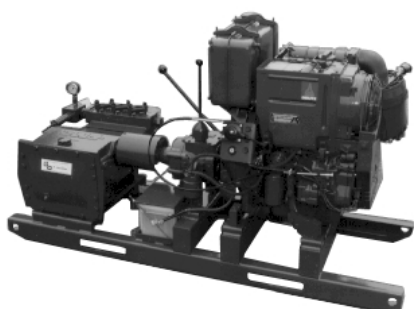
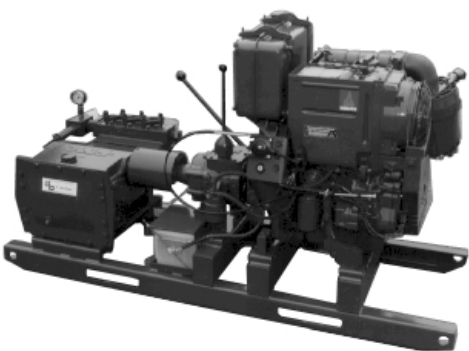




**Service kits
for Flush pump**

TRIDO® 140



Service kits for the
Flush pump

TRIDO® 140

*This publication is an information about service kits available for the flush pumps, **Trido® 140**.*

For further information concerning service measures for the flush pumps, please contact your nearest Atlas Copco representative.

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ATLAS COPCO CRAELIUS AB
MÄRSTA - SWEDEN 2000-05

How to order spare parts and service kits.

To be read before ordering:

1. When ordering spare parts, please state Description and part number of the spare part (not the Ref. no.) as well as type designation and serial number.
2. Parts which are included in a subassembly are given immediately after this part and are preceded by a dash in the description column.

Symbols that may occur:

- *) Placed instead of part number in part number column, means that the indicated part is normally not delivered separately. Can be ordered as a kit, see point 2.
- ***) Optional , equipment not included in standard delivery.
-) Cannot be purchased separately
- A) When ordering, please state part number, hose dimension and length.
- B) See separate list according to **"Service Kits for flush pumps"**.

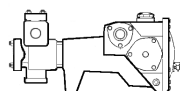


Source of information for the maintenance part in this book.

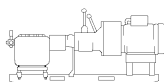
FMC, Owners manual 1985.

Service kits for flush pumps Trido® 140

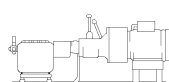
Page	Kit no	Description of kit	Comment	Main product number	Main product name
6.	3715 7431-90	Replacement kit Cylinder & Valves		8492 0208-16	Pump, compl.
7.	3715 7431-96	Replacement kit Valves		8492 0208-16	Pump, compl.
8.	-	Maintenance		8492 0208-16	Pump, compl.
		- Operation, maintenance			Section D
9.		- Starting the pump			Section D-3
10.		- Shutdown procedures during freezing temperatures			Section D-4
11.		- Shutdown procedures during freezing temperatures, (continue)			Section D-5
12.		- Lubrication			Section E-1
13.		- Periodic Maintenance Chart			Section E-2
14.		- Periodic Maintenance Chart, (continue)			Section E-2
15.		- Servicing the Fluid End			Section F-1
16.		- Servicing the Valves			Section F-2
17.		- Servicing the Valves, (continue), Replacing the plunger packings.			Section F-3
18.		- Replacing the plunger packings, (continue).			Section F-4
19.		- Servicing the cylinders			Section F-5
20.		- Servicing the cylinders, (continue)			Section F-6
21.		- Servicing the plunger rod oil seals			Section F-7
22.		- Servicing the plunger rod oil seals, (continue)			Section F-8
23.		- Servicing the drive end			Section F-9
		- Servicing the drive end, (continue)			Section F-10-14
29.		- Troubleshooting Chart			Section F-16-18



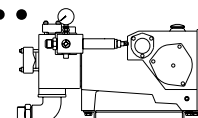
TRIDO® 140E



TRIDO® 140DG

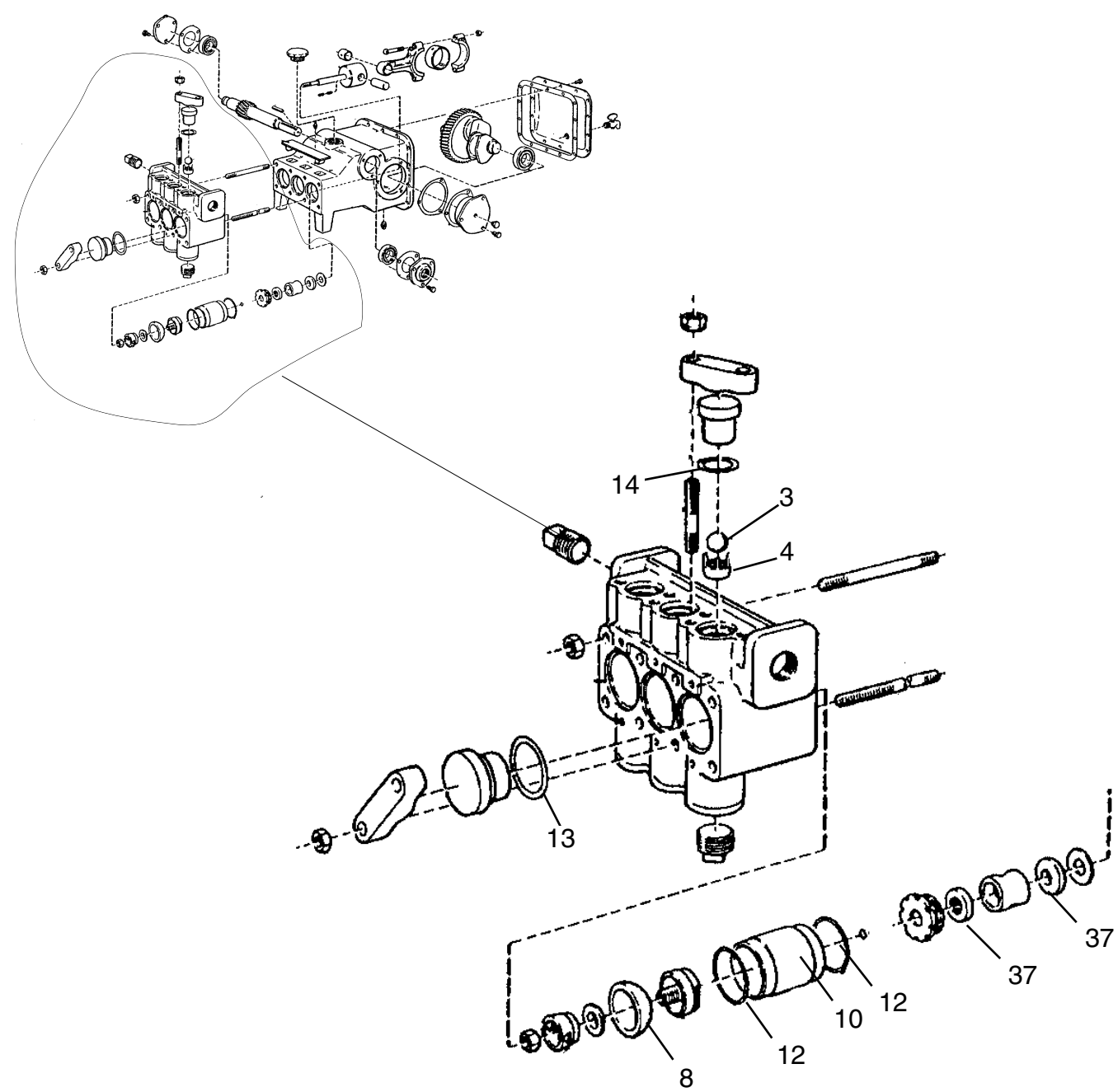


TRIDO® 140EG



TRIDO® 140H2S

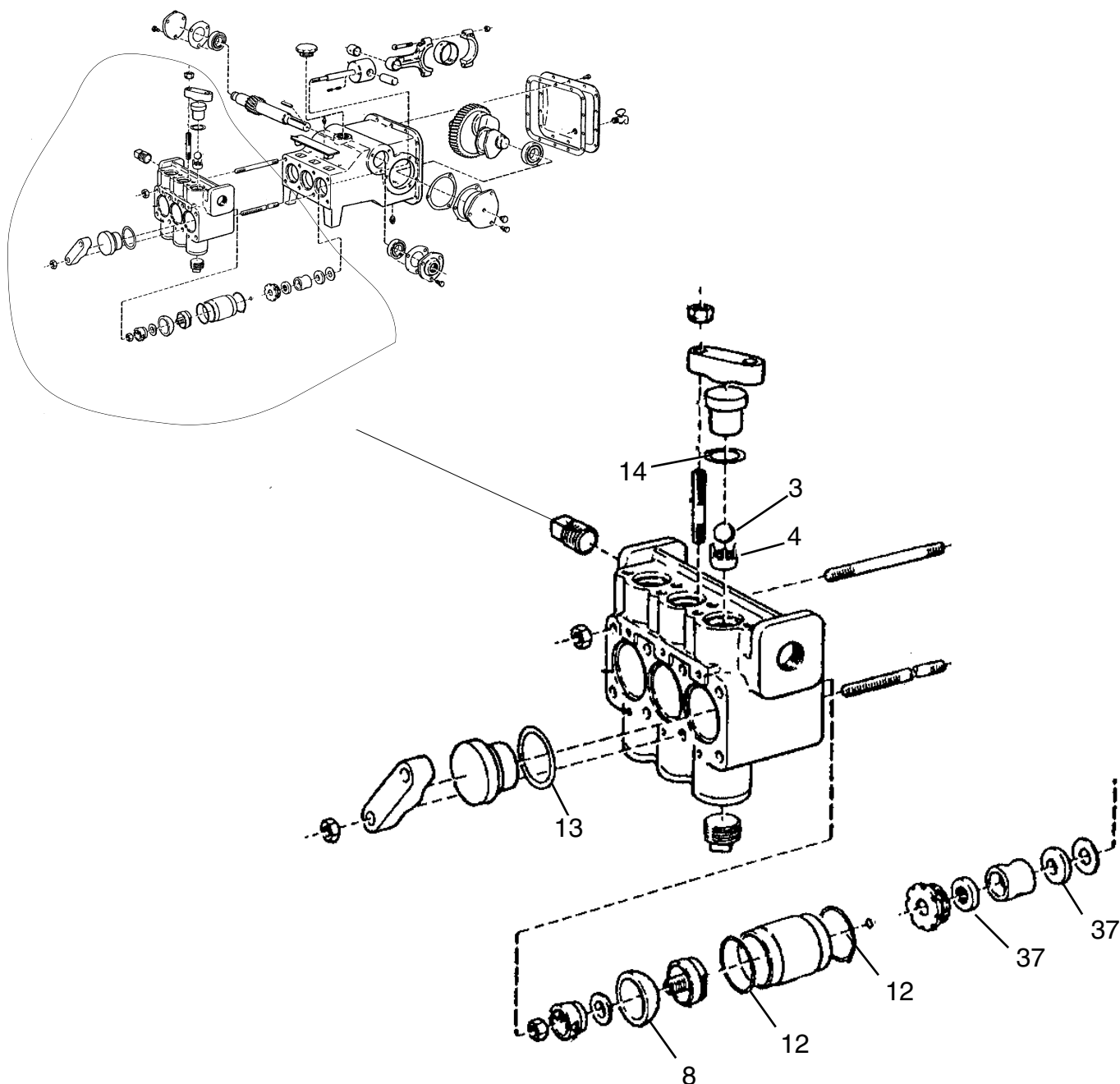
Replacement Kit, cylinder and valves for flush pump, TRIDO® 140
3715 7431-90



Ref. No.	Part No.	Qty.	Description	Notes
	3715 7431-90	1	Replacement kit,cylinder and valves	
3	3715 7440-00*	6	Ball	
4	3715 7441-00*	6	Valve seat	
8	3715 7427-00*	3	Gasket	
10	3715 7431-00*	3	Cylinder	
12	3715 7432-00*	6	Cylinder gasket	
13	3715 7436-00*	3	Gasket	
14	3715 7405-00*	3	Gasket valve.....	
37	3715 7446-00*	6	Plunger rod seal.....	

Replacement Kit, valves for flush pump, TRIDO® 140

3715 7431-96



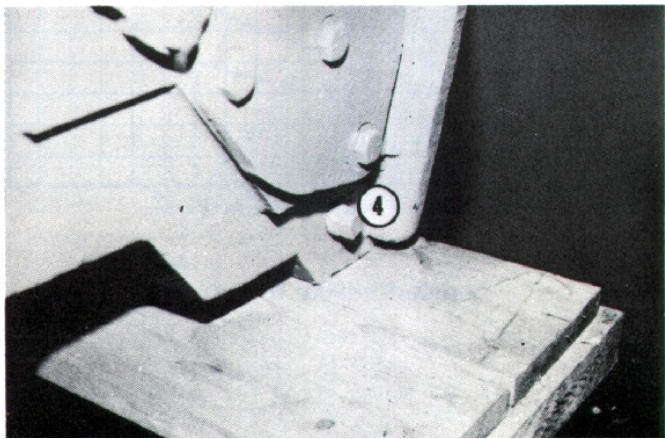
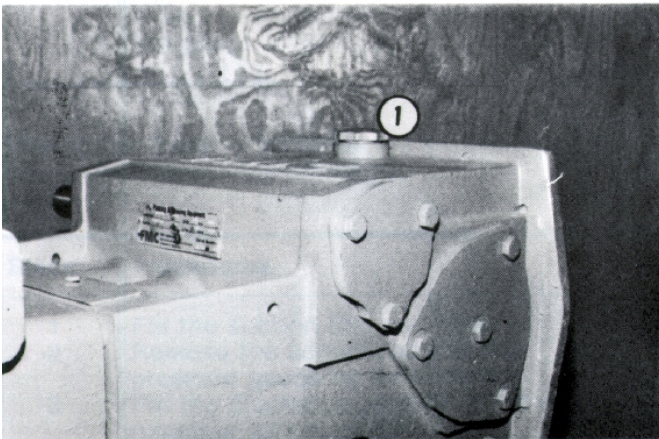
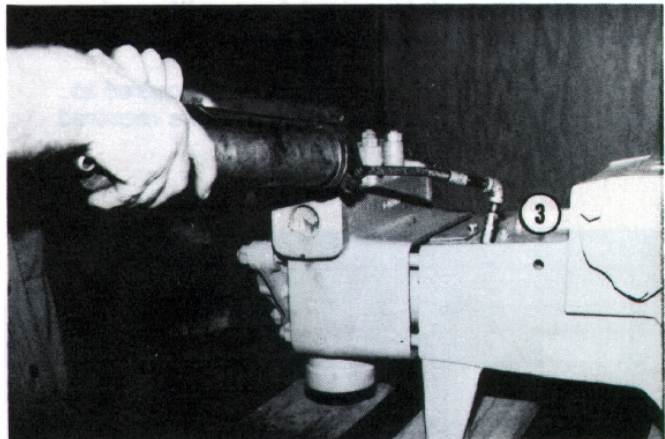
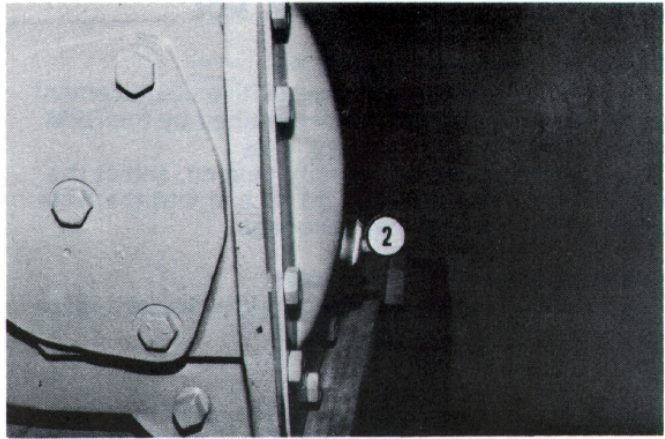
Ref. No.	Part No.	Qty.	Description	Notes
	3715 7431-96	1	Replacement kit, valves.....	
3	3715 7440-00*	6	Ball	
4	3715 7441-00*	6	Valve seat	
8	3715 7427-00*	3	Gasket	
12	3715 7432-00*	6	Cylinder gasket	
13	3715 7436-00*	3	Gasket	
14	3715 7405-00*	3	Gasket valve.....	
37	3715 7446-00*	6	Plunger rod seal.....	

SECTION D (Maintenance)

Operation

Check Points Before Starting—Always make the following checks before starting the pump.

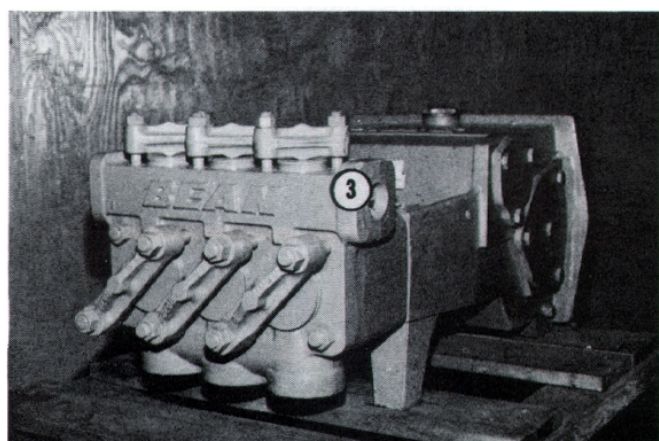
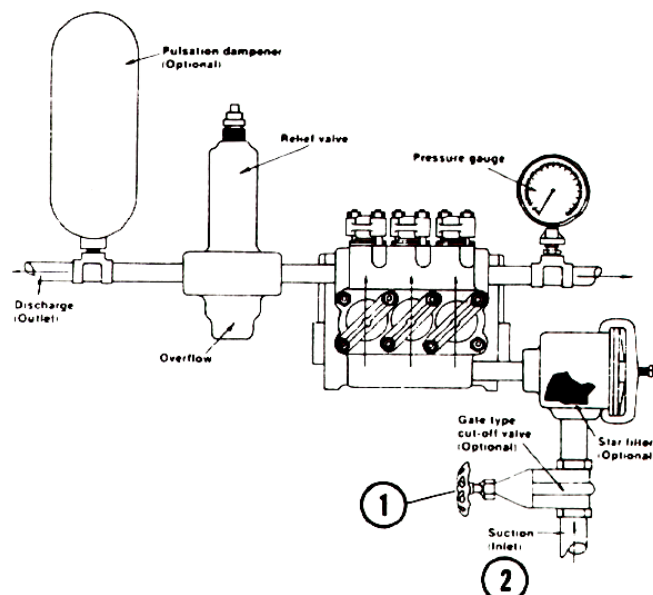
Steps	Procedures
1	Make sure the magnetic drain plug (4) in the bottom of the pump case is tight.
2	Check the oil by means of the petcock if necessary add a good grade of SAE 30 weight oil through the filler opening. (1) NOTE: The oil should come up to the petcock (2) on the back of the drive end.
3	Inspect the entire pump installation to make sure all the joints are tight.
4	Apply grease to the 3 grease fittings (3) and regrease every 1000 hours or twice a NOTE: Grease with a good grade of water resistant grease. (Refer to Lubrication Procedures.)



1. filler cap
2. petcock
3. grease fittings
4. drain plug

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)
2	Note: The gate valve must retain fully open during operation of the pump. Check to assure power is off.
3	Turn the pump over by hand to make sure the crankshaft is free. WARNING Never try to turn the pump over when the power is on. Service personnel could be entangled in moving sheaves.
4	Fill the suction line with fluid, if necessary to prime pump. (2)
5	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 the flow is not continuous (pulsing) shut the pump off and prime.



Priming the pump - The following procedures should be followed for priming the pump.

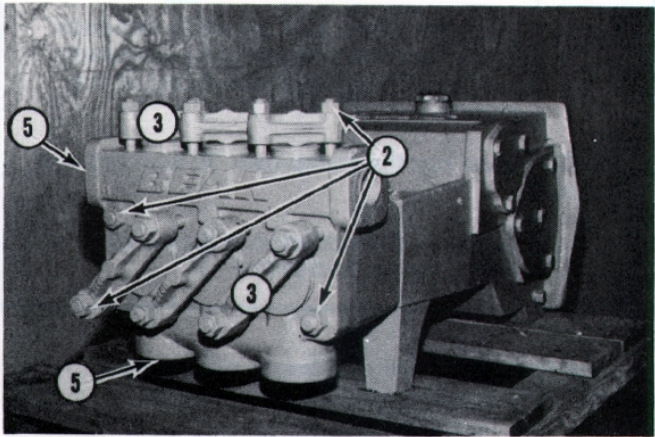
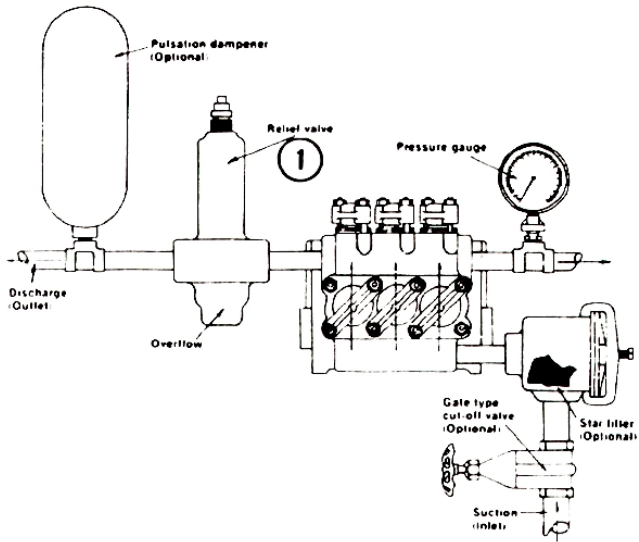
Steps	Procedures
1	Fill the suction line and filter.
2	Remove the accumulator or the pressure gauge by unscrewing.
3	Fill the discharge portion of the valve chamber with fluid. (3)
4	Jog the pump until the fluid is pumped from the discharge ports in a steady, even flow.
5	Reinstall the accumulator or pressure gauge.
6	Start the pump and listen for unsteady flow or erratic noises. If unsteady flow persists repeat steps 1-6 until pump is properly primed.
7	If pump continues not to prime check the plunger packing to see if there is excessive leakage through the packing. Should the packing be leaking 15 to 20 drops per minute shut the pump off and replace the packing. (Refer to Service, Section F)

1. gate valve
2. suction line
3. discharge portion of valve chamber

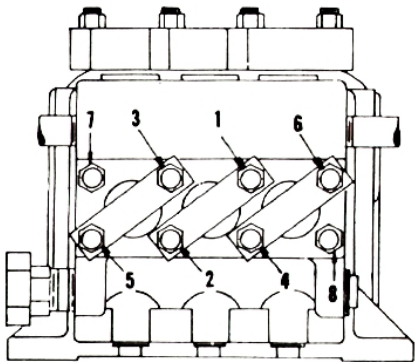
Shutdown Procedures During Freezing Temperatures

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. NOTE: When pumping liquids that cannot be contaminated by using a diesel fuel, pump diesel fuel through the system. By doing this, you will eliminate the need for steps 2-12. WARNING Do not use this procedure when pumping fluids that can be contaminated by having diesel fuel in the pump or suction and discharge lines.
2	Shut the pump off.
3	Relieve pressure on the relief valve by turning the top of the valve counterclockwise (1) WARNING Failure to do this could cause fluid to shoot out when discharge manifold is removed and fluid could possibly splash in operator's eyes.
4	Remove plugs from under the suction valve area of the valve chamber .



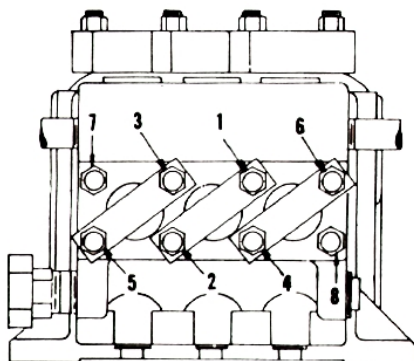
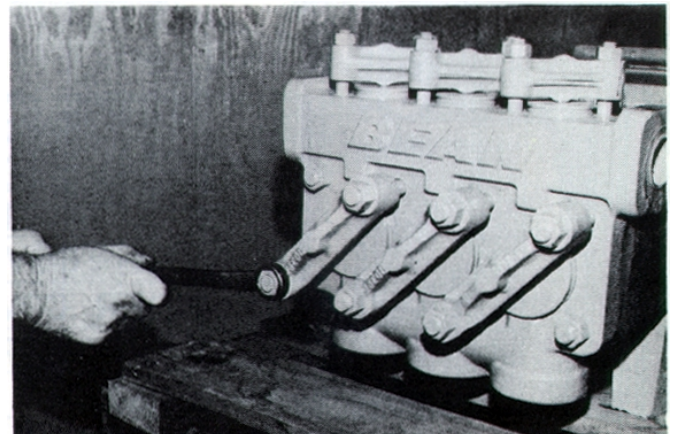
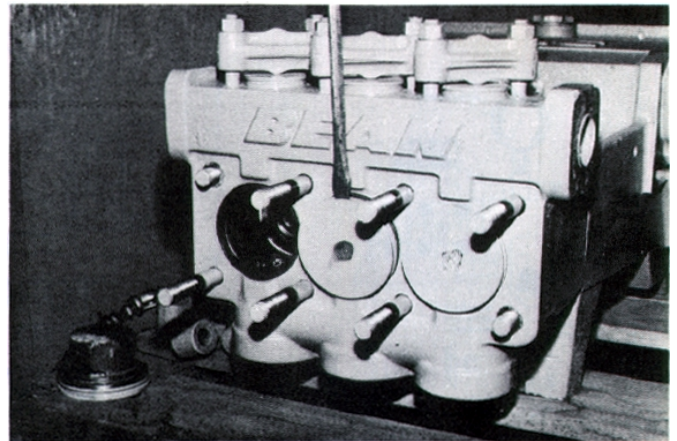
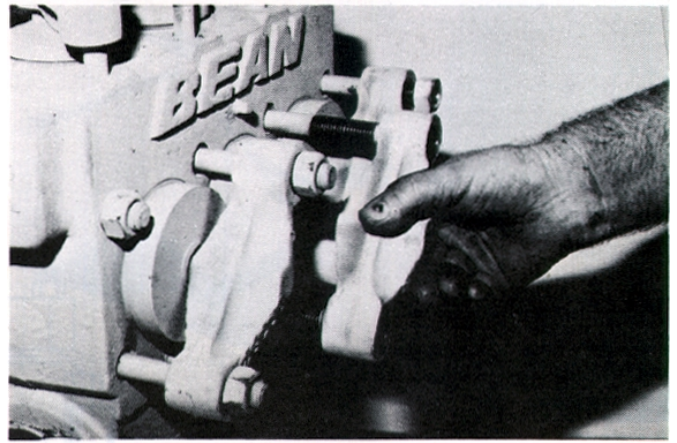
TIGHTENING SEQUENCE



- 1. relief valve
- 2. hex nuts
- 3. cover clamps
- 4. valve covers

Shutdown Procedures During Freezing Temperatures - Cont'd.

Steps	Procedures
5	Remove the six hex nuts and the three clamps from the cylinder chamber.
6	Slide the cylinder cover from the valve chamber.
7	Drain all trapped fluid from inside the valve chamber by lifting the suction valve with the end of a wooden nail or screw driver.
8	Coat the valve cover with a rust preventative agent.
9	Replace the valve cover clamps and hex head screws.
	Note: FMC recommends lubricating bolts before replacing nuts.
10	Torque the hex head nuts in the sequence shown on page D-4. Torque corner nuts to and cylinder cover nuts to 90 ft. lbs. (120 Newton meter).
11	Replace drain plugs in valve chamber.
12	If a drain plug is used under relief valve, remove plug.
13	Remove drain plugs in all low points of piping.
14	Leave all cutoffs open.



Torque sequence for cyl. covers & corner studs

TORQUE SPECIFICATION		
Connecting rods	65 ft. lbs.	89 Nm
Bearing covers	50 ft. lbs.	68 Nm
Cylinder cover	90 ft. lbs.	122 Nm
Valve covers	60 ft. lbs.	82 Nm
Packing nut asy	35 ft. lbs.	48 Nm
Rear cover	15 ft. lbs.	21 Nm

Section E Maintenance Procedures

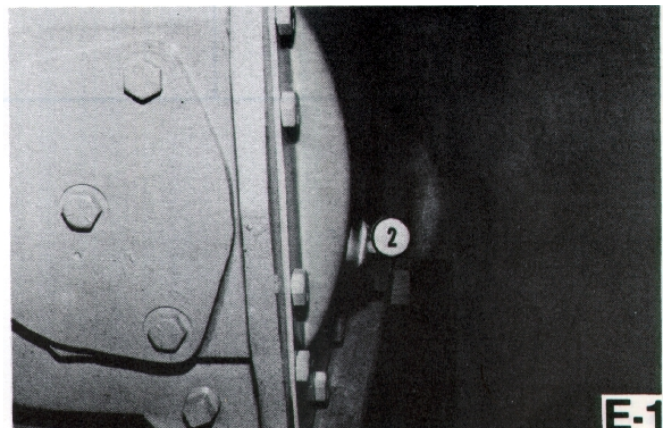
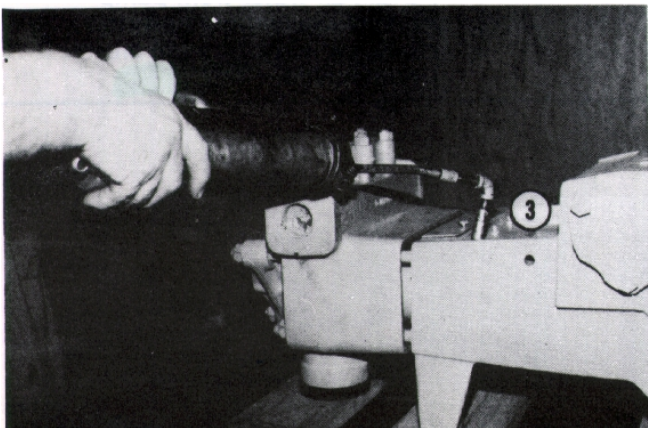
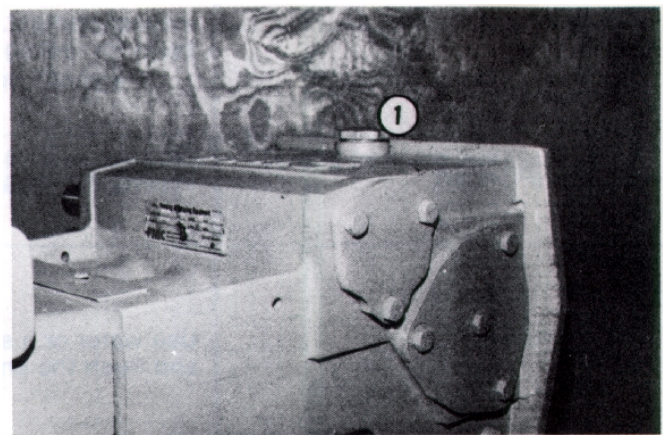
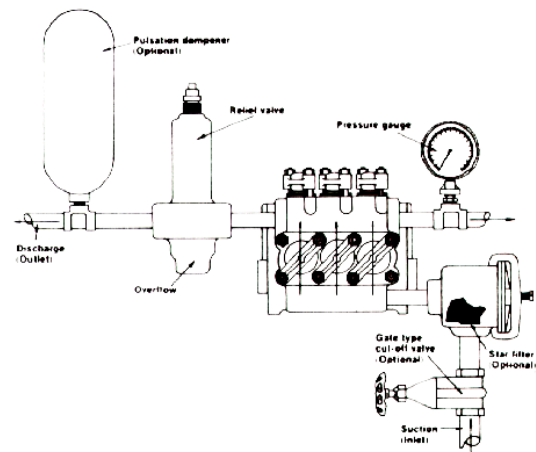
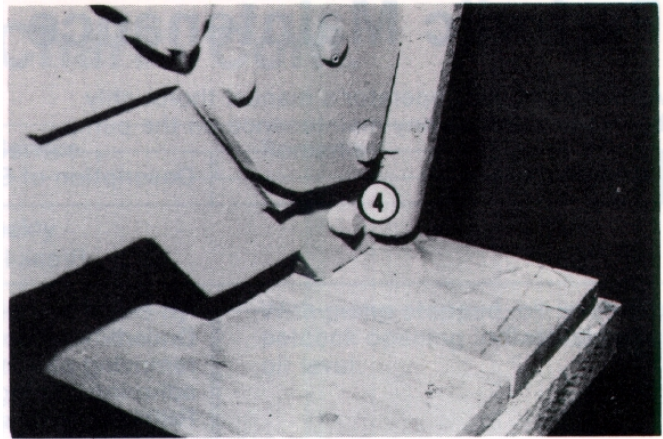
Lubrication

The Trido 140 pump require four quarts (3.7 liters) of grade SAE 30 non detergent lubricant in the crankcase. After the first fifty hours of operation, drain oil from the crankcase and remove any metal adhering to the magnetic drain plug. Thereafter, at the end of each 750 hours of operation, the oil must be drained and the drain plug (4) should be cleaned of any metal adhering to it. Should oil have a milky appearance, this indicates water is leaking past plunger rod seals in 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 (1). Add oil until level with the petcock (2) on the end of pump. Filling oil past this point will damage the seals. Another area of the pump requiring lubrication are the fittings on the plunger oil seal holders. These fittings should be greased once yearly (3).

CAUTION

Do not overgrease fittings to the plunger oil seal holders or damage could occur to oil seal and holders.

Filters should be installed in the suction line to prevent contaminated material from entering the pump and reducing its life and efficiency. During the initial breakin 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 screens should be checked, a regular inspection schedule should be developed from this information.



Periodic Maintenance Chart

Always read your owner's manual thoroughly before performing any service or maintenance procedures.

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

Break in Period

Crankcase	Drain oil from crankcase by removing plug. Clean any metal adhering to plug before placing. Refill pump case with new oil.	After the first 200 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. (Refer to E-1.)

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 shift of operation.
Plunger Rod Oil Seals	Inspect plunger rod oil seals for leakage .	Leaking at the rate of one or two drops per minute indicates the need for replacing the oil seals. (Refer to Servicing Oil Seals, page F-7.)
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. (Refer to page D-4.)

Periodic Maintenance Chart - Cont'd

Always read your owner's manual thoroughly before performing any service or maintenance procedures.

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

Weekly

Crankcase	Check oil level in crankcase by opening the petcock on the end of the pump.	With pump stopped, oil level with petcock opening indicates proper oil level. (Refer to E-1.)
NOTE Do not over-fill, oil will run out oil fill opening when too full.		

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

Every 2500 Hours (equals 3 month of continuous use)

Crankcase	Change oil and clean magnetic plug.	SAE 30 grade, (Refer to E-1).
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Pump System	Drain pump (Refer to page D-3, storing pump during freezing weather.)	During freezing temperatures.
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Section F

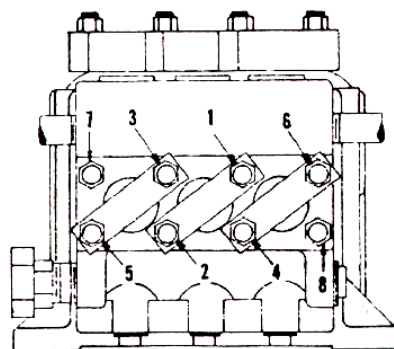
Service

In this section we will cover how to service the pump. The first portion will cover step-by-step procedures for servicing the different areas of the pump. Then at the end of this section you will find a quick reference troubleshooting chart.

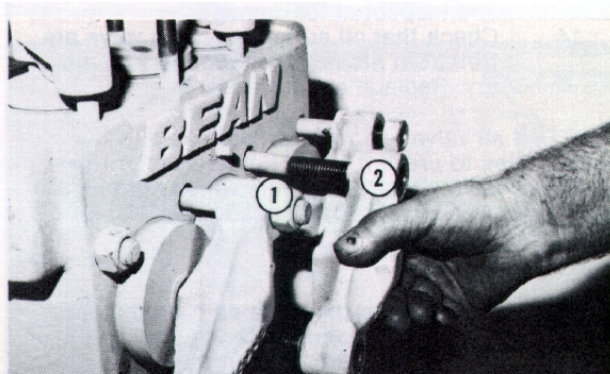
Servicing the Fluid End

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

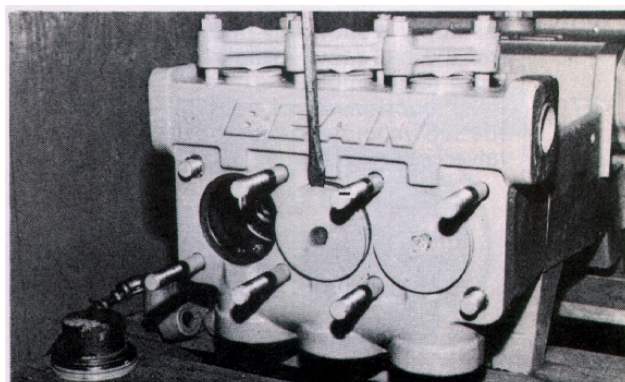
Steps	Procedures
	WARNING Always disconnect pump from power source before performing any service the pump. Failure to do this could cause electrical shock or injury from moving pump parts.
	1 Remove all plugs in discharge or suction inlets.
	2 Remove the six nuts on the studs. (1)
	3 Slide the three cover clamps off the studs. (2)
	4 Slide the three valve covers from the valve chamber.
	5 Place the valve seat remover tool (FMC) or a blunt rod against the suction valve seat and by using a hammer, drive the suction valve seats loose. (4)
	6 Remove the valve through valve cover opening.
	7 Remove all three suction valves in the same manner.
	8 Insert the blunt tool through the opening for the suction valves and position against the discharge valve seat.
	9 Using the hammer, drive the discharge valve out the chamber discharge opening.
	10 Repeat until all discharge valves are removed.



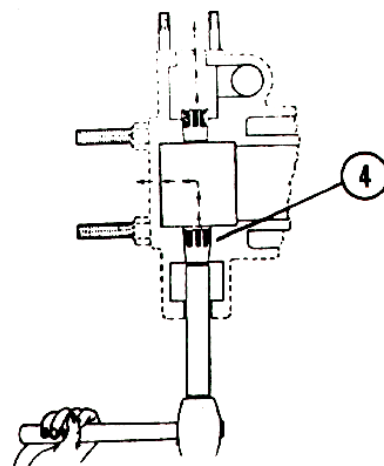
Torquing Sequence



Removing Cover Clamps

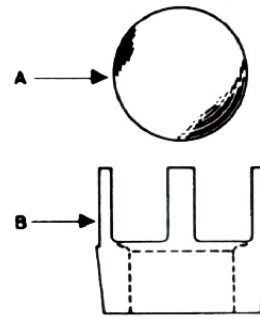


Removing Valve Covers

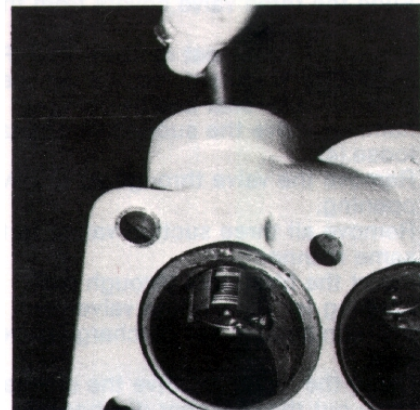
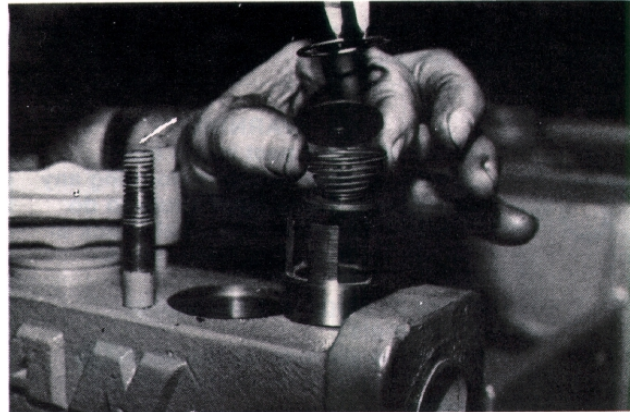


Removing Valves

Steps	Procedures
	NOTE: The complete valve assembly is available for easy and quick servicing of the pump, or individual valve assembly parts are available.
12	Complete valve assemblies can be replaced or just the individual damaged parts. To check the parts of the disc valve, remove the snap ring with a pair of snap ring pliers. This and step 13 are not necessary for ball valves.
13	Once the snap ring has been removed the valve parts may be easily removed and inspected for damage.
14	Check that all surfaces on the valve are free from nicks, burrs and dirt and are dry. Replace any necessary parts.
	NOTE: If all valves show wear, replace all valve assemblies to prevent down time during critical periods.
15	Reassemble the valve parts in the order shown in the illustrations and photo, making sure the disc on the disc and spring assembly is positioned level in the seat.
16	Check that the spring and disc assembly work freely in the disc valve, and the ball moves freely in ball valves, if not reassemble.
17	Insert suction valves squarely in the suction valve openings through the valve cover openings. (1)
	WARNING Incorrectly installed valves could result in severe damage to the pump and/or injury to personnel.
18	Use a dowel approximately the diameter of the valve and drive the valve firmly in the valve chamber.
19	Insert discharge valves through the discharge opening so the snap ring or ball is toward the outside of inlet openings. (2)
20	Drive the discharge valves firmly in place as in step 18.
21	Inspect the gaskets on the valve cover; if damaged replace. Carefully replace valve covers taking care not to damage gaskets. (3).



Ball Valve



F-2

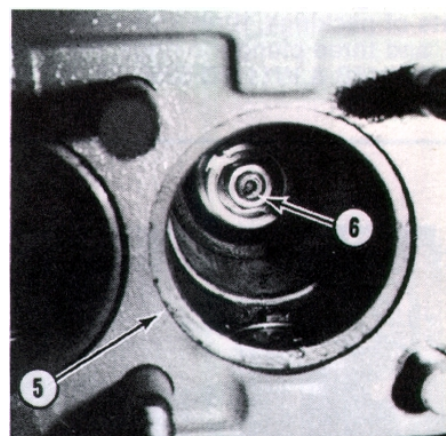
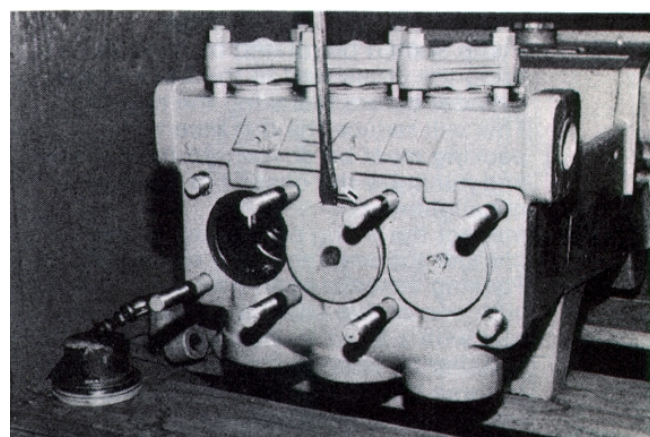
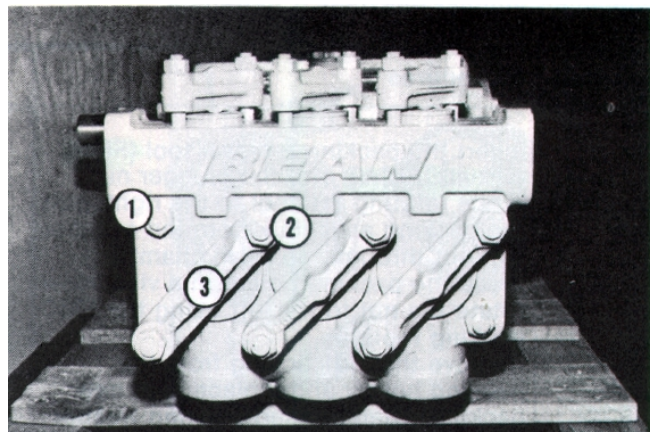
Servicing the Valves - Cont'd.

Steps	Procedures
22	Replace valve cover clamps
23	Replace six nuts and torque to 60 ft. lbs. (80 Nm)

Replacing 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. However, leakage of 15-20 drops per minute indicates worn or damaged packings. To change, follow the steps listed below:

Steps	Procedures
	WARNING Always disconnect the pump from the power source before performing any service to the pump. Failure to do so could result in electrical shock or injury from moving pump parts or drive parts.
	1 Check the corner nuts on the valve chamber to assure that they are at 90 ft. lbs. or 120 Newton meters. (1)
	2 Remove the six hex nuts (2) on the front of valve chamber.
	3 Slide the three cylinder cover clamps (3) from the valve chamber.
	4 Remove the three cylinder covers. It may be necessary to tap on the sides of the covers to free them from the chamber.
	5 Inspect gaskets (5) on the cylinder covers. If damaged, replace with new gaskets.
6	Insert a socket wrench into the valve chamber onto the hex nut (6) in the valve packing. Turn the wrench to the left and remove the nut.



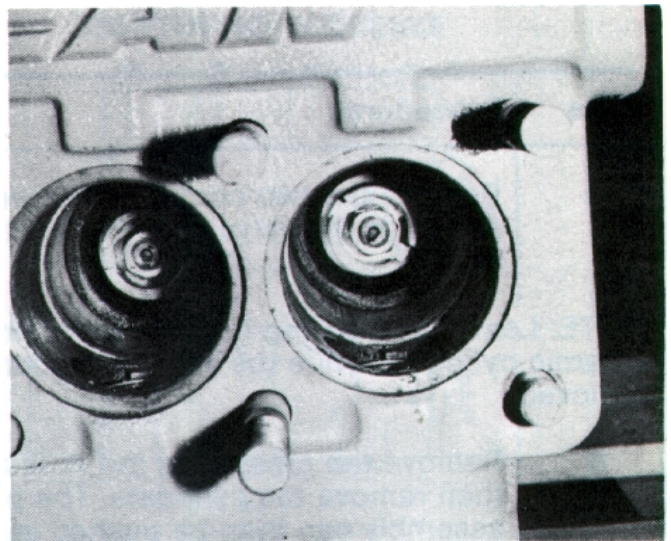
Replacing plunger packings - Cont'd.

Steps	Procedures
7	Insert the packing removal tool into the plunger nut. While rotating the tool to the right, pull the packing assembly from the cylinder and out through the valve chamber.
8	Place the packing holder in a vise. Now rotate the nut to the left using the FMC packing tool.
9	Remove the old packing from the packing holder and replace with new packing. Then reinsert packing washer and packing nut into packing holder and reassemble packing nut.
10	Pump should be rotated by hand to bring the crosshead to the front of the cylinder before installing the packing. This will reduce the distance the packing must be driven into the cylinder and minimize the chance of damage or misalignment.
11	Inspect the o-ring on the end of the plunger and replace if necessary.
12	Packing assembly can now be installed with one or two sharp raps against the tool with a 24 oz. or heavier hammer. If installation is not accomplished by two or three blows, lubrication is necessary.



Replacing plunger packings - Cont'd.

Steps	Procedures
13	Replace the nut in the packing nut with a socket hand wrench by turning to the right.
14	Replace the cylinder covers and cylinder cover clamps.
15	Place hex head nuts in the sequence shown and torque to 90 ft. lbs. or 120 Newton meters.

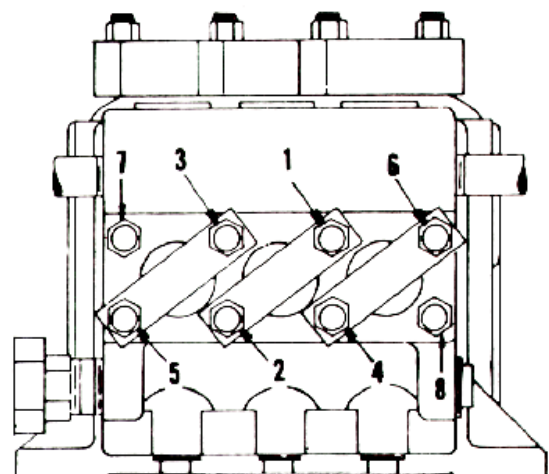


Servicing the cylinders

Excessive wear of packings may be due to buildup inside ceramic cylinders. Ceramic cylinders may be removed and cleaned. To clean cylinders, follow the steps listed below. It is virtually impossible to wear out a ceramic cylinder under normal service conditions, however, they are quite brittle like all ceramic materials and can be cracked or chipped if subject to mechanical impacts or severe thermal shock. Caution should be used when changing from hot to very cold fluids via fast acting solenoid valves. In the event the cylinder is cracked, broken, or needs cleaning, the cylinder can be easily changed or cleaned by following the steps listed:

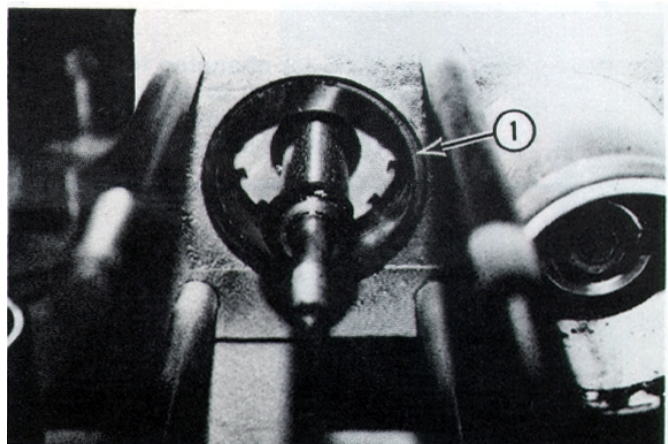
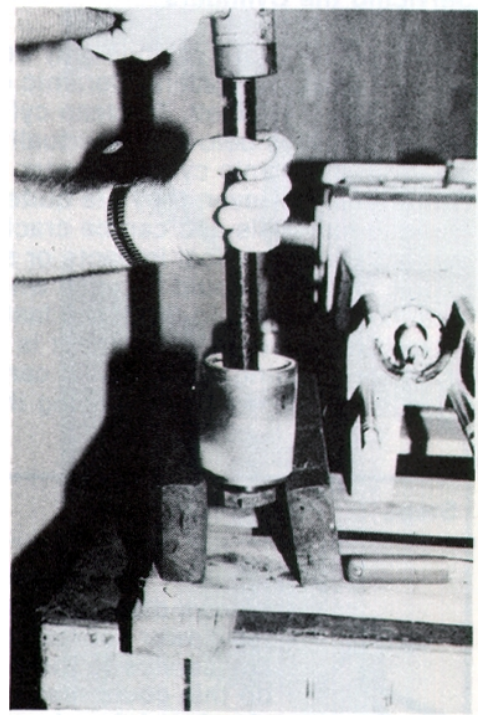
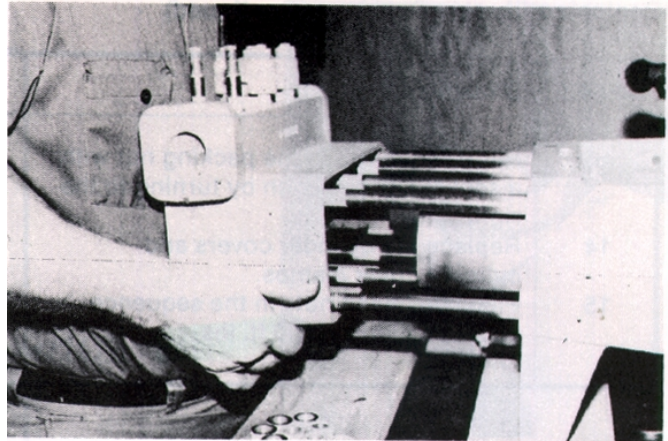
Steps	Procedures
	WARNING Always disconnect the pump from the power source before performing any service to the pump. Failure to do this could result in electrical shock or injury from moving pump or drive parts.
	1 Follow steps 1-5 for changing the plunger packings. (Refer to page F-3.)
	2 Disconnect the suction and discharge piping from the valve chamber.

TIGHTENING SEQUENCE



Servicing the cylinders - Cont'd.

Steps	Procedures
3	Remove the two corner holddown nuts and slide the valve chamber off the studs. NOTE: Leave the packing in place to retain the ceramic cylinders while the valve chamber is being removed.
4	Remove the crosshead rod nuts and remove the cylinders. The packing assembly can then be pushed out of the cylinder.
5	To clean build up from cylinders, submerge the cylinder in uncut muratic acid (28% hydrochloric acid) for 3 minutes. Then rinse in clear water and wash with a strong soap. Submerge the cylinder in the acid for two more minutes and rinse in clear water and wipe off. NOTE: Check oil seals at this point once cylinders are removed and if necessary, replace. To replace, follow procedures listed under changing oil seal. CAUTION When removing the valve chamber and removing the cylinders, be careful to avoid striking the cylinders against a sharp object as they will chip or crack.
6	Replace gaskets on each end of the cylinder. (1)
7	Follow steps 6-14 for replacing plunger packing. (Refer to page F-4 and F-5).
8	Install the valve chamber cover and tighten the two corner nuts to 1/2 the specified torque. (45 ft. lbs. or 60 Newton meters). CAUTION Take care when repositioning valve chamber and tightening nuts not to put cylinders in a bind or bump with a sharp object; damage could occur to ceramic cylinders.



Servicing the cylinders - Cont'd.

Servicing the Plunger Rod Oil Seals

Steps	Procedures
9	Replace the cylinder covers, cylinder clamps, and clamp nuts and tighten nuts until they are tight. Then tighten nuts to 1/2 of the full torque in the sequence indicated in the illustration (45 ft. lbs. or 60 Newton meters). Then repeat tightening sequence bringing to full torque (90 ft. lbs. or 120 Newton meters). This should include the two corner nuts.
10	After one to two hours of pump operation, check torque on the clamp nuts and if necessary, tighten again.

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 fluid end must be disassembled. To change the seals, follow the steps below.

Steps	Procedures
	WARNING Always disconnect the pump from the power source before performing any service to pump. Failure to do this could result in electrical shock or injury from moving pump parts or drive parts.
	1 Break down the fluid end of the pump following the steps listed under servicing the cylinders.
	2 Once valve chamber and cylinder packings have been removed, remove the cover at the pump separation chamber by removing the two screws.

Tightening Sequence

TIGHTENING SEQUENCE

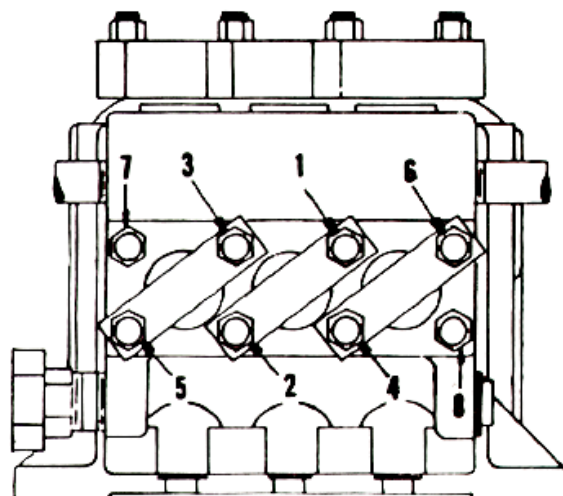
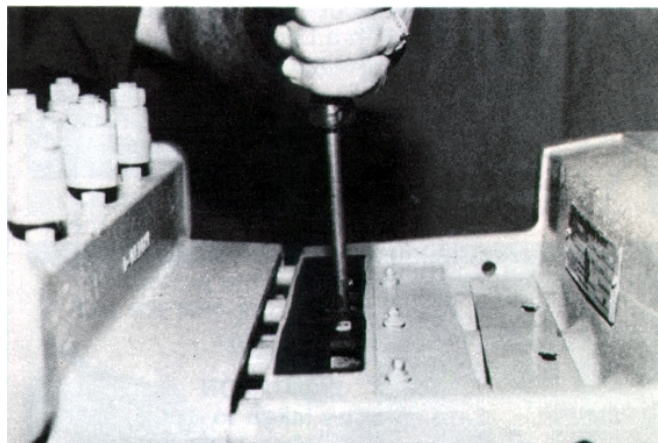
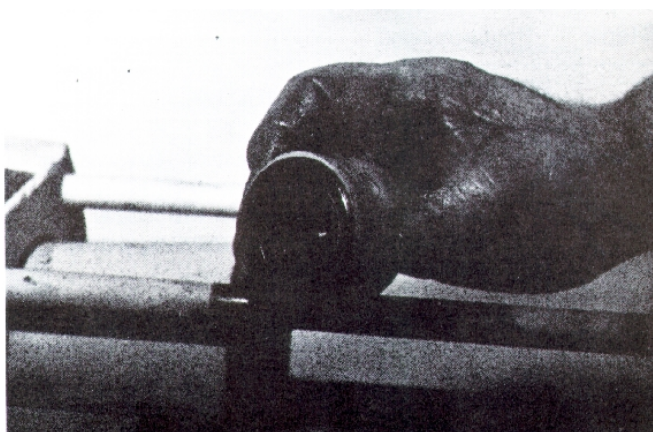
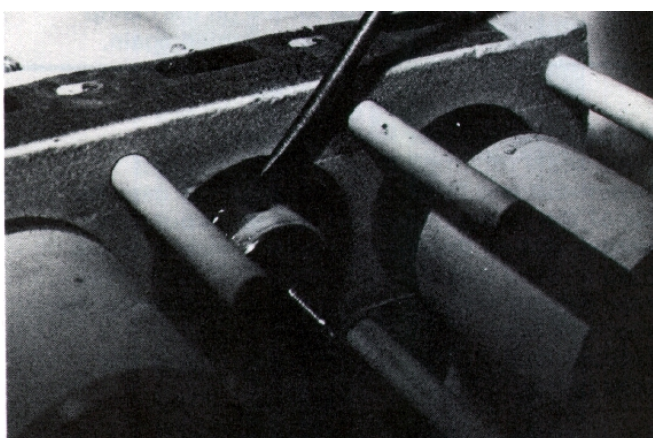
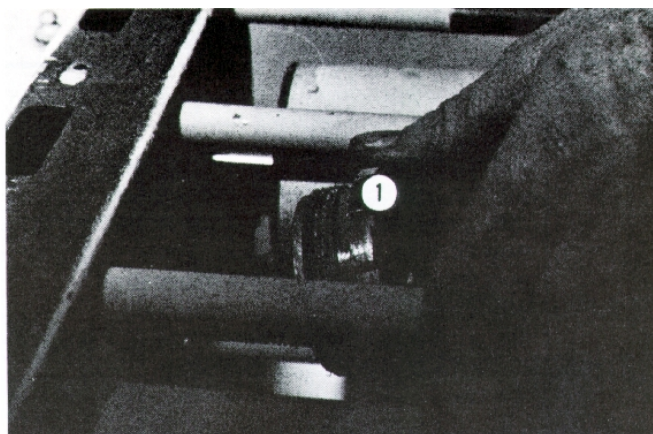


Fig. 6



Servicing the plunger rod oil seals - Cont'd.

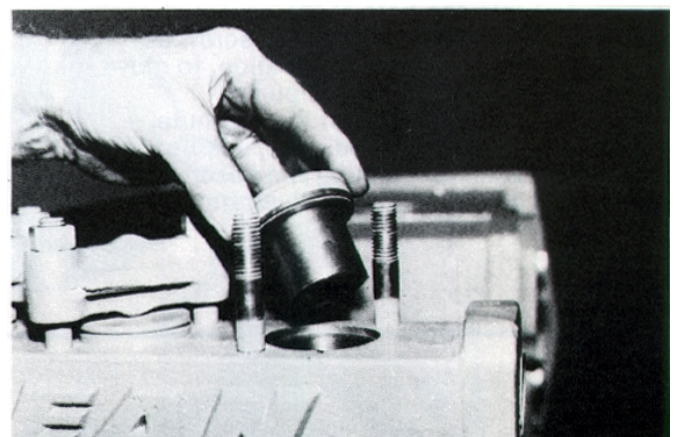
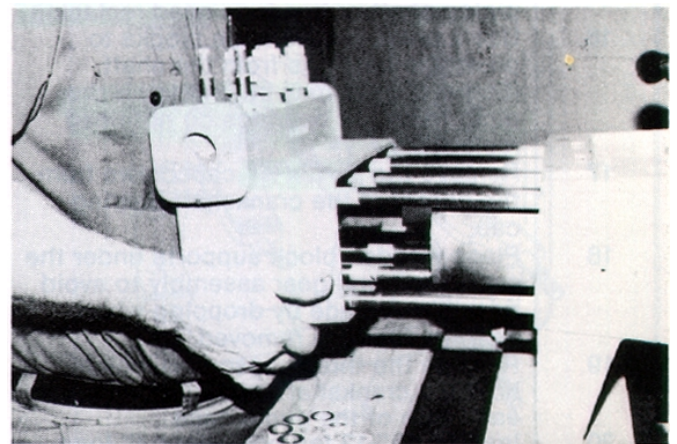
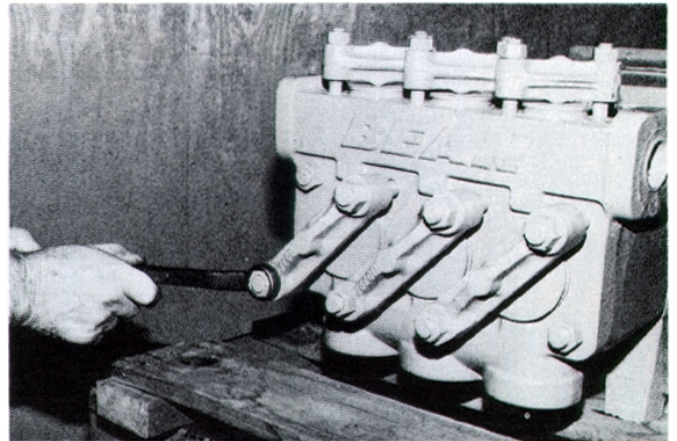
Steps	Procedures
3	Insert a large screwdriver into the opening under the separation cover. Using the screwdriver, rotate the oil seal nut to the left until it is unthreaded from the pump case. (1)
4	Remove the oil seal sleeve and oil seals from each plunger rod opening. Slide the sleeve and oil seals from the plunger rod using simple hook-shaped tool. NOTE: It is never advisable to reuse oil seals which have been removed from the pump.
5	Next replace the outer seal so that the lip on the seal faces the valve chamber. Position seal into sleeve until it bottoms out. Replace inner seal so the lip faces the drive end of the pump.
6	Pack the area between the seals inside the sleeve with a Dow corning valve seal "A" before installing them in the pump.
7	Position piece of thin walled tubing, ground to a thin edge, or thin shim stock or piece of heavy paper rolled in a tube inside the seal. This will protect the lips on the seal while passing them over the plunger rods. Now slide the sleeve and seals with the protection piece of tubing or paper over the rod and into the case. CAUTION Care must be taken to avoid folding the lip under when the seals are passed over the end of the plunger rods. Failure to do this could damage seals resulting in leakage around seals.
8	Once sleeve and oil seals are in place on plunger, replace oil seal nut and tighten.
9	Replace the fluid end parts by repeating steps found in Servicing the cylinders, page F-5.



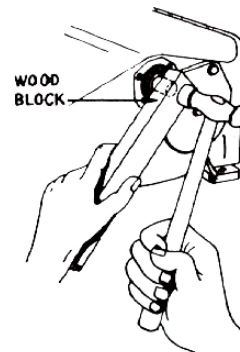
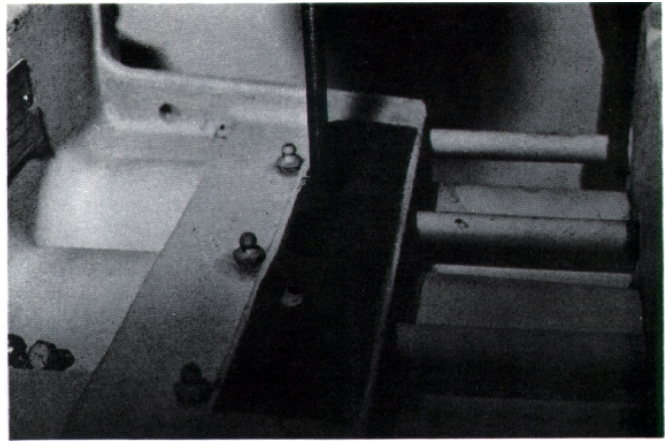
Servicing the Drive End

Servicing the eccentric shaft 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 knocking noise or excessive pump cast temperature.

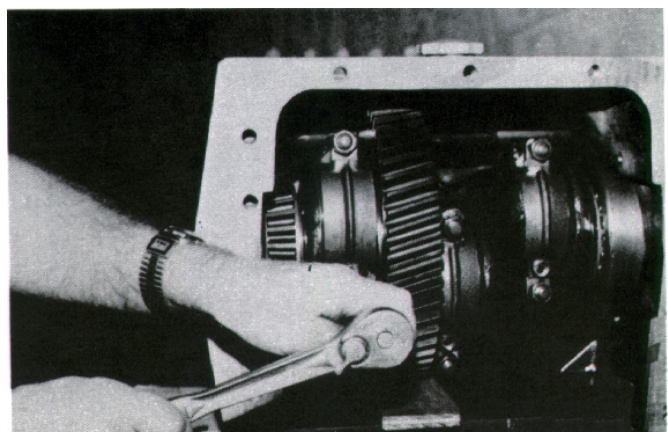
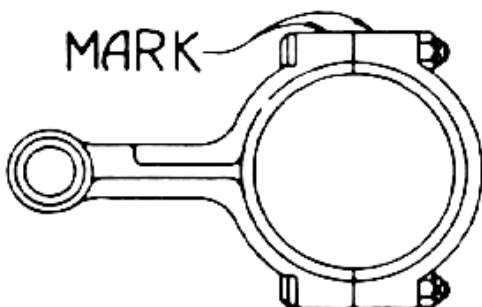
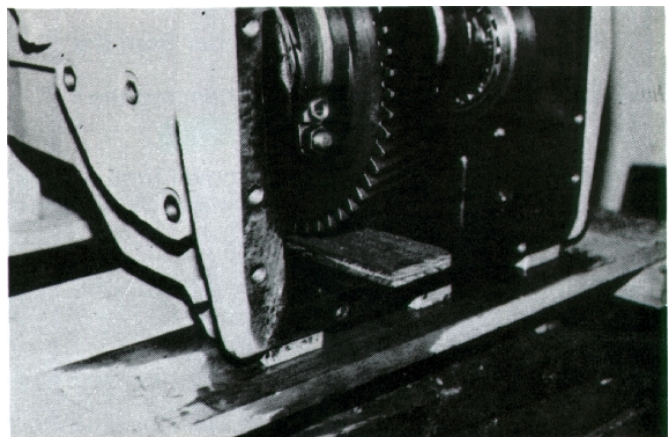
Steps	Procedures
	WARNING Always disconnect pump from power source before performing any service to the pump. Failure to do this could result in electrical shock or injury from moving pump parts or drive end parts.
	1 Disconnect piping to valve chamber.
	2 Remove the pump from its mounting and place on a bench or other convenient place for servicing the power end.
	3 Place container under the drain plug in the drive end and remove the drain plugs and drain all oil from the drive end. Also position a couple of 2x4's under the drive end of the pump.
	4 Remove the 8 nuts on the studs.
	5 Slide the 3 cover clamps off the studs. Slide the 3 valve covers from the valve chamber.
	6 Remove the valve chamber from the pump.
	7 Follow steps 6-20 for changing the valves. (Refer to page F-1).
	NOTE: To prevent unnecessary down time, valves, packing, and other wear areas should be changed while breaking down the pump.
8	The packing must now be removed. Follow steps 5-9 (page F-3, F-4) for changing packing.



Steps	Procedures
10	Pull the cylinders.
11	Loosen the oil seal nut.
12	Remove the oil seal sleeve and oil seal. (Refer to page F-7.)
13	Remove the capscrews, washers, cover and gasket from the power end of the pump.
14	Remove the three 1/2" - 13 x 1/4" cap screws, pinion bearing covers and gaskets at each side of the pump case.
15	Use a wood block and hammer to drive the pinion shaft from the pump case if pinion shaft or bearings need replacing.
16	Use a press and suitable blocks to press the bearings from the shaft. (Steps 15 & 16 may be omitted if the pinion shaft or bearings do not need replacing.)
17	Remove the 1/2" - 13 x 3/4" capcsrews from the center of the crankshaft bearing cap.
18	Place wooden block supports under the crankshaft and gear assembly to avoid possible damage by dropping when bearing cups are removed.
19	Remove the three capscrews which hold the crankshaft bearing housing at each side of the pump case.
20	Insert a 1/2" -13 tap bolt about 4" long into the hole at the center of each housing and turn the screw as suggested in illustration, to move the housing from the pump.
21	Remove the self locking nuts, connecting rod caps, and bearing from each connecting rod assembly and mark as suggested in illustration.

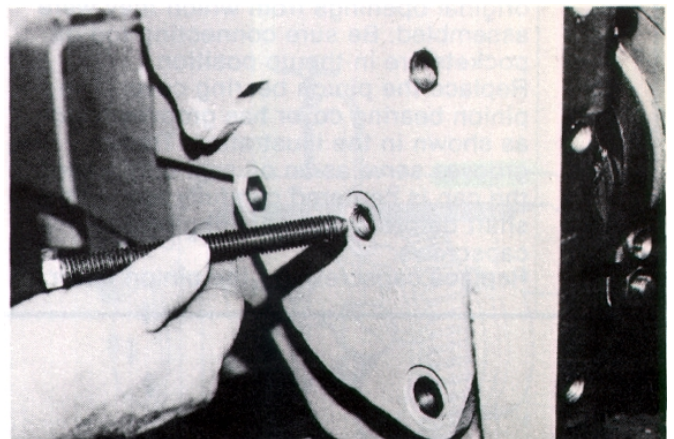
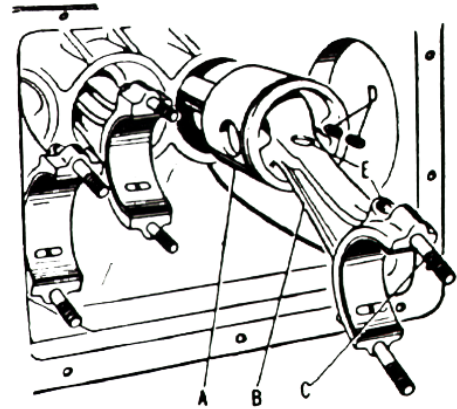
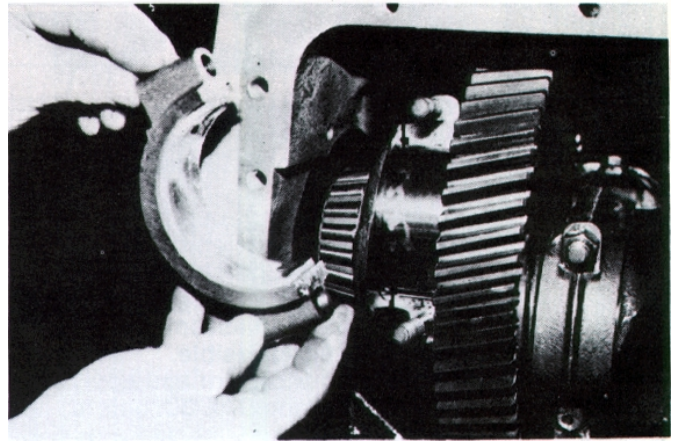


Pinion Shaft



Servicing the Drive End - Cont'd.

Steps	Procedures
	CAUTION Be sure to match and mark each cap and connecting rod for matching when reassembling the pump. Failure to do so could cause damage to connecting rods.
22	Work crankshaft through bearing opening in the case.
23	Pull connecting rods and crosshead assemblies (A&B) from case taking care to place parts so they will be reassembled in the same bore from which they were removed.
24	Remove the two set (D) screws used to lock each crosshead pin in the crosshead assembly and remove crosshead pin.
25	Press bushings out and replace with new bushings if necessary. Bring the bushings in position to 1.2505 inches plus .001 to .000.
26	Using automotive type puller to remove the bearing cones from the crankshaft.
27	Inspect the eccentric shaft bearings for (a) cleanliness (b) rust spots when rotated (c) visible wear or damage (d) slack between the inner and outer races of the bearing.
	NOTE: All damaged bearings or 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.



Steps	Procedures
28	Inspect the eccentric shaft for damage. Excessive scoring or pitting on the eccentric shaft indicates a need for replacement.
29	Inspect the connecting rods for damage. Excessive scoring or pitting on the connecting rods indicates a need for replacement.
30	Inspect the crosshead assemblies and replace if any wear is visible.
31	Clean all parts in a solvent and apply thin coat of oil (grade SAE 30) before installing.
32	Thoroughly clean casing cap in solvent and blow dry.
33	Press new bearings in place.
	CAUTION Use extreme care when installing bearings. They can be easily damaged, shortening their life and efficiency.
34	Reassemble the crosshead assemblies and connecting rods. Be sure to return both set screws to each hold to lock the pins in place with the inner screw seated in the indentation on the outer face of the pin.
35	Replace connecting rods in their original openings from which they were assembled. Be sure connecting rod oil pockets are in the up position.
36	Replace the pinion bearing cover. The pinion bearing cover has screws inside as shown in the illustration. These grooves serves as an oil seal only when the cap is centered carefully around the shaft before final tightening of the capscrews.
37	Replace capscrews in the pinion cover.

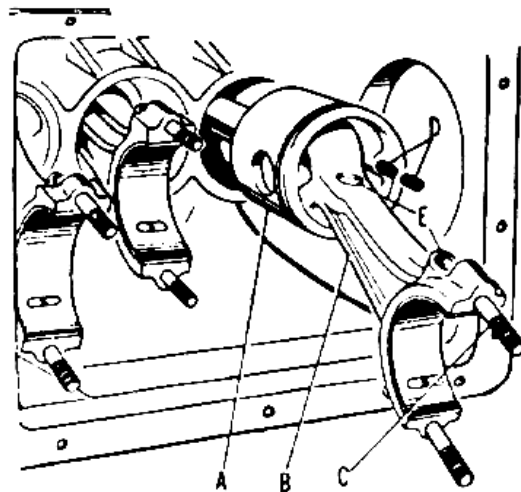


Fig. 12

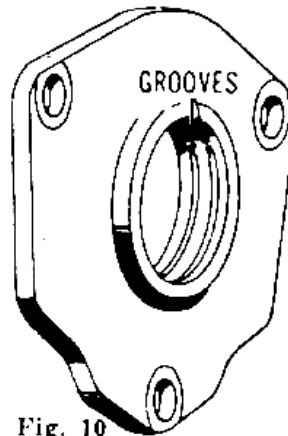
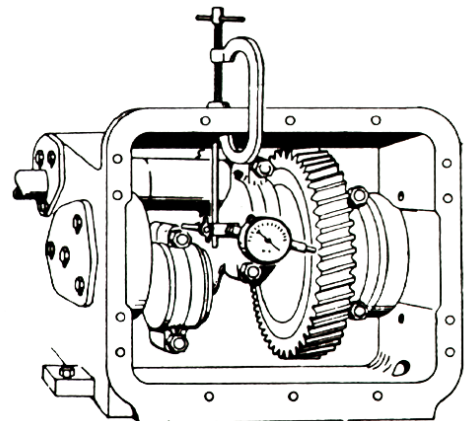
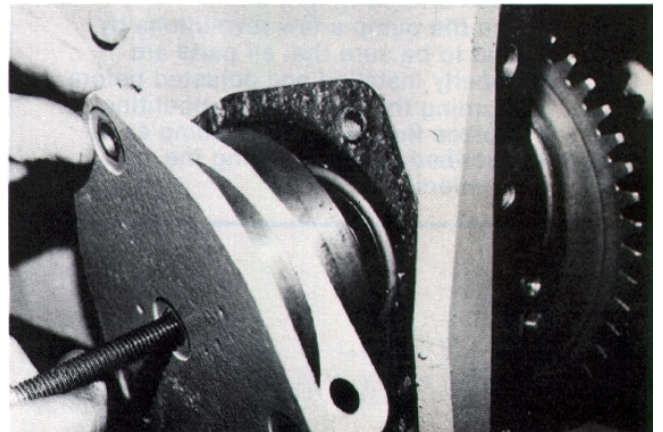
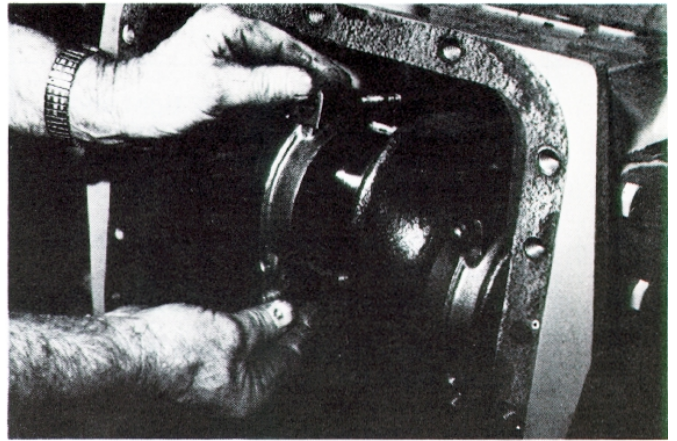


Fig. 10

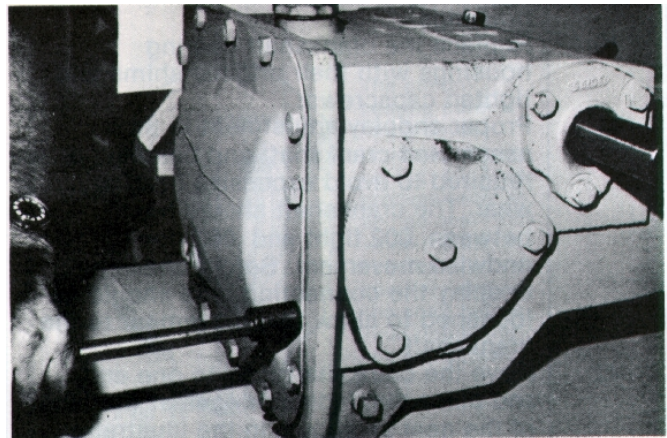
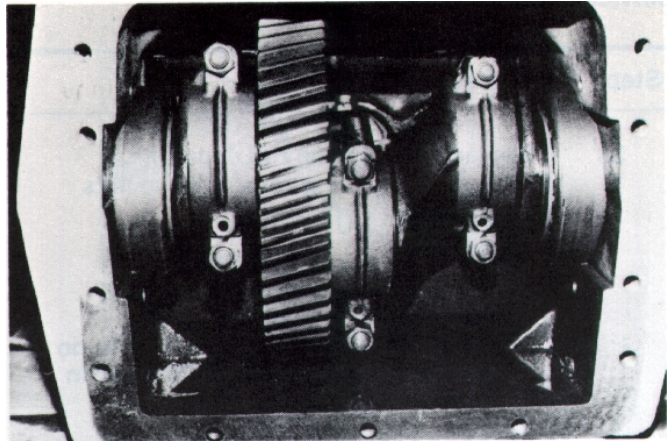
The pinion bearing cover has grooves, inside as shown on Fig 10. These grooves serve as an "oil seal" only when the cap is "centered" carefully around the shaft before final tightening of the cap screws

Servicing the Drive End - Cont'd.

Steps	Procedures
38	Replace connecting rod caps with original connecting rods. Torque nuts to 65 ft. lbs. or 90 Newton meters. CAUTION Be sure to match each cap and connecting rod as they were originally assembled. Failure to do so could cause premature wear in connecting rods or shaft.
39	Replace gaskets on crankshaft bearing housings.
40	Replace the crankshaft bearing housings with their original shims and tighten cap screws.
41	Proper end play adjustment in the assembled crankshaft and bearings is required to avoid excessive bearing wear. The crankshaft should have between .002 tight and .003 free endwise movement. Before checking inplay the connecting rods should be loosened to allow free movement to the crankshaft.
42	Move the crankshaft fully to one end and place dial indicator against the face of the gear as shown in the illustration.
43	Set the dial indicator at zero and move the crankshaft indicating its total endwise movement .
	NOTE: The force- required to move the crankshaft should be only enough to insure total endwise movement but not enough to spring the side of the pump case.



Steps	Procedures
44	If inplay is not between .002 tight and .003 free, remove crankshaft bearing housings and adjust shim. Shim should be equally distributed between the two ends of the shaft .
45	Replace the magnetic drain plugs in the side of the pump case.
46	Torque connecting rod nuts to 65 ft. lbs. or to 90 Newton meters.
47	Replace the capscrews, cover and gaskets from the power end of the pump.
48	Refill the case with 4 qts. / 3,7 liters of clean high grade SAE 30 weight oil.
49	Turn the pump a few revolutions by hand to be sure that all parts are properly installed and adjusted before returning the pump to its mounting.
50	Replace fluid end of the pump as described under Servicing the Cylinders.



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 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 entitled Test and Result will be your aid for determining the Cause and Remedy.

Troubleshooting Chart

Symptom

Discharge Pressure too Low

Test / Result	Cause / Remedy
Connect a hose to the overflow port in the relief valve and start the pump. 1. Close all guns and/or nozzles and check overflow. RESULT: No overflow, see item 1, then recheck pressure. RESULT: Flow through overflow hose, see item 2, then recheck pressure. 2. Open all of the discharge guns or nozzles. RESULT: No flow in the overflow hose, see item 3 and 4, recheck pressure. RESULT: Flow through the overflow hose, see items 5 and 6, or 7, recheck pressure.	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 nuts on top of the valve by turning clockwise. (Refer to page D-1) WARNING Do not exceed the rated pressure of the pump. 3. Incorrect nozzle size. Worn nozzles or nozzels with capacity in excess of the pump capacity, will reduce the discharge pressure - replace where required. Refer to nozzle manufacturer's literature. 4. Pump speed to slow. 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 part as required 6. Worn packing cup in the relief valve. Replace the packing if water is leaking through the openings in the relief valve. 7. Foreign material lodged in the relief valve. Relieve the spring tension and flush the interior or the valve to remove foreign material.
F-16	

Symptom

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

Test / Result	Cause / Remedy
1. Calculate displacement gallonage of the pump as follows: - Measure crankshaft speed with a tachometer - Multiply speed x gal./rev. (Factors are figured assuming 100 % volumetric efficiency.) Gal./Rev. =.589. 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: - Measure the actual gallonage from the pump. Close all guns and discharge valves 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. - Divide the actual GPM found in step a. by the displacement GPM found earlier then multiply by 100 to get the volumetric efficiency. Vol. Eff. I = $\frac{\text{Actual GPM} \times 100}{\text{Displ. GPM}}$ Normal volumetric efficiency - 85-90 % 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.	1. Pump speed to slow Change the sheave combination to obtain desired speed. (Refer to Selecting Operating Speed. page D-1 and Installation Procedures , page C-1) WARNING Do not exceed maximum rated speed. 2. Leakage from the pump plunger packings. Leakage exceeding 60 drops per minute indicates that the packing should be replaced, (Refer to page F-3). 3. Suction or discharge valve seats worn, pitted or broken. Inspect and replace where nesesarry, (Refer to page F-1). 4. Restriction in the suction line. Check for clogged strainers, closed valves, empty suction tank.

Symptom

Noise coming from bearings and crankcases area

Test / Result	Cause / Remedy
See item 1.	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	Cause / Remedy
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 has 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 val.~ 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 3, 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 packing and inspect the valve assemblies. 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. 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. 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. 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 F-3.)