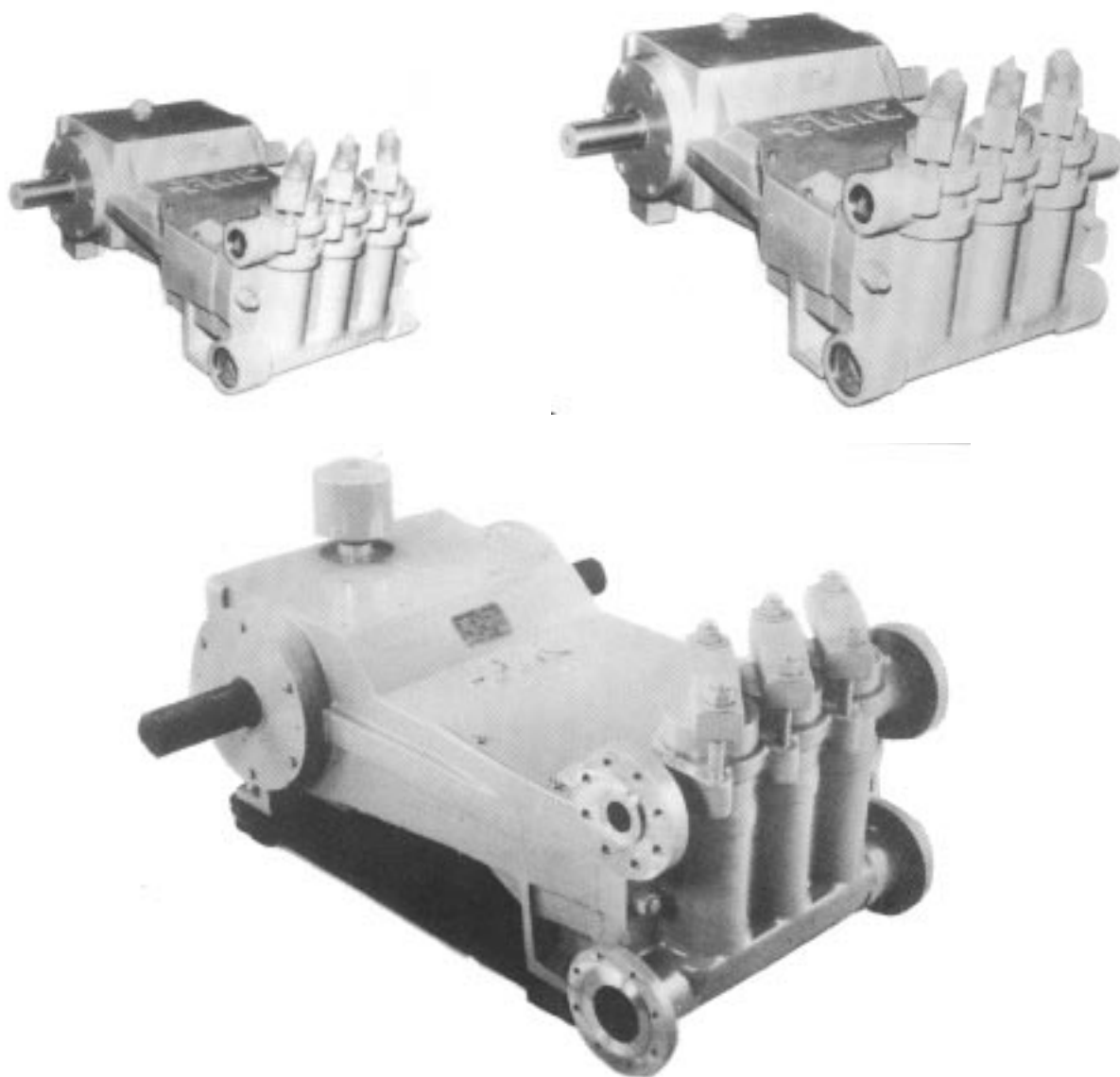


Owners Manual

Industrial Pump Models M08, M12, M16



Section A

Safety Instructions

Accidents occur every year because of careless use of industrial equipment. You can avoid hazards involved with high pressure pumping operations by following these safety instructions.

WARNING

Always use a pressure gauge when operating pump. The pressure must not exceed specified rated pressure of pump or pump could be damaged causing leakage, resulting in injury to personnel in vicinity.

Do not adapt relief valves to maintain more pressure than their specifications state. This could result in relief valve or pump casing bursting due to too much pressure. Personnel in general area could be physically harmed.

Do not put a valve between the pump and relief valve. If the pump should be started with this valve closed this could put excessive pressure on the pump which could cause the pump case to burst and might injure personnel or other equipment in vicinity.

Be sure to use shields or covers on pumps used for pumping hot water or chemicals. This precaution can prevent service personnel from being burnt by hot water or exposed to chemicals when leaks might occur.

Be sure to use shields or covers on all sheaves, belts, and drives. Guards can prevent personnel from becoming seriously injured by being entangled in fast rotating parts.

Always disconnect the pump from the power source before performing any service to the pump. Failure to do this could cause electrical shock or injury from moving pump parts.

Always relieve pressure on the system before performing fluid end maintenance. Failure to do so may spray water or chemicals on service personnel causing water burns or chemical exposure.

Use extreme care when using solvents to clean pump and pump parts. Most solvents are highly flammable. Observe all safety instructions on packaging. Fires could result in serious burns to personnel and serious damage to equipment.

Do not modify the pump to function beyond its specifications.

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To Our Customer

We at FMC would like to express our appreciation in your decision to use one of our industrial pumps. This pump was designed by experienced engineers and built by skilled workmen to provide you with quality equipment.

FMC stands behind all its products. The warranty on your pump is printed on the back of the Delivery Report. Be sure your dealer has you sign a Delivery Report and supplies you with a copy.

Section B

Installation Procedures

Storing Before Installation

Your FMC pump will come to you prepared for any necessary storage periods before installation.

Selecting Pump Location

Always locate the pump as close to the source of supply as possible. The pump should also be located in a light, clean, dry space where adequate inspection and maintenance operations can be performed.

Securing Pump to Foundation

Steps Procedures

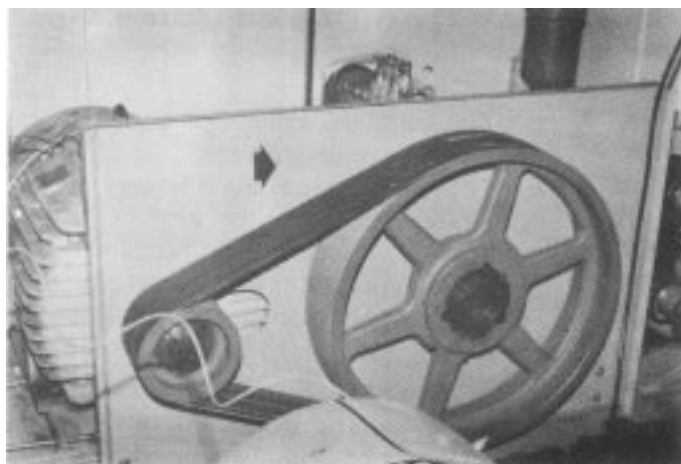
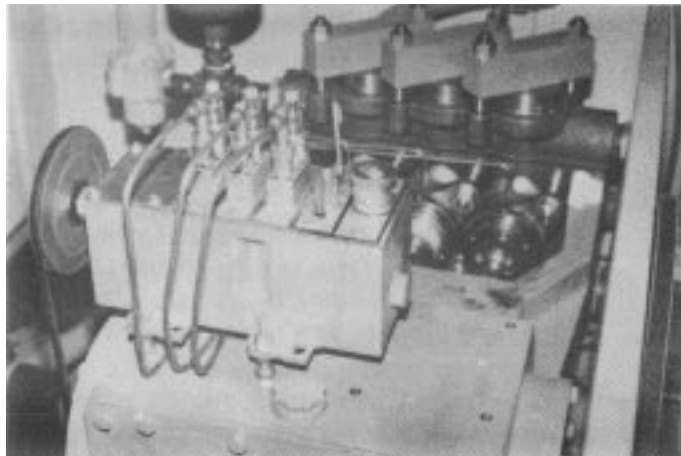
- 1 Locate the pump so the power will turn the top of the pump sheave toward the fluid end of the pump as indicated by arrows on pump case.

NOTE: Fluid can be pumped satisfactorily regardless of the direction of rotation. However, friction and wear on internal components will be reduced by using the recommended rotation.

- 2 Align the power source drive sheave and pump sheave. To check the alignment, use a straight edge, square or rule. Place the straight edge against the sides of the sheaves to be sure they are in line and running exactly parallel to each other.

NOTE: Proper alignment of the drive sheaves is very important to prevent excessive pump bearing and V-belt wear.

- 3 Mount the pump on either a concrete or rigid metal-base using the mounting supplied with the pump and 3/4" bolts. (Use shims, to level the pump if necessary, to prevent straining the pump case.)
- 4 If it is elected to utilize a lubricator, the top of the model M12 and M16 cases are equipped with 1 1/2" threaded holes to accommodate the mounting. Remove the grease fittings from the stuffing boxes and replace with high pressure fittings and tubing.
- 5 Secure the pump to maintain alignment and I to prevent vibration.



Installing the Pump Suction Line

Steps Procedures

- 1 Determine the shortest most direct route possible for the suction hose.
- 2 Make a preliminary design of suction piping. Remember the line should be as large, direct, and short as possible.

NOTE: The line must be laid out so there are no high spots to cause air pockets. Any air pockets in the line could make priming the pump difficult or impossible.

- 3 Analyze the Net Positive Suction Head that would be available in your preliminary design. The NPSHA (Net Positive Suction Head Available) is a characteristic of your pumping system determined by:
 - a. The elevation of the suction supply in relation to the pump suction port (static head)

NOTE: Static head is (+) plus when liquid is above the pump's center line, and (-) minus when liquid is below (or suction lift).

- b. Altitude of the installation above sea level (atmospheric head)
- c. Friction in suction line (friction loss)
- d. Liquid vapor pressure (VP)
- e. Amount of suction head required to accelerate fluid in the suction pipe to prevent cavitation (acceleration head)

NOTE: $NPSHA = \pm \text{static head} + \text{atmos. head} - \text{friction loss} - \text{acceleration head} - VP$

- 4 Compare available NPSH with required NPSH for your pump at your particular RPM requirements.

NOTE: There must be at least two additional feet of NPSHA over the required NPSH to compensate for variations in atmospheric pressure and other similar variables.

- 5 After determining the correct suction line for your required needs install the line. The suction line should be supported independently of the pump.

NOTE: It is advisable to use a flexible connection such as a hose between the hard pipe and pump suction opening to isolate vibrations.

NOTE: Be sure all parts are free of dirt, scale, burrs, or other foreign material which might interfere with pump operation.

Installing the Pump Suction Line - Con't.

Steps Procedures

- 6 Install a foot valve when there is suction lift. The foot valve should be installed in the suction line near the fluid source. The foot valve will keep the lines to the pump filled and avoid the necessity of priming at each start.
- 7 If the supply of liquid is delivered from a pressurized line or through rigid pipe, it is advisable to install a suction line air chamber close to the pump inlet (1) to reduce the possibility of water hammer and cavitation. On pressurized suction lines an accumulator should be used.
- 8 Install drain plugs or drain cocks in low points of suction lines.

NOTE: This is highly important where temperature conditions are below freezing.

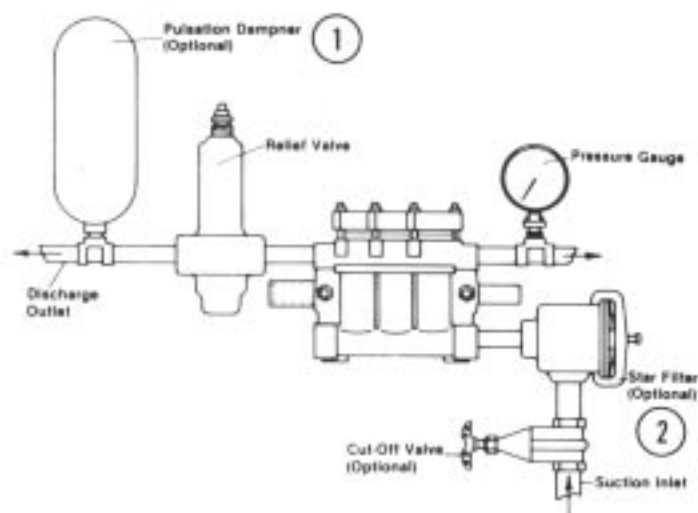
- 9 Install inline strainer (2) in the suction line to remove particles that could damage internal pump components.

NOTE: Use only full opening gate valves for minimizing flow restriction.

- 10 Make sure all joints are air tight.

NOTE: Air leaks reduce pump capacity and cause cavitation.

- 11 Be sure bottom plugs are installed in valve chamber of pump.



Installing Pump Discharge Lines

- StepsProcedures
- 1Determine the shortest most direct route for the discharge line.
- 2Determine the length of hose or pipe required and determine the size of the hose or pipe by considering pressure loss per foot of hose required.
- 3Select weight of pipe required to meet pressure requirements from adjacent chart. Hose ratings are clearly marked on outer surface of hose.

NOTE: Working pressure of hose should not exceed 1/4 of bursting pressure.

Warning
Always use hose or pipe that is designed for your particular pressure requirements. Inadequate hose could burst resulting in possible personal injuries and equipment damage.

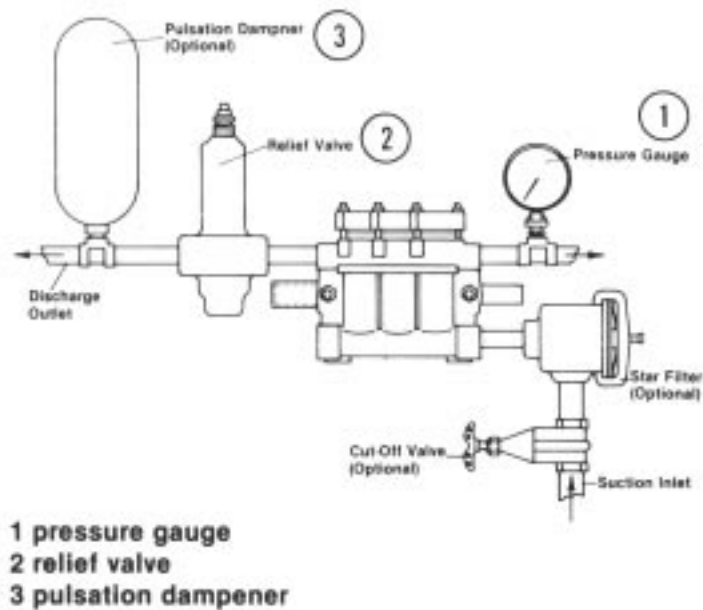
- 4Install pipe or hose to pump.
- NOTE: It is advisable to use a flexible connection between the pump and the rigid pipe (if used) and the discharge opening to isolate vibrations and to allow for easier service.

NOTE: Be sure all parts are free of dirt, scale, burrs, or other foreign material which might interfere with pump operation.

- 5Install the pressure gauge onto the discharge port. The pressure gauge will indicate the fluid pressure so that pressure can be adjusted to the proper level.(1)
- 6Install the relief valve onto the discharge port.
- 7Install the relief valve by-pass. If the fluid is drawn from the tank, the relief valve by-pass should be returned to the tank. The flow may be returned to the suction line (when other means of return are not possible) if it is returned into the line as far as possible from the pump to reduce the possibility of turbulence and cavitation in the suction line.

NOTE: The relief valve by-pass line must be as large as the pipe outlet in the relief valve. Never install valves in the bypass line or between the pump and relief valve.

- StepsProcedures
- Optional 8A pop-off valve may be used in the discharge line to limit the pressure. However, provisions should be made to detect leakage past the valve.
- Optional 9A discharge- pulsation dampener may be installed to absorb pulsations, pounding and prevent water hammer. It should be installed very near the pump. Bladder type pulsation dampners should be precharged to approximately 2/3 of the maximum anticipated pump pressure.



Pipe pressure chart

Pounds per square inch
For cold water, minor shock conditions
Working Pressures

Pipe Size	Seamless Steel Pipe ASTM A120				Butt Welded Pipe ASTM A120			
	Std. Wt. Sch 40	Extra Heavy Sch 80	Sch 160	Double Extra Heavy	Std. Wt. Sch 40	Extra Heavy Sch 80	Sch 160	Double Extra Heavy
1 1/2	1650	3000	4500	8480	1000	1800	2700	5100
3/4	1370	2460	4300	6980	820	1480	2590	4200
1	1220	2190	3780	6340	730	1320	2280	3818
1 1/4	1040	1850	2850	5230	630	1120	1720	3148
1 1/2	900	1650	2630	4680	540	990	1700	2800
2	800	1480	2900	4030	480	890	1750	2430
2 1/2	800	1450	2380	4160	480	870	1430	2500

Section C

Operating Procedures

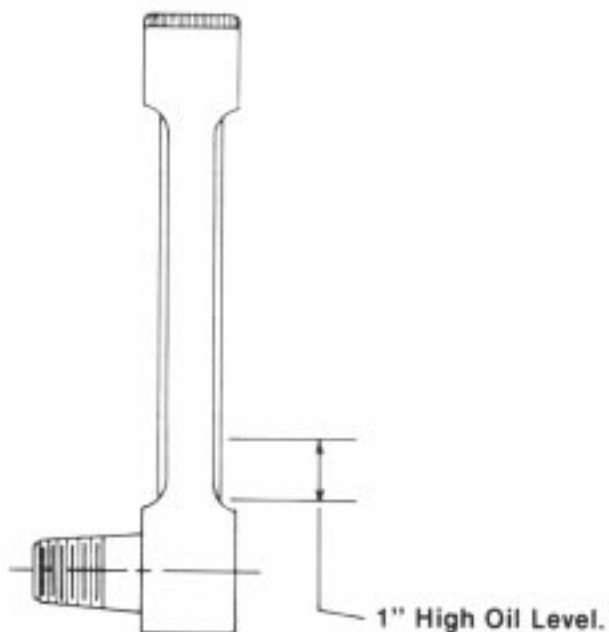
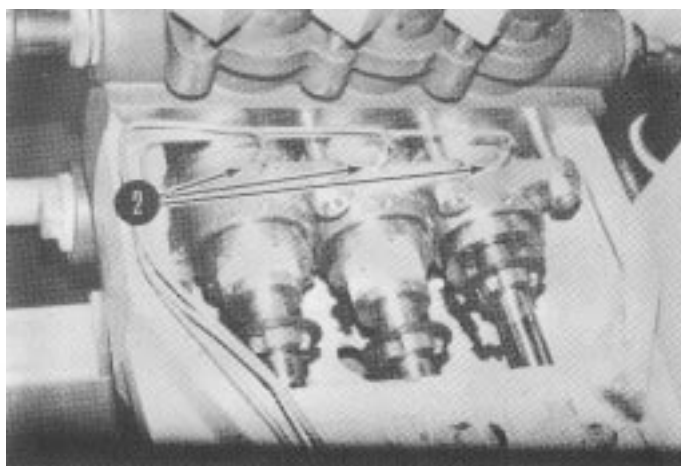
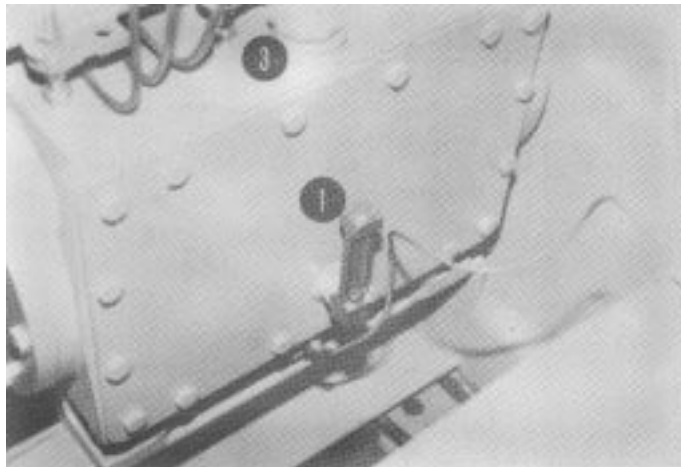
Check Points Before Starting -

Always make the following checks before starting the pump.

Steps	Procedures
1	Make sure the magnetic drain plug in the bottom of the pump case is tight.
2	Check the oil by means of the sight gauge; if necessary add a good grade of SAE 30 wt.

NOTE: The oil level should be kept at approximately 1" high as indicated by the sight gauge.

- | | |
|---|---|
| 3 | Inspect the entire pump installation to make sure all the joints are tight. |
| 4 | If the pump is equipped with a lubricator, check the lubricator oil reservoir. If the pump does not have a lubricator, grease the packings through the grease fittings on the stuffing boxes. |



Starting the Pump

The following procedures should be followed when starting the pump for operation.

Steps	Procedures
-------	------------

- | | |
|---|--|
| 1 | Open the gate valve in the suction line. (1) |
|---|--|

NOTE: The gate valve must remain fully open during operation of the pump.

- | | |
|---|-------------------------------|
| 2 | Check to assure power is off. |
|---|-------------------------------|

WARNING Never try to turn the pump over when the power is on. Service personnel could be entangled in moving sheaves.

- | | |
|---|---|
| 3 | Fill the suction line with fluid, if necessary to prime pump. (2) |
| 4 | Start the pump, and for a few seconds listen for erratic noise or for unsteady flow which indicates the pump is not primed. |

NOTE: Never run the pump over 30 seconds not primed.

If flow is not continuous (pulsing) shut the pump off and prime.

Priming the Pump -

The following procedures should be followed for priming the pump.

Steps	Procedures
-------	------------

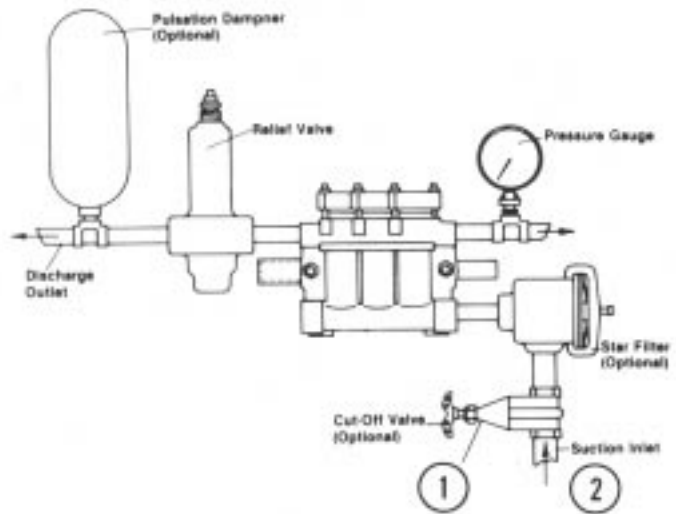
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|---|--|
| 1 | Fill the suction line and filter. |
| 2 | Remove the accumulator or the pressure gauge by unscrewing. |
| 3 | Fill the discharge portion of the valve chamber with fluid. (3) |
| 4 | Jog the pump until the fluid is pumped from the discharge ports in a steady, evenflow. |
| 5 | Reinstall the accumulator or pressure gauge. |

Steps	Procedures
-------	------------

- | | |
|---|--|
| 6 | Start the pump and listen for unsteady flow or erratic noises. |
|---|--|

If unsteady flow persists repeat steps 1-5 until pump is properly primed.

- | | |
|---|--|
| 7 | If pump continues not to prime, check the suction line for air leaks, if the suction line is in good condition check the pump valves for cracked discs or any other condition that would not allow proper valve operation. |
|---|--|



1 gate valve
2 suction line

Shutdown Procedures During Freezing Temperatures

The following procedures should be followed when stopping or storing the pump during freezing weather.

Steps	Procedures
--------------	-------------------

- | | |
|---|---|
| 1 | Let the pump, pump air for a few seconds with the discharge outlet and suction line open. This will flush the valves and discharge lines. |
| 2 | Shut the pump off. |
| 3 | Relieve pressure on the relief valve by turning the nut on top of the valve counterclockwise. (1) |

WARNING

Failure to do this could cause fluid to shoot out when discharge piping is removed and fluid could possibly splash in operator's eyes.

- | | |
|----|--|
| 4 | Remove the piping from at least one of the discharge ports to drain the discharge chamber portion of the valve chamber. |
| 5 | Remove the three pipe plugs from the bottom of the valve chamber. |
| 6 | Drain all trapped fluid from inside the valve chamber by lifting the suction valves with the end of a screwdriver or similar tool. |
| 7 | Replace the pipe plugs and any piping taken off of the pumps discharge ports. |
| 8 | If drain plug is used under relief valve, remove the plug. |
| 9 | Remove drain plugs in all low points of piping. |
| 10 | Leave all cutoffs open. |
| 11 | Check to be sure that no further fluid can enter the drained piping and pump that could cause freeze damage. |

CAUTION

Fluid left in valve chamber will freeze during freezing temperatures resulting in severe damage to pump.

Section D

Maintenance

Procedures

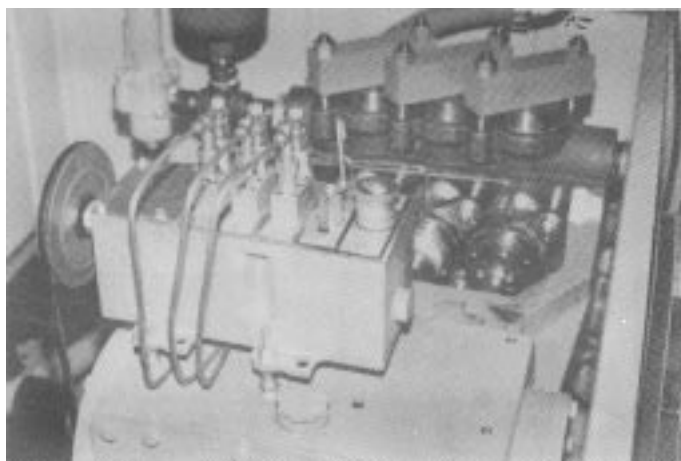
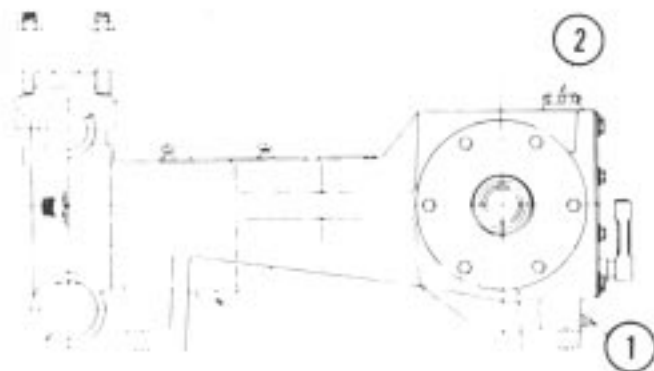
Lubrication

This triplex plunger (or outside packed) pump requires SAE 30 wt. lubricant in the crankcase. After the first 500 hours of operation drain the oil from the crankcase and remove any metal adhering to the magnetic drain plug. Thereafter, at the end of each of 5000 hours operation the oil must be drained and the drain plug(1) should be cleaned of any metal adhering to it.

Should oil have a milky appearance, this indicates water is leaking past plunger rod seals into the pump. The plunger rod seals should be checked and replaced if necessary. After draining all oil replace the drain plug and add the oil through the oil fill opening.(2)

Another area of the pump requiring lubrication is the packings. The packings are lubricated by means of a lantern gland and a plunger lubricator. The lantern gland allows for direct lubrication of the plunger packings. The non-adjustable plunger packings require continuous lubrication with a high pressure lubricator. The M12 and M16 pump cases have drilled and tapped holes for lubricator mounting and the stuffing boxes are equipped with 1/8 NPT holes to mount the high pressure fittings.

A filter should be installed in the suction line to prevent contaminating material from entering the pump and reducing its life and efficiency. During the initial break-in period, the pump filter screen should be inspected frequently. The amount of material trapped in the filter during these inspections will indicate how often the filter screen should be checked and a regular inspection schedule should be developed from this information.



Periodic Maintenance Chart

Before performing any maintenance on your pump read the Owner's manual thoroughly.

Components	Description of Service	Remarks
------------	------------------------	---------

Break-in Period

Crankcase	Drain oil from crankcase by removing plug. Clean any metal adhering to pump before replacing. Refill pump case with new oil.	After the first 500 hours of operation.
Pump Filter Screen	Should be inspected frequently to determine a regular inspection schedule.	The amount of material collected in the filter with each check will indicate how often the filter should be inspected.

Components	Description of Service	Remarks
------------	------------------------	---------

Daily

Complete Pump	General inspection of pump in operation to determine if it is functioning properly.	This inspection should take place once each day.
Plunger Rod Oil Seals	Inspect plunger rod oil seals for leakage.	Leaking indicates the need for replacing the oil seals (refer to Servicing Oil Seals, page F-9.)
Packing (Plunger)	Inspect packings for leakage.	Excessive dripping at this point indicates worn plunger packing. Adjust or replace as necessary. (Refer to Replacing Plunger Packings, page F-3.)
Pump System	Use water or a suitable solvent and flush the entire system.	For overnight shutdown when using materials that might harden or corrode the pump. Drain all water from pump chambers and piping when freezing temperatures are anticipated.

Periodic Maintenance Chart - Con't.

Components	Description of Service	Remarks
------------	------------------------	---------

Weekly

Crankcase	Check oil level in crankcase by visually inspecting the sight gauge.	Oil level should appear 1 " high in sight glass.
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NOTE: Do not over-fill. Excessive oil puts undue strain on oil seals.

Grease fittings	Add grease to fittings	Once a day using a good grade water resistant grease.
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Components	Description of Service	Remarks
------------	------------------------	---------

Every 5000 Hours (equals 7 months of continuous use)

Crankcase	Change oil and clean magnetic plug.	SAE 30 grade (non-detergent)
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Long Term Storage

Pump System	Drain Pump (Refer to page D-3, Storing Pump During Freezing Weather.)	During freezing temperatures.
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Section E

Service

Servicing the Fluid End

Servicing the Valves - Malfunctioning valves are identified by a uniform hammering or vibration and by reduced pump capacity (volumetric efficiency).

Steps Procedures

WARNING

Always disconnect pump from power source before performing any service to the pump. Failure to do this could cause electrical shock or injury from moving pump parts.

- 1 Remove the bar clamps and the valve covers by removing the hex nuts.
- 2 Remove the fastener that retains the spring retainer. At this time the spring retainer, springs, and valve plate may be removed.
- 3 Use the special valve puller at this time to remove the discharge valve seat, as shown in fig. 3. Tighten the puller stem until the valve comes free.
- 4 Repeat steps 2 and 3 for the suction valves.

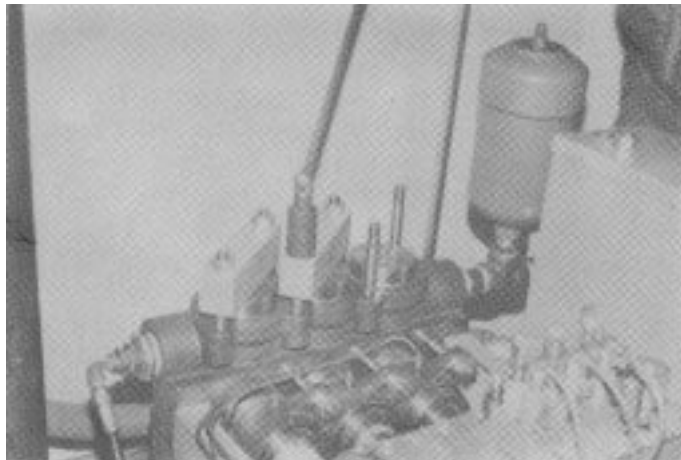
NOTE: The suction valves are removed through the discharge valve seat bores.

NOTE: The suction valves must be installed before the discharge valves can be installed. The following reassembly procedure is applicable for both the suction and discharge valves.

- 5 Select a new seat.
- 6 Wipe the tapered surface of the seat and the pump port taper with a clean cloth.

CAUTION

The valve seats are held in place by a selflocking taper. Therefore both the seat and valve tapers must be dry and oil free to insure proper operation. Failure to do this could damage the pump.



Steps Procedures

- 7 Lower the seat into the port taper and then lift slightly and let drop. If the seat drops straight, it will seize on the taper. When correctly seated, it cannot be pulled up by hand.
- 8 It is necessary to rap it a few times to assure a perfect seal; this may be done with a short section of hardwood or soft brass bar and hammer. Three or four blows are sufficient; additional heavy blows are useless and can result in damage to the seat.
- 9 After the valve seat has been installed, place the valve plates, springs, and spring retainers in place, then secure with fastener and threaded lock plug. Care must be taken to position the valve plate and the retainer so as not to damage the guide while tightening the fastener. Torque fasteners as indicated on page E-19.

CAUTION

Take care not to overtighten the fastener or tighten the retainer stem. Either of these could cause a valve failure.

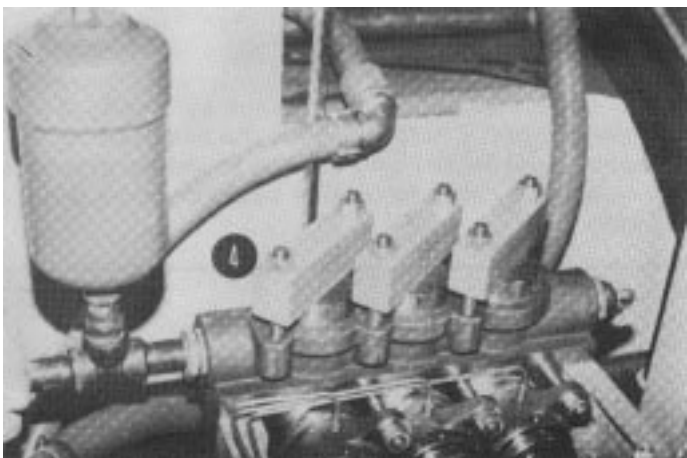
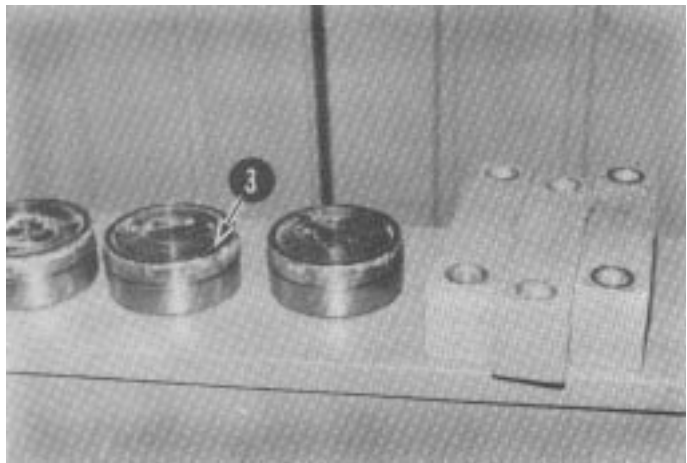
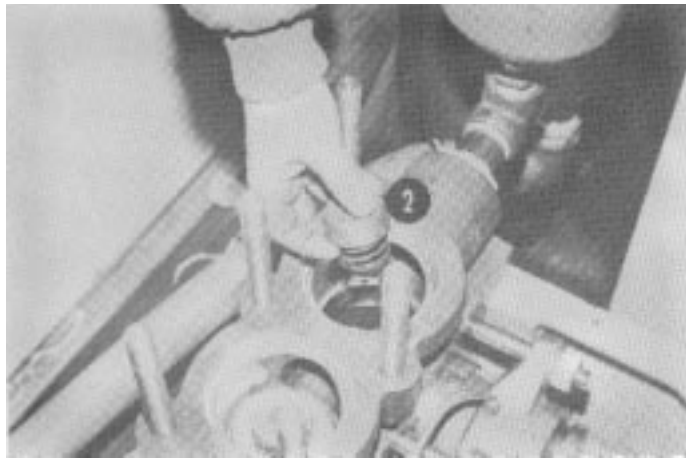
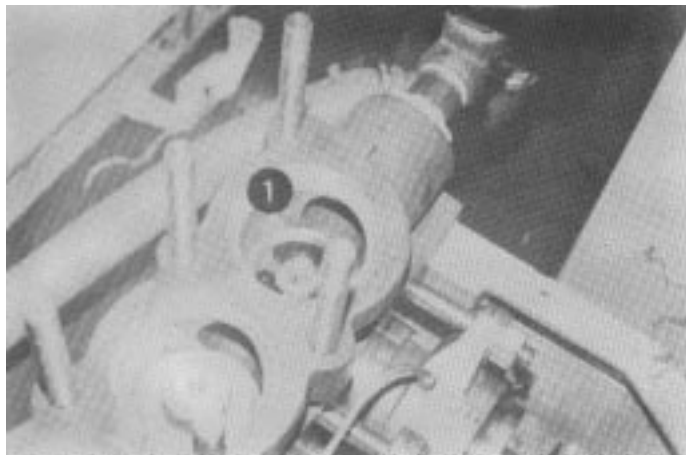
- 10 Replace the o-rings in the valve covers, if necessary, apply grease to the o-rings to hold them in their grooves while installing the valve covers.
- 11 Replace the valve cover clamp and torque as shown on page E-19.

NOTE: Care should be taken to keep the valve cover clamp level on the valve cover to insure proper valve cover loading. Also, always use Fel-pro C5-A anti-seize on stainless threads.

CAUTION

Proper torqueing is important for safety. Over-torqueing could strain the stud and cause stud failure. Under-torqueing can allow fatigue stresses to occur and cause stud failure.

- 1 Seat in position**
- 2 Valve plates, spring, and spring retainer**
- 3 O-rings on valve cover**
- 4 Valve cover clamp**



Servicing the Plunger Packings

Plunger packings must be replaced whenever the leakage around the packings affects the pump's efficiency. A small amount of leakage past the packings is normal and is actually desirable to help cool and lubricate the packings.

Your pump was designed for ease of maintenance. Any stuffing box can be taken out and repacked without disturbing any of the other stuffing boxes.

Steps Procedures

WARNING

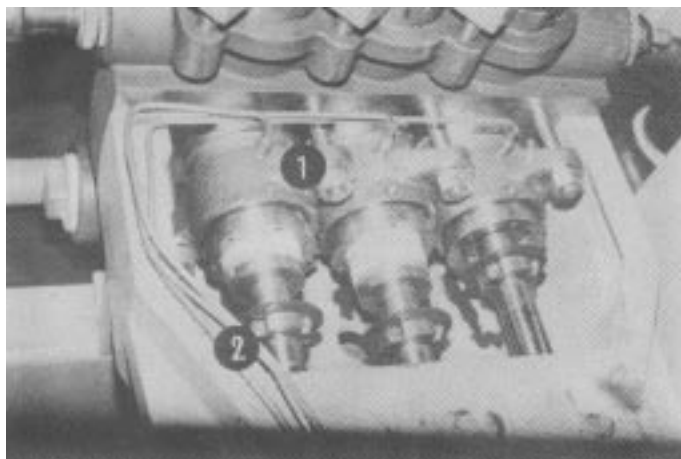
Always disconnect pump from power source before performing any service to the pump. Failure to do this could result in electrical shock or injury from moving pump parts or drive parts.

- 1 Remove any pressure from the valve chamber.
- 2 Remove the pair of hex nuts that attach the stuffing box which is to be serviced. (1).
- 3 Break the plunger clamp by removing the hex head capscrews and removing the upper and lower half of the valve cover clamp. (2).
- 4 Rotate the pump by hand so that the plunger is pushed all the way forward and then continue to rotate the pump so that the plunger rod separates from the plunger and is in its maximum rearward position.
- 5 At this time the stuffing box and plunger may be lifted from the pump and taken to some place where it can be repacked.
- 6 Loosen the nylon tipped set screw and remove the adjusting nut.

CAUTION

Do not use a standard set screw in place of the nylon tipped set screw. Doing this could lead to damaging the adjusting nut and stuffing box beyond repair.

- 7 Remove all of the packing components. (They may be slid out from either end of the stuffing box) Wipe the stuffing box adjusting nut, lantern gland, clean with a cloth dipped in solvent.



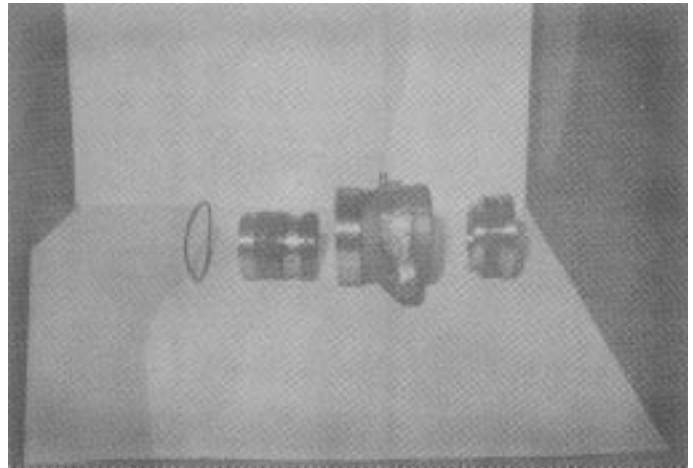
Servicing the Plunger Packings - Cont'd.

Steps	Procedures
--------------	-------------------

- | | |
|---|---|
| 8 | Replace the adjusting nut (however, at this time, do not tighten down the nylon tipped set screws.) |
|---|---|

NOTE: In each new packing set there are three units of packing, composed of a female adapter, pressure ring, and a male adapter. The female adapter is the thin hard phenolic ring. The pressure ring is the nitrile/nylon ring with the two flexible sealing lips. The male adapter is the larger hard phenolic ring with chamfers molded at one end.

- | | |
|---|--|
| 9 | To repack the stuffing boxes, the elements must be installed in the following manner. <ul style="list-style-type: none">a) Set the stuffing box on the adjusting nut so that the o-ring groove is facing upward.b) Place a female adapter in the stuffing box bore flat face down.c) Lubricate a pressure ring with lubriplate lubricant or the equivalent and place in the stuffing box bore flat side down, lip side up.d) Place a male adapter in the bore chamfered side down, flat side up.e) Place the lantern gland in the bore. (Lantern glands may be installed in either direction).f) Repeat steps b, c, and d for the next 2 packing units.g) Place the throat ring on top of the packing stack. |
|---|--|



Servicing the Plunger Packings - Cont'd.**Steps Procedures**

- 10 If the throat ring sticks up past the end of the stuffing box, the adjusting nut should be backed off and the throat ring pushed down so it is flush or below the end of the stuffing box.

CAUTION

Step 10 insures that accidental overtightening of the packing does not occur and the plunger and packing damage that would occur as a result.

- 11 Lubricate the plunger with a good grade of water resistant grease and insert through the adjusting nut until approx. one half of the plunger extends past the end of the throat ring on the other side of the stuffing box.

CAUTION

Do not hammer on the clamp surfaces on the plunger. Damage to these surfaces could cause plunger misalignment and pump failure.

- 12 Apply grease to the o-ring and place in the o-ring groove in the stuffing box. The purpose of the grease is to hold the o-ring in place while reinstalling the stuffing box into the valve chamber.



Servicing the Plunger Packings - Cont'd.

StepsProcedures

- 13 Wipe the stuffing box counterbores in the valve chamber clean of debris before installing the stuffing box.
- 14 Install the stuffing box with the plunger rod as far rearward as possible. This gives the maximum amount of room possible and simplifies assembly.

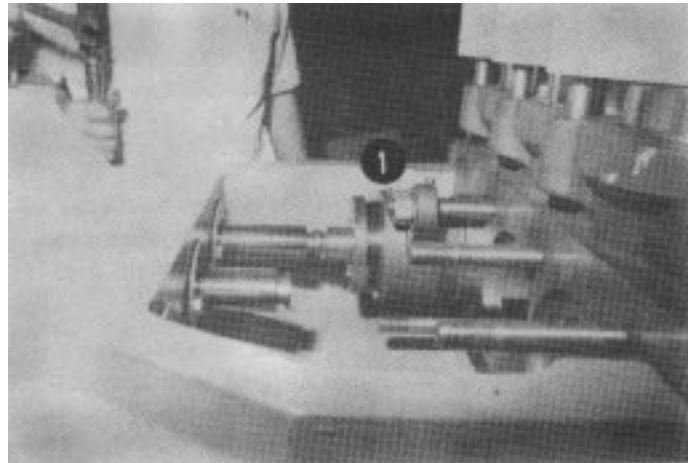
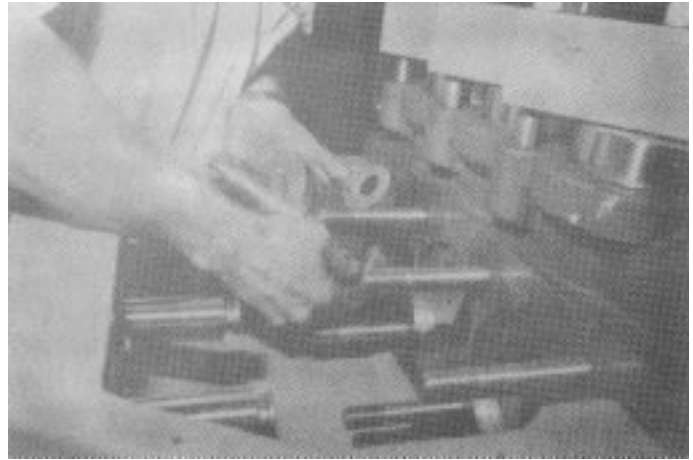
CAUTION

Be careful not to allow the o-ring to slip out of its groove. Also, be careful not to damage the plunger while installing the stuffing boxes.

WARNING

Do not force the stuffing box into the stuffing box counterbores on the valve chamber. Stuffing box should slide in easily. Failure to do this could cause damage to the valve chamber and stuffing box.

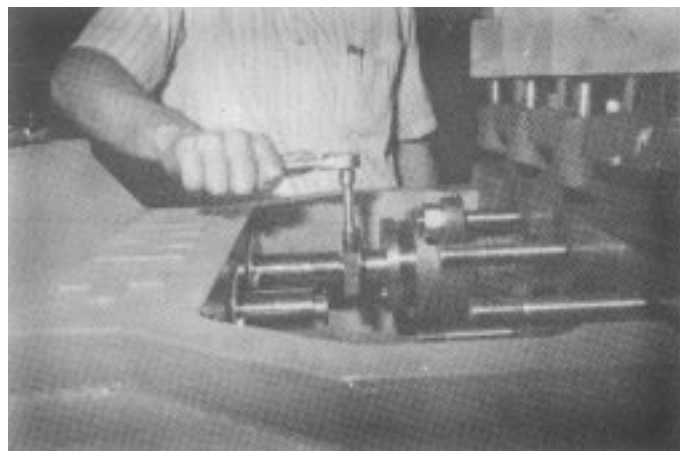
- 15 Hand tighten the hex nuts on the stuffing box studs. Be sure to Use the large stainless steel flat washers under these nuts. (1)
- 16 Replace the deflector shields on the plunger.
- 17 Rotate the pump so the plunger rod moves forward and engages with the plunger.



Servicing, the Plunger Packings - Cont'd.

Steps	Procedures
-------	------------

- | | |
|----|--|
| 18 | Install the plunger clamp being careful to keep the gap between the upper and lower parts uniform while tightening torque as shown on page E-19. |
| 19 | Torque the stuffing box hex nuts in the following manner:
1) Torque both nuts to approx. 1/4 full torque
2) Torque both nuts to approx. 1/2 full torque
3) Torque both nuts to approx. full torque, |



NOTE: Always use Fel-pro C5-A anti-seize on stainless threads.

CAUTION

Using this torque sequence insures that the stuffing box will not bind in its bore during torqueing.

- | | |
|----|---|
| 20 | Tighten the adjusting nut. Torque as shown on page E-19. |
| 21 | Tighten the nylon tipped set screws to ensure that the adjusting nut does not back out during pump operation. |

CAUTION

Do not excessively tighten the set screw. Damage could occur to adjusting nut.

Servicing the Drive End

Servicing the crankshaft and connecting rods

These components seldom need servicing or replacing unless the pump has been run without oil or with severely contaminated oil. Problems with the shaft and rods will be indicated by a knocking noise or excessive pump case temperature.

Steps Procedures

WARNING

Always disconnect pump from power source before performing any service to the pump. Failure to do this could result in electrical shock or injury from moving pump parts or drive parts.

- 1 Disconnect piping to valve chamber.
- 2 Remove the pump from its mounting and place on a bench or other convenient place for servicing the power end.
- 3 Place a container under the drain plug(1) in the drive end and remove the drain plug to drain all oil from the drive end.
- 4 Remove the stuffing boxes using the procedure as outlined in the previous section.

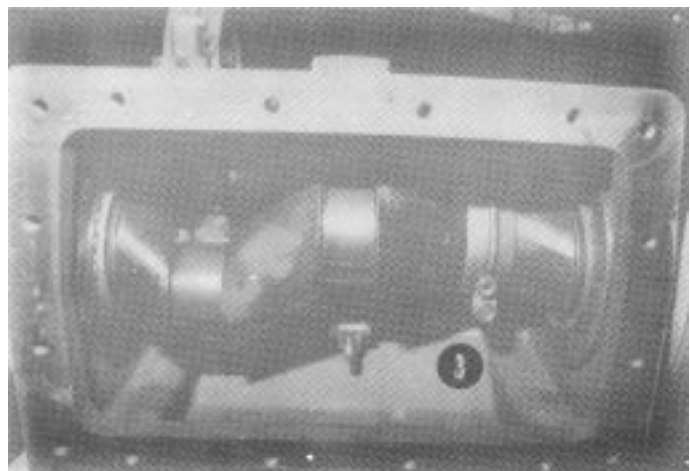
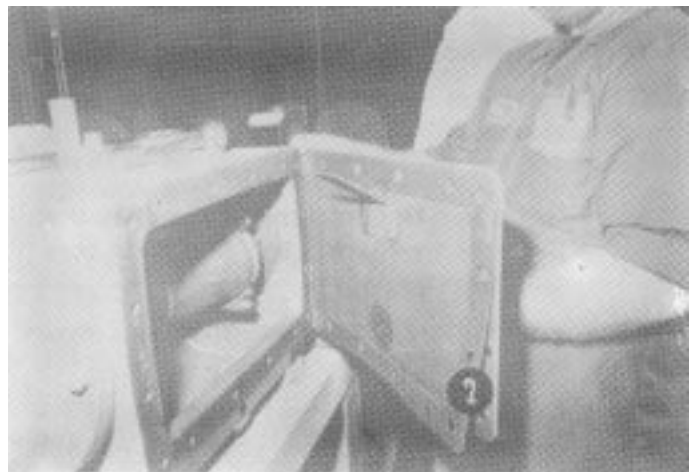
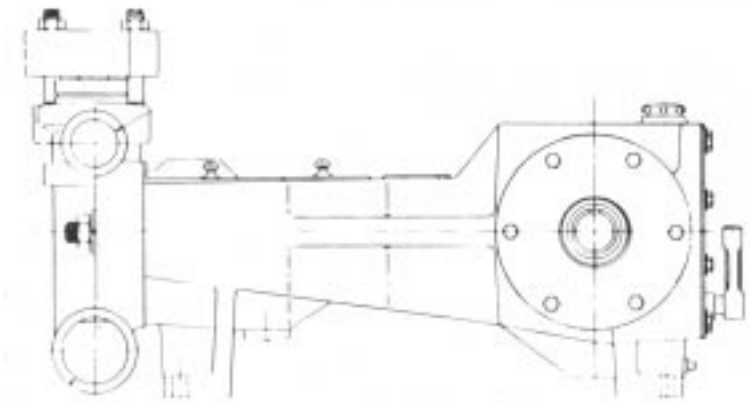
NOTE: To prevent unnecessary down time, valves, packing, and other wear items should be changed while doing drive end maintenance.

- 5 Remove the hex head capscrews holding on the rear cover and remove the rear cover and gasket. (2)
- 6 Remove caps from the connecting rod by unscrewing the nuts. (3)

CAUTION

Caps and rods are coded and must always be assembled with their mate.

- 7 Remove sleeve bearings from the connecting rods.
- 8 Push the connecting rods all the way forward and push the connecting rod bolts all the way forward to aid crankshaft removal. (NOTE) Connecting rod bolts may be removed completely for additional room while removing crankshaft.



Servicing the Drive End - Cont'd

Steps Procedures

- 9 Remove the bolts from the bearing housings.
- 10 Remove bearing housings. It may be necessary to tap on housing with a rubber mallet to free housing from pump base.

CAUTION

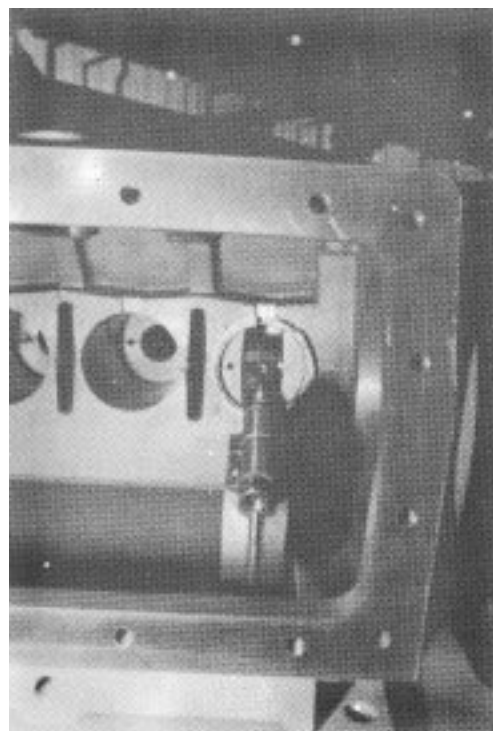
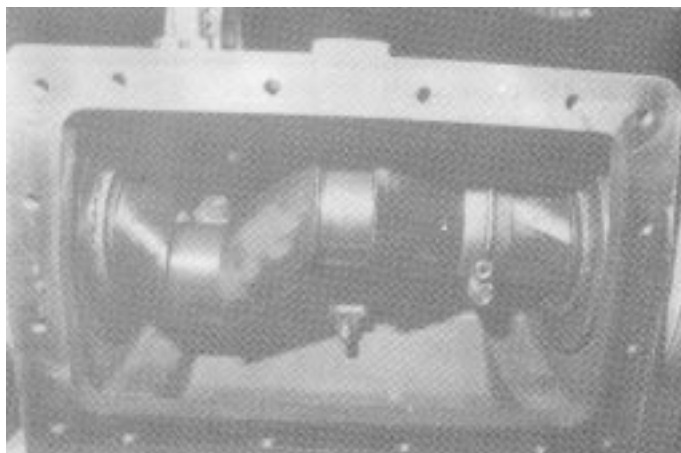
Crankshaft should be carefully handled during bearing housing removal to keep from damaging or scarring the crankshaft or pump case.

- 11 Work crankshaft through bearing opening in case to remove. (Note: It is recommended that two men be available for this operation due to the mass of the crankshaft.)
- 12 Pull connecting rods and crosshead assemblies from case taking care to place parts so they will be reassembled into the same bore from which they were removed.
- 13 All oil seals should be replaced to avoid any unnecessary down time.
 - A. To replace crosshead oil seals refer to Changing Plunger Rod Seals.
 - B. To change eccentric shaft oil seals:
 - (1) Pull oil seals from the bearing housing with a screwdriver or similar object and discard.

CAUTION

Take care not to damage housing bore. Scars on the housing could cause premature wear on bearings and oil seals.

- (2) Press the new seals into the bearing housing so the seal lips are toward the inside of the case. Take care not to damage the seal lips or curl them when assembling.
 - (3) Apply light oil to the seal lips for lubrication.
- 14 Inspect the crankshaft bearings for:
 - a. Cleanliness
 - b. Rough spots when rotated.
 - c. Visible wear or damage

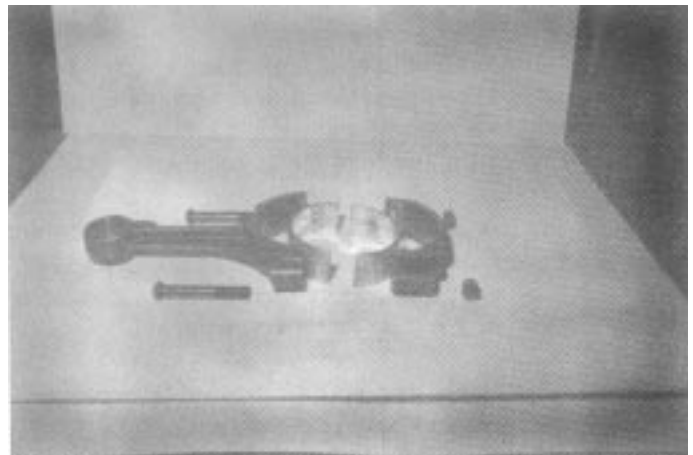


Servicing the Drive End - Cont'd.

StepsProcedures

NOTE: All damaged bearings that have been removed from the shaft must be replaced with new bearings. If one bearing is faulty, it is a good practice to replace both bearings even though no damage is visible on the other bearing.

- 15 Inspect the crankshaft for damage, excessive scoring, or pitting on the eccentric shaft indicates the need for replacement.
- 16 Inspect the connecting rods(1) for damage. Excessive scoring or pitting on the connecting rods indicates the need for replacement.
- 17 Inspect the crosshead assemblies(2) and replace if any wear is visible.
- 18 Clean all parts in a solvent and apply a thin coat of oil (Grade SAE 30) before installing.
- 19 Thoroughly clean pump case in solvent and blow dry.
- 20 To replace bearings, heat cones to 300°F and drop on to crankshaft. Use a press to press the cups into the bearing caps.

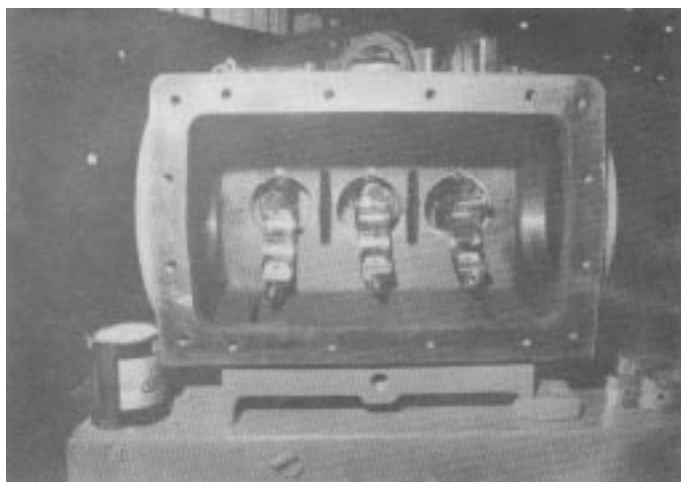
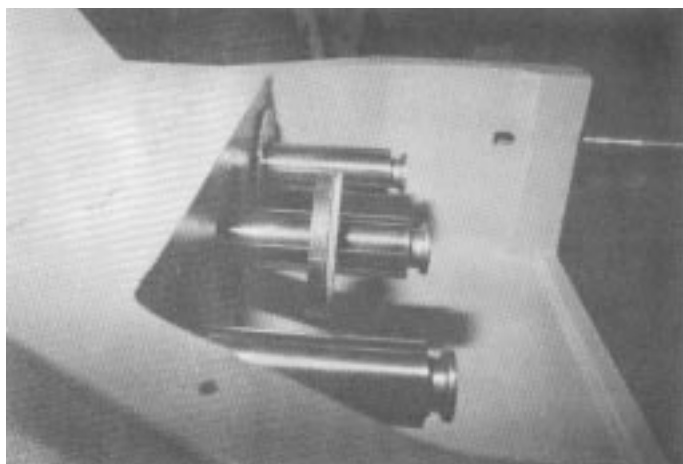
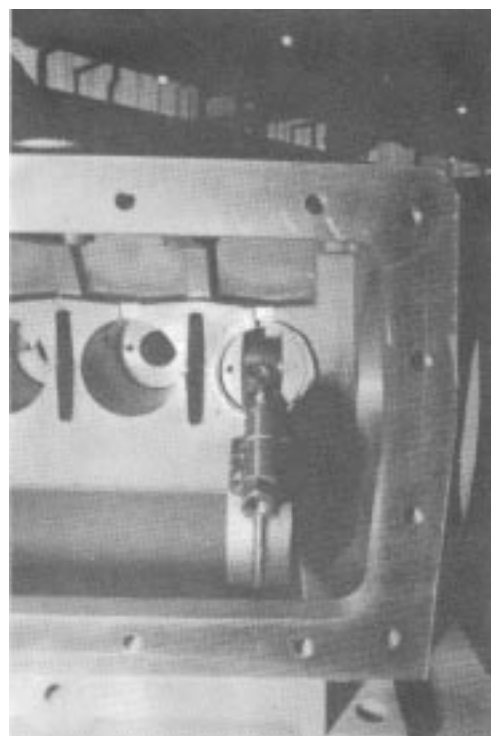
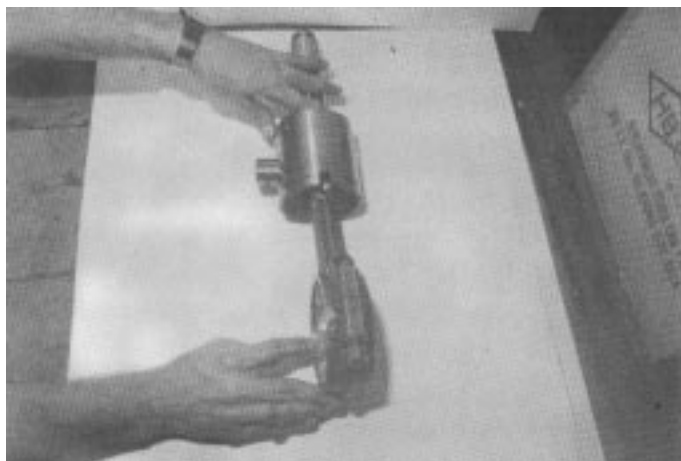


Servicing the Drive End - Cont'd.

StepsProcedures

- 21 Before installing the crosshead assemblies, remove the oil seal holders
- 22 Reassemble the crosshead and connecting rod assemblies. Be sure to align the oil slot in the crosshead with the oil pocket and the connecting rod. Be sure to replace the set screw that retains the wrist pin.
- 23 Replace the crosshead assemblies and connecting rods. Be sure to keep the oil slots and oil pockets facing upward. Reassemble in the same bores as removed from.
- 24 Replace bearing inserts in connecting rods.

NOTE: Before reinstalling the crankshaft push the connecting rods and connecting rod bolts as far forward as possible.



Servicing the Drive End - Cont'd.

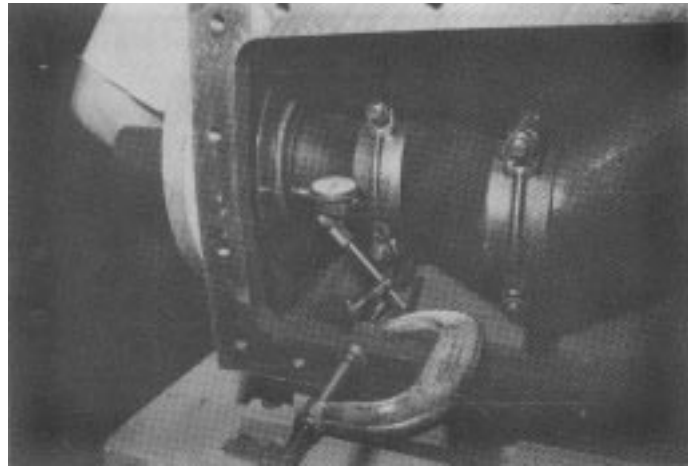
Steps	Procedures
-------	------------

- | | |
|----|--|
| 25 | Replace the crankshaft by carefully threading the shaft through the openings in the end of the case. Take care not to damage the bearings. |
| 26 | Replace shims and gasket and bearing housing. |

NOTE: The gasket goes against the pump case. The shims go between the gasket and bearing cover.

NOTE: Always use shims and gaskets.

- | | |
|----|---|
| 27 | Measure the crankshaft end play by: <ul style="list-style-type: none">a. loosening the connecting rodsb. placing a dial indicator on the pump case and against crankshaft as shown in picturec. move the eccentric shaft fully to one endd. Set the dial indicator to zeroe. move the crankshaft to its maximum pointf. read the end play on the dialg. end play must be between .002 tight and .005 loose
remove or add shims as necessary |
| 28 | Replace capscrews and torque bearing cover bolts connecting rod bolts to value shown on page E-19. |
| 29 | Replace back cover and gasket Torque the capscrews to value shown on page E-19. |
| 30 | Replace the plunger rod oil seal holder. (Refer to Servicing the Plunger Rod Oil Seals). |



Servicing the Plunger Rod Oil Seals

These seals retain oil in the pump case and prevent dirt and fluids from entering the case by way of the plunger rods. Oil leakage around the plunger, dirt on the case, or milky colored oil are signs of worn or damaged crosshead seals. The seals may be replaced without disassembly of the drive end; however, the plunger clamps must be broken. To change the seals, follow the steps below.

Steps Procedures

WARNING Always disconnect the pump from the power source before performing any service to the pump. Failure to do this could result in electrical shock or injury from moving pump parts or drive parts.

- 1 Break the plunger clamps by removing the hex head capscrews and the top and bottom pieces of the plunger clamps.
- 2 Rotate the pump until at least a gap exists between the plunger and plunger rod.
- 3 Remove the two hex head capscrews that hold the plunger rod oil seal holders to the pump case.
- 4 Slide the oil seal holders off the plunger rods.
- 5 With a blunt object, push the old seals out of the seal holders.
- 6 Reassemble the new seals in the seal holder by pushing each seal in with the spring loaded lip facing upward or toward the pump case. Replace o-ring or gasket behind seal holder.
- 7 Replace seal holder being very careful not to roll up the oil seal lips while sliding over the plunger rods.

NOTE: Seals should be lubricated with lubriplate or the equivalent before installation to insure proper initial operation.

- 8 Retorque bolts to specification.



Servicing the Bearings

A knocking sound around the bearing or excessive heat coming from the pump case adjacent to the bearing are indications of faulty bearings. To replace or inspect bearings, the crankshaft must be removed to allow access to the bearings. (Refer to step 13 Servicing the Drive End).

Servicing the Eccentric Shaft Oil Seal

The oil seal also helps retain oil in the pump case and prevents dirt or fluid from entering the case. Oil leakage around the shaft, excessively dirty oil, or milky colored oil are indications of a worn or damaged seal. The eccentric shaft oil seal can be changed by removing the bearing housing. (Refer to step 13 Servicing the Drive End

Reading the Troubleshooting Chart

The following chart is designed to help you easily define and correct problem areas. As you can see, the chart is divided into two columns. The first item is the Symptom; this is the signal that something is wrong. Once you have noticed the symptom you must determine the Cause because one symptom may be the signal for any one of various problems. The column titled Test and Result will be your aid for determining the Cause and Remedy.

Troubleshooting Chart

Symptom

Discharge Pressure too Low

Test/Result

Connect a hose to the overflow port in the relief valve and start the pump:

1. Close discharge line and allow all flow to be bypassed across the relief valve.

RESULT: No overflow, see item 1, then recheck pressure.

RESULT: Flow through overflow hose, see item 2, then recheck pressure.

2. Open discharge line.

RESULT: No flow in the overflow hose, see items 3 and 4, recheck pressure.

RESULT: Flow through the overflow hose, see items 5 and 6, or 7, recheck pressure.

Cause/Remedy

1. Restriction in suction line.

Checked for clogged strainers, closed valves, empty suction tank.

2. Incorrect relief valve adjustment.

To increase the relief pressure, tighten the nut on top of the valve by turning clockwise.

WARNING

Do not exceed the rated pressure of the pump.

3. Insufficient or unexpectedly low discharge system resistance.

Positive displacement pumps do not generate pressure unless they pump against some type of restriction, be it an RO membrane, oil formation or a nozzle.

4. Pump speed too low.

Change the sheave combination to obtain the desired speed.

CAUTION

Do not exceed the maximum rated speed.

5. Worn seat or stem in the relief valve.

Replace parts as required.

6. Worn packing cup in the relief valve.

Replace the packing if water is leaking through the openings in the relief valve body.

7. Foreign material lodged in the relief valve.

Relieve the spring tension and flush the interior of the valve to remove foreign material.

Symptom

Discharge gallonage too low - low discharge gallonage will be caused by slow pump speed or low volumetric efficiency.

Test/Result

1. Calculate displacement gallonage of the pump as follows:
 - a. Measure crankshaft speed with a tachometer.
 - b. Multiply speed by gallons per revolution as shown on specification sheet. (assuming 100% V. E.)

RESULT: Displacement gallonage lower than required, see item 1.

RESULT: Displacement gallonage equal to or larger than required gallonage, see next test.

2. Volumetric efficiency is a measure of how much the actual output is less than the displacement. To determine vol eff.:
 - a. Measure the actual gallonage from the pump. Close discharge system and measure the number of gallons coming from the overflow hose for one minute.

NOTE: One gal. of water weighs 8.33 lbs. and fills .1337 cu. ft.

NOTE: Measured flow is actual gallon per minute (GPM) output.

- b. Divide the actual GPM found in Step a. by the displacement GPM found earlier then multiply by 100 to get the volumetric efficiency.

$$\text{Vol. Eff. I} = \frac{\text{Actual GPM} \times 100}{\text{Displ. GPM}}$$

Normal Volumetric Efficiency - 85% for the higher pressure models.
95% for the lower pressure models.

RESULT: Normal volumetric efficiency but gallonage less than required, see item 1.

RESULT: Volumetric efficiency less than normal, see items 2, 3, and 4 or cavitation.

Cause/Remedy

1. Pump speed too slow.

Change the sheave combination to obtain desired speed. (Refer to Selecting Operating Speed, pg. D-1 and installation Procedures, page C-1.)

WARNING

Do not exceed maximum Rated speed.

2. Leakage from the pump plunger packings. Excessive leaking indicates that the packing should be replaced. (Refer to pg. E-3)
3. Suction or discharge valve seats worn, pitted, or broken.

Inspect and replace where necessary. (Refer to page E-1.)
4. Restriction in the suction line.

Check for clogged strainers, closed valves, empty suction tank.

Symptom

Noise coming from bearings and crankcase area

Test/Result

See Item 1.

Cause/Remedy

1. Worn or damaged bearings
Change bearings (Refer to Servicing, page 1.)

Symptom

Cavitation - Cavitation in the pump occurs when the cylinders do not completely fill with water during the suction stroke. Resultant pressure pulsations can severely damage the pump and related piping if the condition is not recognized and corrected immediately.

Test/Result

Check the following to determine if cavitation exists:

1. Volumetric Efficiency

$$\text{Vol. Eff.} = \frac{\text{Actual GPM}}{\text{Displ. GPM} \times 100}$$

(See Discharge Gallonage refer to preceding page)

RESULT: Less than normal vol. eff. with good valves and plunger packings indicates cavitation.

2. Discharge Pressure

RESULT: Less than expected and fluctuating erratically indicates cavitation.

3. Pulsations in suction or discharge line.

RESULT: Erratic pulsations of abnormal magnitude indicate cavitation.

4. Listen for sharp erratic hammering sounds in the valve chamber.

Do not confuse the sharp regular sounds of the valves with the erratic sound that indicates cavitation.

NOTE: There are several causes of cavitation. Once the problem as been determined as cavitation from the above test the following test must be performed to determine the cause.

1. Reduce the temperature of the pump liquid to room temperature.

RESULT: If cavitation stops, see item 1.

2. If the relief valve overflow is piped into the pump suction line, disconnect the overflow line.

RESULT: If cavitation stops, see item 2.

3. Disconnect the suction inlet piping and replace it with a short hose connected to a barrel or tank.

RESULT: If cavitation stops, see items 4 and 5.

4. Disconnect the discharge piping and connect a short hose to the pump outlet.

RESULT: If cavitation stops, see item 6.

5. Replace the pump plunger packings and inspect the valve assemblies. See items 3 and 7.

Cause/Remedy

RESULT: If cavitation stops, see item 7.

1. Vapor pressure too high at pumping temperature. Reduce the temperature or increase the suction pressure by an amount sufficient to overcome the vapor pressure. Refer to Section C, Installations, page C-2.
2. Turbulence in the pump suction inlet. Relocate overflow lines further from the pump inlet. If necessary, provide a tank to supply undistributed suction flow conditions to the pump.
3. Suction or discharge valves' seats worn, pitted, or broken. Inspect and replace, where necessary. (Refer to page F-1.)
4. Excessive losses in the suction piping. Increase the suction pipe diameter, increase the suction pressure or reduce the length of the suction line. In some cases, an air chamber may be required to sufficiently reduce the suction losses. (Refer to Installations, page C-2.)
5. Air leaking into the suction system. Inspect and tighten all the hose and pipe connections.
6. Water hammer in the discharge line. Install an air chamber or an accumulator in the discharge piping. (Refer to installations, page C4.)
7. Weak and partially worn plunger packing. Partially worn plunger packing may draw air on suction stroke but not leak on the discharge stroke. This will cause the pump to operate as if cavitating. Adjust or replace the packing. (Refer to Servicing, page E-3.)

ORDERING PARTS

Parts should be obtained through the dealer from whom equipment was purchased. FMC dealers carry a complete line of service parts; however, in the event they are not available, your dealer will order them for you. In order to reduce errors when purchasing parts from your dealer always supply your dealer with the following information.

When possible give part number, serial number, and model number of pump.

State part number, followed by complete part name. Check parts list to be sure part number and name agree on the order.

Indicate quantity of item wanted. When necessary, qualify amounts with words “each”, “feet”, etc.

Specify shipping instructions: i.e., via freight truck, parcel post, express, etc.

Indicate the date of order.

Claims for Damaged Material

Claims for parts lost or broken should be filed with the transportation company involved without delay.

If necessary for any cause to return materials, please secure approval and shipping directions from us.

Emergency Requests

When corresponding with the factory, please refer to pump serial number, model number, date of purchase, and inform us if pump is operating under unusual conditions. Emergency requests should be made by phone or wire to establish priority and expedite shipment.

Torque Specifications (Toleranced $\pm 5\%$)

Model M08

	English	Metric
Valve Fasteners	30 ft. lbs.	41 N-m
Valve Cover Nuts	200 ft. lbs.	271 N-m
Oil Seal Holder Capscrews	25 ft. lbs.	34 N-m
Plunger Clamp Capscrews	5 ft. lbs.	7 N-m
Bearing Housing Capscrews	25 ft. lbs.	34 N-m
Connecting Rod Nuts	45 ft. lbs.	61 N-m
Backcover Capscrews	20 ft. lbs.	27 N-m
Stuffing Box Nuts	1st 10 ft. lbs.	14 N-m
	2nd 40 ft. lbs.	54 N-m
	3rd 100 ft. lbs.	136 N-m

Model M12

	English	Metric
Valve Fasteners	30 ft. lbs.	41 N-m
Valve Cover Nuts	200 ft. lbs.	271 N-m
Oil Seal Holder Capscrews	25 ft. lbs.	34 N-m
Plunger Clamp Capscrews	5 ft. lbs.	7 N-m
Bearing Housing Capscrews	55 ft. lbs.	75 N-m
Connecting Rod Nuts	65 ft. lbs.	88 N-m
Backcover Capscrews	30 ft. lbs.	41 N-m
Stuffing Box Nuts	1st 10 ft. lbs.	14 N-m
	2nd 40 ft. lbs.	54 N-m
	3rd 125 ft. lbs.	169 N-m

Model M16

	English	Metric
Valve Fasteners ($\frac{1}{2}$ ")	40 ft. lbs.	54 N-m
Valve Fasteners ($\frac{5}{8}$ ")	60 ft. lbs.	81 N-m
Valve Cover Nuts	480 ft. lbs.	650 N-m
Oil Seal Holder Capscrews	25 ft. lbs.	34 N-m
Plunger Clamp Capscrews	20 ft. lbs.	27 N-m
Bearing Housing Capscrews	55 ft. lbs.	75 N-m
Connecting Rod Nuts	90 ft. lbs.	122 N-m
Backcover Capscrews	30 ft. lbs.	41 N-m
Stuffing Box Nuts	1st 20 ft. lbs.	27 N-m
	2nd 80 ft. lbs.	108 N-m
	3rd 200 ft. lbs.	271 N-m



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