above entries are not applicable to a specific unit, therefore, completion of this form must be confined within the limits of each pump and the specified optional accessory equipment.

Typical Waterflood Pump Installation Suction and Discharge Piping Arrangement...



HORIZONTAL PLUNGER PUMP WITH DUAL SUCTION AND DISCHARGE CONNECTIONS HAS THE ADVANTAGES OF:

- LOW SUCTION CONNECTION MINIMIZES SUCTION PRESSURE (HEAD) REQUIREMENTS.
- DUAL CONNECTIONS SIMPLIFIES THE DESIGN OF SUCTION AND DISCHARGE PIPING.
- LOW CENTER OF GRAVITY REDUCES VIBRATIONS.
- LOW PROFILE EASES MAINTENANCE AND REPAIR.

FOR ACCEPTABLE PERFORMANCE THE PUMP MUST BE PROVIDED WITH ADEQUATE SUCTION PRESSURE. A MINIMUM OF 4 TO 5 FEET OF WATER (OR ITS EQUIVALENT OF OTHER FLUID) ABOVE THE PUMP SUCTION IS USUALLY SUFFICIENT. HIGH TEMPERATURE, ALTITUDE, VAPOR PRESSURE, LINE FRICTION, PUMP SPEED AND ACCELERATION HEAD WILL INCREASE THIS MINIMUM REQUIREMENT.

30

NOTES

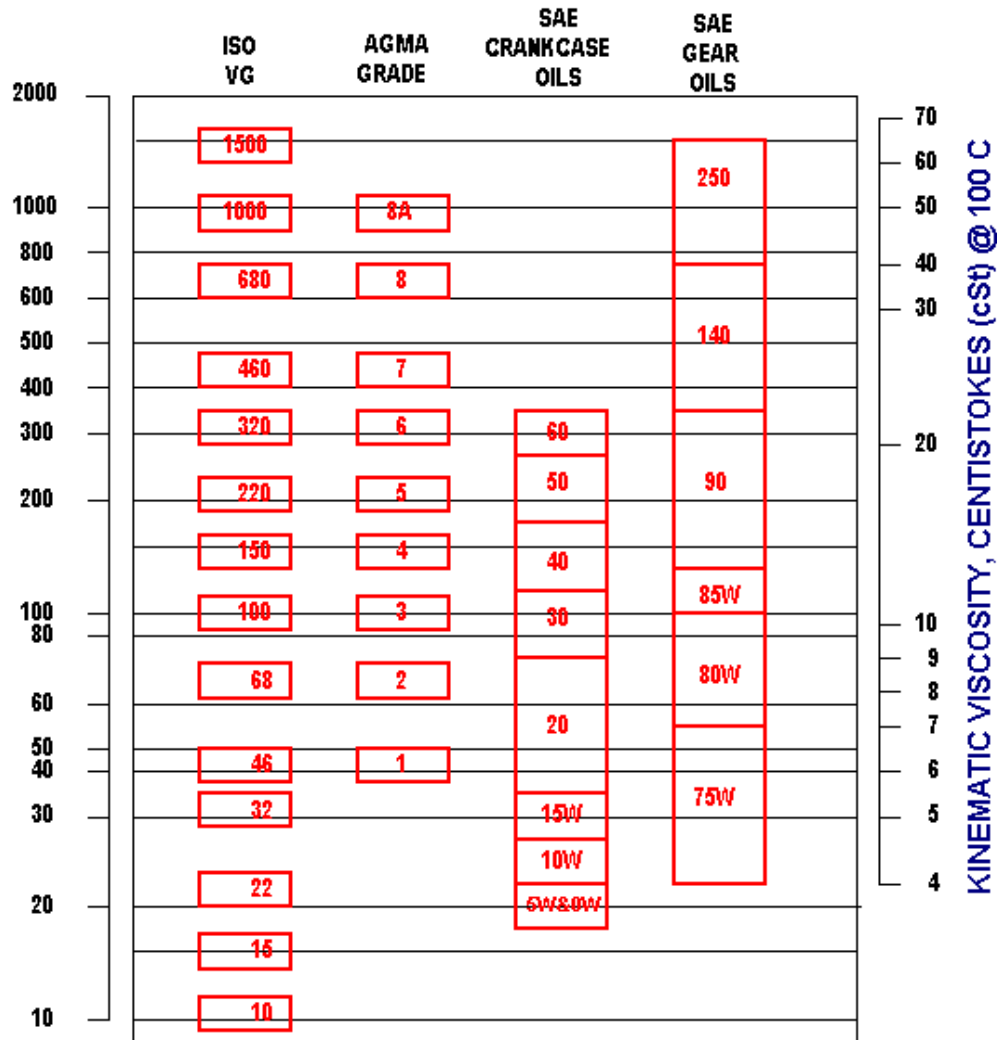
- A SEPARATE SUCTION LINE IS RECOMMENDED FOR EACH PUMP. THE LINE SHOULD BE A MINIMUM OF ONE SIZE LARGER THAN THE PUMP SUCTION FLANGE OR OPENING TO PROVIDE A MAXIMUM OF 1 TO 2 FEET/SECOND FLUID VELOCITY. IF BENDS ARE NECESSARY USE ONLY 45° LONG RADIUS ELLS. A SLOPE OF 1/4" PER FOOT FROM TANK TO PUMP IS RECOMMENDED.
- A FLEXIBLE HOSE AND/OR EXPANSION JOINT IN THE SUCTION LINE (ALSO DISCHARGE LINE) PROVIDES FOR THERMAL EXPANSION AND TENDS TO DAMPEN VIBRATIONS.
- DIRECT THE DISCHARGE LINE, USING 45° LONG RADIUS ELLS, TO GRADE OR BELOW GRADE LEVEL AS SOON AS POSSIBLE TO RELIEVE STRAIN AND REDUCE VIBRATIONS. THE LINE SIZE SHOULD BE SUFFICIENT NOT TO EXCEED A MAXIMUM FLUID VELOCITY OF 8 TO 10 FEET/SECOND.
- IF CHARGING PUMP IS USED IT SHOULD BE LOCATED NEAR THE SUPPLY TANK. IN ITS SELECTION GIVE CONSIDERATION TO THE FLUID PUMPED, VELOCITY, PLUNGER PUMP VALVING, LINE FRICTION, ETC. SIZE CHARGE PUMP TO 1-1/2 TIMES RECIPROCATING PUMP VOLUME CAPACITY, MINIMUM.

GENERAL RECOMMENDATIONS

- PROVIDE SAFETY SHUT DOWN CONTROLS FOR ALL MALFUNCTIONS OF THE SYSTEM, PUMP AND PRIME MOVER, INCLUDING:
 - LOW SUCTION PRESSURE OR LOW TANK LEVEL
 - LOW DISCHARGE PRESSURE
 - HIGH DISCHARGE PRESSURE
 - LOW OIL PRESSURE OR LOW OIL LEVEL
 - HIGH TEMPERATURE, EXCESSIVE VIBRATIONS, OVERLOADING OF PRIME MOVER, ETC.
- FOR SERVICING AND SAFETY PROVIDE ADEQUATE WORK AREA AROUND THE PUMP UNIT.
- CARE AND OPERATIONS SHOULD INCLUDE CLEANLINESS, DAILY INSPECTIONS, PERIODIC INSPECTIONS, ROUTINE MAINTENANCE AND PREVENTIVE MAINTENANCE.

ISSUE DATE:		
NATIONAL - OILWELL		
TYPICAL WATERFLOOD PUMP INSTALLATION SUCTION & DISCHARGE PIPING ARRANGEMENT		
SIZE	DRAWING NO.	REV
C	GSK-3886P	

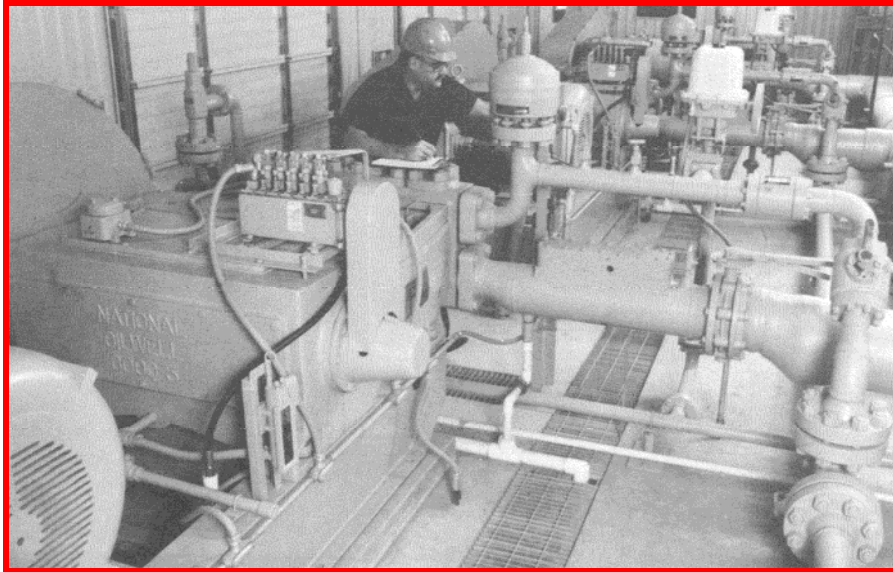
Viscosity Equivalents...



NOTES:

- *Assumes 100 VI single grade oils. Read across horizontally.
- *SAE grades based upon viscosity at 100 C. ISO and AGMA grades based upon viscosity at 40 C
- *Equivalence is in terms only of viscosity. Quality requirements are a separate consideration.
- *Viscosity limits are approximate: For precise data, consult ISO, AGMA and SAE specifications.
- *W grades define only in terms of 100 C viscosity. For low temperature limits, consult SAE specifications.
- *ISO = International Standardization Organization
- *AGMA = American Gear Manufacturers Association
- *SAE = Society of Automotive Engineers

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