TECHNICAL MANUAL

UNIT, INTERMEDIATE DIRECT SUPPORT AND

INTERMEDIATE GENERAL SUPPORT MAINTENANCE MANUAL

DRILLING SYSTEM, WELL, ROTARY,
TRUCK MOUNTED, AIR TRANSPORTABLE,
600 FEET CAPACITY
MODEL LP-12
NSN 3820-01-246-4276

This technical manual is an authentication of the manufacturer's commercial literature and does not conform with the format and content requirements normally associated with Army technical manuals. This technical manual does, however, contain all essential information required to operate and maintain the equipment.

Approved for public release; distribution is unlimited.

HEADQUARTERS, DEPARTMENT OF THE ARMY
8 MAY 1989

CHANGE

NO. 3

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 30 June 1993

Unit, Intermediate Direct Support and Intermediate
General Support Maintenance Manual

DRILLING SYSTEM, WELL, ROTARY
TRUCK MOUNTED, AIR TRANSPORTABLE,
600 FEET CAPACITY
MODEL LP-165F299
NSN 3820-01-246-4276

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UNIT, INTERMEDIATE DIRECT SUPPORT AND
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No. 1

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INTERMEDIATE GENERAL SUPPORT MAINTENANCE MANUAL

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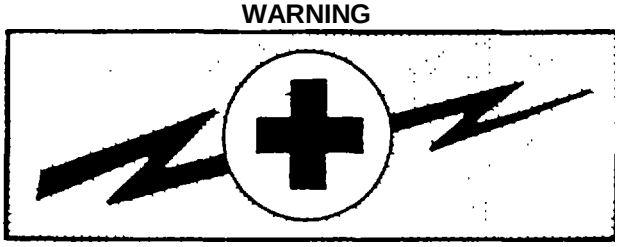
WARNING



MI 131637

ELECTRIC POWER LINES CAN KILL

Never raise mast or crane, or operate drill unit with less than 25 feet working clearance to any electrical power line.

Do not touch live electrical parts.

Check for buried utility lines before drilling.

WARNING

Crane and drilling operations have inherent hazards that cannot be mechanically safe guarded. Operator and maintenance personnel are required to wear hard hats and safety shoes.

Compressed air used for cleaning can create airborne particles that may enter the eyes. Pressure will not exceed 30 psig. Eye protection required.

Never operate engine in enclosed areas. Exhaust gases, particularly carbon monoxide, may build up. These gases are harmful and potentially lethal.

Cleaning solvent (PD-680, Type II) is toxic to skin, eyes and respiratory tract. Skin and eye protection required. Avoid repeated or prolonged contact. Good general ventilation is normally adequate.

Welding operations produce heat, highly toxic fumes, injurious radiation, metal slag and airborne particles. Protection equipment consisting of welding goggles with proper tinted lenses, apron or jacket, and welder's boots required. Good general ventilation is normally adequate.

Exercise care when using sharp or pointed tools to prevent injury to personnel.

Personnel will be trained in safe climbing practices. Climbing devices will be used on mast at all times. Safety climbing devices will be inspected prior to each use to insure good working order.

For Artificial Respiration, refer to FM 21-11.

WARNING

NOISE HAZARD

exist for all personnel within 15 Feet of an operating drilling unit. Personnel must wear approved ear protection equipment. Failure to do so may result in impairment or loss of hearing.

b

INTRODUCTION

1. SCOPE

This manual covers the 600 Feet Capacity Well Drilling System, Model LP-12, NSN 3820-01-246-4276. This manual consists of six volumes.

2. DRILLING SYSTEM

The Drilling System consists of three main components; a well drilling machine; a support vehicle (rig tender); and a well completion kit. Government furnished (GFE) incorporated as part of the system include a trailer mounted power unit and 3,000 gallon, collapsible, fabric water tank.

3. DRILLING MACHINE VOLUME 1

The drilling machine is a truck mounted rotary well drilling machine consisting of a 32 foot mast, three drum drawworks assembly, rotary table, mud pump and air compressor. The components of the drilling machine are powered by the truck engine.

4. SUPPORT VEHICLE VOLUME 2

The support vehicle is a truck mounted vehicle consisting of a 1,000 gallon water tank, hydraulically driven water pump, an electric fuel pump and fuel dispensing nozzle, a welder-generator assembly, and an electro-hydraulic crane. The support vehicle also provides a storage area for transport of drill pipe, collars, hand tools, operating and accessory equipment for the drilling machine, and the well completion equipment.

5. TRUCKS VOLUMES 3, 4 and 5

The drilling machine and support vehicle are mounted on truck chassis of the same model. The drilling machine truck has a special design low profile cab. The truck is a diesel engine powered, 6x6 vehicle with a transfer case to transfer engine power to truck mounted components.

6. WELL COMPLETION -VOLUME 6

The well completion kit consists of equipment necessary for completion of a 600-ft. water well.

7. OPERATION INSTRUCTIONS

Refer to TM5-3820-256-10 for Operation, Preventive Maintenance and Lubrication of the Well Drilling System.

8. REPAIR PARTS

For repair parts refer to TM5-3820-256-24P, Repair Parts and Special Tools List.

9. APPENDIXES VOLUME 6

Maintenance Allocation Chart is contained in Appendix A; Torque Requirements are contained in Appendix B.

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CHAPTER 1

GENERAL INFORMATION

1-1 DESCRIPTION.

1-1.1 Drilling System. The well drilling system consists of three main components; a drilling machine; a support vehicle; and a well completion equipment kit. The system is designed to be transportable by highway, rail, marine and air modes. Government furnished equipment (GFE) incorporated as part of the system include a trailer mounted power unit and 3,000 gallon, collapsible, fabric water tank.

1-1.2 Drilling Machine. The drilling machine is a truck mounted rotary well drilling machine consisting of a 32 ft. mast, three-drum drawworks assembly, rotary table, mud pump and air compressor. The components of the drilling machine are powered by the truck engine. Operation and maintenance instructions for the drilling machine are contained in this manual volume.

1-1.3 Support Vehicle. The support vehicle is a truck mounted vehicle consisting of a 1,000 gallon water tank, hydraulically driven water pump, an electric fuel pump and fuel dispensing nozzle, a welder-generator assembly, and an electro-hydraulic crane. The support vehicle also provides a storage area for transport of drill pipe, collars, hand tools, operating and accessory equipment for the drilling machine, and the well completion equipment. Operation and maintenance instructions are contained in Volume 2 of this manual.

1-1.4 Well Completion Equipment. The well completion kit consists of equipment necessary for completion operations of a 600-ft. well. Instructions for use of well completion equipment are contained in Volume 6 of this manual.

1-1.5 Trucks. The drilling machine and support vehicle are mounted on truck chassis of the same model. Truck operator instructions are contained in Volume 3 of this manual. Service and maintenance instructions are contained in Volumes 4 and 5 of this manual.

1-2 CAPABILITIES.

1-2.1 Drilling System Capabilities.

a. Air transportable.

b. Equipped for rotary drilling with mud or air and air percussion drilling.

c. Equipped to drill wells up to 600 ft.

d. Adaptable for drilling to depth of 1500 ft.

e. Truck mounted for mobility.

f. Three mode water transfer pumping system.

1-3 REPAIR PARTS.

1-3.1 Repair Parts. For repair parts refer to TM5-3820-256-24P, Repair Parts and Special

Tools List (RPSTL) for Drilling System, Well, Rotary, Truck Mounted, Air Transportable, 600 Feet Capacity.

1-4 TAULATED DATA.

1-4.1 Table 1-1 contains specification data for the drilling machine.

Table 1-1. Tabulated Data

Manufacturer.....George E. Failing Co.
Model.....LP-12

Overall Dimensions:
- Length ..... 35' - 0"
- Width..... 8’ 0"
- Height (mast lowered) .....8' 0"
- Height (mast raised) .....38' 0"
- Shipping Weight .....38,000 lb

Capacities:
- Fuel Tanks .....200 Gallons
- Hydraulic Reservoir .....79 Gallons
- Water Injection Tank .....25 Gallons

Main Components:
- Truck Chassis
  - Make .....International Harvester
  - Model .....F-1954 6X6 Modified

Engine
- Make .....International Harvester
- Model DT-466
- Fuel .....Diesel
- Horsepower. 210
- Displacement ..... 466.1 Cu. In.

Power Take-Off (Subdrive)
- Make ..... Borg Warner/Rockford
- Model P-4 1079
- Maximum Speed .....3000 RPM
- Clutch .....Type HE

Air Compressor
- Make .....GHH
- Model ..... CF 128 G
- Operating Pressure 217PSIG
- Max. Operating Pressure 217PSIG
- Operating Volume.....352.4 ACFM
- Max. Operating Volume .....625 ACFM

Mud Pump

Make	George E. Failing
Model	FM-45
Length of Stroke	6.25 in.
Displacement	104 - 208 GPM
Horsepower at Max. Pressure	23 - 46 HP
R.P.M. (Crankshaft)	50 - 100 RPM
(Jackshaft)	236 - 473 RPM
Maximum Pressure	310 PSI

Foam/Water Injection Pump

Make	Cat Pumps
Model	1015
Volume	12 GPM
Discharge Pressure	700 PSI
Max. Inlet Pressure	-8.5 PSI 59 +40 PSI
RPM	900 RPM

Force Feed Lubricator

Make	Manzel
Model	76
Tank Capacity	12 pints
Piston Size	3/8 inch
Maximum Pressure	2,500 psi
Drops Per Stroke	27 (max.); 4 (min.)
Cubic In. Per Stroke	.055 (max.); .008 (min.)
Strokes Per Minute	50 (max.); 3 (min.)
Drive Ratio	50:1

Rotary Table Transmission

Make	Funk
Model	HMD-12700B
Gear Ratios:	
1	6.27:1
2	3.12:1
3	1.75:1
4	1.00:1

Rotary Table Hydrostatic Motor

Make	Sunstrand
Model	23
Displacement	5.43 in^3/REV.
Working Pressure (Max.)	5,000 psi
Max. Speed @ Max. Disp	2,900 RPM

Chapter 2

All information in chapter 2 is contained in TM 5-3810-256-10.

2-1/(2-2 blank)

CHAPTER 3

SERVICE AND LUBRICATION

3-1 PERIODIC SERVICE

3-1.1 Table 3-1 contains operator services to be performed at the intervals indicated.
B = Before; D = During; A = After; W = Weekly; M = Monthly

Table 3-1. Periodic Services

ITEM NO.	INTERVAL B	D	A	W	M	Item to be Inspected	Procedures Check for and have repaired or adjusted as necessary.	Equipment is not ready/ available if:
1	x	x				Mast Lighting	For night operations, check lights illumination.	
						Discharge Piping		
2	x			x		Hoses	Check flexible hoses for wear or damage.	Wire braid reinforcement is exposed.
3		x				Pipes/Connections	Check for leaks.	Unrepairable leaks cause significant pressure loss.
						Mast		
4	x			x		Mast Weldment	Check for damage and for cracked or rusted welds.	Mast is not structurally sound.
5	x					Crown Block Assy	Check sheaves for wear.	
6	x					Sprocket Assy	Check sprocket for worn or broken teeth.	One or more teeth are missing.
7	x					Pulldown Assy	Check chain for wear and damaged or missing cotter pins.	Connecting links are loose.
8	x					Mast Raising Cylinder	Check that hardware is secure and pivots are adequately lubricated.	Hardware is loose or missing.
						Mud Pump Drive		
9				x		Drive Case	Check oil level.	
10	x			x		Mud Pump	Check for oil contamination Check oil level.	Oil contains grit or water.
						Air Compressor and Drive		
11		x				Shaft Seal	Check for air leaks.	
12		x				Oil Cooler	Check cooler fins for damage, connections for leaks.	
13	x	x	x			Oil Filter	Check filter gage.	Gage indicates in red area.
14		x				Cooler Motor	Check for leaks.	

ITEM NO.	INTERVAL B	D	A	W	M	Item to be Inspected	Procedures Check for and have repaired or adjusted as necessary.	Equipment is not ready/ available if:
15	x					Air Filter	Check for tight connections that ejection. valve is not damaged or missing.	Check
16	x					Air/Oil Separator	Check oil level at sight glass.	
17				x		SubDrive	Check oil level.	
18	x					Driveshafts	Check for worn bearings.	
19		x				Hydraulic Pumps	Check for leaks at connections and seals.	
						Drawworks		
20	x					Driveshaft	Check for worn bearings.	
21				x		Bevel Gear Box	Check oil level.	
22	x					Drum Brakes	Check brake band lining for wear.	
23	x					Third Drum Clutch Control	Check linkage connections for security.	
24	x					Drum Assemblies	Check wire ropes for frayed strands.	
25		x				Hydraulic Piping	Check lines and fittings for leaks.	
26	x					Reservoir	Check oil level in sight gage.	
27	x					Hyd. Oil Filter	Check dirt alarm gage.	Gage indicates CHANGE.
28		x				Water/Foam Injection Assy.	Check lines and fittings for leaks.	
29	x					Water Injection Pump	Check lubricating oil level.	
30		x				Foam Pulse Pump	Check for leaks.	
31		x				Lubrication Assy	Check lines and fittings for leaks.	
32	x					Lubricator	Check oil level.	
33	x					Breakout Tong	Check tong die for wear.	
34	x					Hydraulic Breakout Assy	Check wire rope for breaks.	
35		x				Breakout Cylinder	Check connections and seals for leaks.	
36	x					Shift Linkage	Check linkage for security and correct adjustment.	
37		x				Hydraulic Pump	Check for leaks.	
38				x		Rotary Table Transmission	Check oil level.	
39	x					Driveshaft	Check for worn bearings.	
40	x					Dust Deflector	Check for loose or missing hardware.	

ITEM NO.	INTERVAL B	D	A	W	M	Item to be Inspected	Procedures Check for and have repaired or adjusted as necessary.	Equipment is not ready/ available if:
41	x	x				Transfer Cylinder	Check rubber boot for damage. for leaks at connections and seals.	Check
42	x					Rotary Table Base	Check for sufficient lubricant.	
43	x					Pulldown Transmission Control	Check linkage for security and correct adjustment.	
						Chain Feed Drive		
44		x				Hydraulic Motor	Check for leaks.	
45				x		Pulldown Transmission	Check oil level.	
46		x				Instrument Panel Assy	Check for proper indication of all gages.	Readings are not within specified limits.
47		x				Air Compressor Panel	Check for proper indication of all gages.	
48	x					Air Control Piping	Check lines and fittings for leaks.	
49		x				Control Valves	Check operation.	
50	x		x			Air Line Conditioner	Check air line filter for moisture accumulation.	Drain moisture.
		x					Check air regulator gage for proper pressure reading.	
	x						Check lubricant level.	
51	x					Throttle Control	Check linkage for security and correct adjustment.	
52	x					Frame Lighting	For night transit, check for illumination of clearance lights.	
53	x					Driller Platform	Check for cracked or rusted welds, loose or missing hardware.	
54	x					Leveling Jacks	Check for leaks at connections or seals.	
55					x	Drill Frame	Check for damage and cracked or rusted welds.	
56	x					Front Mounted Winch	Check oil level.	
57		x				Winch Motor	Check for leaks.	
58		x				Control Valve	Check for leaks.	
59		x				Hydraulic Pump	Check for leaks.	
60					x	Hand Jack	Check oil level.	

3-2 LUBRICATION

3-2.1 Lubricated Items. Lubrication instructions for the rig components that require lubrication are contained in the lubrication chart, figure 3-1.

LEGEND FOR FIGURE 3-1

SYMBOL	LUBRICANT	SPECIFICATION
GL	Medium Pressure Gun Lubricant	MIL-G-10924C
GO	Gear Oil	MIL-L-2105C
HO	Hydraulic Oil	MIL-H-46170
MO	Motor Oil, API Class MS	MIL-L-2104C
RO	Rock Drill Oil, SAE 100 EP CAGE 54527 P/N DAROCK DRILL 500	NSN:9150-00-142-9320

SYMBOL	INTERVAL
2	Once Daily
4	Once Weekly
6	Once Monthly
0	Before raising or lowering mast
A4	Drain and Refill every 4 months

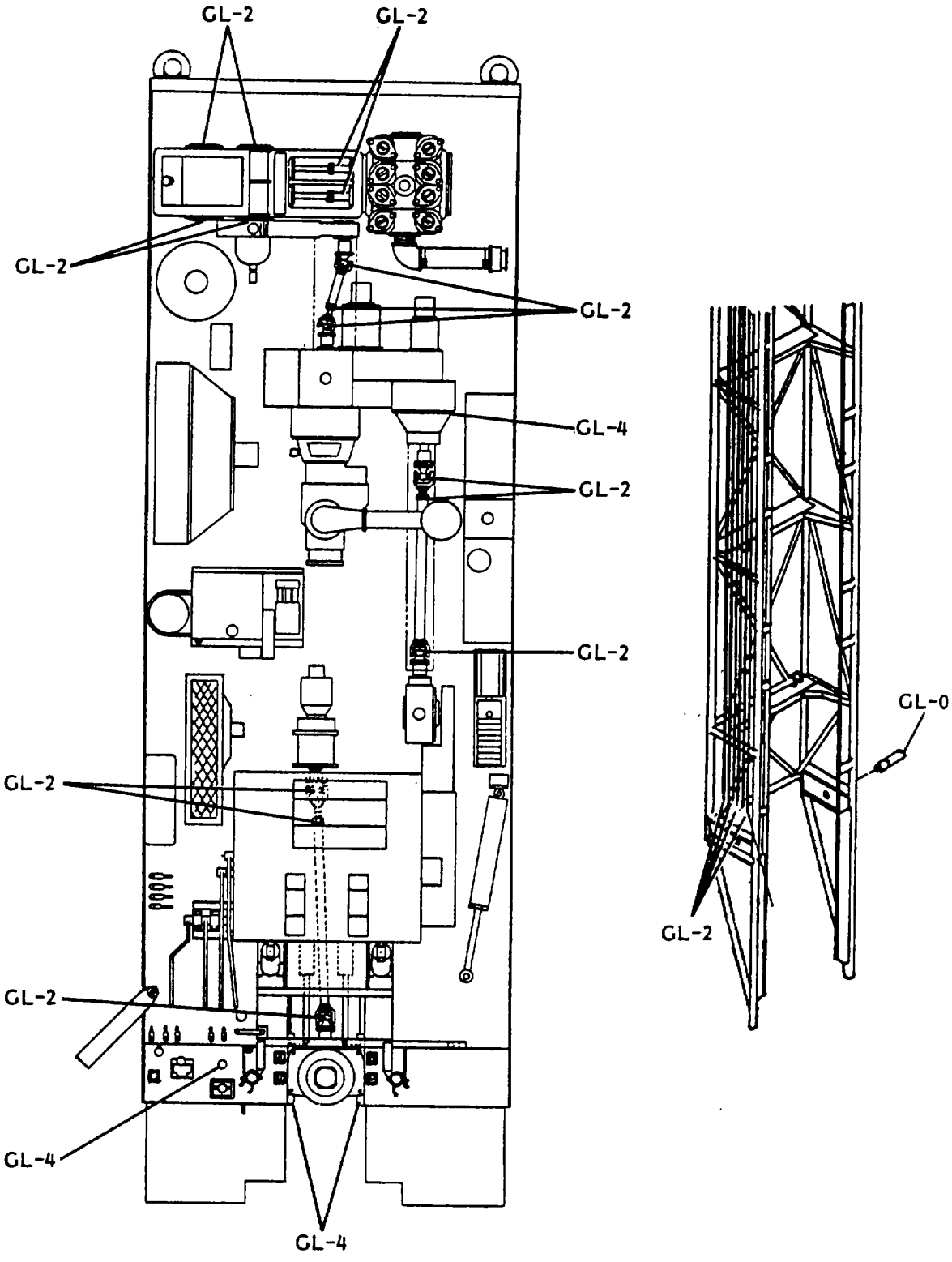

Figure 3-1. Lubrication Chart (Sheet 1 of 3)

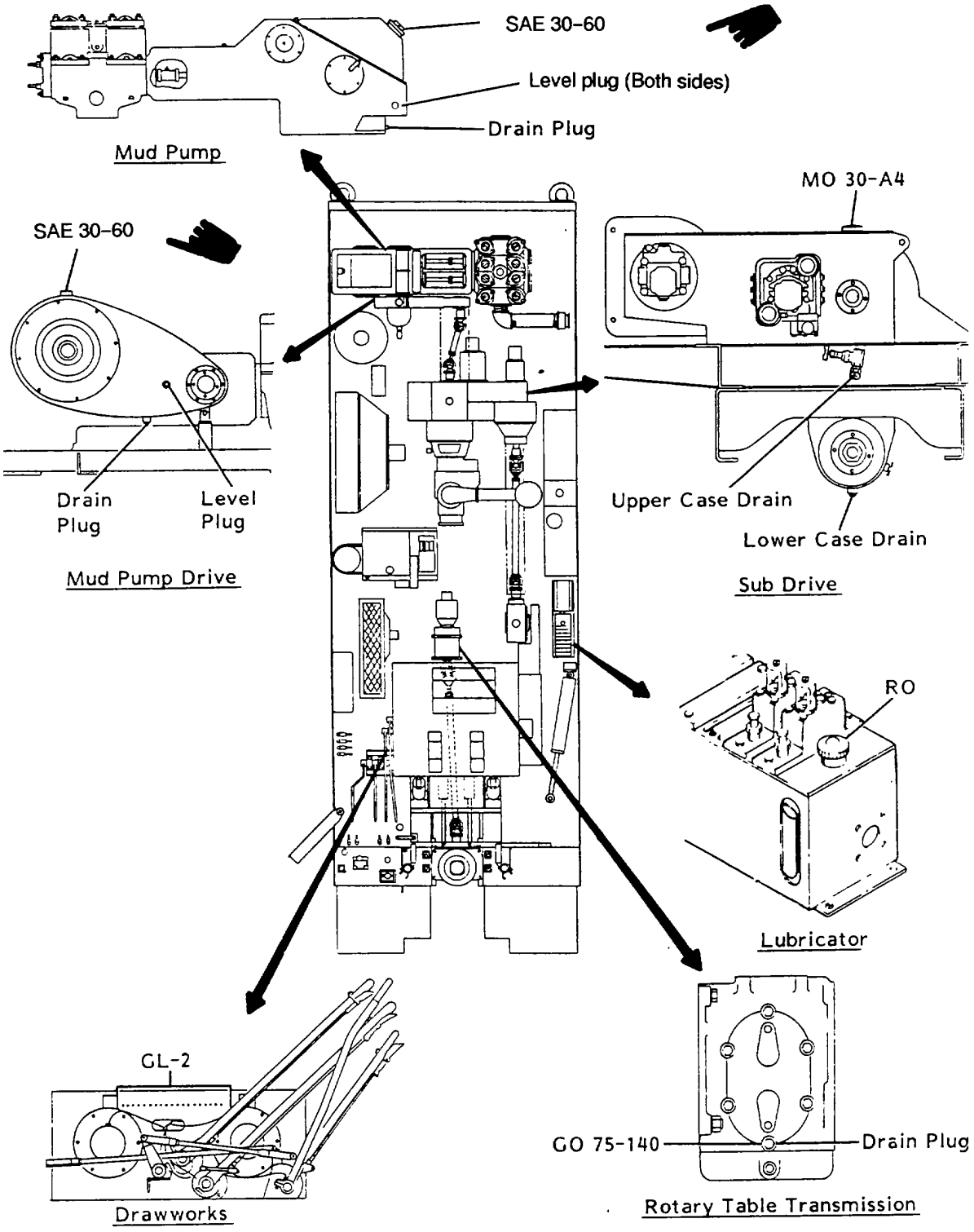

Figure 3-1. Lubrication Chart (Sheet 2 of 3)

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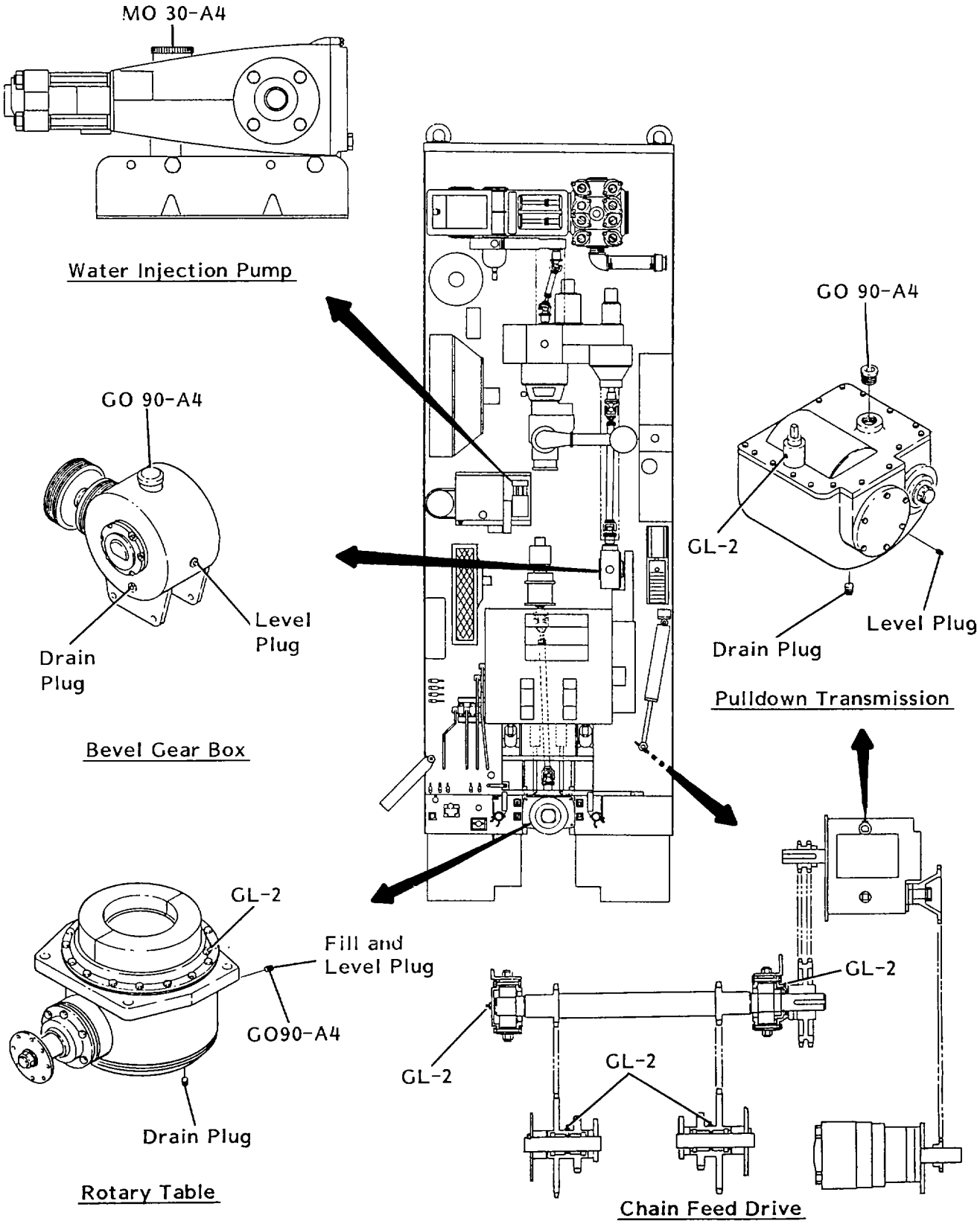


Figure 3-1. Lubrication Chart (Sheet 3 of 3)

CHAPTER 4

MAINTENANCE

4-1 INTRODUCTION

4-1.1 Scope. This chapter provides instructions for locating and correcting failures and unsatisfactory performance problems. Where repair requires that a component be disassembled, these instructions should only be accomplished to the degree necessary to effect repairs. Some components of the drilling machine, due to their complexity and manufacturing process, are not recommended for repair by other than the manufacturer. When instructions are not provided in this manual for an item, repair should not be attempted.

4-2 TROUBLESHOOTING

4-2.1 Introduction. The troubleshooting table, Table 4-1 is provided to assist operation and maintenance personnel in locating the cause of a malfunction. This table is designed to cover the most common or likely problems that may occur, but cannot cover every conceivable malfunction. In providing possible causes to a problem consideration is not given to causes such as improper control settings or empty reservoirs. Any time a problem occurs, check first to see that all controls are positioned correctly, that switches are correctly set and that liquids are at their proper levels.

Table 4-1. Troubleshooting

PROBLEM	POSSIBLE CAUSE	REMEDY
POWER TAKE-OFF		
Clutch slipping	Out of adjustment Greasy/oily plates	Adjust clutch. Clean.
Clutch self-engages.	1. Adjustment	Check and correct adjustment.
	2. Worn parts	Check linkage and release collar for wear.
Clutch will not release	Pilot bearing	Check for broken or frozen pilot bearing.
Excessive heat	Output shaft bearings running hot.	Check bearing adjustment and for oversupply of lubricant.
SUBDRIVE ASSEMBLY		
Output shaft rotates unevenly	Stretched drive chain; worn chain rollers; or binding on sprockets.	Replace drive chain.
Excessive noise	1. Drive chain binding.	Replace drive chain and sprockets.
	2. Worn or burned bearings.	Replace bearings.

Table 4-1. Troubleshooting - continued

PROBLEM	POSSIBLE CAUSE	REMEDY
MUD PUMP & DRIVE		
Mud pump clutch will not engage	1. Insufficient air pressure.	Inspect entire air line installation for any restrictions or leaks which could decrease air supply to clutch. Check operating valve for full opening. Check tattle tale switch. If operating in cold weather, the air lines may be restricted due to freezing of the moisture in the air system. The addition of Denatured alcohol or Ethylene Glycol in the air receiver will eliminate this problem. Avoid the use of all rust inhibitors or commercial antifreeze.
	2. Ruptured diaphragm.	Replace diaphragm.
	3. Drive ring worn out.	Replace drive ring.
Mud pump clutch slips.	1. Insufficient air pressure.	Inspect entire air line installation for any restrictions or leaks which could decrease air supply to clutch. Check operating valve for full opening. Carefully inspect clutch for possible air leakage at the diaphragm. If operating in cold weather, the air lines may be restricted due to freezing of the moisture in the air system. The addition of Denatured alcohol or Ethylene Glycol in the air receiver will eliminate this problem. Avoid the use of all rust inhibitors or commercial antifreeze.
	2. Ruptured diaphragm.	Replace diaphragm.
	3. Drive rings worn out.	Replace drive rings.
	4. Dirt in drive ring.	Disassemble and clean.
Clutch drags or will not disengage	1. Misalignment of clutch and driving member.	Realign clutch and driving member.
	2. Dirt in driving ring.	Disassemble and clean.

Table 4-1. Troubleshooting - continued

PROBLEM	POSSIBLE CAUSE	REMEDY
Clutch drags or will not disengage - continued	3. Tight center plate.	Replace center plate.
Clutch overheating	1. Clutch slippage.	Refer to Mud Pump Clutch Slips.
	2. Misalignment of clutch and driving member.	Align clutch and member.
	3. Dirt in driving ring or spider.	Disassemble and clean.
	4. Plates not free on hub.	Disassemble and clean, de-burr or replace defective parts.
Clutch noisy	1. Pressure plate and insulation not fully disengaging.	Disassemble, clean or replace if defective.
	2. Excessive wear from misalignment or from clutch not fully disengaging.	Realign clutch and driven member. Refer to Clutch Drags or Will Not Disengage.
Mud pump does not operate	1. Clutch slipping.	See Mud Pump Clutch Slips symptom, preceding.
	2. Broken universal joint in drive line.	Inspect universal joints in mud pump drive line. Replace any found defective.
	3. Internal damage to drive assembly.	Remove drive assembly inspection plate. Inspect shafts, sprockets, and drive chains. Replace damaged parts .
	4. Damage in mud pump power frame.	Remove power frame hood. Inspect shafts, sprockets, drive chains and connecting rods for breakage. Replace damaged parts.
Mud pump operates but does not move mud	1. Excessive worn fluid valves and seats.	Replace fluid valves and seats.
	2. Excessively worn piston cups and cylinder liners.	Replace piston cups and cylinder liners.

Table 4-1. Troubleshooting - continued

PROBLEM	POSSIBLE CAUSE	REMEDY
Excessive noise from drive assembly	1. Stretched drive chain.	Replace drive chain.
	2. Broken teeth on sprockets.	Replace any damaged sprockets.
	3. Bearing failure.	Replace damaged bearings.
Excessive noise from mud pump power frame	1. Stretched drive chain.	Replace drive chain.
	2. Broken teeth on sprocket.	Replace sprocket.
	3. Bearing failure.	Replace damaged bearings.
AIR COMPRESSOR DRIVE		
Air compressor drive clutch will not engage	1. Insufficient air pressure.	Inspect entire air line installation for any restrictions or leaks which could decrease the air supply to the clutch. Check tattle tale switch. Check operating valve for full opening. If operating in cold weather, the air lines may be restricted due to freezing of the moisture in the air system. The addition of Denatured alcohol or Ethylene Glycol in the air receiver will eliminate this problem. Avoid the use of all rust inhibitors or commercial antifreeze.
	2. Ruptured diaphragm.	Replace diaphragm.
	3. Drive rings worn out.	Replace drive rings.
Air compressor drive clutch slips	1. Insufficient air pressure.	Inspect entire air line installation for any restrictions or leaks which could decrease the air supply to the clutch. Check operating valve for full opening. Carefully inspect clutch for possible air leakage at the diaphragm. If operating in cold weather, the air lines may be restricted due to freezing of the moisture in the air system. The addition of Denatured alcohol or Ethylene Glycol in the air receiver will

Table 4-1. Troubleshooting - continued

PROBLEM	POSSIBLE CAUSE	REMEDY
Air compressor drive clutch slips - continued	1. Insufficient air pressure - continued	eliminate this problem. Avoid the use of all rust inhibitors or commercial antifreeze.
	2. Ruptured diaphragm.	Replace diaphragm.
	3. Drive rings worn out.	Replace drive rings.
	4. Dirt in drive ring.	Disassemble and clean.
Air compressor drive clutch drags or will not disengage	1. Misalignment of clutch and driving member.	Realign clutch and driving member.
	2. Dirt in driving ring.	Disassemble and clean.
Clutch overheating	1. Clutch slippage.	Refer to drive clutch slips.
	2. Misalignment of clutch and driving member.	Align clutch and member.
	3. Dirt in driving ring or spider.	Disassemble and clean.
	4. Plates not free on hub.	Disassemble and clean, de-burr or replace defective parts.
	5. Pressure plate and insulator not fully disengaging.	Disassemble, clean or replace if defective.
Clutch noisy	Excessive wear from misalignment or from clutch not fully disengaging.	Realign clutch and driven member. Refer to Drive Clutch Drags or Will Not Disengage.
WATER INJECTION DRIVE MOTOR		
Oil leakage	1. Hose fittings loose, worn or damaged.	Check and replace damaged fittings or "O" Rings. Torque to manufacturers specifications.
	2. Oil seal rings deteriorated by excess heat.	Replace oil seal rings.
	3. End cover bolt loose or its sealing area deteriorated by corrosion.	(a) Loosen then tighten single bolt to 22-26 ft.-lbs. (30-35 N m) (b) Replace bolt.

Table 4-1. Troubleshooting - continued

PROBLEM	POSSIBLE CAUSE	REMEDY
Oil leakage - continued	4. Internal shaft seal worn or damaged.	Replace seal.
	5. Worn coupling shaft and internal seal.	Replace coupling shaft and seal.
Significant loss of speed under load	1. Lack of sufficient oil supply.	(a) Check for faulty relief valve and adjust or replace as required.
		(b) Check for and repair worn pump.
		(c) Check for and use correct oil for temperature of operation.
	2. High internal motor leakage.	Replace worn rotor set.
	3. Severely worn or damaged internal splines.	Replace rotor set, drive link and coupling shaft.
	4. Excessive heat.	Locate excessive heat source in the system and correct the condition.
	5. Loose V-belt.	Tighten V-belt or replace.
Low mechanical efficiency or undue high pressure required to operate motor	1. Line blockage	Locate blockage source and repair or replace.
	2. Internal interference.	Disassemble unit, identify and remedy cause and repair, replacing parts as necessary.
	3. Lack of pumping pressure.	Check for and repair worn pump.
	4. Excessive binding or loading in system.	Locate source and eliminate cause.
Pulsation	1. Belt slippage.	Tighten or replace, use correct belt.
	2. Air leak in inlet plumbing.	Disassemble, reseal, and reassemble.

Table 4-1. Troubleshooting - continued

PROBLEM	POSSIBLE CAUSE	REMEDY
Low pressure	5. Relief valve stuck, partially plugged or improperly adjusted, valve seat worn.	Clean, and adjust relief valve, check for worn and dirty valve seats.
	6. Inlet suction strainer clogged or improper size.	Clean. Use adequate size. Check more frequently.
	7. Worn piston assembly. Abrasives in pumped fluid or severe cavitation. Inadequate water supply.	Install proper filter. Suction at inlet manifold must be limited to lifting less than 20 feet of water or -8.5 PSI vacuum.
	8. Fouled or dirty inlet or discharge valves.	Clean inlet and discharge valve assemblies.
	9. Worn inlet or discharge valves or leaky discharge hose.	Replace worn valves, valve seats and/or discharge hose.
Pump runs extremely rough, pressure very low.	1. Restricted inlet or air entering the inlet plumbing.	Proper size inlet plumbing; check for air tight seal.
	2. Inlet restrictions and/or air leaks. Damaged cup or stuck inlet or discharge valve.	Replace worn cup or cups, clean out foreign material, replace worn valves.
	3. Worn inlet manifold seals.	Replace worn seals.
	4. Worn inlet seals allow pump to draw air.	Install new inlet manifold seals.
Cylinder O-rings blown next to discharge manifold	1. Pressures in excess of rated PSI.	Check for plugged nozzle, closed valves or improperly adjusted by pass valve.
	2. Warped manifold.	Replace manifold.
Leakage at the cylinder O-rings at the discharge manifold and black, powdery substance in the area of the O-rings	Loose cylinders. Cylinder motion caused by improper shimming of the discharge manifold.	Remove spacer shims on manifold studs. Do not remove too many shims or the ears of the manifold will be bowed when the manifold is retightened, causing looseness in the center cylinder.

Table 4-1. Troubleshooting - continued

PROBLEM	POSSIBLE CAUSE	REMEDY
Water leakage from under the inlet manifold	Worn inlet manifold seals. Leaking sleeve O-ring.	Install seals. If piston rod sleeves are scored, replace sleeves and sleeve O-rings.
Oil leak between crankcase and pumping section	1. Worn crankcase piston rod seals.	Replace crankcase piston rod seals.
	2. Excess oil from wicks.	Reduce quantity of oil per oiling.
Oil leaking in the area of crankshaft	Worn crankshaft seal or improperly installed oil seal retainer packing.	Remove oil seal retainer and replace damaged gasket and/or seals.
	Bad bearing.	Replace bearing.
Excessive play in the end of the crankshaft pulley	Worn main ball bearing from excessive tension on drive belt.	Replace ball bearing. Properly tension belt.
Water in crankcase	1. May be caused by humid air condensing into water inside the crankcase.	Change oil at 2 month or 200 hour intervals.
	2. Leakage of manifold inlet seals and/or piston rod sleeve 0-ring.	Replace seals, sleeve and O-rings.
Oil leaking from underside of crankcase	Worn crankcase piston rod seals.	Replace seals.
Oil leaking at the rear portion of the crankcase	Damaged or improperly installed oil gauge or crankcase rear cover O-ring, and drain plug O-ring.	Replace oil gauge or cover O-ring, and drain plug O-ring.
Oil leakage from drain plug	Loose drain plug or worn drain plug O-ring.	Tighten drain plug or replace O-ring.
Loud knocking noise in pump.	1. Pulley loose on crankshaft.	Check key and tighten set screw.
	2. Broken or worn bearing.	Replace bearings.

Table 4-1. Troubleshooting - continued

PROBLEM	POSSIBLE CAUSE	REMEDY
Frequent or premature failure of the inlet manifold seals.	1. Scored rods or sleeves.	Replace rods and sleeves.
	2. Over pressure to inlet manifold.	Reduce inlet pressure per instructions.
Short cup life	1. Damaged or worn chrome plating of the cylinders.	Replace cylinders.
	2. Abrasive material in the fluid being pumped.	Install proper filtration on pump inlet plumbing.
	3. Excessive pressure and/or temperature of fluid being pumped.	Check pressures and fluid inlet temperature; be sure they are within specified range.
	4. Over pressure of pumps.	Reduce pressure.
	5. Running pump dry.	Do not run pump without water.
	6. Front edge of piston sharp.	Replace with new piston.
	7. Chrome plating of cylinders damaged causing excessive wear of cups. May be caused by pumping acid solution.	Install new cups and cylinders. Pump only fluid compatible with chrome.
Strong surging at the inlet and low pressure on the discharge side	Foreign particles in the inlet or discharge valve or worn inlet and/or discharge valves.	Check for smooth lap surfaces on inlet and discharge valve seats. Discharge valve seats and inlet valve seats may be lapped on a very fine oil stone; damaged cups and discharge valves cannot be lapped but must be replaced.
FORCE FEED LUBRICATOR		
Feed rate too high	Feed regulator set too high.	Lower feed regulator setting.
Feed rate too low	1. Feed regulator set too low.	Raise feed regulator setting.
	2. Clogged inlet strainer or inlet tube.	Remove and clean inlet strainer and tube.

Table 4-1. Troubleshooting - continued

PROBLEM	POSSIBLE CAUSE	REMEDY
Feed rate too low - Continued	3. Sight glass felt gasket clogged.	Replace sight glass felt gasket.
	4. Discharge check valves seating improperly.	Turn feed regulator full open and operate hand crank rapidly to flush check valve.
Sight well overflowing.	Discharge check valve stuck shut or defective.	Replace check valve.
Cage glass leaks	1. Plug loose.	Remove plug cap and tighten plug.
	2. Damaged or defective top and bottom rubber washers.	Replace top and bottom rubber washers.
DRAWWORKS - AUXILIARY DRUM		
Clutch will not engage	1. Insufficient air pressure.	Inspect entire air line installation for any restrictions or leaks which could decrease the air supply to the clutch. Check operating valve for full opening. If operating in cold weather, the air lines may be restricted due to freezing of the moisture in the air system. The addition of Denatured alcohol or Ethylene Glycol in the air receiver will eliminate this problem. Avoid the use of all rust inhibitors or commercial antifreeze.
	2. Ruptured tube.	Replace tube.
	3. Malfunctioning quick release valves.	Rebuild or replace quick release valves.
	4. Drive rings worn out.	Replace drive rings.
Clutch slips	1. Insufficient air pressure.	Inspect entire air line installation for any restrictions or leaks which could decrease the air supply to the clutch. Check operating valve for full opening. Carefully inspect clutch for possible air leakage at the quick release valves or the tube.

Table 4-1. Troubleshooting - continued

PROBLEM	POSSIBLE CAUSE	REMEDY
Clutch slips-continued	1. Insufficient air pressure - continued	If operating in cold weather, the air lines may be restricted due to freezing of the moisture in the air system. The addition of Denatured alcohol or Ethylene Glycol in the air receiver will eliminate this problem. Avoid the use of all rust inhibitors or commercial antifreeze.
	2. Ruptured tube.	Replace tube.
	3. Malfunctioning quick release valves.	Repair or replace quick release valve.
	4. Drive rings worn out.	Replace drive rings.
	5. Dirt in drive ring.	Disassemble and clean.
Clutch drags or will not disengage	1. Misalignment of clutch and driving member.	Realign clutch and driving member.
	2. Dirt in driving ring.	Disassemble and clean.
	3. Tight center plate.	Replace center plate.
	4. Quick release valves stuck.	Repair or replace quick release valves.
Clutch overheating	1. Clutch slippage.	Refer to Clutch Slips.
	2. Misalignment of clutch and driving member.	Align clutch and driving member.
	3. Dirt in driving ring or spider.	Disassemble and clean.
	4. Plates not free on hub.	Disassemble and clean, de-burr or replace defective parts.
Clutch noisy	1. Pressure plate and insulator not fully disengaging.	Disassemble, clean or replace if defective.
	2. Excessive wear from misalignment or from clutch not fully disengaging.	Realign clutch and driven member. Refer to Clutch Drags or Will Not Disengage.

Table 4-1. Troubleshooting - continued

PROBLEM	POSSIBLE CAUSE	REMEDY
Brake will not Hold	1. Control linkage out of adjustment.	Adjust control linkage.
	2. Worn brake lining.	Replace brake lining.
	3. Brake lining wet.	Replace brake lining.
Brake will not Release	1. Control linkage out of adjustment.	Adjust control linkage.
	2. Broken brake lining.	Replace brake lining.
	3. Grease on brake lining.	Replace brake lining.
	4. Grease on brake lining.	Replace brake lining.
No output from drive assembly	Broken or stripped drive gears.	Disassemble drive assembly and replace any defective parts.
Excessive noise	1. Worn bearings on shaft or in drive assembly.	Replace any worn bearings.
	2. Broken or worn gears in drive assembly.	Replace broken or worn gears.
HOISTING DRUM		
Clutch will not engage	1. Insufficient air pressure.	Inspect entire air line installation for any restrictions or leaks which could decrease the air supply to the clutch. Check operating valve for full opening. If operating in cold weather, the air lines may be restricted due to freezing of the moisture in the air system. The addition of Denatured alcohol or Ethylene Glycol in the air receiver will eliminate this problem. Avoid the use of all rust inhibitors or commercial antifreeze.
	2. Ruptured tube.	Replace tube.
	3. Malfunctioning quick release valves.	Rebuild or replace quick release valves.

Table 4-1. Troubleshooting - continued

PROBLEM	POSSIBLE CAUSE	REMEDY
Clutch will not engage - continued	4. Drive rings worn out.	Replace drive rings.
Clutch slips	1. Insufficient air pressure.	Inspect entire air line installation for any restrictions or leaks which could decrease the air supply to the clutch. Check operating valve for full opening. Carefully inspect clutch for possible air leakage at the quick release valves or the tube. If operating in cold weather, the air lines may be restricted due to freezing of the moisture in the air system. The addition of Denatured alcohol or Ethylene Glycol in the air receiver will eliminate this problem. Avoid the use of all rust inhibitors or commercial antifreeze.
	2. Ruptured tube.	Replace tube.
	3. Malfunctioning quick release valves.	Repair or replace quick release valve.
	4. Drive rings worn out.	Replace drive rings.
	5. Dirt in drive ring.	Disassemble and clean.
Clutch drags or will not disengage	1. Misalignment of clutch and driving member.	Realign clutch and driving member.
	2. Dirt in driving ring.	Disassemble and clean.
	3. Tight center plate.	Replace center plate.
	4. Quick release valves stuck.	Repair or replace quick release valves.
Clutch overheating	1. Clutch slippage.	Refer to Drive Clutch Slips.
	2. Misalignment of clutch and driving member.	Align clutch and member.

Table 4-1. Troubleshooting - continued

PROBLEM	POSSIBLE CAUSE	REMEDY
Clutch overheating - Continued	3. Dirt in driving ring or spider.	Disassemble and clean.
	4. Plates not free on hub.	Disassemble and clean, de-burr or replace defective parts.
Clutch noisy	1. Pressure plate and insulator not fully disengaging.	Disassemble, clean or replace if defective.
	2. Excessive wear from misalignment or from clutch not fully disengaging.	Realign clutch and driven member. Refer to Drive Clutch Drags or Will Not Disengage.
Brake will not hold	1. Control linkage out of adjustment.	Adjust control linkage.
	2. Worn or wet brake lining.	Replace brake lining if worn. Dry brake lining if wet.
Brake will not release	Control linkage out of adjustment.	Adjust brake control linkage.
Brake grabs	1. Broken brake lining.	Replace brake lining.
	2. Grease on brake lining.	Replace brake lining.
Hoisting drum jerks or does not rotate	1. Stretched drive chains.	Replace drive chains.
	2. Damaged or worn gears in drive assembly.	Inspect drive gears. Replace if worn or damaged.
	3. Broken teeth on drive sprocket.	Replace drive sprockets.
	4. Damaged splines in clutch.	Inspect clutch and replace any damaged parts.
Excessive noise when hoisting drum is operated	1. Worn or damaged bearings.	Inspect bearings. Replace any found worn or damaged.
	2. Worn or damaged gears in drive assembly.	Replace worn or damaged gears.

Table 4-1. Troubleshooting - continued

PROBLEM	POSSIBLE CAUSE	REMEDY
THIRD DRUM		
Clutch Slipping	1. Out of adjustment. 2. Worn clutch plates. 3. Grease or oil on plates.	1. Adjust clutch or linkage. 2. Replace clutch plates. 3. Replace clutch plates.
Clutch jumps out of engagement	1. Out of adjustment. 2. Worn dog on lever lock mechanism.	1. Adjust clutch. 2. Replace lock dog.
Clutch drags or will not release	1. Control linkage out or adjustment. 2. Weak release springs. 3. Clutch collar not aligned with shift fork.	1. Adjust linkage. 2. Replace springs. 3. Realign collar and fork.
Clutch Overheats	1. Clutch slippage. 2. Out of adjustment.	1. Refer to "Clutch Slipping". 2. Adjust clutch.
Clutch Noisy	1. Out of adjustment. 2. Clutch plates not fully disengaging. 3. Worn clutch plates.	1. Adjust clutch. 2. See "Clutch drags or will not release". 3. Replace clutch plates.
Brake will not hold	1. Control linkage out of adjustment. 2. Worn brake lining. 3. Grease or oil on lining.	Adjust control linkage. Replace brake lining. Replace brake lining.
Brake grabs	1. Broken brake lining. 2. Grease on brake lining.	Replace brake lining. Replace brake lining.
Third drum jerks or does not rotate	1. Stretched drive chains. 2. Damaged or worn gears in drive assembly. 3. Broken teeth on drive sprocket.	Replace drive chains. Inspect drive gears. Replace if damaged or worn. Replace damaged sprocket.

Table 4-1. Troubleshooting - continued

PROBLEM	POSSIBLE CAUSE	REMEDY
CHAIN FEED DRIVE MOTOR		
Motor fails to start	1. System leakage - loose connections or broken lines.	Inspect and tighten port connections and lines.
	2. No fluid - inadequate fluid supply at inlet or in system.	Check fluid level in reservoir. Replenish as necessary.
	3. System return line or drain line restricted.	Check drain filter. Clean and/or replace filter element.
	4. System inlet line restricted.	Check all strainers and filter for dirt and sludge. Clean if necessary.
	5. Fluid viscosity too heavy to pick up prime.	Completely drain the system. Add new filtered fluid of proper viscosity.
	6. Air in system.	Tighten any loose connections. Bleed air from highest point in system and replenish fluid.
	7. Drive train damaged.	Check and repair drive train.
	8. Pump driven in wrong direction.	Drive direction must be reversed immediately to prevent seizure.
	9. Pump coupling or shaft sheared.	Check shaft engagement and damage. Replace the necessary parts.
	10. System relief valve stuck open.	Disassemble and clean the valve with solvent. Use pressure gauge to adjust the relief valve.
	11. Pump or motor binding.	Remove and disassemble the unit. Check for correct assembly of parts. Also check for dirt or metal chips. Clean the parts thoroughly and replace any damaged parts.
Motor not developing sufficient speed or torque	1. Insufficient pump speed.	Check pump drive speed.
	2. Insufficient fluid pressure.	Check delivery of pump. Make certain sufficient hydraulic fluid is available to the pump.
	3. System overload relief valve set too low.	Check pressure and reset relief valve.

Table 4-1. Troubleshooting - continued

PROBLEM	POSSIBLE CAUSE	REMEDY
Motor not developing sufficient speed or torque - continued	4. Motor requiring excessive torque.	Remove motor and check torque requirements of driven shaft.
	5. Parts of motor cartridge scored due to excessive pressure or foreign matter in oil.	Remove motor for overhaul.
Motor turning in wrong direction	1. Improper port connections or control.	Reverse port connections or shift valve.
	2. Components in system not functioning as intended.	Check complete system for proper operation.
Motor noisy	1. Air in system.	Bleed air from highest point in system and replenish fluid.
	2. Motor internally damaged.	Remove motor for overhaul.
	3. Noise from other system components telegraphing back through lines and emerging from motor.	Check complete system for proper operation.
External leakage from motor	Worn seals or cut "O" rings.	Install new seals and "O" rings.
Motor shaft continuing to rotate when control is in "OFF" position	Control valve is not functioning properly.	Check control valve for correct spool and leakage.

Table 4-2. Air Compressor Troubleshooting

PROBLEM
CHECK & CORRECTION (Refer to figure 4-1)

1. Failure to Engage Compressor

a. Check for truck air system pressure PSI (No. 31). If low, compressor relay is disconnected. After the air supply pressure is restored, reset Tattletale button on relay No. 34.

b. Check power on the contact NC relay No. 34.

c. Check connection and power to the solenoid valve No. 6.

d. See troubleshooting for air compressor drive clutch (table 4-1).

Table 4-1. Troubleshooting - continued

PROBLEM	POSSIBLE CAUSE	REMEDY

PROBLEM
CHECK & CORRECTION (Refer to figure 4-1)

2. Failure to Load Compressor
   a. Check indicating switches No. 2, 7, 9, and 17 for shutdown condition.
   b. Inspect hose connections to the inlet throttle actuator No. 3a and check for air pressure by loosing connection at the actuator inlet.
   c. Check connection and power to the solenoid valve No. 26.
   d. Check proportional controller No. 28 for air passage.

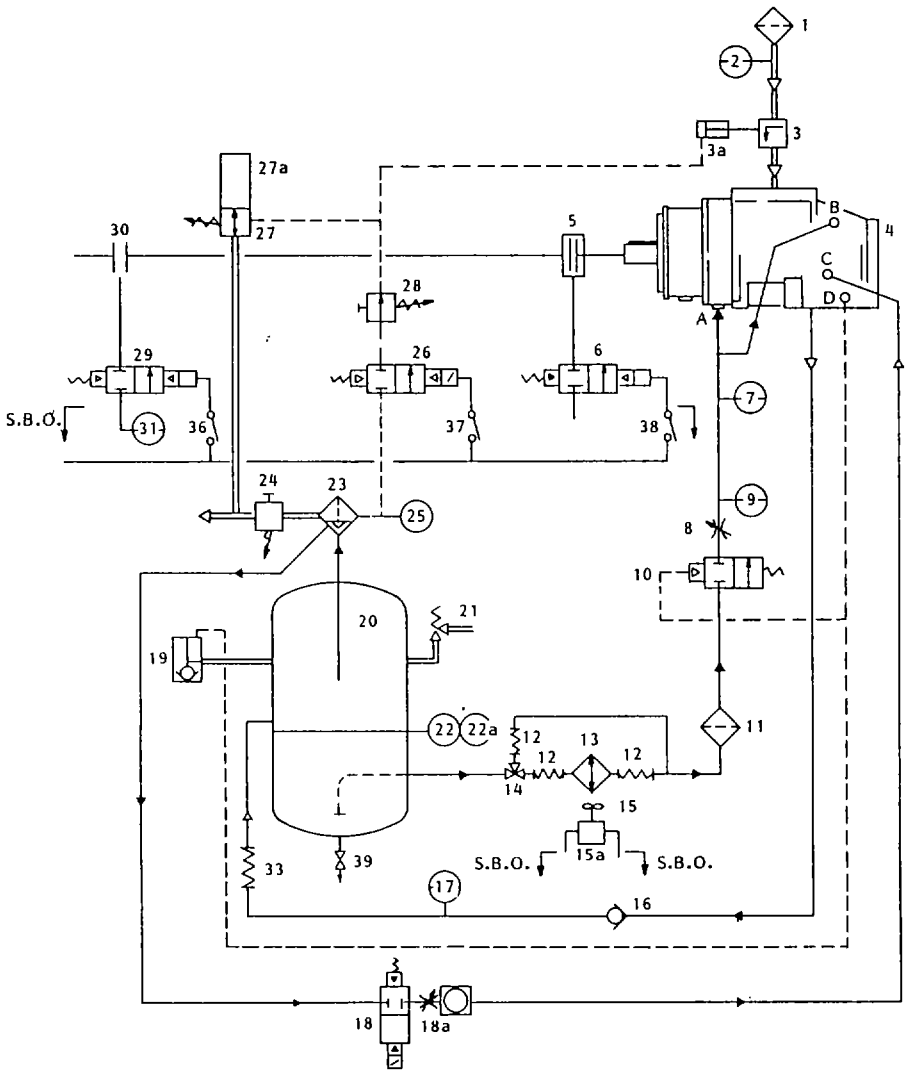
3. Unscheduled Shutdown
3.1.a. Check the indicators No. 2, 7, 9, and 17 for extreme conditions and if detected rectify the cause of problem.
   b. Wait for complete evacuation of system pressure by blow down valve (No. 19).
   c. Reset Tattletale button at relay (No. 34) and restart compressor.
   d. Observe the indicators No. 2, 7, 9 and 17 for each of the shutdown limits. Rectify the cause of individual problems as described in the following paragraphs.

3.2.a. High discharge air/oil temperature (indicating switch No. 17)
   1. Check oil level in reservoir No. 20.
   2. Check oil injection lines to ports A and B for leaks.
   3. Check oil injection needle valve No. 8 (not closed) and open more if necessary.
   4. Check oil injection pressure on indicator No. 17.
   5. Check oil injection temperature indicator No. 9.
   6. Check connection and signal pressure to oil stop valve No. 10.
   7. Check differential pressure drop indicator on filter No. 11 and if high check the filter and replace the cartridge.

3.2.b. High inlet air vacuum (indicating switch No. 2)
   1. Check air filter cartridge for cleanliness.
   2. Check air filter body.
   3. Check air filter cap body.
   4. Check air inlet piping.

3.2.c. High oil injection temperature (indicating switch No. 9)
   1. Check oil cooler fan blades for damage.
   2. Check oil cooler for cleanliness.
   3. Check oil level in air/oil separator No. 20.
   4. Check discharge lines from thermostatic control valve No. 14.
   5. Check operation of thermostatic valve No. 14.
   6. Check operation of cooler fan for proper speed and air flow.
   7. Check temperature differential between indicator No. 9 and No. 22a.

3.2.d. Low oil injection pressure indicating switch No. 7
   1. Check oil level in the air/oil separator No. 20.
   2. Check oil lines upstream of the pressure sensing point and downstream to the injection point.
   3. Check function of oil stop valve No. 10.
   4. Check oil needle valve No. 8 and open more if necessary.



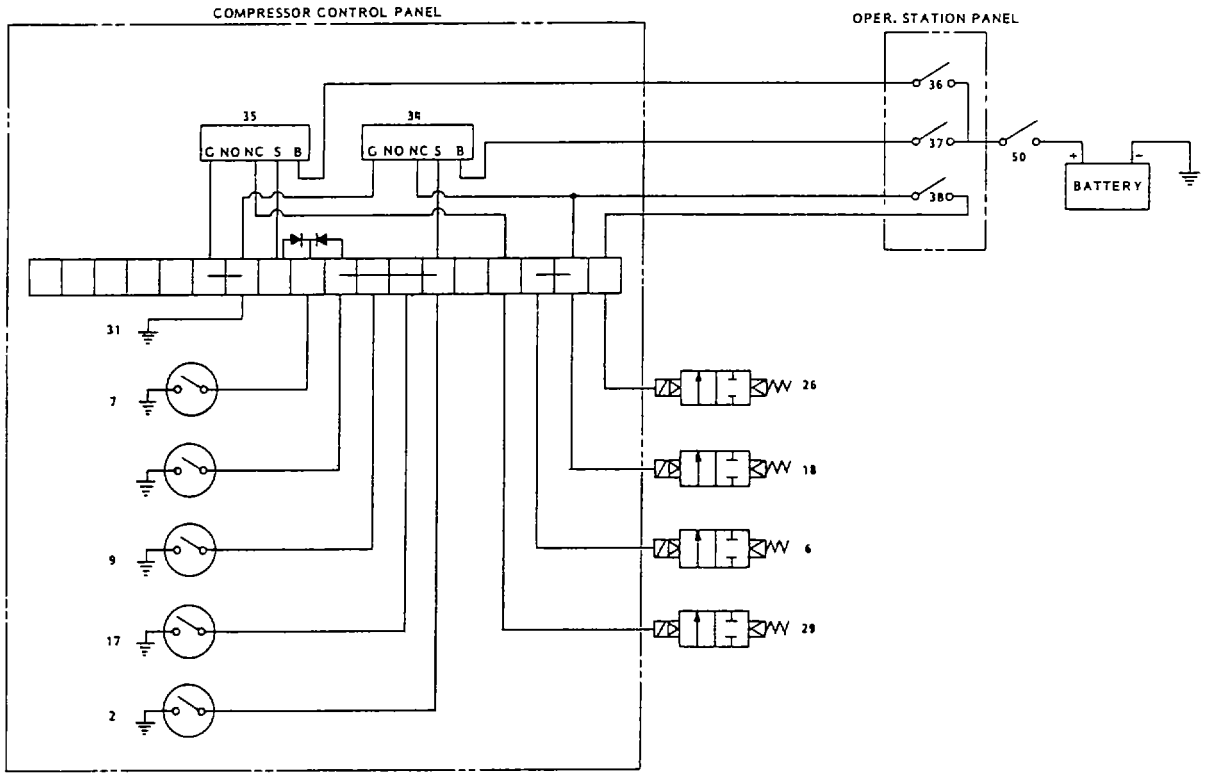
1. Intake Air Filter With Inlet Cap
2. Pressure Ind Switch - Suction
3. Intake Air Throttle Ass.
3a. Inlet Throttle Actuator
4. Air Compressor
5. Air Clutch Coupling
6. Compressor On, Off Solenoid Valve
7. Press Ind Switch - Oil Injection
8. Regulator Valve - Oil Injection
9. Temperature Ind Switch Oil Inject
10. Oil Stop Valve
11. Oil Filter Ass.
12. Expansion Joint
13. Oil Cooled Ass.
14. Cooler Thermostatic By-Pass Valve
15. Cooler Fan
15a. Cooler Hydraulic Motor
15b. Hydraulic Motor Speed Contr. Valve
16. Check Valve
17. Temperature Ind Switch Compr Disch
18. Scavenge Line Solenoid Valve
18a. Side Glass Throttle Comb Valve
19. Blow Down Valve
20. Air-Oil Separator
21. Pressure Safety Valve
22. Level Indicator - Oil
22a. Temperature Indicator - Oil
23. Coalescent Element
24. Minimum Pressure Valve
25. Pressure Indicator - Air
26. Load/No Load Solenoid Valve
27. Bleeding Valve
27a. Bleeding Valve Silencer
28. Proportional Controller
29. Mud Pump On/Off Solenoid Valve
30. Mud Air Pump Clutch Coupling
31. Press. Ind. Switch Truck Air Supply
33. Expansion Joint
36. Mud Pump On/Off Switch
37. Compressor On/Off Switch
38. Compressor Load/No Load Switch
39. Drain Valve
40. Compressor Air End Discharge Press.

FLOW DIAGRAM

Air Pipe
Air-Oil Pipe
Oil Pipe
Control Pipe

A Connection For Oil Injection (Gear Lubrication)
B Connection For Discharge - Side Bearing Lubrication
C Connection From Secondary Separator Drain
D Connection For Compressor Discharge

Figure 4-1. Air Compressor Diagrams (Sheet 1 of 2)



2. Pressure Ind. Switch - Suction
6. Compressor On/Off Solenoid Valve
7. Pressure Ind. Switch - Oil Injection
9. Temperature Ind. Switch - Oil Injection
17. Temperature Ind. Switch - Sompr. Disch.
18. Scavenge Line Solenoid Valve
26. Load/No Load Solenoid Valve
29. Mud Pump On/Off Solenoid Valve
31. Pressure Ind. Switch Truck Air Supply
34. Compressor Circuit Relay
35. Mud Pump Circuit Relay
36. Mud Pump On/Off Switch
37. Compressor On/Off Switch
38. Compressor Load/No Load Switch
50. Ignition Switch

Figure 4-1. Air Compressor Diagrams (Sheet 2 of 2)

Table 4-2. Air Compressor Troubleshooting - continued

PROBLEM
CHECK & CORRECTION (Refer to figure 4-1)

3.2.d. Low oil injection pressure indicating switch No. 7 - continued
5. Check differential pressure drop indicator on filter No. 11 and if high check the filter and replace the cartridge.
6. Check operation of thermostatic bypass valve No. 14.

3.2.e. If all the checks in the above paragraphs a, b, c, and d, do not reveal the source of the shutdown, check the switches, relays and connections of the control system and the panel. In case of temperature switches inspect the capillary line to the sensors and sensors themselves for possible damage.

4. Excessive Oil Consumption
a. Too much oil in the system (above operating level).
b. Broken or leaking discharge line or oil injection line.
c. Plugged oil scavenger line.
d. Closed scavenge line needle valve No. 18a.
e. Malfunctioning solenoid valve No. 18.
f. Loss of power to solenoid valve No. 18.
g. Scavenge line not reaching bottom of separator element No. 23.
h. Defective separator element No. 23.
i. Incorrect oil.
j. Malfunction of minimum pressure valve No. 24.

5. Air Oil Discharge Temperature Too Low
a. High oil injection rate.
b. Fan speed too high.
c. Fan pitch too high.

6. If all the checks described in the preceeding paragraphs fail to pinpoint the source of malfunction it is recommended to contact the manufacturer for assistance.

4-3 MAINTENANCE OF AIR CONTROL SYSTEM

4-3.1 Control air Valve. (Figure 4-2)

4-3.1.1 Removal. The operating portion of the valve can be removed without disturbing the air connections. Remove capscrews (1) to remove the valve from pipe bracket (2). Remove the strainers (3) and gaskets (4) from pipe bracket.

4-3.1.2 Disassembly.

a. Remove cap nut (13) from housing (12). Remove nuts (9) and lockwashers (10). Separate housing (12) from body (36).

b. Remove nut (5). Remove shaft (7) and ball (8) from yoke (6), then remove yoke (6).

1. Capscrew
2. Pipe Brack
3. Strainer
4. Gasket
5. Nut
6. Yoke
7. Shaft
8. Ball
9. Nut
10. Lockwasher
11. Stud
12. Housing
13. Cap Nut
14. Setscrew
15. Cam
16. Shaft
17. Arbor
18. Spring
19. Washer
20. Spring
21. Arbor
22. Nut
23. Stud
24. Screw
25. Housing
26. Seat
27. Spring
28. Nut
29. Follower
30. Diaphragm
31. Seat
32. O-Ring
33. Spring
34. Valve
35. O-Ring
36. Body
37. Cotter Pin
38. Pin
39. Cam Dog
40. Pin
41. Lever
42. Roll Pin
43. Roller
44. Setscrew
45. Lever
46. Ring
47. Protector
48. Ring
49. Washer
50. O-Ring
51. Guide
52. O-Ring
53. Plunger
54. Spring
55. Seat
56. O-Ring
57. Spacer
58. Valve
59. Spring
60. Ring

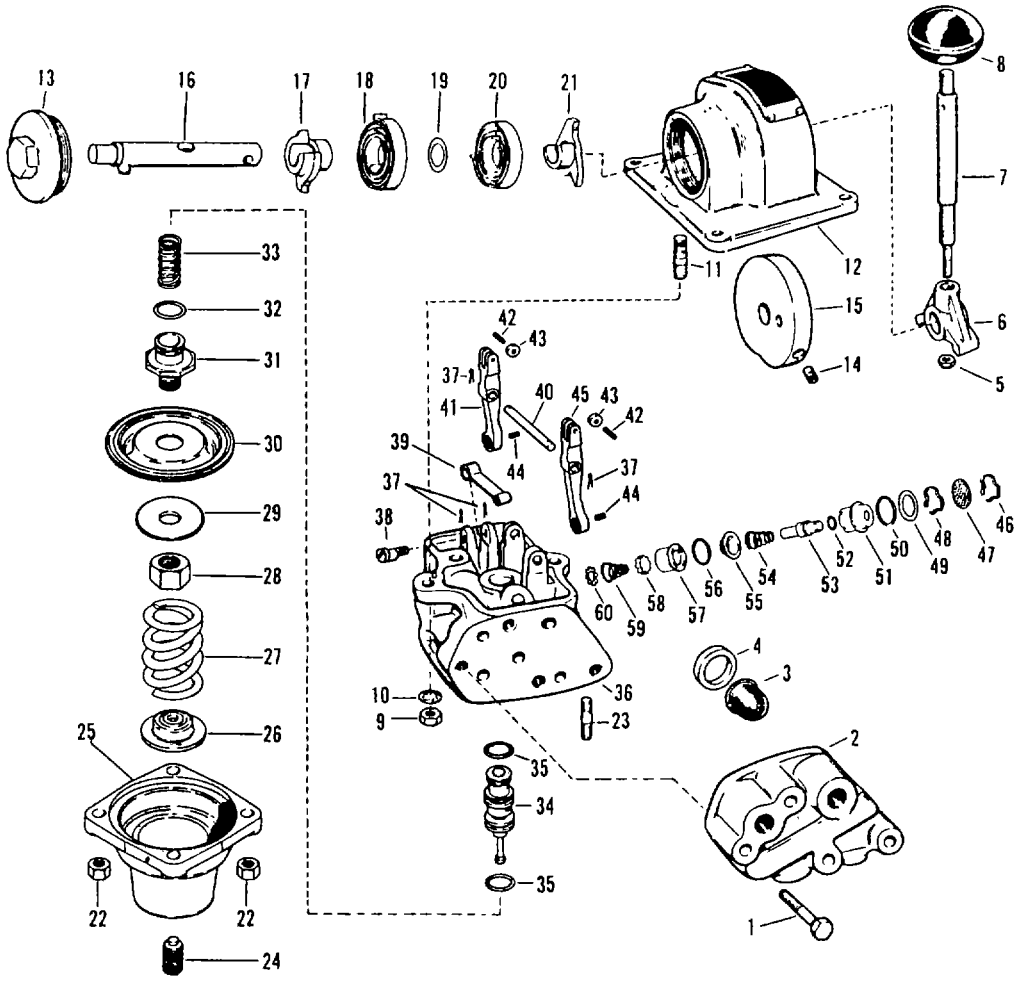


Figure 4-2. Control air Valve

c. Loosen setscrew (14) and remove shaft (16), arbor (17), springs (18, 20), washer (19) and arbor (21). Remove cam (15).

d. Remove nuts (22), screw (24), housing (25), seat (26), spring (27), nut (28), follower (29), diaphragm (30), seat (31), o-ring (32), spring (33), valve (34) and o-rings (35).

e. Remove cotter pins (37) from pin (38) and remove pin and cam dog (39).

f. Remove cotter pins (37) from pin (40) and remove levers (41, 45). Remove roll pins (42), rollers (43) and setscrews (44). Remove pin (40).

g. Remove rings (46), protectors (47), rings (48), washers (49), o-rings (50), guides (51), o-rings (52), plungers (53) and springs (54).

h. Remove seat (55), o-ring (56), spacer (57), inlet valve (58), spring (59) and ring (60).

4-3.1.3 Cleaning, Inspection and Repair.

a. Wash all metal parts in a non-flammable solvent and all rubber parts with soap and water. Rinse each part thoroughly and blow dry with a low pressure air jet. Arrange the parts on a clean white surface in the order of figure 4-2.
b. Examine each part carefully. Flex the diaphragm and o-rings. If cracked or worn replace them. Replace all parts that may not provide satisfactory service.

4-3.1.4 Assembly. During assembly, lubricate each part. Use No. 107 Lubriplate on metal to metal surfaces and Cosmolube on all rubber parts. Equivalent greases may be used.

a. Assemble spacers (57), valves (58), springs (59) and rings (60). Install in body (36).

b. Install -rings (56), seats (55), springs (54), plungers (53), o-rings (52), guides (51), o-rings (50), washers (49), rings (48), protectors (47) and rings (46).

c. Assemble setscrews (44), rollers (43) and roll pins (42) to levers (41, 45). Install pin (40) in body (36), then install levers (41, 45) and cotter pins (37).

d. Position cam dog (39) in place on body (36) and install pin (38) and cotter pins (37).

e. Assemble seat (31), diaphragm (30), follower (29) and nut (28). Install o-ring (32) on seat (31) and o-rings (35) on valve (34). Install valve (34) in body (36).

f. Install screw (24), seat (26), spring (27), diaphragm assembly (28 32) and spring (33) in housing (25). Assemble housing (25) to body (36) and install nuts (22).

g. Assemble arbors (17, 21), springs (18, 20) and washer (19) on shaft (16). Position cam (15) in housing (12), then install assembled shaft (16) in housing (12) through cam (15). Tighten setscrew (14).

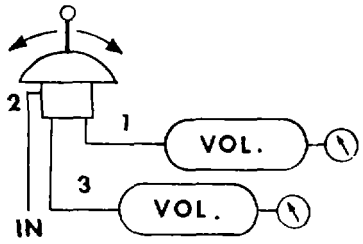
h. Install yoke (6) on shaft (16), then install ball and shaft (8, 7) in yoke (6). Install nut (5).

i. Assemble the housing (12) to body (36) and install lockwashers (10) and nuts (9).

4-3.1.5 Installation.

a. Install strainers (3) and gaskets (4) in pipe bracket (2).
b. Position assembled valve on pipe bracket and install capscrews (1).

4-3.1.6 Pilot Valve Lever Adjustment. (Refer to figure 4-2)



(Inlet pressure, 10 psi higher than stamped on nameplate)

Figure 4-3. Adjustment Set-up

a. Use the adjustment set-up illustrated in figure 4-3. Turn adjusting screw (24) in until control spring (27) is slightly compressed. Remove valve protectors (47). Move the valve handle (7) back and forth, on both sides of the "OFF" position, observing the action of levers (41 and 45). The pilot valves should be fully open after the handle moves through the first 10° travel arc. If the pilot valve levers need adjusting, place the handle in a maximum increasing pressure position. With a 3/32" hexagon wrench, turn adjusting screw (44) of the activated lever (either 41 or 45) out, just far enough to crack the exhaust valve. The gage will show a drop in pressure. From this point, turn the adjusting screw in a full three (3) turns. This will open the inlet valve of the pilot valve to its maximum capacity.

b. Move the handle to the opposite extreme position and repeat the adjustment for the other pilot valve lever.

4-3.1.7 Cam Dog Adjustment. (Refer to figure 4-2) The eccentric cam dog pin (38) aligns the cam dog (39) with the rise on cam (15). If pressure response is not identical to handle position in both quadrants, compensate this difference by turning the cam dog pin (38) either clock-wise or counterclockwise.

4-3.1.8 Pressure Setting Adjustment. (Refer to figure 4-2) Use the adjustment set-up illustrated in Figure 4-3. Adjusting screw (24) varies the minimum and maximum pressure setting a like amount without changing the range of pressure. Turning the adjusting screw in raises the maximum and minimum pressure, turning it out decreases the maximum and minimum pressure.

4-3.1.9 No Preload Setting. (Refer to figure 4-2)

a. This setting has the OUT ports open to exhaust and the IN port is closed in the normal position.

b. Place the handle 10° from OFF in either quadrant. Turn adjusting screw (24) in until a reading is obtained on the gage then turn it out by 1/4 turns until the gage reads zero. At zero pressure give the adjusting screw another 1/4 turn out to open the exhaust valve.

c. Move the handle to full increasing pressure position. The gage should read the pressure stamped on the nameplate. Related handle positions in both quadrants will have identical pressure readings.

4-3.1.10 Preload Setting. (Refer to figure 4-2) a. This setting calls for a predetermined downstream pressure when the handle is moved 10° from OFF position in either handle quadrant.

b. Place the handle 10° from OFF in either quadrant. Turn adjusting screw 24 in until the gage reads the desired preload pressure. Move the handle to the maximum pressure position. The gage should read the pressure on the nameplate plus the preload setting.

4-3.2 Pilotair Valve. (Figure 4-4) 4-3.2.1 Disassembly.

a. Remove capscrews (1) and lockwashers (2) to separate the housing assembly from the valve assembly. Remove followers (3).

b. To disassemble the valve assembly, remove screws (4), washers (5) and flanges (6). Remove guides (7), o-rings (8), plungers (9) and o-rings (10).

c. Remove springs (11), seats (12) and o-rings (13), then lift valves (14) from the body (19).

d. Disassemble the valves by removing rings (15), springs (16) and valves (17) from spacers (18).

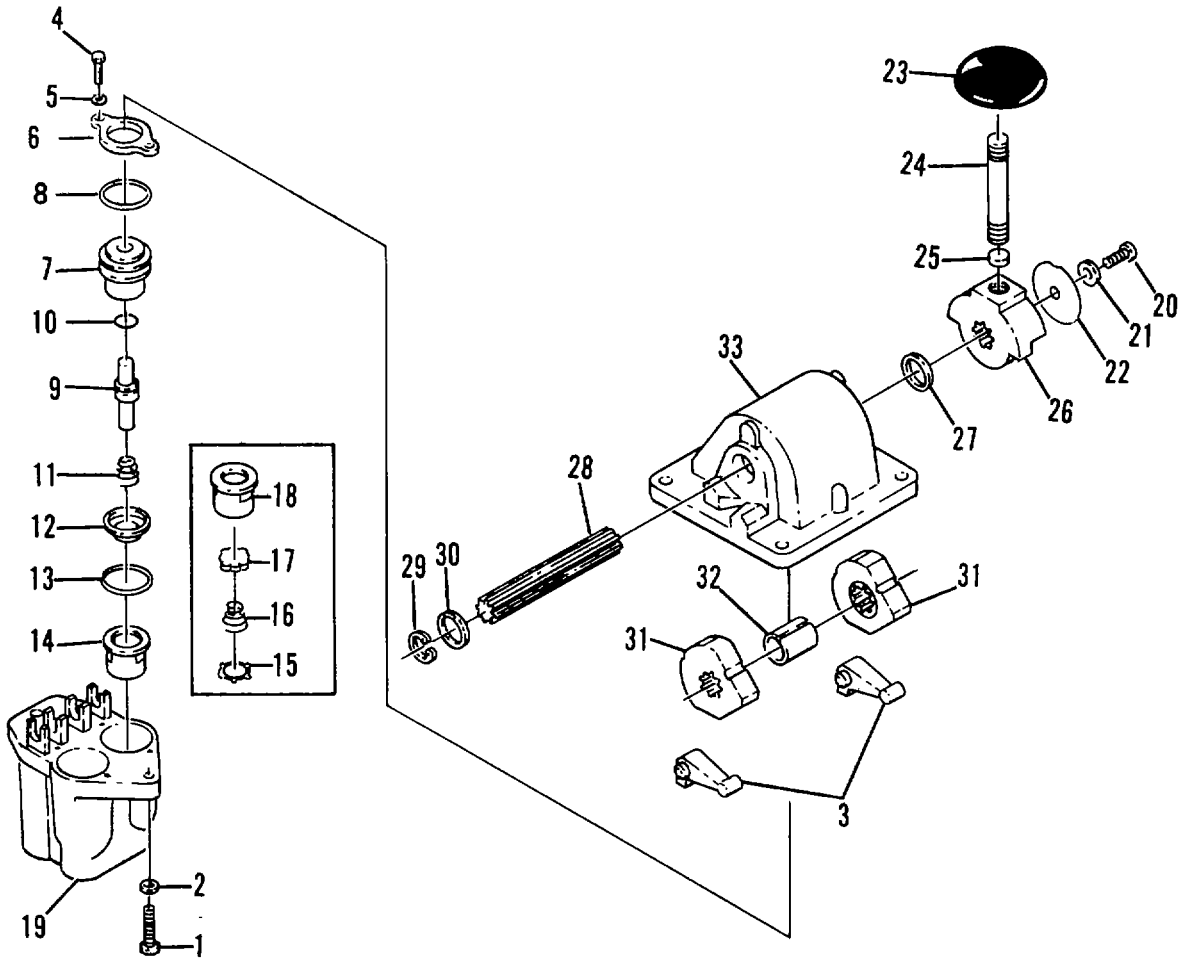
NOTE

Under normal conditions the cam housing assembly should not require disassembly. If, however, disassembly is necessary, it is important that the position of the cams (31) on the shaft (28) in relation to the position of the handle (24) be noted.

The cams are marked for position on the shaft and for the valve cavity that they are to operate.

The position index mark indicates the position of the cam on the shaft when the handle is in the upright position. This mark appears on the edge of the cam.

The engraved cavity number indicates the valve cavity that the cam is to operate. This marking appears as an Arabic numeral on the same side of the cam as the position index mark.



1. Capscrew
2. Lockwasher
3. Follower
4. Screw
5. Washer
6. Flange
7. Guide
8. O-Ring
9. Plunger
10. O-Ring
11. Spring
12. Seat
13. O-Ring
14. Valve
15. Ring
16. Spring
17. Valve
18. Spacer
19. Body
20. Screw
21. Washer
22. Nameplate
23. Knob
24. Handle
25. Plug
26. Hub
27. Washer
28. Shaft
29. Ring
30. Washer
31. Cam
32. Arbor (Spacer)
33. Housing

Figure 4-4. Pilotair Valve

NOTE - continued

With the front (vertical side) of the cam housing facing the operator and with the handle facing toward the right (single handle models), the position index marks and engraved cavity numbers appear on the right side of the cams.

The valve cavities are numbered 1 and 2 from the left with the cam housing in the same position as above.

e. Remove screw (20), washer (21), and nameplate (22). Remove the knob (23), handle (24) and plug (25) from hub (26). Remove hub (26) and washer (27) from the shaft (28).

f. Remove the shaft (28) with ring (29) and washer (30). This will drop the cams (31), and arbors (32) out of the housing (33).

4-3.2.2 Cleaning, Inspection and Repair.

a. Clean all metal parts of the valve assembly with a non-flammable solvent. Wash all rubber parts with soap and water.

b. It is recommended that the cam housing be cleaned as an assembled unit. Clean in mineral spirits or in any solvent that is not harmful to Nylatron GS plastic.

c. Rinse parts thoroughly and blow dry with a low pressure air jet.

d. Inspect all parts and replace those which are worn or damaged.

4-3.2.3 Assembly. During assembly lubricate all metal-to-metal surfaces and bronze bushings in cam housing with no. 107 Lubriplate. Lubricate all rubber parts with Dow Corning no. 55 Pneumatic Grease.

NOTE

Replacement cams (31) are not marked for index position and cavity number. If any cam is to be replaced, the replacement cam must be marked identically to the cam it replaces.

a. Assemble hub (26), plug (25), handle (24) and knob (23). Insert shaft (28) into hub (26) and install nameplate (22), washer (21) and screw (20). Install washer (27) on shaft.

b. Insert the assembled shaft into housing (33) slightly. Position cams (31) so that the engraved cavity numbers and index marks face toward the handle (24). It is imperative that the position index marks appear in a line at bottom center when the handle is in the upright position.

c. Place cam (31) marked no. 2 on shaft next to handle, then install arbor (32), and cam (31) marked no. 1.

d. Slide shaft (28) through left side of housing (33) and install washer (30) and ring (29).

e. Install valves (17), springs (16) and rings (15) in spacers (18).

f. Place assembled valves (14) in cavities of body (19). Install o-rings (13), seats (12), and springs (11).

g. Install o-rings (10 and 8) on plungers (9) and guides (7), respectively.

h. Install plungers (9), guides (7), flanges (6), washers (5) and screws (4).

i. Install cam followers (3) on valve body (19), then assemble the housing assembly to the valve assembly and install lockwashers (2) and capscrews (1).

4-3.3 Air Line Conditioner Unit. (Figure 4-4A)

WARNING

Before performing maintenance on the air line conditioner unit, open drain valve (1) on bowl of filter (2) to allow air pressure to drain from system.

4-3.3.1 Air Line Filter. The air line filter removes contaminants and moisture from air used for air controls.

a. Replacing Element. The filter element may be replaced without removing the entire filter from the piping.

(1). Close valve (3), then open drain valve (1) and release air pressure.

(2). Grasp filter bowl (5), placing thumb on release (4). Move release down with thumb and rotate bowl counterclockwise, then pull bowl straight down.

(3). Remove and discard o-ring (6) and element (7).

(4). Coat the o-ring (6) with light oil or petroleum jelly, then install o-ring (6), element (7) and bowl (5). Turn bowl clockwise until release (4) locks in place.

(5). Close drain valve (1) and open valve (3).

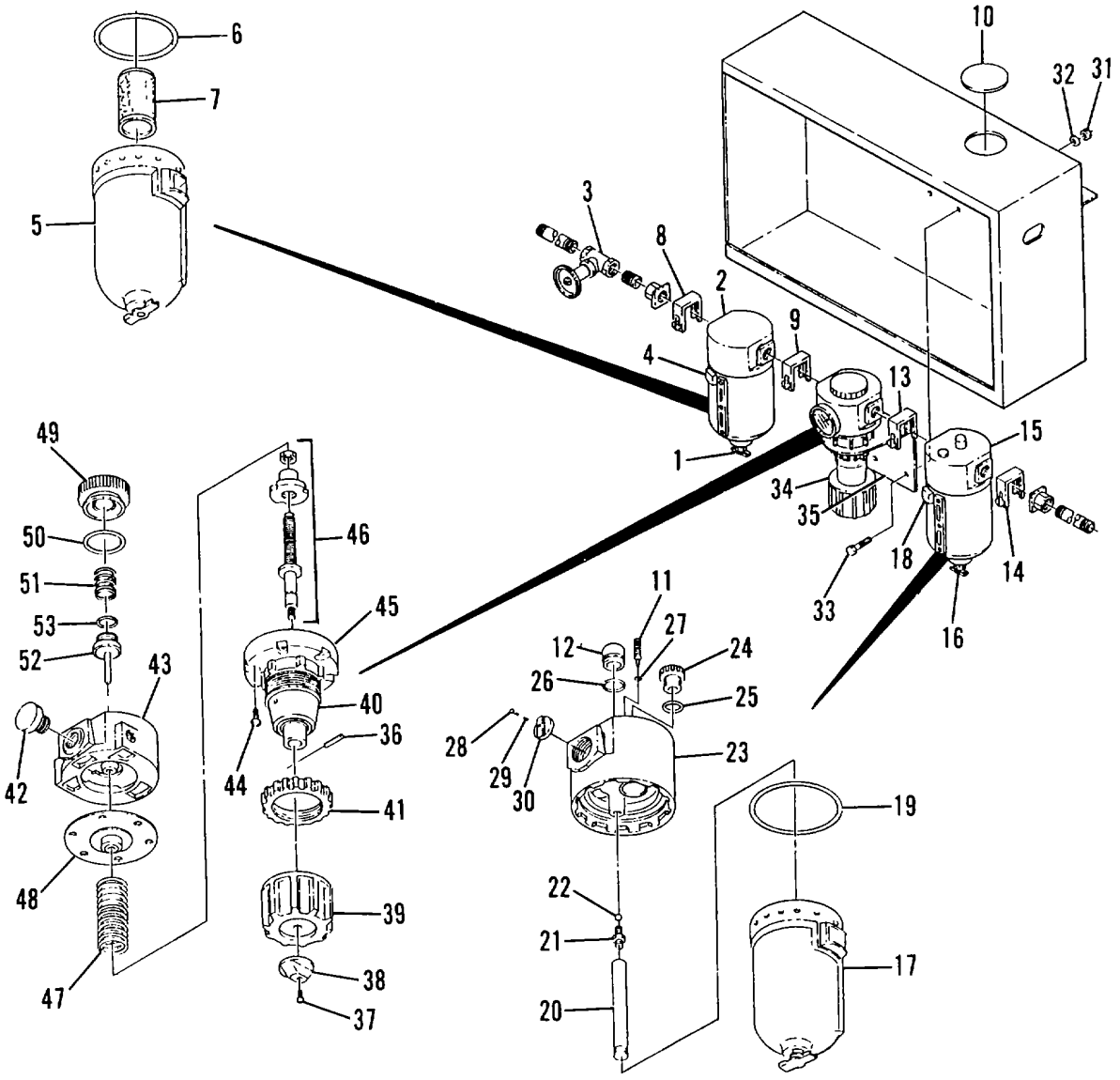
b. Replacing Filter Assembly.

(1). Close valve (3), then open drain valve (1) and release air pressure.

(2). Loosen and remove connection blocks (8 and 9). Remove filter (2).

(3). Place new filter (2) in position and install connection blocks (8 and 9). Tighten blocks.

(4). Close drain valve (1) and open valve (3).



1. Drain Valve
2. Filter
3. Valve
4. Release
5. Filter Bowl
6. O-Ring
7. Element
8. Connection Block
9. Connection Block
10. Rubber Plug
11. Adjusting Screw
12. Sight Dome
13. Connection Block
14. Connection Block
15. Air Lubricator
16. Drain Valve
17. Bowl
18. Release
19. O-Ring
20. Siphon Tube
21. Adapter
22. Ball
23. Head
24. Fill Plug
25. O-Ring
26. O-Ring
27. O-Ring
28. Screw
29. Spring
30. Orifice
31. Nut
32. Lockwasher
33. Screw
34. Regulator
35. Bracket
36. Roll Pin
37. Screw
38. Lock
39. Knob
40. O-Ring
41. Nut
42. Gauge
43. Head
44. Screw
45. Cover
46. Adjusting Stem
47. Spring
48. Diaphragm
49. Plug
50. O-Ring
51. Spring
52. Valve
53. O-Ring

Figure 4-4A. Air Line Conditioner Unit

4-3.3.2 Air Line Lubricator. The air line lubricator may be used to inject a light oil into the air line to lubricate air controls or to inject an anti-freeze solution into the air line to prevent moisture in air from freezing in sub-freezing climates.

a. Adjustment. To adjust the amount of lubricant or anti-freeze introduced into air flow remove rubber plug (10) from cabinet, then use a screwdriver to turn the adjusting screw (11) counterclockwise to increase, clockwise to decrease. Lubricant/anti-freeze flow is observed at sight dome (12).

b. Replacement.

(1). Close valve (3) and open drain valve (1) to release air pressure.

(2). Loosen and remove connection blocks (13 and 14). Remove lubricator (15).

(3). Place new lubricator (15) in position and install connection blocks (13 and 14). Tighten blocks.

(4). Close drain valve (1) and open valve (3).

c. Repair. Repair of the air lubricator is restricted to the replacement of any defective parts. Most repair can be done without removing the assembly from the piping. Remove only those parts necessary to accomplish repair.

(1). Close valve (3) and open drain valve (1) to release air pressure.

(2). Open drain valve (16) to drain lubricant (or anti-freeze) from bowl (17).

(3). Grasp bowl (17), placing thumb on release (18). Move release down with thumb and rotate bowl counterclockwise, then pull bowl straight down. Remove and discard o-ring (19).

(4). Unscrew siphon tube (20) and adapter (21) with ball (22) from head (23).

(5). Remove fill plug (24) and o-ring (25).

(6). Remove sight dome (12) and o-ring (26).

(7). Remove adjusting screw (11) and o-ring (27).

NOTE

To replace the orifice (30), the assembly must be removed from the piping. See paragraph b. above.

(8). Remove screw (28), spring (29), and orifice (30) from head (23).

NOTE

Before installing o-rings, coat them lightly with oil or petroleum jelly.

(9). As necessary, Install orifice (30), spring (29), screw (28), o-ring (27), adjusting screw (11), o-ring (26), sight dome (12), o-ring (25) and fill plug (24) in head (23).

(10). Assemble ball (22) to adapter (21) and screw adapter into head (23). Screw siphon tube (20) on adapter (21).

(11). Install o-ring (19) and bowl (17). Turn bowl clockwise until release (18) locks into place.

(12). Close drain valve (16). Remove drain plug (24) and refill bowl (17) with lubricant (or anti-freeze). Install plug.

(13). Close drain valve (1) and open valve (3).

4-3.3.3 Air Line Regulator. The air regulator sets the pressure in the air control system. Pressure should be maintained between 110-130 psi during operation.

a. Removal.

(1). Close valve (3) and open drain valve (1) to release air pressure.

(2). Loosen and remove connection blocks (9 and 13). Remove nuts (31), lockwashers (32) and screws (33) to remove regulator (34) and bracket (35) from cabinet.

(3). Push out roll pin (36), remove screw (37), lock (38), knob (39) and o-ring (40). Unscrew nut (41) and separate the regulator from the bracket.

b. Disassembly.

(1). Unscrew gauge (42) from head (43).

(2). Remove screws (44), and remove cover (45) from head (43). Remove adjusting stem (46), spring (47), and diaphragm (48).

(3). Remove plug (49), o-ring (50), spring (51), valve (52) and o-ring (53).

c. Repair. Replace damaged or worn parts.

d. Assembly.

(1). Install o-ring (53) on valve (52) and place in head (43). Install spring (51), o-ring (50) and plug (49).

(2). Place the adjusting stem (46) in the cover (45) and put spring (47) on stem (46). Position the diaphragm (48) on the cover (45) so that the holes are aligned.

(3). While holding the diaphragm in place, assemble the cover (40) to head (43) and install screws (44).

(4). Screw gauge (42) into head (43).

e. Installation.

(1). Install the assembled regulator (34) on bracket (35) and secure with nut (41).

(2). Position knob (39) on stem (46) and install roll pin (36).

(3). Install lock (38) and screw (37).

(4). Position the regulator (34) and bracket (35) in the cabinet and install screws (33), lockwashers (32) and nuts (31).

(5). Install and tighten connection blocks (9 and 13).

4-4 MAINTENANCE OF THE MUD PUMP DRIVE

4-4.1 Mud Pump Drive Assembly. (Figure 4-5)

4-4.1.1 Removal and Disassembly.

a. Remove screws (1), lockwashers (2) and clutch guard (3).

b. Disconnect air line (4) from rotor seal (5). Remove rotor seal from mud pump jackshaft. Remove grease fitting (6).

c. Disconnect clutch air lines (7) from mud pump jackshaft. Pull clutch assembly (8) from jackshaft. Refer to paragraph 4-4.2 for maintenance of clutch assembly.

d. Remove plug (9) and drain lubricant.

e. Remove screws (10), lockwashers (11),screws (12), lockwashers (13), adapter (14) and gaskets (15, 16).

f. Remove screws (17) and lockwashers (18) that fasten to case cover (19). Remove nuts (20), lockwashers (21) and screws (22). Separate case cover (19) from case and remove gaskets (23). Leave filler cap (24) installed.

g. Disconnect drive chain (25) at the cotter pin type connector link.

h. Remove clutch bowl (26), with sprocket (27) and associated parts assembled, from the mud pump jackshaft. Remove spacer (28).

i. Disconnect drive shaft from u-joint flange (29). Remove screws (30), lockwashers (31), nut (32), lockwasher (33), and screw (34). Lift the case (35), with assembled parts, from mounting bracket (36).

j. Remove gasket (37) from adapter (38). The adapter (38) shall remain installed on the mud pump.

k. To disassemble parts assembled to clutch bowl (26), remove lockwire (39), nuts (40), screws (41), and sprocket (27).

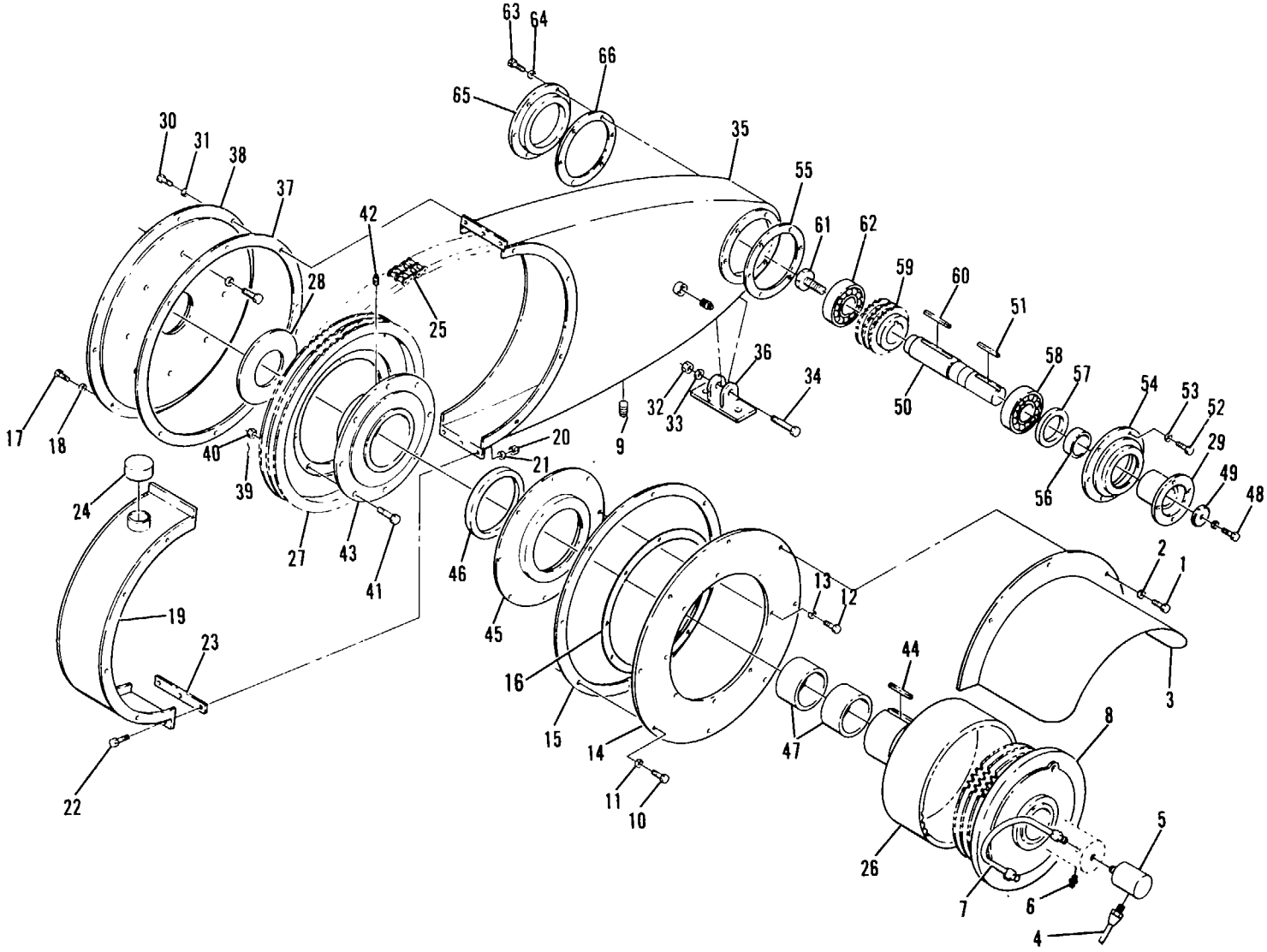


Figure 4-5. Mud Pup Drive Assembly

Legend for Figure 4-5

1. Screw
2. Lockwasher
3. Clutch Guard
4. Air Line
5. Rotor seal
6. Fitting
7. Air Line
8. Clutch Assembly
9. Plug
10. Screw
11. Lockwasher
12. Screw
13. Lockwasher
14. Adapter
15. Gasket
16. Gasket
17. Screw
18. Lockwasher
19. Case Cover
20. Nut
21. Lockwasher
22. Screw
23. Gasket
24. Filler Cap
25. Chain
26. Clutch Bowl
27. Sprocket
28. Spacer
29. Flange
30. Screw
31. Lockwasher
32. Nut
33. Lockwasher
34. Screw
35. Case
36. Bracket
37. Gasket
38. Adapter
39. Lockwire
40. Nut
41. Screw
42. Setscrew
43. Hub
44. Key
45. Retainer
46. Seal
47. Bushing
48. Screw
49. Washer
50. Shaft
51. Key
52. Screw
53. Lockwasher
54. Retainer
55. Gasket
56. Spacer
57. Seal
58. Bearing
59. Sprocket
60. Key
61. Lock Screw
62. Bearing
63. Screw
64. Lockwasher
65. Retainer
66. Gasket

l. Loosen setscrews (42) and remove hub (43) from clutch bowl (26). Secure key (44) to clutch bowl with masking tape to prevent its being misplaced.

m. Remove the retainer (45) and seal (46) from clutch bowl (26). Bushings (47) shall remain installed unless replacement is required due to damage.

n. Remove screw (48) and washer (49). Remove flange (29) from shaft (50) and remove key (51).

o. Remove screws (52), lockwashers (53), retainer (54) and gasket (55). Remove spacer (56) and seal (57).

p. Remove shaft (50), with bearings and sprocket, from case (35). Pull bearing (58) from shaft (50) and remove sprocket (59) and key (60).

q. Remove lockscrew (61) and pull bearing (62) from shaft (50). Secure keys (51,60) in place on shaft (50) with masking tape to prevent their being misplaced.

r. Remove screws (63), lockwashers (64), retainer (65) and gasket (66).

4-4.1.2 Repair. Inspect all parts for wear and damage, paying particular attention to bearings and sprockets. Replace any worn parts. At assembly, install new seals and gaskets.

4-4.1.3 Assembly and Installation.

a. Remove masking tape from shaft (50) and remove key (51). Install sprocket (59) on shaft (50), then install bearings (58,62) and lockscrew (61).

b. Install gasket (66), retainer (65), lockwashers (64) and screws (63) on case (35). Place the chain (25) in the case (35) such that it will be behind the sprocket (59) when it is installed.

c. Install the shaft (50), with assembled bearings and sprocket, in the case (35). See that bearing (62) seats evenly in retainer (65).

d. Install the spacer (56) on shaft (50). Install seal (57) in retainer (54). Install gasket (55), retainer (54), lockwashers (53) and screws (52). Rotate shaft (50) to see that bearings have properly seated and are not binding.

e. Install key (51), flange (29), washer (49) and screw (48).

f. If bushings (47) were removed, install new bushings in clutch bowl (26). Press in one bushing from each end of clutch bowl shaft, so that the bushings are flush at each end.

g. Attach hub (43) to sprocket (27) with screws (41), nuts (40) and lockwire (39). Install seal (46) in retainer (45).

h. Install retainer (45) on shaft of clutch bowl (26). Install key (44) and sprocket (27), with assembled hub, on clutch bowl. Tighten setscrews (42).

i. Install spacer (28) and clutch bowl (26) assembly on the mud pump jackshaft.

j. Place a new gasket (37) on adapter (38). Place case (35) with previously assembled parts on bracket (36) and against adapter (38). Install screw (34), lockwasher (33), nut (32), lockwashers (31) and screws (30).

k. Engage chain (25) on sprockets (59,27) and fasten connecting link.

l. Install gaskets (23), case cover (19), screws (22), lockwashers (21) and nuts (20). Install lockwashers (18) and screws (17).

m. Install gaskets (15,16), adapter (14), lockwashers (13), screws (12), lockwashers (11) and screws (10).

n. Install the clutch assembly (8) on mud pump jackshaft and engage in clutch bowl (26). Connect the clutch air lines (7) to mud pump jackshaft.

o. Install fitting (6) and rotor seal (5) in jackshaft and connect air line (4). Connect drive shaft to flange (29).

4-4.2 Mud Pump Drive Clutch.

4-4.2.1 Disassembly.

NOTE

Wear on the clutch driving plates is determined by measuring the travel of the insulator plate with the clutch engaged (see figure 4-6). This is measured before disassembly. If wear exceeds allowable limits, replace the driving plates.

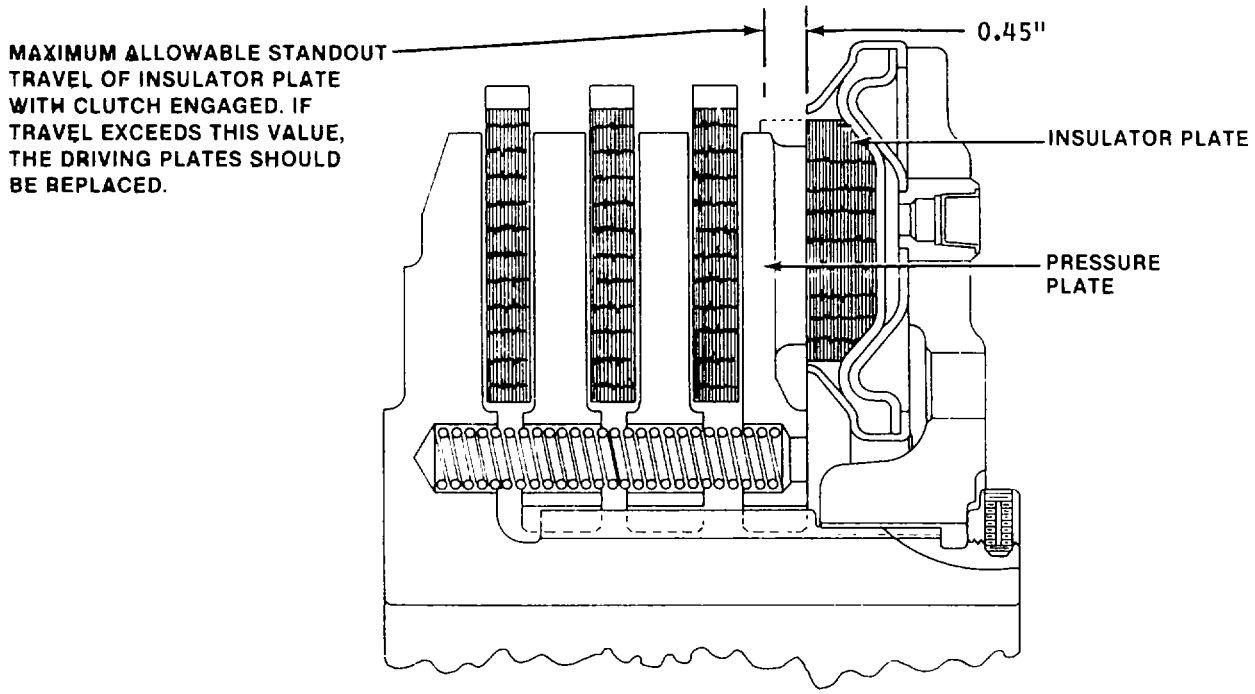
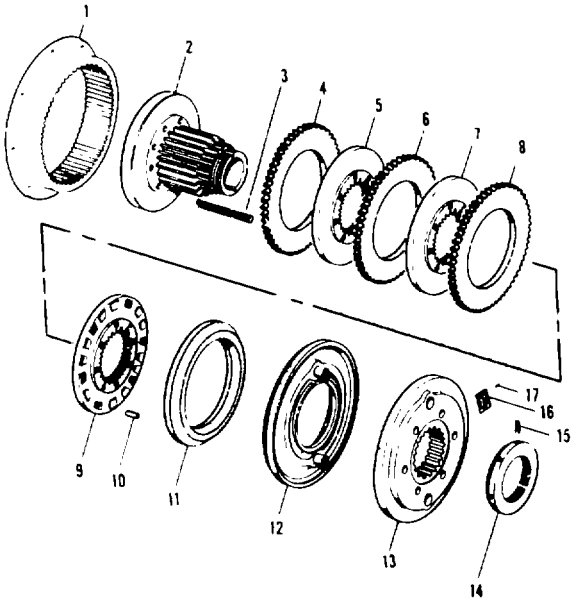


Figure 4-6. Clutch Plate Wear Limits

a. Place the clutch on a working surface, hub-and-back plate (2, figure 4-7) down.

b. Unscrew the hex-socket-head setscrew (15) from the special nut (14) until the nut is free to turn.

c. Remove the special nut (14) from the hub-and-back plate. Use a spanner or chain wrench.



1. Ring
2. Plate
3. Spring
4. Plate
5. Plate
6. Plate
7. Plate
8. Plate
9. Plate
10. Rollpin
11. Plate
12. Diaphragm Assembly
13. Plate
14. Nut
15. Setscrew
16. Nameplate
17. Drivescrew

Figure 4-7. Mud Pump Drive Clutch

d. Remove the front cover plate (13) and diaphragm assembly (12) from the insulator plate (11).

e. Remove the insulator and pressure plate assembly (11 and 9) from the hub-and-back plate. Pry the insulator plate from the pressure plate only if replacement of the parts is necessary. Six roll pins (10) hold the insulator plate to the pressure plate. Remove the rollpins only if replacement of the parts is necessary.

f. Remove the six release springs (3) from the hub-and-back plate.

g. Remove the three driving plates (4, 6 and 8) and two center plates (5 and 7) from the hub-and-back plate (2).

h. Remove the nameplate (16) from the front cover plate (13) only if replacement of the parts is necessary. Remove the nameplate by prying the two drive screws (17) from the front cover plate. The specification number of the clutch is found on this nameplate.

4-4.2.2 Cleaning and Inspection

a. Thoroughly clean all parts with suitable cleaning agents. After cleaning, dry with compressed air. Lubricate all machined surfaces with clean oil. Examine each part after cleaning to make certain all foreign matter has been removed.

b. Inspect castings for cracks. Replace cracked castings. Inspect tapped holes for damaged threads. Chase damaged threads with a standard tap of the correct size. Replace all castings that cannot be repaired properly.

c. Inspect the teeth of the driving rings. Replace a damaged driving ring.

d. Inspect all flexible hoses for cracks, sponginess, or other damage. Replace a damaged hose.

e. Inspect the diaphragm for surface cracks and hardening. Replace a damaged or questionable diaphragm assembly.

f. Inspect all gear teeth for cleanliness and damage. Foreign particles tend to collect in the root of the gear teeth. Clean thoroughly and repair minor nicks with a fine file. Replace parts with gear teeth that cannot be repaired.

g. It is very important that all air holes and hoses be clean and clear.

h. Inspect the driving plates for cracks, nicks or chips. Replace damaged driving plates.

i. Inspect for cracked or warped pressure plate. Replace the plate if it is damaged.

j. Replace return springs as standard practice after any clutch failure.

4-4.2.3 Assembly.

a. Place the hub-and-back plate (2) on a workbench with the hub side up.

b. Place the six release springs (3) in position in the machined counterbored holes in the hub-and-back plate.

c. Install a driving plate (4), center plate (5), driving plate (6), center plate (7), and driving plate (8), onto the hub-and-back plate. Index the center plates to align with the springs and hub-and-back plate.

d. Insert six rollpins (10) into the holes provided in the pressure plate (9). Install the insulator plate (11) onto the rollpins of the pressure plate, and use a rubber mallet to firmly set the insulator plate on the rollpins.

e. Install the pressure and insulator plate assembly onto the hub-and-back plate, making certain to align the bores in the pressure plate with the release springs. After placing the pressure plate in position, center the springs by inserting a drift pin or suitable tool through the holes in the pressure plate.

f. Install the diaphragm assembly (12) against the insulator plate on the hub-and-back plate.

g. Install the front cover plate (13) against the diaphragm assembly hub side down, aligning the hub splines and the air hose connections on the diaphragm assembly.

NOTE

The air inlet holes must be assembled within 7-1/2 degrees of the keyway in the hub-and-back plate.

h. Clamp the front cover plate down, and secure it with the special nut (14). Tighten the nut until it bottoms, then unscrew the nut until a setscrew hole in the nut is aligned with the slot in the hub-and-back plate. Secure the special nut to the huband-back plate with the setscrew (15).

i. If replacement is necessary, place the nameplate (16) in position on the front plate, and secure it with two drivescrews (17).

4-5 MAINTENANCE OF THE MUD PUMP.

4-5.1 Mud Pump Fluid End. (Figure 4-8).

4-5.1.1 Replacing Valves.

a. Remove nuts (1), cover (2) and gasket (3). Lift out spring (4) and valve assembly (5).

b. Examine the valve assembly for wear. If the rubber insert (8) is worn it may be replaced.

c. Remove the screw (6), washer (7), insert (8) from valve (9).

d. Examine the valve seat (10) in the fluid cylinder. If it has been damaged by wear, it will need to be replaced. Do not remove the seat (10) unless replacement is required.

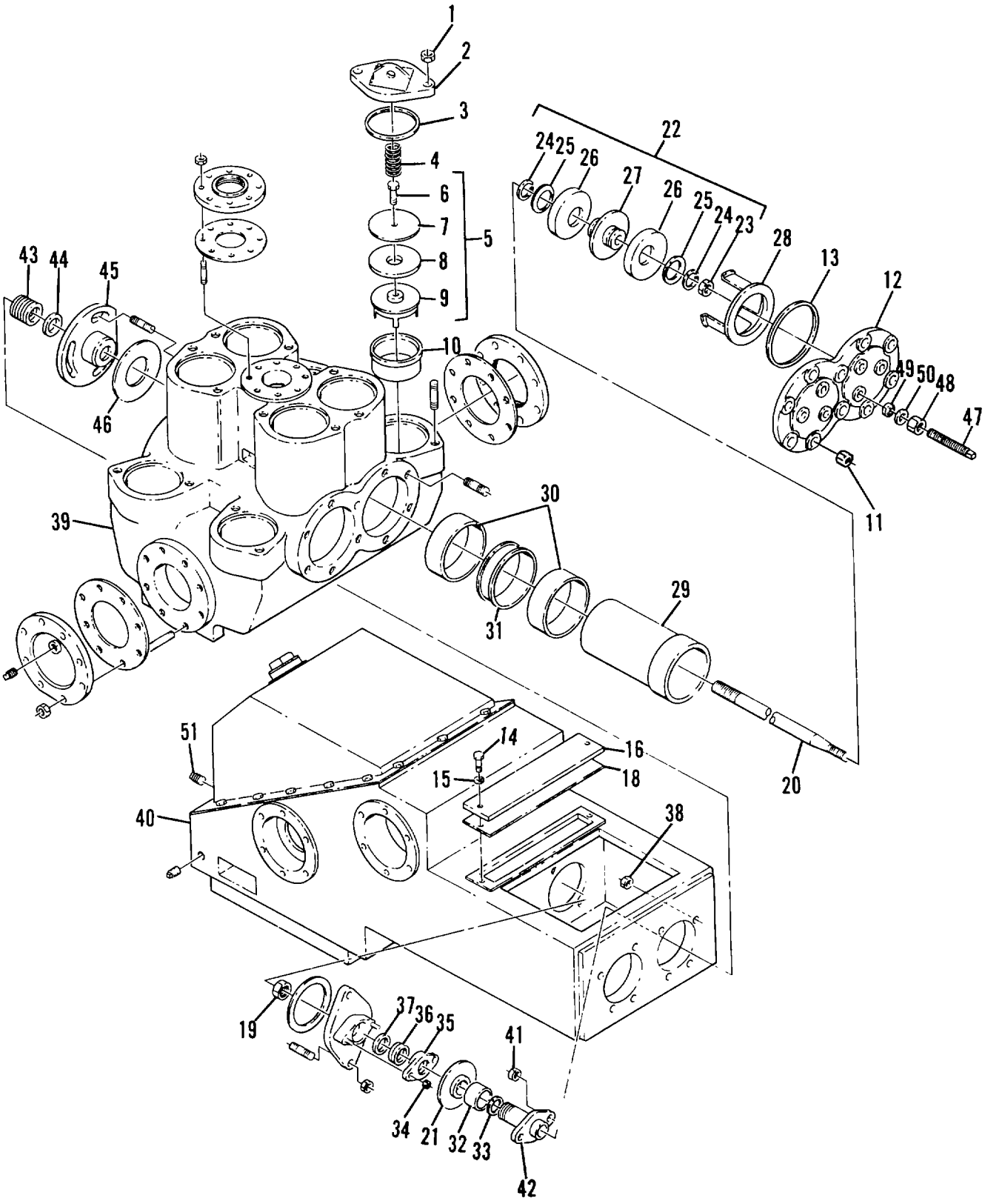


Figure 4-8. Mud Pump (Sheet 1 of 2)

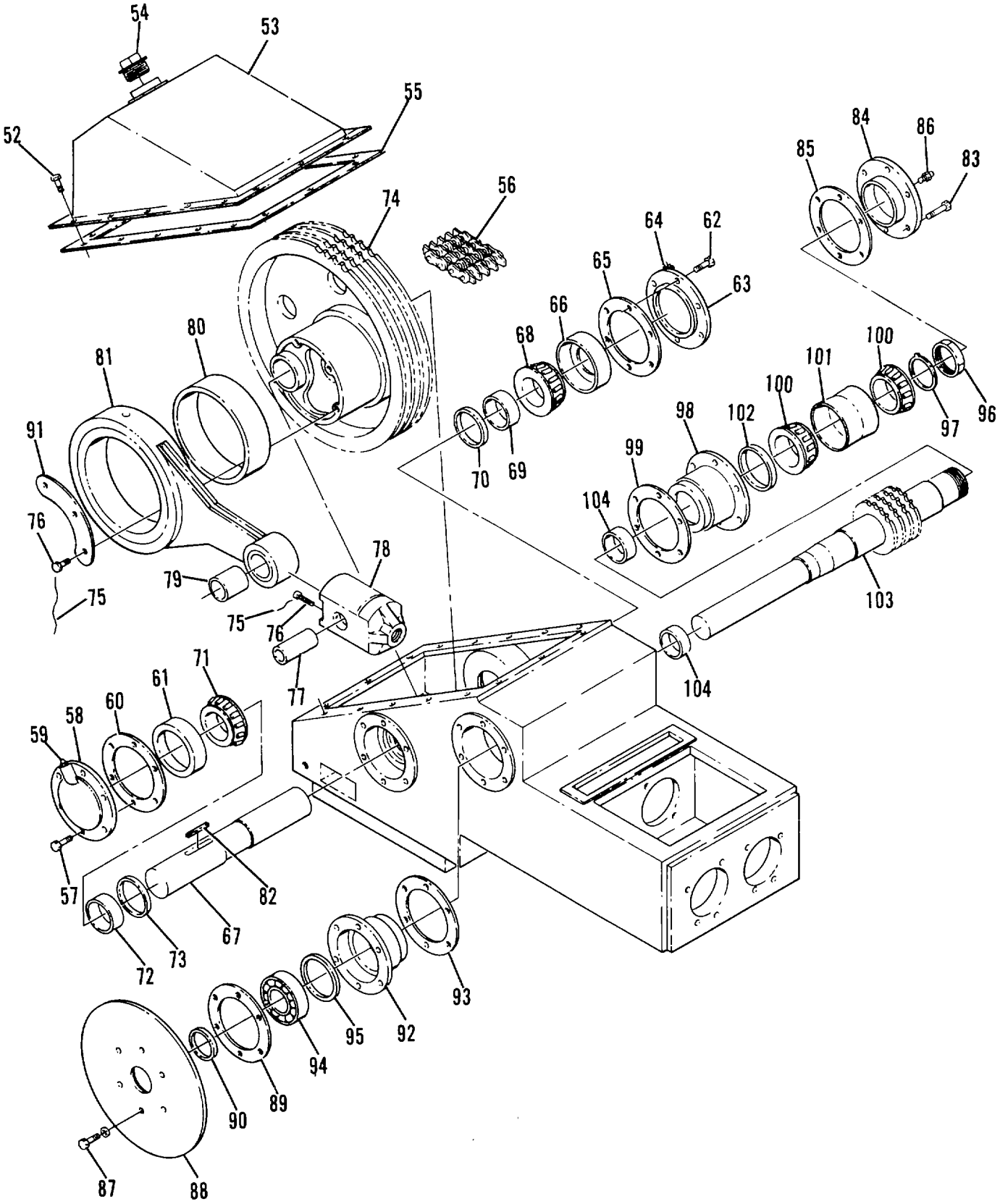


Figure 4-8. Mud Pump (Sheet 2 of 2)

Legend for Figure 4-8

1. Nut
2. Cover
3. Gasket
4. Spring
5. Valve Assembly
6. Screw
7. Washer
8. Insert
9. Valve
10. Valve Seat
11. Nut
12. Head
13. Gasket
14. Capscrew
15. Lockwasher
16. Plate
17. Deleted
18. Gasket
19. Locknut
20. Piston Rod
21. Baffle
22. Piston Assembly
23. Nut
24. Lock Ring
25. End Plate
26. Cup
27. Body
28. Clamp
29. Liner
30. Sleeve
31. Spacer
32. Nut
33. Packing
34. Nut
35. Gland
36. Packing
37. Washer
38. Nut
39. Fluid Cylinder
40. Frame
41. Nut
42. Gland
43. Packing
44. Junk Ring
45. Stuffing Box
46. Gasket
47. Setscrew
48. Nut
49. Packing
50. Washer
51. Plug
52. Screw
53. Cover
54. Filler
55. Gasket
56. Chain
57. Screw
58. Plate
59. Fitting
60. Shim
61. Bearing Cup
62. Screw
63. Plate
64. Fitting
65. Gasket
66. Bearing Cup
67. Shaft
68. Bearing Cone
69. Bushing
70. Seal
71. Bearing Cone
72. Bushing
73. Seal
74. Sprocket
75. Lockwire
76. Screw
77. Pin
78. Crosshead
79. Bushing
80. Bushing
81. Connecting Rod
82. Key
83. Screw
84. Plate
85. Gasket
86. Fitting
87. Screw
88. Retainer
89. Gasket
90. Seal
91. Retainer
92. Housing
93. Gasket
94. Bearing
95. Seal
96. Locknut
97. Lockwasher
98. Housing
99. Gasket
100. Bearing Cone
101. Bearing Cup
102. Seal
103. Jackshaft
104. Bushing

NOTE

A valve seat puller is provided in mud pump tool set.

e. Insert seat puller in valve seat (10) so that the puller shoulders are behind valve seat. Tighten the nut on puller, slowly, until valve seat is disengaged. Lift valve seat (10) from fluid cylinder with puller.

NOTE

Before a new seat is installed, clean both the seat and hole in cylinder thoroughly to remove any abrasive particles.

f. Position new seat (10) in fluid cylinder then, using a block of wood and hammer, carefully tap the seat into place.

g. Assemble the insert (8), washer (7) to valve (9) and install screw (6). Install valve assembly (5) in fluid cylinder.

h. Install spring (4), gasket (3) and cover (2). Install nuts (1) and tighten alternately. Torque to 150 ft.-lb.

4-5.1.2 Replacing Pistons and Liners.

a. Remove nuts (11), then remove pump head (12) and gaskets (13). Remove clamp (28).

b. Remove capscrews (14), lockwashers (15), plate (16) and gasket (18), to gain access to piston rod locknut (19). Loosen locknut.

c. Unscrew piston rod (20) from crosshead (78), remove locknut (19) from rod, and remove rod (20) with piston assembly (22). As this assembly is withdrawn, remove baffle (21).

d. To disassemble piston (22) from rod (20), remove nut (23). Remove assembled piston from rod.

NOTE

Correction of a worn piston may only require the replacement of piston cups (26). Perform the following step to replace piston cups.

e. Remove lock rings (24), end plates (25), and piston cups (26) from body (27). Install new piston cups (26) and install end plates (25) and lock rings (24) on piston body(27).

f. Examine liner (29) in the fluid cylinder. If it has been damaged by wear, it will need to be replaced.

NOTE

A liner puller is provided in mud pump tool set.

g. Insert puller in liner such that its pulling shoulders engage the back (inboard) face of the liner (29). Slowly tighten puller rod until the liner is free, then remove the puller with liner (29).

h. Remove the rubber liner sleeves (30) and spacer (31) from pump. The rubber sleeves (30) shall be discarded.

i. To replace liner (29), place new rubber sleeves (30) and the spacer (31) on the liner (29), then slip liner into place in the fluid cylinder.

j. Unscrew nut (32) and remove packing (33). Remove nut (34), gland (35), packing (36) and washer (37).

k. Using new packing (33 and 36), install washer (37), packing (36), gland (35), nut (34), packing (33) and nut (32).

NOTE

The fluid cylinder (39) should not be separated from the mud pump frame (40) unless leakage has occurred. If leakage has been occurring, perform steps l thru o.

l. Remove nuts (38) and separate the fluid cylinder (39) from the mud pump frame (40).

m. Remove nuts (41), packing glands (42), packing (43), junk rings (44), stuffing boxes (45) and gaskets (46).

n. Install new junk rings (44), packing (43) in stuffing box (45). Assemble packing glands (42) to stuffing box and install nuts (41).

o. Install new gaskets (46) on stuffing boxes (45) and install them on fluid cylinder (39). Assemble fluid cylinder to frame (40) and install nuts (38). Tighten nuts to 260 ft. lbs.

p. Install the piston assembly (22) on the rod (20) and tighten nut (23). Install the assembled rod and piston into the fluid cylinder, through the baffle (21) and into mud pump frame. Install clamp (28).

q. Install the locknut (19) and then screw rod (20) into crosshead. Tighten locknut.

NOTE

When screw rod into crosshead, always leave two to three threads exposed on the rod behind the locknut when it is locked down.

CAUTION

When installing head (12) after new liners have been installed, always loosen the liner adjusting setscrews (47) before bolting the head down.

r. Loosen nuts (48) on liner setscrews (47) and back setscrews out of head (12). Install new packing (49) behind washer (50) and thread setscrew back into head until it is flush with inside surface.

s. Install gaskets (13) and head (12). Install nuts (11) and tighten alternately. Torque nuts to 260 ft.-lbs.

t. Install gasket (18), plate (16) and secure with capscrews (14) and lockwashers (15).

CAUTION

Never adjust liner setscrews (47) while pump is running. Do not overtighten setscrews since too much pressure on liner can cause "bottle-necking" of liner sufficient to prevent piston from passing.

u. Alternately tighten liner setscrews (47) slowly until fluid stops leaking through "weep" holes located on upper sides of fluid end. When set, tighten nut (48) while holding setscrew in position.

4-5.2 Mud Pump Power End. (Figure 4-8)

4-5.2.1 Disassembling Power End. The mud pump drive case and mud pump clutch must be removed before performing the following steps.

a. Remove plug (51) and drain the mud pump power end. Remove screws (52), cover with filler (53, 54) and gasket (55).

b. Disconnect the chain (56) at the cotter pin type connector link.

c. Remove screws (57), plate (58) with fitting (59), shims (60) and bearing cup (61).

d. Remove screws (62), plate (63) with fitting (64), gasket (65), and bearing cup (66).

e. Attach a hoisting device to the eccentric sprocket (74) so that it will be supported when the shaft is removed.

f. Remove screws (14), lockwasher (15), plate (16) and gasket (18). Loosen locknut (19) and unscrew rod (20) from crosshead (78).

NOTE

The shaft (67) MUST be removed from the side in which the shaft contains a tapped hole (3/4-16). In the case both ends are tapped, the end for removal is designated by a 1/4-inch hole next to the tapped hole.

g. Remove shaft (67) using a puller bolt in the tapped hole of the shaft. As shaft is pulled, bearing cone (68), bushing (69) and seal (70) can be removed from the opposite side.

h. When shaft is fully removed, remove bearing cone (71), bushing (72) and seal (73). Key (82) can be held in place on shaft (67) with masking tape.

i. Lift sprocket (74), with connected parts (75-81), from the mud pump frame (40).

j. Remove lockwires (75), screws (76) and retainers (91). Remove pins (77) to disconnect crossheads (78) from connecting rods (81). Bushings (79 and 80) should remain installed in connecting rod (81) unless worn or damaged.

k. Remove screws (83), plate (84), and gasket (85). Leave fitting (86) in plate (84).

l. Remove screws (87), retainer (88), and gasket (89). Remove seal (90) from retainer (88).

m. Install screws in puller holes of housing (92) and pull housing (92) from the mud pump frame. Remove gasket (93), bearing (94) and seal (95).

n. Install screws in puller holes of housing (98) and pull housing (98), with jackshaft and bearings assembled, from the mud pump frame. Remove gasket (99).

o. Remove locknut (96), lockwasher (97) and outer bearing cone (100), then pull jackshaft (103) from housing (98). Remove bearing cup (101) inner bearing cone (100) and seal (102). Remove bushings (104) from jackshaft (103).

4-5.2.2 Inspection and Repair.

a. Examine the bushings (79, 80) for excess wear. Refer to table 4-3 for wear limit.

b. Install the crossheads (78) in the slide (bore) and check clearance. Refer to table 4-3 for limit.

NOTE

Oversize crossheads (.010 in.) may be installed if crosshead slide is rebored. In case of excessive bore size, the pump may be returned to factory for sleeving.

c. Inspect and replace all worn parts. Always install new seals at assembly.

Table 4-3. Clearance Limits

COMPONENT PART	LIMIT
1. Eccentric Bushings	
a. Good Condition	.006"-.015"
b. Worn out	.030 or making noise
2. Crosshead Bushings	
a. Good Condition	.0005"-.001"
b. Worn out	.007" or making noise
3. Crosshead to Slide	
a. Good Condition	.010"-.017"
b. Worn out	.060" or making noise

4-5.2.3 Assembling Power End.

a. Install bushings (79,80) in connecting rod (81). Assemble crosshead (78) to connecting rod and install pin (77), screws (76) and lockwire (75).

b. Assemble connecting rods on eccentric sprocket (74) and install retainers (91), screws (76) and lockwire (75). Attach a hoisting device to the sprocket and lift it into place in the mud pump frame.

c. Remove the masking tape holding key (82) in place. Install bushing (72) and bearing cone (71) on shaft (67). Install seal (73) in bore of mud pump frame.

d. Orient the shaft (67) so that the key (82) is aligned with keyway in sprocket (74). Install the shaft (67) in sprocket (74). Install seal (70).

e. Install bushing (69) and bearing cone (68) by tapping with a soft hammer. (Sometimes it will simplify the bearing installation if it is heated in oil to expand it.) Remove hoist from sprocket.

f. Install bearing cup (66), gasket (65), plate (63) and screws (62). Install bearing cup (61), shims (60), plate (58) and screws (57).

g. To adjust the bearings (68, 71), remove shims (60) until the bearings bind when plates (58 and 63) are tightened down; then loosen the plate (58) and bump the eccentric sprocket. Add shims (60) until the bearings are tight but not binding.

h. Install bushings (104) on jackshaft (103). Install seal (102), inner bearing cone (100) and bearing cup (101) in housing (98).

i. Install jackshaft (103) in housing (98), then install outer bearing cone (100), lockwasher (97) and locknut (96). Tighten locknut so that bearings are tight, but not binding. Install gasket (99) on housing.

j. Install the housing (98) and jackshaft (103) assembly in mud pump frame.

k. Install gasket (93) and housing (92). Install seal (95) in housing (92) over jackshaft.

l. Install gasket (85), plate (84) and screws (83). Install seal (90) in retainer (88). Place bearing (94) on jackshaft (103) and squarely in housing (92).

m. Place retainer (88),with gasket (89), against bearing (94) and install screws.(87). Tighten screws alternately to push bearing (94) into housing (92) and on jackshaft (103).

n. Install chain (56). Screw rod (20) into crosshead (78) and tighten locknut (19).

NOTE

When screwing rod into crosshead, always leave 2 to 3 threads exposed on the rod behind the locknut when it is locked down.

o. Install gasket (18), plate (16), lockwashers (15) and screws (14). Install gasket (55), cover (53) and screws (52). Install plug (51).

p. Refer to lubrication instructions and service the mud pump.

4-6 MAINTENANCE OF THE SUBDRIVE ASSEMBLY

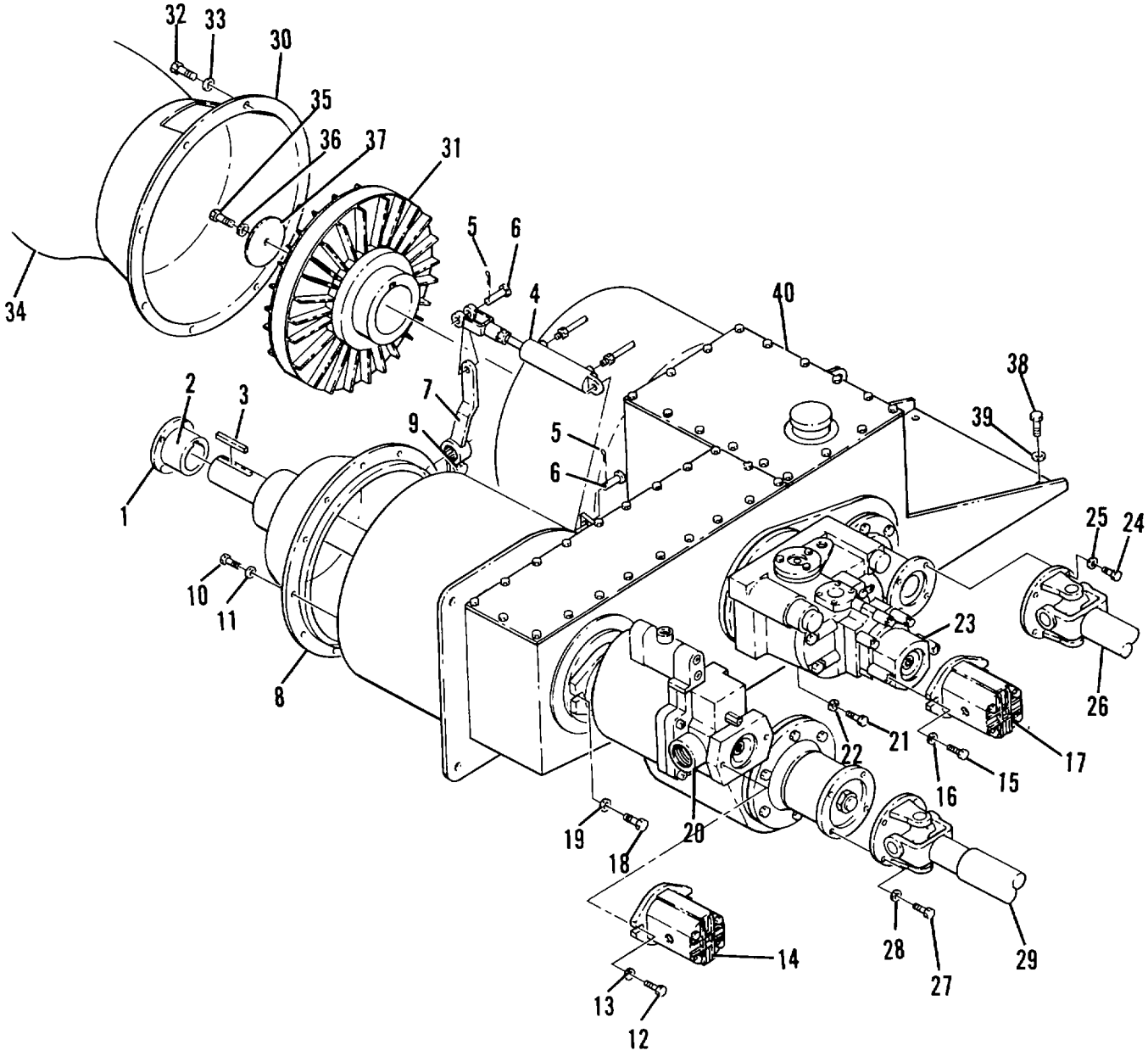
4-6.1 Subdrive Assembly.

4-6.1.1 Removal (Figure 4-9)

a. Disconnect drive shaft from flange (1). Loosen setscrews (2) and remove flange (1) from PTO shaft. Secure key (3) to shaft with masking tape.

b. Disconnect air lines from cylinder (4). Remove cotter pins (5) and pins (6). Remove cylinder (4).

c. Engage lever (7) to hold clutch facings in place, when PTO assembly (8) is removed. Loosen screw (9) and remove lever (7).



1. Flange
2. Setscrew
3. Key
4. Air Cylinder
5. Cotter Pin
6. Pin
7. Lever
8. Power Take-off
9. Screw
10. Screw
11. Lockwasher
12. Screw
13. Lockwasher
14. Pump
15. Screw
16. Lockwasher
17. Pump
18. Screw
19. Lockwasher
20. Pump
21. Screw
22. Lockwasher
23. Displacement Pump
24. Screw
25. Lockwasher
26. Driveshaft
27. Screw
28. Lockwasher
29. Drivehsaft
30. Clutch Housing
31. Clutch
32. Screw
33. Lockwasher
34. Air Compressor
35. Screw
36. Lockwasher
37. Washer
38. Screw
39. Lockwasher
40. Subdrive Assembly

Figure 4-9. Subdrive Assembly, Major Components

CAUTION

Care should be exercised when removing the PTO from subdrive assembly so that the facings and pilot bearing are not damaged.

d. Attach a lifting device to the PTO assembly (8) and remove screws (10) and lockwashers (11). Lift PTO assembly out and away from subdrive assembly. Refer to paragraph 4-6.2 for maintenance of PTO.

e. Close all valves at outlets from hydraulic tank. Place a container beneath hydraulic hose connections to pumps on subdrive. Disconnect all hydraulic lines.

NOTE

The hoses should be tagged in some way to aid in locating them properly at assembly.

f. Remove screws (12 and 15) and lockwashers (13 and 16) to remove pumps (14 and 17). Refer to paragraph 4-6.4 for maintenance of pump.

g. Remove screws (18) and lockwashers (19) to remove pump (20). Refer to paragraph 4-6.3 for maintenance of pump.

h. Remove screws (21) and lockwashers (22) to remove displacement pump (23). Refer to paragraph 4-6.5 for maintenance of pump.

i. Disconnect driveshaft (26) by removing screws (24) and lockwashers (25). Swing driveshaft (26) away from flange. Disconnect lower driveshaft (29) by removing screws (27) and lockwashers (28). Lower driveshaft (29) clear of subdrive.

j. Through the access hole in the clutch housing (30), disconnect the air lines from the air compressor drive clutch (31). Remove screws (32) and lockwashers (33) attaching clutch housing to subdrive case.

k. Remove the hardware that attaches the air compressor (34) to the drill frame. Move the air compressor, with clutch housing, away from the subdrive assembly far enough to give access to the clutch (32).

l. Remove the screw (35), lockwasher (36) and washer (37). Remove the clutch (31) from the shaft of the subdrive. Refer to paragraph 4-7.2 for maintenance of the clutch.

m. Remove screws (38) and lockwashers (39). Attach a hoisting device to the subdrive assembly (40) and lift it from the drill frame. Set the subdrive on a stand that will support it in the upright position. Drain the lubricant from the case.

4-6.1.2 Disassembly. (Figure 4-10)

a. Remove screws (1), lockwashers (2) and plate (3) with filler cap (4). Note the position of filler cap in relation to the case so that it will be properly oriented at assembly. Remove gasket (5).

b. Remove screws (6), lockwashers (7), plate (8) and gasket (9).

c. Disconnect chains (10,11 and 12) at the cotter pin type connectors and remove chains.

d. Loosen setscrew (13) and remove flange (14) and key (15) from shaft. Remove screws (16), lockwashers (17), retainer (18), seal (19) and gasket (20).

e. Using screws in the puller holes in retainer (21), pull the retainer with shaft assembly from the subdrive case. Remove gasket (22).

f. Remove the sprockets (23 and 24), key (25), spacer (26), sprocket (27), and key (28) from shaft (29). Pull shaft (29) from retainer (21) and remove bearing (30).

g. Remove screws (31), lockwashers (32), retainer (33), gasket (34), bearing (35) and seal (36).

h. Remove screws (37) and lockwashers (38). Using screws in the puller holes, pull adapter (39) from case and remove gasket (40).

i. Remove snap ring (41) and push sprocket (42) out of retainer (39). Remove snap ring (43) and pull bearing (44) from adapter (39).

j. Loosen setscrews (45) and pull hub (46) with associated parts from shaft, and remove key (47).

k. Remove the snap ring (48), and pull bearing (49) from hub (46). Remove screws (50) and lockwashers (51) to separate drive ring (52) and hub (46).

l. Remove screws (53) and lockwashers (54), then, using screws in the puller holes, pull retainer (55) with shaft assembly from the case and remove gasket (56).

m. Pull bearing (57) from shaft (58). Remove shaft from retainer (55) and remove bearing (59), sprocket (60), key (61) and seal (62).

n. Remove screws (63), lockwashers (64), adapter (65) and gasket (66).

o. Remove cotter pin (67), nut (68), flange (69) and key (70).

p. Remove screws (71) and lockwashers (72); then, using screws in the puller holes, pull retainer (73) from case with shaft assembly, and remove gasket (74).

q. Remove screws (75), lockwashers (76), retainer (77) and gasket (78).

r. Remove bearing (79), sprocket (80), key (81), shaft (82) and bearing (83). Remove seal (84).

s. The elbow (86), plug (87), valves (88), nipples (89) and drain cock (90) may remain in case (85) unless replacement is necessary.

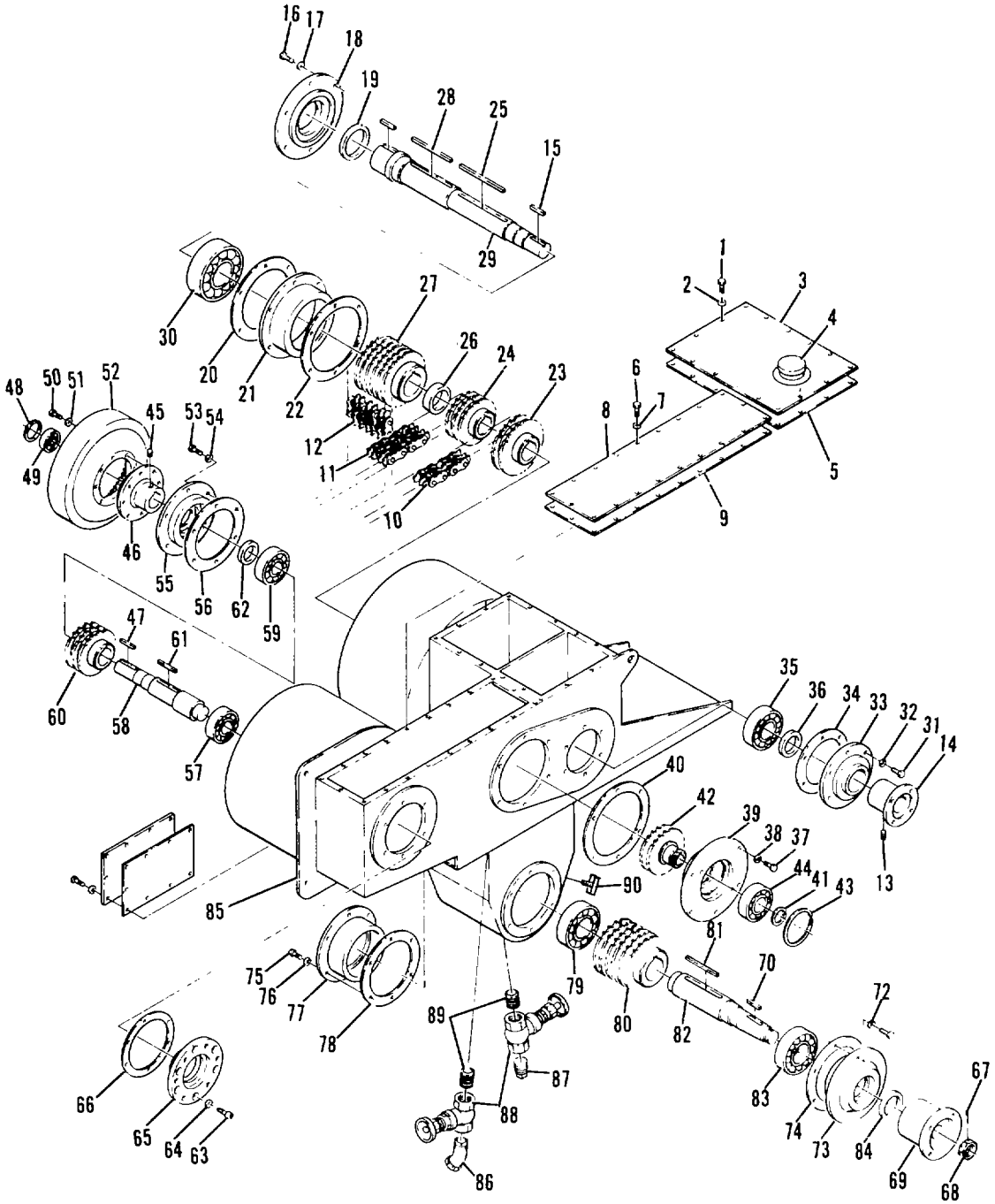


Figure 4-10. Subdrive Assembly, Exploded view

Legend for Figure 4-10

1. Screw
2. Lockwasher
3. Plate
4. Filler Cap
5. Gasket
6. Screw
7. Lockwasher
8. Plate
9. Gasket
10. Chain
11. Chain
12. Chain
13. Setscrew
14. Flange
15. Key
16. Screw
17. Lockwasher
18. Retainer
19. Seal
20. Gasket
21. Retainer
22. Gasket
23. Sprocket
24. Sprocket
25. Key
26. Spacer
27. Sprocket
28. Key
29. Shaft
30. Bearing
31. Screw
32. Lockwasher
33. Retainer
34. Gasket
35. Bearing
36. Seal
37. Screw
38. Lockwasher
39. Adapter
40. Gasket
41. Snap Ring
42. Sprocket
43. Snap Ring
44. Bearing
45. Setscrew
46. Hub
47. Key
48. Snap Ring
49. Bearing
50. Screw
51. Lockwasher
52. Drive Ring
53. Screw
54. Lockwasher
55. Retainer
56. Gasket
57. Bearing
58. Shaft
59. Bearing
60. Sprocket
61. Key
62. Seal
63. Screw
64. Lockwasher
65. Adapter
66. Gasket
67. Cotter Pin
68. Nut
69. Flange
70. Key
71. Screw
72. Lockwasher
73. Retainer
74. Gasket
75. Screw
76. Lockwasher
77. Retainer
78. Gasket
79. Bearing
80. Sprocket
81. Key
82. Shaft
83. Bearing
84. Seal
85. Case
86. Elbow
87. Plug
88. Valve
89. Nipple
90. Drain Cock

4-6.1.3 Inspection and Repair

a. Clean all parts thoroughly and inspect for damage or wear.

b. Check sprockets for broken or missing teeth.

c. Check bearings for burn marks, metal filings, and pitted roller balls.

d. Replace all worn or damaged parts. Use new gaskets and seals at assembly.

4-6.1.4 Assembly.

a. Install key (81) in shaft (82) and install sprocket (80). Press bearings (83 and 79) onto shaft (82).

b. Install retainer (77) and gasket (78)in case (85) and install screws (75) and lockwashers (76).

c. Install assembled shaft (82) in case and seat the bearing (79) in retainer (77). Install the seal (84) in retainer (73) and install the retainer (73) and gasket (74) over the shaft (82). Install screws (71) and lockwashers (72).

d. Rotate shaft to make sure the bearings are not binding. Install key (70), flange (69), nut (68) and cotter pin (67).

e. Install key (61) in shaft (58) and install sprocket (60). Press bearings (59 and 57) onto shaft (58).

f. Install adapter (65) and gasket (66) in case (85) and secure with screws (63) and lockwashers (64).

g. Install assembled shaft (58) and seat the bearing (57) in adapter (65). Install the seal (62) in retainer (55) and install the retainer (55) and gasket (56) over shaft (58). Install screws (53) and lockwashers (54).

h. Rotate the shaft (58) to make sure the bearings are not binding. Install key (47).

i. Press the bearing (49) into hub (46) and install snap ring (48). Assemble drive ring (52) to hub (46) and install screws (50) and lockwashers (51).

j. Install the assembled hub (46) on shaft (58) and tighten setscrews (45).

k. Press bearing (44) into adapter (39) and install snap ring (43). Install sprocket (42) in adapter (39) and bearing (44), and install snap ring (41).

l. Install the adapter (39) and gasket (40) on case (85) and install screws (37) and lockwashers (38).

m. Press bearing (30) onto shaft (29), then install shaft and bearing in retainer (21).

n. Install key (28), sprocket (27), spacer (26), key (25) sprocket (24) and sprocket (23) on shaft (29).

o. Install the retainer (21), with shaft assembly, and gasket (22) in case (85). Install seal (19) in retainer (18) and install retainer and gasket (20) over shaft (29). Install screws (16) and lockwashers (17).

p. Install seal (36) and bearing (35) in retainer (33). Install the retainer (33) and gasket (34) over shaft (29) and install screws (31) and lockwashers (32).

q. Rotate shaft (29) to be sure bearings are not binding. Install key (15), flange (14) and tighten setscrews (13).

r. Install and connect chains (10,11 and 12).

s. Install gaskets (9 and 5), plates (8 and 3), screws (6) and lockwashers (7).

NOTE

Make sure that plate (3) is installed with filler cap (4) in original position, or case will not fill with lubricant properly.

4-6.2 Power Take-Off. (Figure 4-1 1)

4-6.2.1 Disassembly.

a. Use a standard bearing puller and remove the pilot bearing (T25).

b. Straighten the tang on lockwasher (T27). Hold clutch and shaft, remove shaft nut (T26) and lockwasher (T27).

c. To remove clutch from shaft place prybars at opposite sides of the clutch housing and behind pressure plate (H3). Exert pressure outward (away from the roller bearings). Rap pilot end of the shaft sharply with soft hammer to jar clutch assembly off the taper of the drive shaft.

NOTE
Follow steps d. through m. to disassemble the clutch assembly.

d. Remove clutch release lever (holdback) spring (H 12) from clutch release sleeve (H22).

e. Match mark each half of release sleeve collar (H23) to assure that they will be assembled in their same relative position.

f. Remove the two nuts and bolts holding the collar (H23) together, then remove collar from release sleeve (H22).

g. Remove retaining rings (H34) from pins (H33).

h. Remove pins (H33) from links (H30) and levers (H13).

i. Remove retaining rings (H15) from pins (H14) that connect release levers (H13) to the bosses on the clutch body (H1). Remove pins and levers from clutch body. Note the direction the heads of the link to release sleeve and release lever to pressure plate pins are facing before removing so they may be installed in the same direction as they were removed.

j. Remove the adjusting ring lock retaining bolt (H17), lockwasher (H18) and lock (H19) from pressure plate (H 3).

k. Remove clutch adjusting ring (H9) by turning COUNTER-CLOCKWISE out of the clutch pressure plate.

l. Lift clutch pressure plate (H3) straight up, off bosses of clutch body (H1).

m. Remove the three clutch pressure plate separator springs (H36) from holes in clutch body.

n. Remove clutch and drive key (T28) from drive shaft (T8).

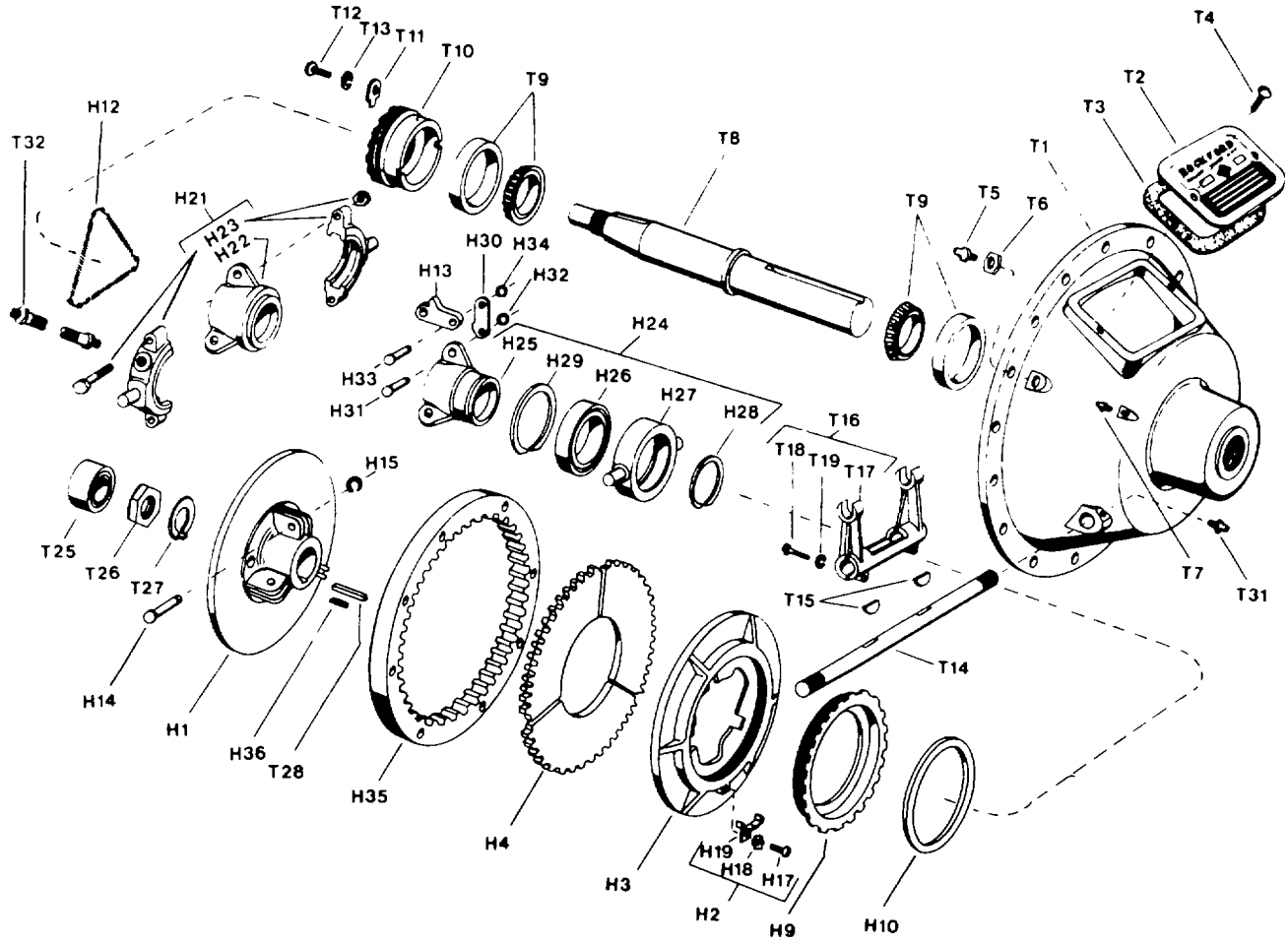


Figure 4-1 1. Power Take-Off

o. Loosen the two bolts (T18) in yoke (T17).

p. Slide yoke left or right on the cross shaft to expose woodruff keys (T15).

q. Remove woodruff keys (T15) from cross shaft (T14). Withdraw shaft (T14) from yoke (T17) and housing (T1).

r. Remove bearing retainer lock bolt (T12) and lock (T11).

s. Remove bearing retainer (T10). To remove rotate counter clockwise.

t. Remove the clutch shaft from the front of the housing. Tap the output end of the shaft if the bearing cup sticks in the housing.

u. The cup of the rear roller bearing will remain in the housing after the clutch shaft has been removed.

NOTE
Turn the housing face down.

v. There are three holes provided at the rear of the housing for removal of the rear bearing cup. Insert a punch in the holes and tap alternately at three points. Avoid cocking and cramping the bearing during removal.

NOTE
On some housings these three holes may be plugged with screws. Remove screws and proceed per above instructions.

w. Wash the bearings thoroughly with solvent. Blow dry with compressed air and examine for wear, corrosion or rough spots. If it is determined that the bearings are unsatisfactory for further use, they must be removed from the clutch shaft as follows:

(1) Place a split type bearing remover between the two roller bearings.

(2) Place clutch shaft and bearing remover on bench press and push bearing from the shaft.

(3) Invert the shaft in the press and remove the other bearing in the same manner.

4-6.2.3 Cleaning, Inspection and Repair.

a. Wash all parts of the Power Take-Off EXCEPT the CLUTCH FACINGS in a good solvent, then, blow dry before inspection.

b. Examine bearing, cups, races, balls, and rollers for indications of corrosion or pitting. Apply light engine oil to the bearings; then, while holding the inner race, revolve the bearing and outer race slowly to check for free rolling of the balls or rollers on the races and cup. Rough or sticking spots of the bearings are cause to reject the bearings from further use.

c. Examine the clutch FACINGS for being scored, burned or cracked; inspect driving TEETH for wear or damage and measure thickness of the facings. Replace any clutch facing that is badly scarred, burned, or has driving teeth which are worn and/or damaged, or if the facing thickness is worn to under 5/16 of an inch.

d. Inspect the FRICTION SURFACES on the clutch body and pressure plate for being flat, smooth, and free from cracks and heat checks. The drive BOSSES and KEYWAY of the clutch body, and the adjusting ring THREADS and boss NOTCHES of the pressure plate should be examined for wear, and if worn excessively, should be replaced.

e. Inspect the INNER FACE and THREADS of the adjusting ring for wear or damage. If worn excessively, replace adjusting ring.

f. Examine all lever and link pins and pin holes in links, release levers, release sleeve and pressure plate for wear. If pins and pin holes in parts are worn excessively, parts must be replaced.

g. Inspect the FINGERS of the adjusting ring lock for wear. Replace lock if fingers are worn excessively or have been damaged. Lock must have sufficient tension to hold adjusting ring from turning when clutch is operating.

h. Examine the WEARING SURFACE of release sleeve collar and mating surface on release sleeve. If parts show excessive wear, they must be replaced.

i. Inspect the surface of the clutch release yoke fingers and mating TRUNNIONS on the release sleeve collar for wear. If parts are worn excessively, they must be replaced.

j. Examine threads, keyways, and pilot bearing surface of drive shaft.

k. Check the pressure plate separator springs for being broken or weak. Approximate spring pressure is 15 to 20 lbs. with spring compressed to 13/16 of an inch.

4-6.2.4 Assembly.

NOTE

Use steps a. through n. to assemble the clutch assembly, then the remaining steps to assemble the power take-off assembly.

a. Place the clutch body (H1) on workbench with hub end (release lever bosses) of pressure plate up. Place clutch pressure plate separator springs (H36) in holes provided in plate next to release lever bosses.

b. Place the pressure plate (H3) on top of the clutch body (smooth face down) with notches in pressure plate in line with the release lever bosses of the clutch body, then lower pressure plate down on the three pressure plate separator springs (H36).

c. Lubricate threads on clutch adjusting ring (H9) and turn it CLOCKWISE into pressure plate (H3) until it bottoms.

d. Install clutch release levers (H13) in opening of bosses or clutch body (H1) with notch end of lever up and out.

NOTE

Determine the direction the clutch will rotate when attached to the engine, then install lever pins (H14) with the heads of the pins leading the rotation of the clutch.

CAUTION

Be sure retaining rings (H 15) are securely locked on pins (H14).

e. Align holes in levers (H13) with holes in bosses of outer plate; then, insert pins (H14) through pin holes and secure with retaining rings (H 15).

f. Heeding the match marks previously placed on the two halves, lubricate inside diameter of clutch release sleeve collar (H23). Place the two halves together over the shoulder on release sleeve (H22) with machined side of collar down and secure them together with two bolts and nuts. Rotate collar on sleeve to check for free turning. If collar binds on sleeve, it may be necessary to shim between the collar halves to allow running clearance.

CAUTION

Be sure that the tapped hole in release sleeve is facing grease tube when assembled in Power Take-Off.

g. Place clutch release lever (holdback) spring (H12) over end of release sleeve (H22) and up against release collar before installing links (H30) to release sleeve (H22).

h. Place one release lever link (H30) on each side of each hole on clutch release sleeve (H22) with triangular end of release lever link at release sleeve and point of triangle facing toward center of release sleeve.

i. Attach links to release sleeve with link pins (H31) and retaining rings (H32).

CAUTION

When installing pins, all pins must be installed with head leading rotation.

j. Place the clutch release sleeve (H22), with other parts assembled, down on clutch with each pair of release links (H30) astride release lever (H13). Connect links to levers with pins (H33) and retaining rings (H32).

NOTE

Be sure retaining rings (H32) are securely locked on pins (H33).

k. With the clutch release links (H30) and release levers (Hi 3) connected, slide clutch release lever (holdback) spring (H 12) over ends of release lever links and into place on release levers (H 13).

I. Insert the clutch facings (H4) (three segments) in between the clutch body (H1) and pressure plate (H 3), and center.

m. Lock clutch facings between the pressure plates as follows:

(1) With the clutch assembly resting on workbench, turn the clutch adjusting ring (H9) COUNTER-CLOCKWISE until pressure plate (H3) almost contacts clutch facing (H4).

(2) Place clutch driving ring over clutch facings with teeth in driving ring in mesh with teeth of clutch facings, and locate the driving ring centrally relative to the pressure plate and clutch body.

NOTE

If driving ring is not properly located relative to pressure plate and clutch body, the clutch cannot be assembled to the flywheel as the teeth of clutch facings will not enter the teeth of driving ring even though the clutch drive shaft enters the pilot bearing.

(3) Engage the clutch by applying pressure on top of release sleeve and collar assembly and lock clutch facings between the pressure plate and clutch body. If clutch facings are still free to move, disengage the clutch and turn adjusting ring COUNTER-CLOCKWISE just enough to lock the clutch facings in place when clutch is engaged.

NOTE

The clutch must now be kept engaged until the Power Take-Off assembly is attached.

n. Remove clutch driving ring (H35) from the clutch facings and attach it to the subdrive with the specified bolts and lock washers.

o. If roller bearings (T9) were removed from clutch shaft (T8), they must be installed as follows:

(1) Lubricate inside diameter of roller bearing cone, then start cone straight on clutch drive shaft with wide face of the bearing cone facing shoulder on drive shaft.

(2) Place Steel ring approximately 1/4 " thick over end of shaft and rest on inner cone of bearing.

CAUTION

The steel ring must bear against the inner cone of bearing. Do not allow any pressure to be applied against the rollers or bearing may be damaged.

(3) Place clutch drive shaft and bearing on steel ring in press.

(4) With ram of press bearing on the upper end of shaft, press bearing cone tight against shoulder on the shaft.

p. Install bearing cup in housing then shaft and bearings as follows:

(1) Support the Power Take-Off housing (T1) on wooden blocks, forward (bell) side of housing up.

(2) Lubricate outside diameter of roller bearing cup and start cup straight into bearing bore of Power Take-Off housing with back face of bearing cup down.

CAUTION

Be sure cup is fully set in Power Take-off housing bore square.

(3) Use a hard wood block about 15" long, placed on front face of bearing cup to set cup in bore; tap block on cup alternately in several places to prevent cramping of cup.

(4) Lubricate roller bearings with light oil; insert output end of clutch drive shaft through bearing bore from forward side of Power Take-Off housing, until shaft bearing contacts bearing cup.

(5) Lubricate second bearing cup and place over clutch drive shaft front face down.

(6) Start bearing cup straight in bearing bore of Power Take-Off housing, using hard wood block and hammer, tap bearing cup to contact bearing rollers.

(7) Lubricate threads of bearing retainer (T10). Place retainer over pilot bearing end of clutch shaft with notches of bearing retainer up.

(8) Thread bearing retainer into Power Take-Off bearing bore up against bearing cup. Tighten bearing retainer while rotating clutch shaft, until bearing retainer is tight and bearing cups are fully set. Full set of bearing cups can be determined by increased effort required to rotate clutch drive shaft.

(9) Back bearing retainer out two or three notches, shaft end play should be .004-.006 inch.

4-6.2.5 Clutch Drive Shaft End Play. Use the following steps to check and set shaft end play.

a. Support the Power Take-Off housing with a sling or chain hoist, drive (pulley) end of shaft down.

b. Lower Power Take-Off until end of drive shaft rests on wood block on floor.

c. Take up space between bearing retainer and drive shaft by inserting four pieces of suitable shim stock equally spaced around shaft. The four pieces of shim stock must be of same thickness.

d. Mount a dial indicator to pilot bearing end of drive shaft, position indicator to contact face of Power Take-Off housing next to bearing retainer. Set dial indicator at zero.

e. Lift Power Take-Off housing and drive shaft assembly from wood block.

CAUTION
Do not hit the shaft hard enough to disturb the dial indicator.

f. Tap pilot bearing end of shaft lightly to set shaft and outer bearing assembly against the outer roller bearing cup.

g. Note reading of dial indicator. Indicator will show amount of end play between drive shaft and housing.

h. Lower Power Take-Off until end of drive shaft again rests on wood block and weight of Power Take-Off is no longer supported by hoist.

i. Tap lightly on inner side of Power Take-Off Housing, alternately around bearing retainer to insure that inner roller bearing is set against bearing cup. Dial indicator should again be at zero.

j. Readjust end play if necessary, by turning bearing retainer CLOCKWISE to decrease or COUNTER CLOCKWISE to increase drive shaft end play.

k. Repeat steps e thru i to insure shaft end play readings are correct.

l. Install bearing retainer lock and bolt.

m. Remove shim stock and dial indicator.

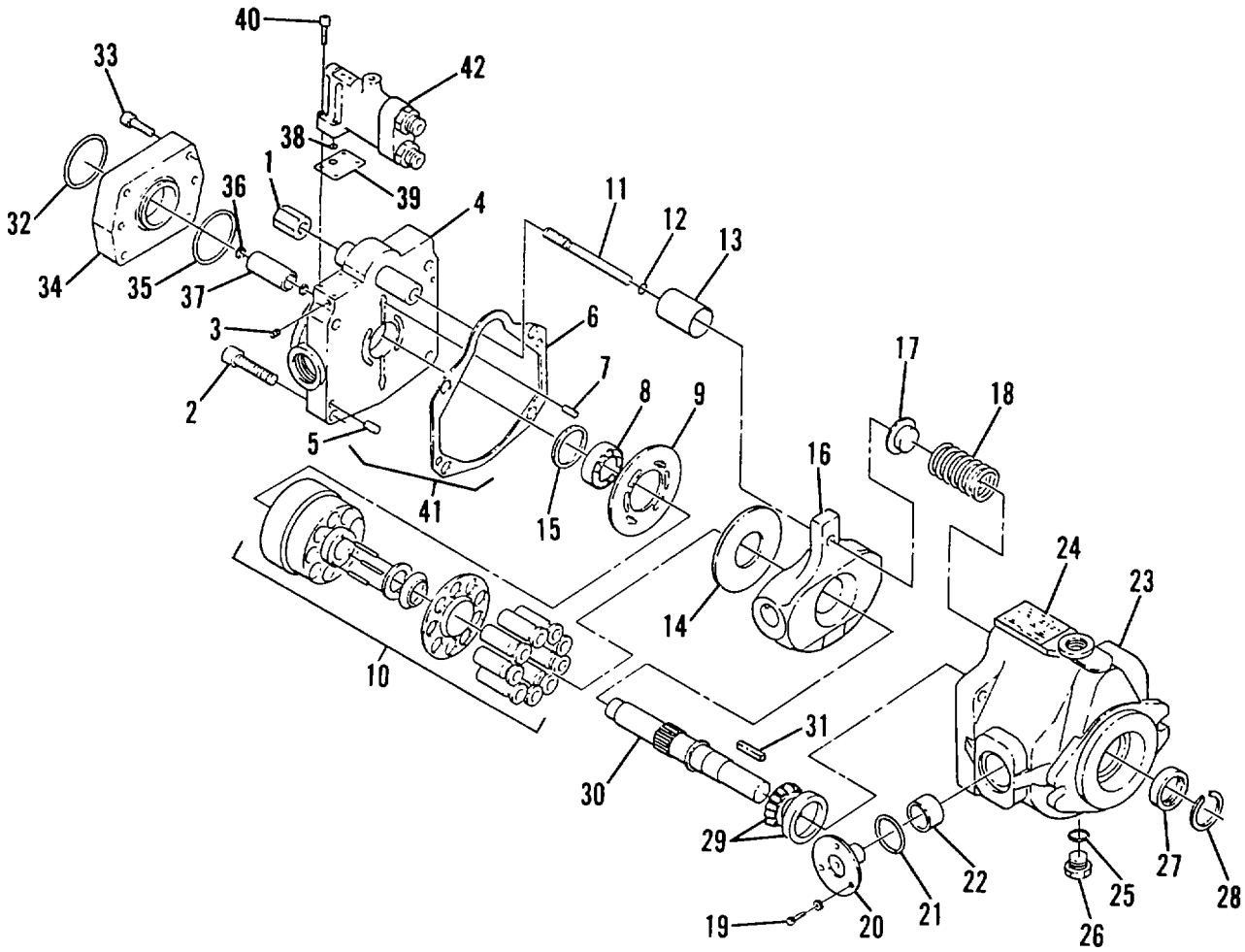
n. Support Power Take-Off on wood blocks in horizontal position.

o. Fill bearing cavity with Lithium Base #2 grease, until grease starts to seep out around the clutch shaft at each end of Power Take-Off.

NOTE
Rotate the clutch drive shaft when filling bearing cavity to be sure that bearings and housing are full of grease.

4-6.3 Hydraulic Pump. (Figure 4-12)

4-6.3.1 Disassembly. Thoroughly clean the pump prior to disassembly. Cleaning with a solvent wash and air drying is adequate, providing clean solvent is used.



1. Lock Nut
2. Socket Head Bolt
3. Plug
4. Cover
5. Locating Pin - End Cap
6. End Cap Gasket
7. Locating Pin, Valve Plate
8. Bearing Kit, Rear
9. Valve Plate
10. Cylinder Block Kit
11. Flow Adjustment Screw
12. O-Ring
13. Control Cylinder
14. Thrust Plate
15. Shim
16. Swashplate
17. Spring Retainer
18. Spring
19. Socket Head Bolt
20. Trunnion
21. O-Ring
22. Journal Bearing
23. Housing
24. Name Plate
25. O-Ring
26. Plug
27. Lip Seal - Shaft
28. Retaining Ring
29. Bearing Kit, Front
30. Shaft
31. Key
32. O-Ring
33. Hex Head Cap Screw
34. Auxiliary Mounting Adapter
35. O-Ring
36. Retaining Ring
37. Coupling
38. O-Ring
39. Gasket
40. Socket Head Bolt
41. End Cap Kit
42. Control Valve Kit

Figure 4-12. Hydraulic Pump.

a. Using retaining ring pliers, remove the retaining ring (28) from the pump.

b. Using a punch, or some type of sharp instrument, puncture the shaft seal and gently pry it out of the housing. Remove the old seal from the shaft and discard.

c. Using an internal hex wrench, remove the four socket head screws (40) which hold the control (42) on the end cap (4). Remove the control (42) and gasket (39) from the end cap (4). Remove the o-ring (38) from the groove in the mating surface of the control.

d. Remove the screws (33), adapter (34), o-rings (32, 35), retaining rings (36) and coupling (37).

e. Using appropriate wrenches, remove the protective locknut (1) from the maximum flow adjustment screw (11).

f. Using the proper wrench loosen the four socket head bolts (2) which hold the end cap (4) to the pump housing (23). Remove two of the bolts opposite each other.

g. There is an internal loading on the end cap and as the last two screws are loosened, it should begin the separate from the housing. Loosen the screws alternately until the end cap has separated from the housing, then remove the screws entirely.

h. The end cap (4) can now be lifted off the pump. However, be certain that the valve plate (9) does not fall and become damaged. If the valve plate tends to lift off with the end cap, hold it in plate and remove both parts together. If the valve plate (9) remains on the bearing plate (14), remove it at this time.

CAUTION

All surfaces exposed are critical and caution must be used to avoid damage. Surface damage will cause low efficiency or even a totally inoperative pump.

i. Remove the control cylinder (13) by sliding it off the cylinder rod.

CAUTION

Do not attempt to remove the tube around which the control cylinder was fitted. The tube was pressed into the end cap during manufacturing is not replaceable.

j. Remove the valve plate (9) from the end cap (4), if not previously removed. Remove the valve plate locating pin (7).

k. Using an internal hex wrench, remove the maximum flow adjustment screw (11) by turning it clockwise through the end cap. The adjustment screw may be pulled through the cylinder rod once the threaded portion of the screw has surpassed the threads in the end cap.

l. Remove and discard the o-ring (12) from the adjustment screw (11).

m. Remove the bearing race (8) from the end cap. The race is installed with a slip fit. Note that there may be shims installed between the bearing race and the cap to adjust end play. Retain these shims for reassembly. Loss of these shims will result in improper end play causing reduced bearing life and possibly reduced pump performance.

n. Using a clam type bearing puller, remove the tapered roller bearing (8) from the shaft (30). Care must be taken not to damage the cylinder block (10) surface or contaminate the unit during this operation. A spacer is also required to protect the end of the pump shaft from damage by the puller screw.

o. Remove the end cap gasket (6) from the pump housing (23).

p. With the pump laying horizontally, slide the cylinder block assembly (10) off the shaft while holding the external end of the shaft (30).

q. If the cylinder block assembly (10) does not remain together during removal, it can be reassembled at a later time. (The rotating group consists of a retainer, retainer guide, washer, three pins, nine pistons and the cylinder block).

r. Remove the thrust plate (14) from its counterbore in swashplate (16). The thrust plate may be difficult to remove due to the oil between the flat surfaces of the thrust plate and the swashplate. Avoid damaging all critical surfaces.

s. With a punch or metal scribe, mark right and left trunnions (20) to insure reassembly to the correct side of the housing.

t. Using a hex or internal hex wrench as needed, remove the three cap screws (19) from each trunnion.

u. Remove each trunnion by using a soft, blunt object to drive it out of the housing (23) from the inside. Remove o-ring (21) from each trunnion.

v. After both trunnion assemblies have been removed, the swashplate (16) can be removed from the pump housing (23).

w. Lift the spring retainer (17) and bias spring (18) out of the pump housing (23).

x. Once the swashplate has been removed, the shaft (30) can be easily removed from the end cap side of the housing. The front bearing (29) is pressed onto the shaft and will be removed with the shaft. However, the bearing race will remain in the housing.

y. The tapered bearing (29) can be pressed off the shaft (30) if necessary. Be careful not to damage the seal diameter of the shaft while removing the bearing.

4-6.3.2 Cleaning, Inspection and Repair.

a. If the control (42, Figure 4-12) is not performing properly because of sticking or contamination, it can be further disassembled for cleaning or repair. (Refer to Figure 4-13).

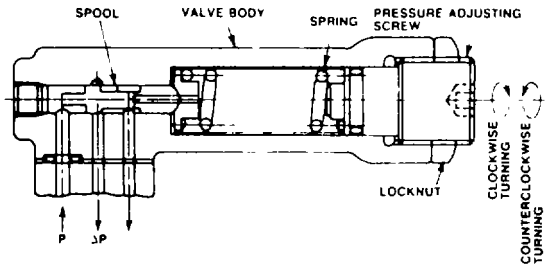


Figure 4-13. Hydraulic Pump Control.

(1) Using appropriate wrenches, loosen the adjustment screw locknut and remove the adjustment screw. The control spring and spring retainer can now be removed from the cavity.

(2) Using an internal hex wrench remove the threaded plug from the opposite end of the control and remove the control spool.

(3) Flush the control cavity with clean solvent and wash all parts in solvent and air dry. Examine spool and cavity surfaces for nicks or scratches and replace any parts found to be defective.

(4) Replace spring and spring retainer in cavity from adjustment end and reinstall adjustment screw and locknut. Install control spool in opposite end of control and install plug. Insure that orientation of spool is correct.

(5) Reinstall control on pump housing replacing o-ring and control gasket as part of the procedure.

b. Thoroughly clean and inspect all parts. Examine for nicks, burrs, scoring discoloration, etc. Replace all damaged parts.

c. Cleaning parts by using a solvent wash and air drying is adequate, providing clean solvent is used. As with any precision equipment, the internal mechanism and related items must be kept free of foreign materials and chemicals.

d. It is recommended that all gaskets and o-rings be replaced. All gasket sealing surfaces must be cleaned prior to installing a new gasket. Lightly lubricate all o-rings with clean petroleum jelly prior to assembly.

4-6.3.3 Assembly. (Figure 4-12)

a. Press the bearing (29) onto the shaft (30). The bearing must be pressed on until it rests on the shoulder of the shaft.

b. Press new bearing race (29) into the housing (23) if it was previously removed or if a new bearing cone was installed on the shaft. Insert the shaft and bearing (29, 30) into the housing (23).

c. Lubricate the seal (27) with oil and carefully slide it over the shaft (30). Make sure the shaft is covered or other measures have been taken to protect the seal from damage by the shaft keyway. Press the seal into place and securely install the retaining ring (28) in the groove within the housing (23).

d. Replace shims (15) in the end cap (4) if removed upon disassembly and install the bearing race (8).

NOTE

When properly installed the bearing race will protrude approximately 7/64" above the surface of the end cap. It functions with the small pin installed in the end cap to hold the valve plate in the proper position.

e. Install the valve plate locating pin (7) in the end cap (4). The pin will protrude from the housing approximately .050-.094".

f. Install the end cap gasket (6) onto the housing being certain the locating pins (5) are in place.

g. Install a new o-ring (12) on the adjusting screw (11). The o-ring must be well lubricated prior to installation. Install the adjustment screw (11) (threaded end first) into the cylinder rod of the end cap (4). Using an internal hex wrench, turn the adjustment screw counterclockwise until the screw is against the internal thread stop. This is the maximum flow position.

h. Lubricate the end cap face with clean hydraulic oil. Then install the valve plate (9) so that the slot locates over the locating pin (7) and the center bore fits over the protruding bearing race (8).

i. Lubricate the cylinder rod and the inside of the control cylinder (13) with clean hydraulic oil. Slide the control cylinder onto the cylinder rod.

j. Install bias spring (18) and spring retainer (17) into the housing (23). Insert the swashplate (16) into the housing insuring that spring retainer is completely inserted in the hole in the back side of the swashplate.

k. Install new o-rings (21) on trunnions (20). Insure that trunnions are on correct side of the housing and oriented correctly then, carefully drive trunnions into place. Install capscrews (19) and torque to 7-9 ft-lbs.

l. Lubricate the thrust plate (14) with clean hydraulic oil and install it into the counterbore of the swashplate (16). Make certain the thrustplate lies flat against the swashplate face.

m. Prior to assembly of the cylinder block (10), inspect the pistons, retaining ring, retaining guide, washer and pins for damage, contamination or excessive wear. Replace any parts found to be defective. If one or more pistons are found to be defective, it is necessary to replace the complete cylinder block kit. Refer to Figure 4-14 and the following steps to assemble the block kit.

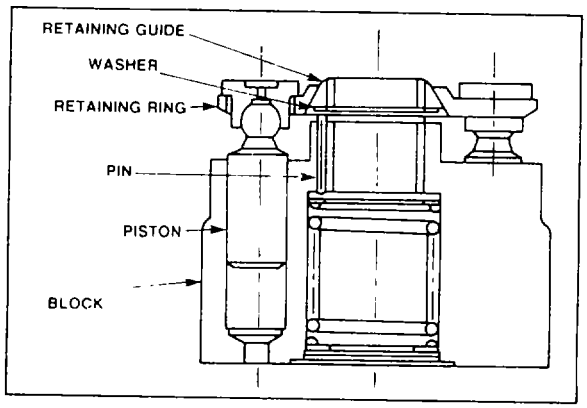


Figure 4-14. Cylinder Block Kit

(1) Install locating pins in neck end of cylinder block.

(2) Place the washer on the three pins. Install the retaining ring guide on the washer.

(3) Place retaining ring over retaining ring guide. The guide should protrude through the center of the retaining ring. Make certain the washer remains centered under the retaining ring guide.

(4) Lubricate each of the pistons with clean hydraulic oil and install through the retaining ring and into the block.

n. Slide the cylinder block assembly (10, figure 4-12) onto the shaft (30) and against the thrust plate (14). Use care that the washer and retaining guide do not come off the locating pins.

NOTE

When properly installed, a spring load can be felt when pushing against the cylinder block.

o. Stand the unit vertically with the shaft seal (27) down to insure all parts remain in position. Then rotate the cylinder block two or three times to confirm that the piston slippers are completely in contact with the thrust plate.

p. Install the tapered bearing (8) on the pump shaft (30) with an arbor type press for the most satisfactory results. The bearing must not be driven onto the shaft. Press against the inner race of the bearing and use care not to damage the roller cage.

NOTE

The bearing must be pressed on until it rests on the shoulder of the shaft to insure adequate bearing clearance.

q. Lubricate the valve plate (9) and the cylinder block (10) with clean hydraulic oil. Install the end cap (4) while holding the valve plate in place so it does not drop off during assembly.

r. Install the four socket head bolts (2) which attach the end cap and tighten alternately until the internal spring has compressed far enough for the end cap to rest on the housing (23). Tighten bolts to 62-80 ft. lbs.

s. Install lock nut (1) and torque to 12-16 ft-lbs.

t. It is suggested, that a new o-ring (38) be installed on the control and a new gasket (39) placed on the end cap mating surface. Make certain the large hole on the gasket will mate with the o-ring on the control when assembled.

u. Place the control (42) on the end cap and reinstall mounting screws (40). Tighten to 61-69. in. lbs. torque. Install retaining rings (36), coupling (37), o-rings (32, 35) and adapter (34). Install screws (33).

4-6.3.4 Maximum Flow Adjustment. Maximum volume or flow from the pump can be varied to match the application requirement by turning the flow adjusting screw located on the back of the pump.

a. Using appropriate wrenches, loosen the locknut and turn the adjusting screw clockwise to decrease maximum pump flow or counterclockwise to increase maximum flow.

b. The flow rate will be increased or decreased by approximately .15 in.3/rev. per turn for each complete turn of the adjustment screw.

c. Stops are provided to limit both minimum and maximum positions of the screw within the following angle and displacement per revolution range.

Pump Size L38
Swashplate Angle..... 7° to 18°
Displacement. ..... 0.9 in. 3/rev. to 2.3 in. 3/rev.

CAUTION
Excessive torque may damage threads and allow setting to change during operation.

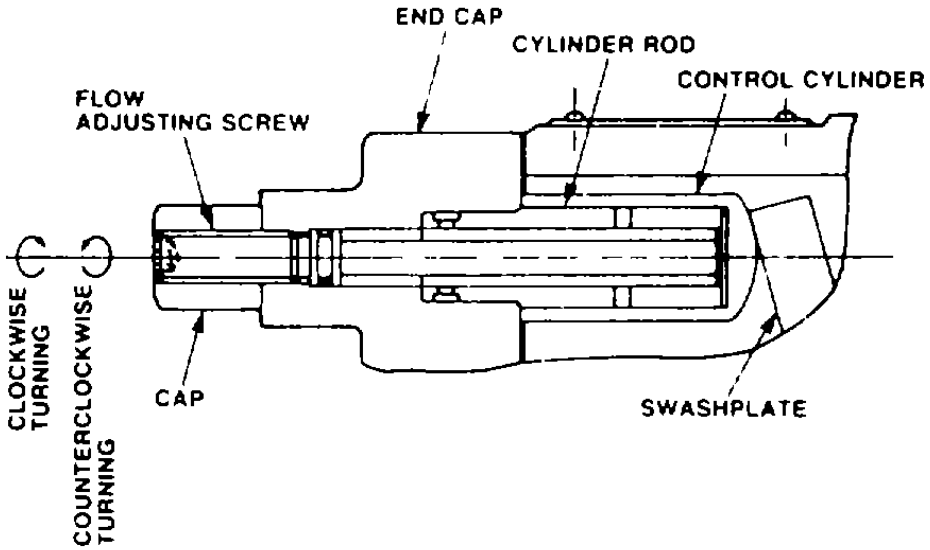


Figure 4-15. Pump Flow Adjustment

d. After adjustment, hold the screw in place and torque the locknut to 12-16 ft. lbs.

4-6.4 Hydraulic Gear Pump. (Figure 4-16)

4-6.4.1 Disassembly. Thoroughly clean the exterior of the pump prior to disassembly.

a. Clamp the pump body (1) securely in a soft jawed vise. Cover sharp edges of drive shaft with tape.

b. Remove nuts (12), lockwasher (11), and screws (8 and 10).

CAUTION

Do not use a screwdriver to attempt to pry flange (2) or end cover (3) from body (1).

c. Carefully remove the flange (2) and end cover (3) from the pump body (1). Should these be tight on their dowels, lightly tap with a mallet to release. Remove seals (15), loading rings (16) and backing ring (7).

d. Withdraw the gears (4 and 5) and bearings (6) from the body (1) as an assembly and carefully note their original positions.

NOTE

It is suggested the top bearing be lightly marked on an unmachined surface to aid proper assembly.

e. Remove retaining ring (13),then, supporting the flange outer face downward, tap out the oil seal (17) with a soft metal drift.

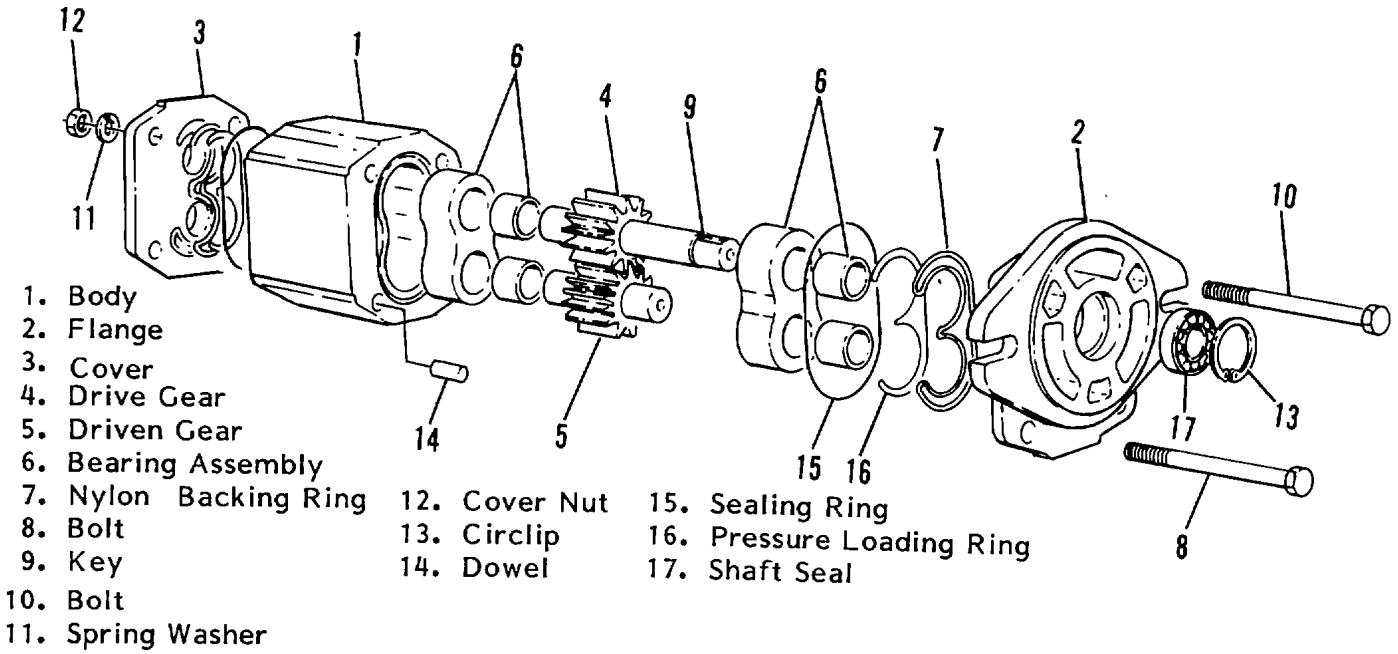


Figure 4-16. Hydraulic Gear Pump

4-6.4.2 Inspection and Repair.

a. General. Discard all seals and thoroughly clean all parts: check that all machined faces and threads are free from burrs, scores and other damage. Replace any damaged bolts, washers and circlips, etc.

b. Bearings.

(1) Examine each bearing for wear and damage, particularly on the faces, bearing bores and across the seal bridge. The bearings' outer radii should be free from damage by contamination and aeration.

(2) Ensure that the lubricating scrolls in the bearing bore are free from foreign matter and excessive oil lacquer.

(3) Check that the bearings are a sliding fit in the body bore.

(4) If the bearings are not badly damaged they may be salvaged in the following way:

(a) Place a sheet of O grade emery paper lubricated with paraffin on a truly flat surface, then polish the bearing face using a light rotary motion.

(b) Outer radii may be lightly polished to obtain free movement in the body. Maintain sharp corner on outer face adjacent to gears.

c. Body.

(1) Inspect the pump body for external damage and cracks, etc. Examine the body bore for damage and excessive wear. It is normal for the gears to have cut a light track in the body bore on the inlet side. If the body is in good condition, with no excessive scoring or other damage of the gear track and the depth of the track does not exceed 0.10mm (0.004"), the body is re-usable.

(2) Using a Vernier height gauge and dial test indicator, measure the body bore track depth (Figure 4-17).

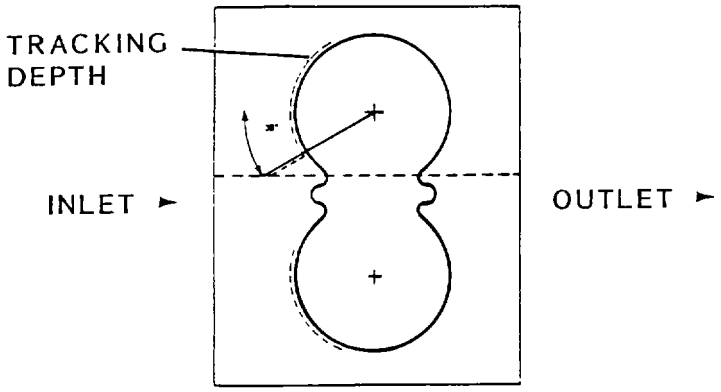


Figure 4-17. Body Bore Measurement

(3) The only re-working advisable is to remove burrs at the edge of the gear track and in the bearing locations, and this should be carefully effected with fine emery cloth.

NOTE

Under working conditions hydraulic pressure within the pump forces the gears towards the inlet side of the body on the running track. Therefore, if the running track is past the limit for re-use, the fitting of new bearings may not improve efficiency as the new bearing will tend to prevent the gears bottoming in the running track.

c. Gears.

(1) Inspect the gears for scored or worn side faces or journals, damaged teeth, thread or keyway, and surface cracks.

(2) Slight wear and scoring on the journals can be erased by polishing between lathe centres using O grade emery paper lubricated with paraffin. Slightly scored side faces may be renovated by sandwiching emery paper between the gear face and a scrap bearing, as in Figure 4-18.

(3) While servicing the drive and driven gears, particular attention should be paid to the following points.

(a) Gear widths of drive and driven gears must be within 0.005mm(0.0002") of each other to ensure satisfactory pump efficiency. (See Figure 4-18).

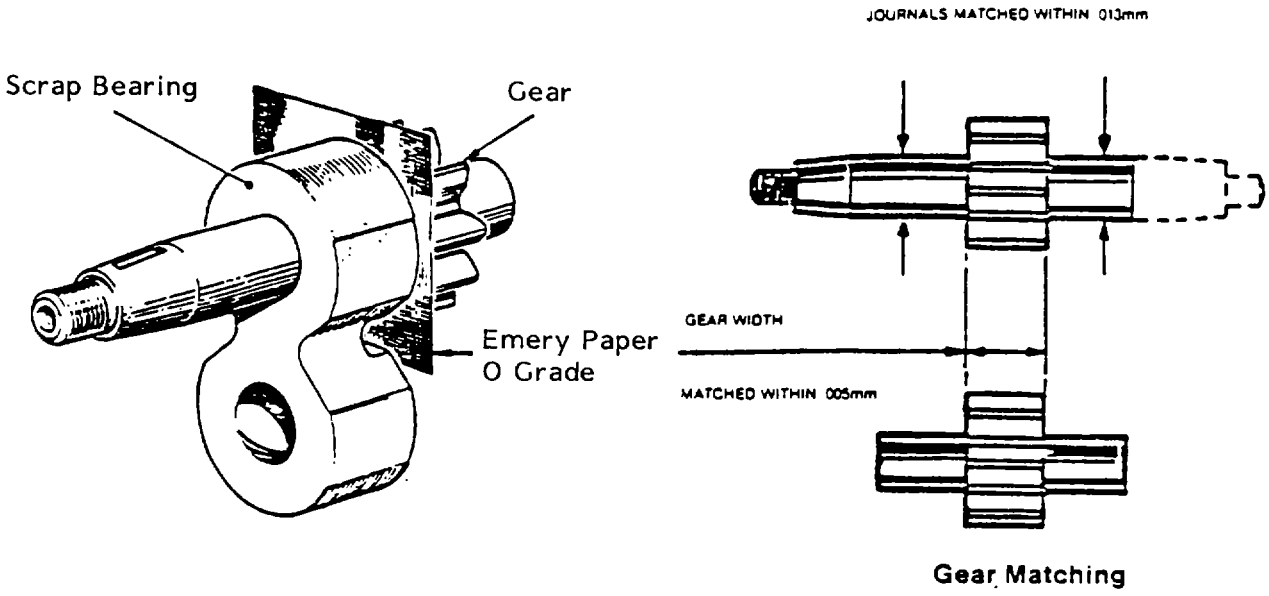


Figure 4-18. Pump Gears

(b) Journals must be within 0.013 mm (0.0005") of each other. (See Figure 4-18).

(c) Gear faces must be flat. This feature may be checked by blueing a bearing face and rotating against gear this will also reveal any sharp edges on the teeth.

(d) Replacement gears are supplied only as matched pairs.

4-6.4.3 Assembly.

a. Place the flange (2, figure 4-16), machined surface down, on a clean flat surface. Apply a little grease to the oil seal (17) and, with garter spring facing into pump, use a suitable tool to press seal into flange. Install retaining ring (13).

b. Install the backing rings (7), loading rings (16) and seals (15) in flange (2) and cover (3), using a little light grease to aid their retention.

c. Place the cover (3) in a soft jawed vise with machined face up. Be sure that dowels (14) are in place on body, then assemble body (1) to cover, ensuring that inlet side of body is correctly positioned.

d. Lightly lubricate the body bore, both faces and bore of bearings (6).

e. Install the cover end bearing into the body bore with recessed face up and relieved radii towards pump outlet and slide it gently to the bottom.

f. Insert the gears (4 and 5) into their respective bores in pump body (1).

g. Place the flange end bearing (6) over the gear shaft and slide it into location with the recessed face toward gears and the relieved radii towards pump outlet.

h. To avoid damaging seal (17), place a protective sleeve over the drive shaft and gently press the flange (2) down onto the pump body (1).

i. Install the screws (8 and 10) and install lockwashers (12) and nuts (11).

4-6.5 Displacement Pump. (Figure 4-19)

4-6.5.1 Disassembly.

CAUTION
The end cap screws should not be loosened until the shaft seal has been removed.

a. Remove the large retaining ring (1) located on the shaft end of the pump. Remove the side opposite the tangs from the groove first.

b. The aluminum housing (2) is removed next. It is held in place by the friction of the O-ring (3) on its outside diameter. Pry the housing toward the end of the shaft until the O-ring (3) is free.

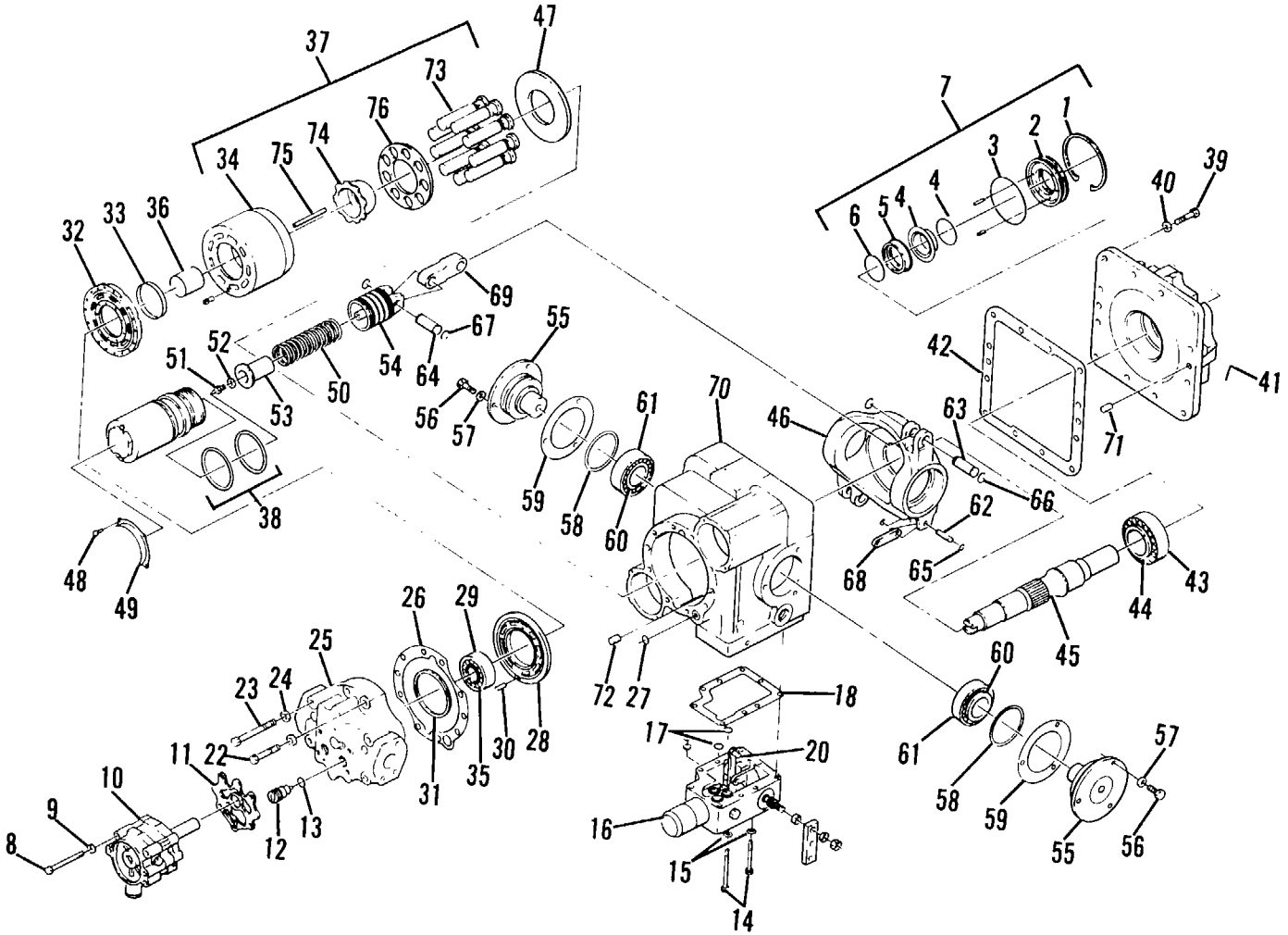


Figure 4-19. Displacement Pump

Legend for Figure 4-19

1. Retaining Ring
2. Housing
3. O-Ring
4. O-Ring
4a. Stationary Seal Pilot
5. Sealing Ring
6. O-Ring
7. Shaft Seal
8. Cap Screw
9. Washer
10. Charge Pump
11. Gasket
12. Check Valve
13. Shim
14. Cap Screw
15. Washer
16. Control Valve
17. O-Rings
18. Gasket
19. Cotter Pin
20. Washer
21. Pin
22. Cap Screw
23. Cap Screw
24. Washer
25. End Cap
26. Gasket
27. O-Ring
28. Valve Plate
29. Bearing Race
30. Pin
31. Shim
32. Bearing Plate
33. Pilot Ring
34. Cylinder Block
35. Bearing
36. Spacer
37. Block Assembly
38. Servo Housing
39. Screw
40. Washer
41. Front Cover
42. Gasket
43. Bearing Race
44. Bearing
45. Shaft
46. Swashplate
47. Thrust Plate
48. Cap Screw
49. Retainer
50. Spring
51. Screw
52. Washer
53. Retainer
54. Piston
55. Trunnion
56. Screw
57. Washer
58. O-Ring
59. Shim
60. Bearing
61. Bearing Race
62. Pin
63. Pin
64. Pin
65. Snap Ring
66. Snap Ring
67. Snap Ring
68. Link
69. Link
70. Housing
71. Pin
72. Pin
73. Piston
74. Ball Guide
75. Pin
76. Slipper

c. Remove the housing (2) from the shaft. This part is actually an assembly that is being held together by the friction of an internal O-ring (4). It will normally remain assembled until physically separated.

d. The bronze sealing ring (5) is also held in place by internal O-ring (6) friction. Work this part free and carefully slide over the shaft.

NOTE

All of the shaft seal (7) parts have now been removed. It is recommended that this entire shaft seal (7) be replaced.

e. To remove the charge pump (10), remove cap screws (8) and washers (9). Before removing the charge pump, mark its housing and the main pump end cap (25) to insure proper orientation when re-assembling.

CAUTION

Protect exposed surfaces and ports to prevent damage and parts falling into main pump.

f. The charge pump (10) lifts straight off the main pump. There is a spacer in the idler shaft bore that can slip out as the pump is removed; be certain to control this spacer so it can not fall into the main pump. Remove gasket (11).

g. Remove charge check valves (12) and shims (13).

h. Remove the hex, cap screws (14) and washers (15) and swing the control (16) away from the pump housing. This area is sealed with both O-rings (17) and a gasket(18).

CAUTION

Caution must be exercised after the control valve (16) is swung away from the pump housing since this opens a large cavity into the housing. Also during removal and installation of the control link pin, parts can be dropped into the main housing requiring total disassembly of the unit.

i. Swing the control (16) away from the housing as far as it will go to expose the cotter pin (19). Remove the cotter pin, washer (20) and connecting pin (21). It is suggested that a piece of wire be inserted through the eye of the cotter pin so the pin can easily be retrieved if it falls into the pump. Remove control (16).

j. Remove all but two of the hex, cap screws (22 and 23) and washers (24) holding the end cap (25) to the housing. Make sure the two remaining screws are opposite each other.

k. There is an internal spring loading on the end cap (25) and as the last two screws are loosened, it should begin to separate from the housing. Loosen these screws alternately until the end cap (25) has fully separated from the housing, then remove the screws entirely.

I. The end cap (25) can now be lifted off the pump; however, be certain that the valve plate (28) does not fall and become damaged. If the valve plate tends to lift off with the end cap, hold it in place on the end cap and remove both parts together. If the valve plate (28) remains on the bearing plate (32) remove it at this time.

CAUTION

All surfaces exposed are critical and caution must be used to avoid damage.

m. Remove gasket (26) and o-ring (27).

n. The end cap (25) is actually an assembly consisting of a tapered bearing race (29) which is a slip fit in the end cap and the valve plate locating pin (30). These parts should be removed from the end cap. There may or may not be a shim (31) located under the bearing race which should be removed.

o. Remove the bronze bearing plate (32) and the pilot ring (33) from the cylinder block(34). If the pilot ring remains with the bearing plate, remove it at this time.

p. The tapered bearing (35) must now be removed from the shaft. A bearing puller should be used that will pull against the inner race of the bearing. A spacer is required to protect the slot in the end of the pump shaft from the puller screw. Protect the face of the cylinder block (34) during this operation.

q. After removal of the bearing (35), slip the spacer (36) out of the bore in the cylinder block (34). Place the pump horizontally in preparation for removal of the cylinder block assembly (37).

r. Slide the cylinder block assembly (37) off the shaft while holding the external end of the shaft. If the cylinder block assembly does not remain together during removal, it can be easily reassembled at a later time.

s. Set the pump on the servo housings (38) and remove the front cover screws (39) and washers (40). Lift off the front cover (41) and gasket (42).

t. The race (43) for the tapered shaft bearing (44) is a press fit in the front cover (41).

u. Lift the shaft (45) and bearing (44) out of the center hole of the swashplate (46).

v. Remove thrust plate (47) from its counterbore in the face of the swashplate (46). Reach through the center hole in swashplate and push against exposed edge of thrust plate (47). Do not allow part to fall and become damaged.

w. The tapered bearing (44) can be pressed off the shaft (45) if required. Be careful not to damage the seal diameter of the shaft while removing the bearing.

NOTE

From this point on it is necessary to mark all parts so that neutral (zero swashplate angle) will be retained when the parts are reassembled. The swashplate is held in neutral by springs inside the servo housings. These springs are adjusted by turning the servo housings.

x. First, mark the servo housing (38) for location to the pump housing. This set of marks should line up to show the rotational position of the servo housing to the pump housing.

y. Remove the locking retainers (49) using a 12 point, 3/16 socket for the cap screws (48).

NOTE

After removing the retainers (49), scribe a line to mark the height of the servo housing in relation to the pump housing.

z. Unscrew the servo housings (38) using channellock pliers to grip the flats on top of the housings.

NOTE

At this time the servo springs (50) should be removed if replacement is necessary as the pump housing will provide a means of leverage when breaking the screws loose. Do not reuse the screw (51) holding the spring (50) to the servo piston (54) as it has a nylon locking insert that is not effective when reused. These springs should not be removed unless necessary.

aa. To remove springs, remove screw (51), washer (52), retainer (53) and spring (50).

ab. The trunnions (55) should be marked to insure reassembly to the correct side of the housing. Remove the hex, head screws (56) and washers (57) from each trunnion (55).

NOTE

Friction caused by the O-ring (58) on the trunnion may make it necessary to use a slide hammer to pull the trunnion assembly.

ac. Remove the trunnions (55) from housing. Be certain to keep the plastic shims (59) with the proper trunnion to insure satisfactory bearing adjustment after reassembly. If bearing (60) is to be removed, it must be pulled from the shaft of trunnion (55). The race (61) is a press fit in swashplate (46).

ad. After both trunnion assemblies have been removed, the swashplate assembly can be removed from the pump housing (70). The piston (54), pins (62,63, 64), snap rings (65, 66, 67) and links (68,69) may remain installed on swashplate (46) unless parts are being replaced.

4-6.5.2 Assembly

a. When installing the swashplate assembly (46) into the housing (70), the feedback link (68) must be laid back along the top of the swashplate so it can be reached through the opening for the control valve. After installing swashplate be certain feedback link is accessible.

b. Press bearings (60) onto shafts of trunnions (55). Place shims (59) and O-rings (58) on trunnions.

c. Install the trunnions (55), checking for proper orientation with the housing (70) and install the cap screws (56) and washers (57). The swashplate (46) should have no sideplay yet rotate freely. If necessary, alter the plastic shims (59) to obtain the proper adjustment. Torque screws (56) to 16-21 ft-lbs.

d. Install the servo springs (50), retainers (53), washers (52) and screws (51), if these parts were removed. Use new screws (51). Tighten to 10-11 ft-lbs.

e. Slide the servo housing (38) over the servo piston (54) and thread it into the pump housing (70). Adjust the housing to the height and rotational position as determined by the markings made during disassembly.

f. Install the thrust plate (47) on the swashplate for the neutral (zero angle) measurement. Using a depth micrometer, measure the distance from the end cap mounting face of the pump housing to the face of the thrust plate 90° to the trunnions, at the outer edge of the thrust plate. Take the same measurement at a point 180° (opposite edge of the thrust plate) from the first. These measurements must not vary more than .001" from each other.

g. If adjustment is required follow these steps.

   (1) Back out both servo housings (38) until the spring load is released on the swashplate (46) (check by rocking swashplate).

   (2) Thread in each housing (38) until spring load just starts to be felt on the swashplate (46).

   (3) Check measurements as described previously.

   (4) Thread each housing farther in until the measurements are within .001" of each other.

h. After adjustment has been completed, the retainers (49) can be installed and peened into the locking slot on the housing. Remove the thrust plate (47) and set the pump on the servo housings (38).

i. Press bearing (44) onto shaft (45). Insert the shaft and bearing assembly through the cast hole in the swashplate (46), allowing the bearing to rest on the cast leveled edge.

NOTE

If drive shaft (45), bearings (44,35), housing (70), front cover (41) or end cap (25) are replaced, the shaft end play must be checked.

j. To check the shaft end play, assemble the above parts plus the gaskets (26, 42). The shaft end play should be from .006" to .016". If adjustment is necessary, a shim (31) can be placed under the bearing race (29) in the end cap (25). Disassemble these parts and resume reassembly procedure.

k. Install the front cover (41) and gasket (42),being certain that the locating pins (71) are in place in the housing (70). These parts will go on only one way and have all the mounting holes align with the housing (70). Install screws (39) and washers (40) and torque to 27-37 ft-lbs.

l. Turn the unit on its side with the large control cavity on top and install the thrust plate (47). Lubricate the thrust plate with clean hydraulic oil prior to assembly.

m. Prior to reassembly of the cylinder block (37), inspect the pistons for contamination or excessively worn slipper pads. If excessive wear is found, install a new cylinder block kit (32, 33, 34, 36 and 37).

NOTE

To install the cylinder block assembly (37), it is necessary to check the alignment of certain parts. There is no special relationship of pistons (73) to bores, springs, etc. However, the alignment of the ball guide (74) and cylinder block (34) splines is critical. The undersized tooth in the spline of the cylinder block (34) must line up with the missing tooth in the ball guide (74) spline. These in turn line up with a missing tooth on the shaft (45) spline. The hole for the bearing plate locating pin (75) in the cylinder block (34) face is in line with the undersize tooth in the cylinder block and provides an assembly guide.

n. Lubricate the thrust plate (47), slippers (76), pistons (73) and bores with clean hydraulic oil. While holding the shaft (45) on the external end, align the missing tooth of the shaft and ball guide (74) by sighting through the control cavity. Using the locating pin (75) hole as a guide, slide the cylinder block assembly (37) onto the shaft (45) and against the thrust plate (47). When properly installed a spring load can be felt when pushing against the cylinder block (34).

o. Set the pump vertically and install the spacer (36) into the center bore of the cylinder block (34).

p. The tapered bearing (35) should be installed with an arbor type press for the most satisfactory results. This bearing can not be driven onto the shaft due to the internal spring loading of the cylinder block and shaft. Press on the inner race of the bearing and use care not to damage roller cage. The bearing must be pressed on until it rests on the shoulder of the shaft to insure ¶ adequate bearing clearance.

q. Install the pilot ring (33) in the bearing plate (32) and the locating pin in the cylinder block. Install the bearing plate (32) so that the milled slot locates over the pin and the pilot ring (33) fits in the center bore of the cylinder block (34). After installation, lubricate the exposed surfaces with clean hydraulic oil.

r. Assemble the bearing race (29), shim (31) (if required) and locating pin (30) in the end cap (25). Check the valve plate (28) to be certain it is a pump valve plate (has 2 tapered slots) and that it is for correct rotation (slots point away from direction of rotation).

s. Lubricate the end cap (25) face with clean hydraulic oil. Install the valve plate (28) so that the slot locates over the pin and the center bore fits over the protruding bearing race (29). Place the end cap gasket (26) on the housing (70), being certain the locating pins (72) are in place, then install the O-ring (27) in the counter bore in the housing (70).

t. Install the end cap (25) and valve plate (28), holding the valve plate so it does not drop off during assembly. The end cap will align with the housing mounting holes in one position only.

u. Install two screws (22, 23) and tighten alternately until the internal spring has compressed far enough for the end cap (25) to rest on the housing (70). Install the remaining cap screws and torque to 27-37 ft. lbs.

v. Install O-ring (6) in bronze sealing ring (5). Place the six or more springs that are part of the seal assembly (7) in the cavities in the housing (70). Wrap the end of the shaft (45) to protect parts from damage and install sealing ring (5) over shaft with O-ring facing pump. Use hand force only to install.

w. Install o-ring (4) in housing (2) and insert the stationary seal pilot (4A) into the aluminum housing (2), locating the notch in the stationary seal over the pin in the housing.

x. Install the O-ring (3) on the outside diameter of the housing (2) then slide it into place against the bronze sealing ring (5). Since this is a spring loaded assembly, it may be necessary to push against the aluminum housing to expose the retaining ring groove.

y. Install the retaining ring (1) with the beveled side out, putting the side opposite the tangs into the groove first. Be certain that the retaining ring has snapped into its groove completely.

z. Place a new gasket (18) on the housing, and place the orifice plate and O-rings (17) in the control (16).

aa. install the connecting pin (21) through the control linkage and the feedback link (68) on the swashplate (46) with the headed side toward the center of the pump. Use caution not to drop parts into the pump housing. Install washer (20) and cotter pin (19).

ab. Swing the control (16) into place against the housing (70), being certain the orifice and O-rings are in place, then install cap screws (14) and torque to 10-11 ft-lbs.

NOTE

Check valves (12) are cartridges and are interchangeable with each other. It is suggested that these check valves be replaced in pairs.

ac. Lubricate o-rings (13) and install check valves (12) and o-rings (13). Use caution to prevent damage to the o-rings. Be certain the valves (12) are below the surface of the end cap (25). Torque to 30-40 ft-lbs.

ad. When replacing the charge pump (10), align the gasket (11) so that the small relief valve port is open and not blocked by the gasket. Rotate the charge pump shaft so it aligns approximately with the slot in the end of the pump drive shaft. Hold the idler spacer in place and install the charge pump onto the end cap (25). Rotate the charge pump until the tang and slot engage and the pump is solidly on the end cap. As the charge pump is installed make sure the alignment roll pin is engaged in the charge pump and pump end cap.

ae. Install the four hex, cap screws (8) and washers (9) and tighten to 10-11 ft-lbs.

4-6.6. Driveshafts. (Figure 4-19A). The primary maintenance to be performed on the universal joints and driveshafts is lubrication of the grease fittings. Parts that are most susceptible to wear are in the universal joints. Repair parts to overhaul a universal joint and driveshaft are furnished in repair kits. The following procedures are adequate to repair any of the universal joints and driveshafts installed on the drilling machine.

WARNING

Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death. Do not work on a shaft with engine running .

4-6.6.1 Removal. Remove the mounting screws connecting the flange yokes (1) to the driving and driven components.

4-6.6.2 Disassembly.

a. Using a soft drift, tap the outside of the bearing assembly (3) to loosen snap ring (2). Tap bearing only hard enough to break assembly away from snap ring.

b. Remove snap ring (2) from yoke (1). Turn joint over and remove opposite snap ring.

c. Set the yoke (4) in an arbor press with a piece of tube stock beneath it. Position the yoke with the lube fitting pointing up to prevent interference during disassembly. Place a solid plug on the upper bearing assembly (3) and press it through to release the lower bearing assembly.

d. If the bearing assembly (3) will not pull out by hand after pressing, tap the base of the lug near the bearing assembly to dislodge it.

e. To remove the opposite bearing assembly, turn the yoke (1) over and straighten the cross (5) in the open cross hole. Then carefully press on the end of the cross so the remaining bearing assembly (3) moves straight out of the bearing cross hole. If the cross or bearing assembly are cocked, the bearing assembly will score the walls of the cross hole and ruin the yoke.

f. Repeat this procedure on the remaining bearing assemblies to remove the cross from the shaft yoke (4 or 6).

NOTE

If driveshaft is to be separated make corresponding marks on yokes (4 and 6) so that these will be properly alined at assembly.

g. If parts replacement is required, unscrew dust cap (7) and remove sleeve yoke (4), washer (8) and cork washer (9).

4-6.6.3 Assembly. At assembly use all new parts of journal and bearing kits (items 2, 3 and 5) and shaft dust cap kit (items 7, 8 and 9).

a. Slide dust cap (7), washer (8) and cork washer (9) over shaft of yoke (6).

b. Position sleeve yoke (4) so that alignment marks of both yokes (4 and 6) are on same side, then slide sleeve yoke onto shaft and screw dust cap (7) onto sleeve yoke.

c. Pack the four grease cavities of the cross (5) with a high quality extreme pressure N. L. G. I. Grade 1 or 2 grease. Also pack each bearing assembly (3) approximately 1/4 full with this grease.

d. Position the cross (5) in the yoke (4 or 6) with its lube fitting on the inboard side (toward driveshaft).

e. Move one end of the cross (5) to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke lug. Place a bearing assembly (3) over the trunnion diameter and align it to the cross hole. Using an arbor press, hold the trunnion in alignment with the cross hole and place a solid plug on the upper bearing assembly. Press the bearing assembly into the cross hole enough to install a snap ring (2).

f. Repeat e. for opposite bearing, then again for flange yoke (1).

g. Repeat steps c. through e. for opposite end of driveshaft.

4-6.6.4 Installation. Attach the flange yokes (1) to the driving and driven components with proper attaching hardware. Torque screws to 40-48 lb-ft.

4-7 MAINTENANCE OF AIR COMPRESSOR DRIVE

4-7.1 Air Compressor Assembly.

4-7.1.1 Shaft Seal Assembly. (Figure 4-20)

a. Disassembly.

NOTE

Prepare a clean area for disassembly and reassembly. The components of the shaft seal should not be exposed to grinding dust, chips or corrosive atmosphere. EXTREME CAUTION should be exercised in handling of the shaft seal, as the carbon seal rings are extremely fragile. NEVER subject the shaft seal to hammer blows or impacts, as these can damage the sealing components.

(1) With shaft seal in horizontal position, remove screws (11), lockwashers (12) and keys (13).

(2) Remove retaining ring (1) from shaft (10).

(3) Gently slide or pry end ring (3) off of shaft (10) end do not force if end ring binds, realign by lightly tapping on end ring with a rubber mallet and slide end ring off.

(4) Remove carbon seal ring (4), springs (6), and drive pin (5). Note location of parts as they are removed.

(5) Remove housing (8) and second carbon seal (4). Remove second end ring (9) from shaft. Remove o-rings (2 and 7) from two end rings (3 and 9), and both sides of housing (8).

(6) Discard o-rings (2, 7) carbon seal rings (4), springs (6) and retaining rings (1).

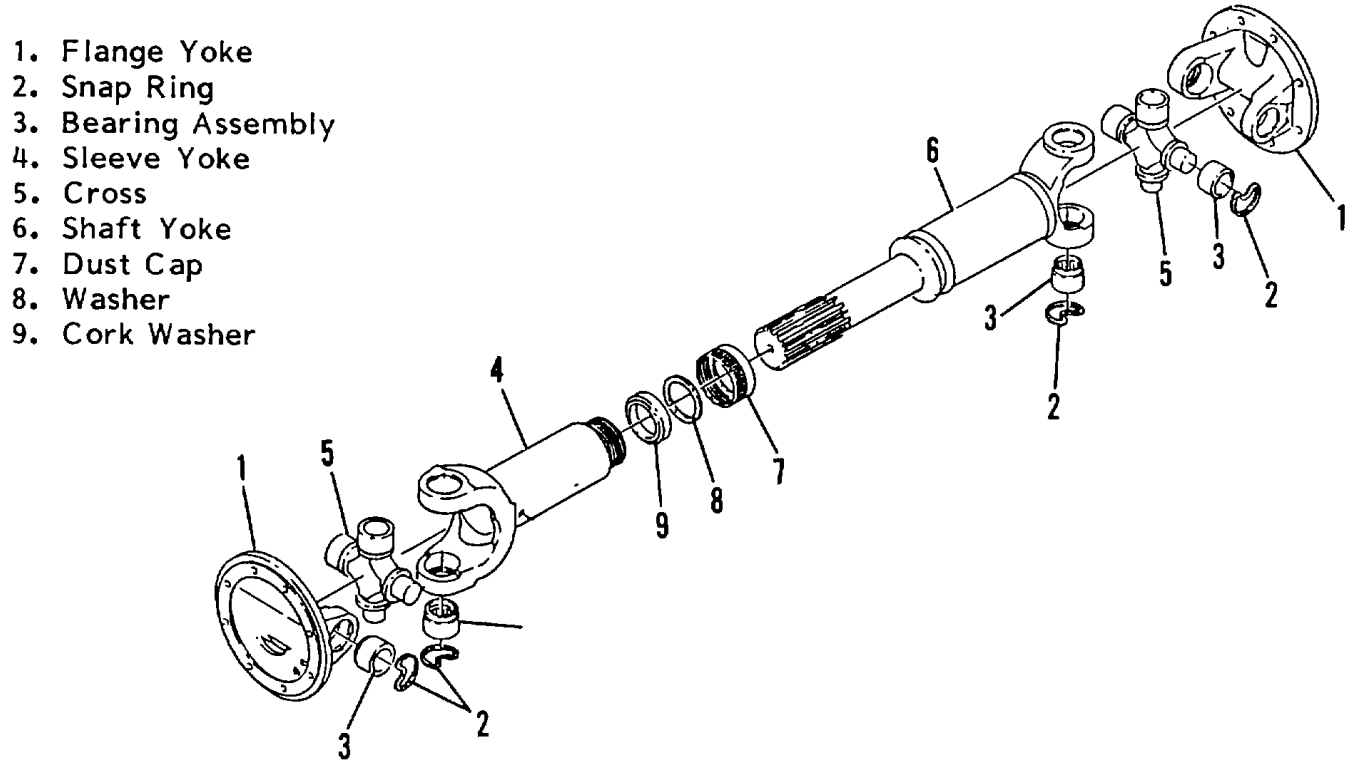
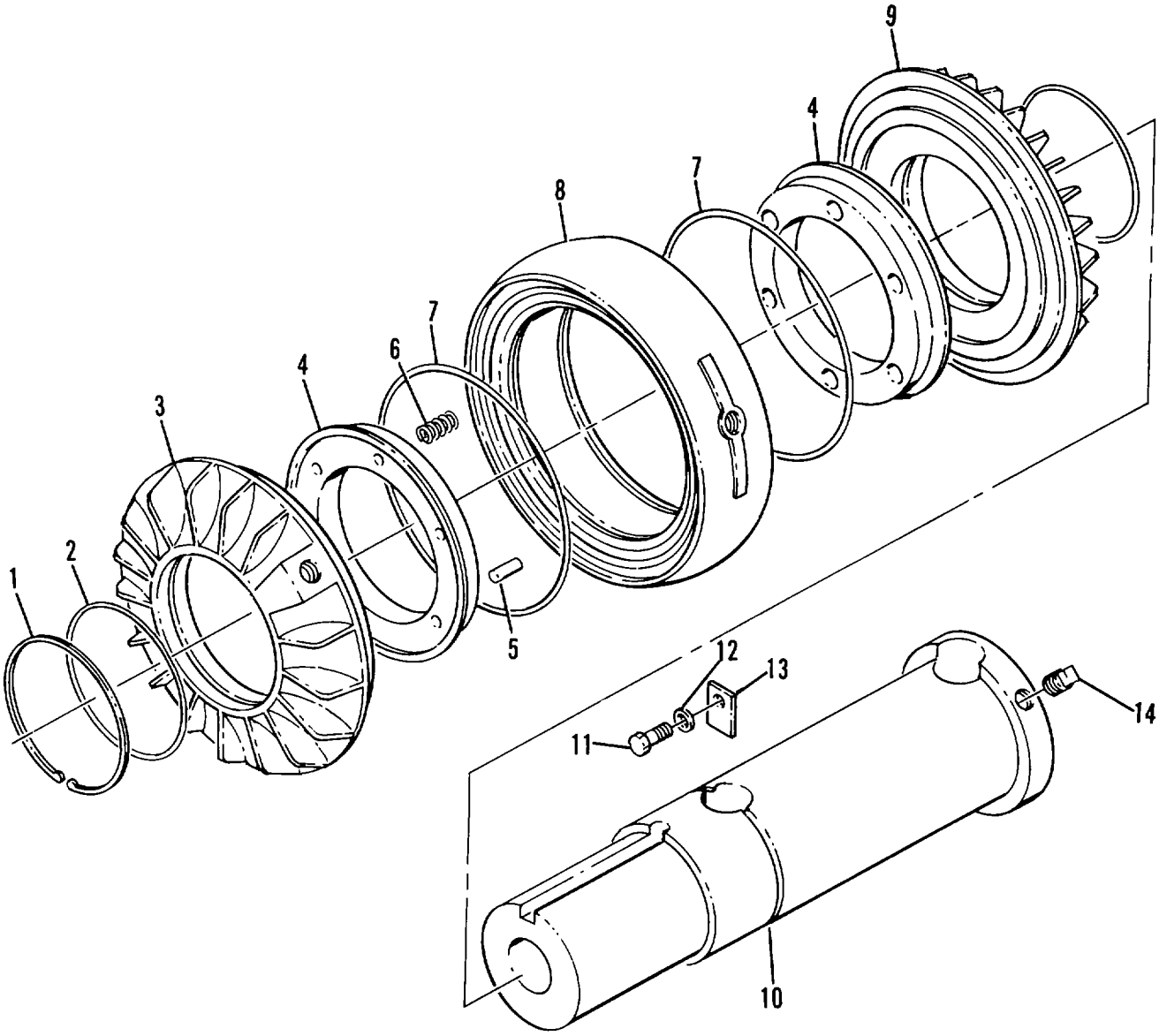


Figure 4-19A. Driveshaft



1. Retaining Ring
2. O-Ring (End Ring)
3. End Ring w/Air Outlet
4. Carbon SEal Ring
5. Drive Pin
6. Spring
7. O-Ring (Housing)
8. Housing
9. Eng Ring w/out Air Outlet
10. Adapter Shaft
11. Socket Head Cap Screw
12. Lockwasher
13. Drive Key
14. Set Screw

Figure 4-20. Shaft Seal Assembly

b. Cleaning and Repair

(1) Degrease all parts and remove any foreign material from grooves etc.

(2) Sealing surfaces on end rings (3 and 9) must be relapped to flatness, (and ground if any dents or cuts appear in the sealing surface). Sealing surfaces should be micro-lapped to a tolerance of 6-10 light bands.

(3) End rings should be THOROUGHLY cleaned and all abrasive removed prior to reassembly.

c. Assembly.

(1) Using a OO grade of non-detergent grease, apply a medium coating of grease to 4 o-rings (2 and 7) carbon seal rings (4) and sealing surfaces of end rings (3 and 9).

(2) Install two smaller o-rings (2) in end rings (3 and 9). Install two larger o-rings (7) in housing (8). Be certain the o-rings are in their grooves.

(3) With sealing surface of end ring (9) facing up, slide end ring slowly over end of shaft (10) against shoulder on opposite end. DO NOT COCK END RING as this will cause o-ring (2) to be cut by retaining ring grooves on the shaft.

(4) Install one carbon seal ring (4) over shaft (spring holes must face up).

(5) Install housing (8) over shaft and slide gently over carbon seal (4) until carbon seal bottoms out in housing. The drive pin holes in housing and carbon seal MUST BE ALIGNED.

(6) Install drive pin (5) and springs (6) making certain drive pin is free to move in carbon seal and is bottomed out in carbon seal.

(7) Install second carbon seal (4) with spring holes down. NOTE: drive pin hole in carbon seal must be aligned with drive pin (5). Without compressing the springs (6), be certain each spring is in its respective counter bored hole in carbon seal. Carbon seal should be resting on the springs and parallel with table surface. If carbon seal appears cocked the springs are not positioned properly in spring holes.

NOTE

Again be certain the drive pin hole in upper carbon is aligned with drive pin in housing before proceeding.

(8) With sealing surface down, slide second end ring (3), over shaft and very gently contact upper carbon. VERY GENTLY, slide the end ring down over the shaft compressing the springs (6) until the upper retaining ring groove is fully exposed. DO NOT FORCE. This operation may take several tries as the drive pin (5) must slide into the carbon seal (4). Excessive pressure will crack the carbon seal.

(9) Holding the end ring (3) down, install retaining ring (1), release pressure. Inspect retaining ring being certain it is completely seated in its groove.

(10) Install pipe plugs in end ring with air outlets - static test - check for audible air leaks and with a soap solution to be certain no o-rings have been cut or carbon seal damaged. A moderate leakage may be expected until carbons seals have seated against end rings during operation.

(11) Align key slots in end rings with slots in shaft. Install keys (13), screws (11) and lockwashers (12).

4-7.1.2 Air Compressor Drive Clutch. (Figure 4-21)

a. Disassembly.

(1) Remove all but two of the screws (1) and lockwashers (2). Slowly remove the remaining screws loosening alternately.

(2) Lift off pressure plate (3) and remove spacers (4) and adjustment spacers (5).

(3) Remove shoulder bolts (6), washers (7) and springs (8).

(4) Remove outer torque plate (9), with diaphragm (12) attached, inner torque plate (17) and hub (18).

(5) Remove all the screws (16), lockwashers (15), clamp rings (13 and 14), diaphragm (12) and seals (10 and 11) from outer torque plate (9).

(6) To separate backplate (21) from hub (24), remove screws (22) and lockwashers (23). Remove register pins (20) if replacement is necessary.

b. Inspection and Repair.

(1) The outer and inner torque plates (9 and 17) should be replaced if friction plate is excessively worn.

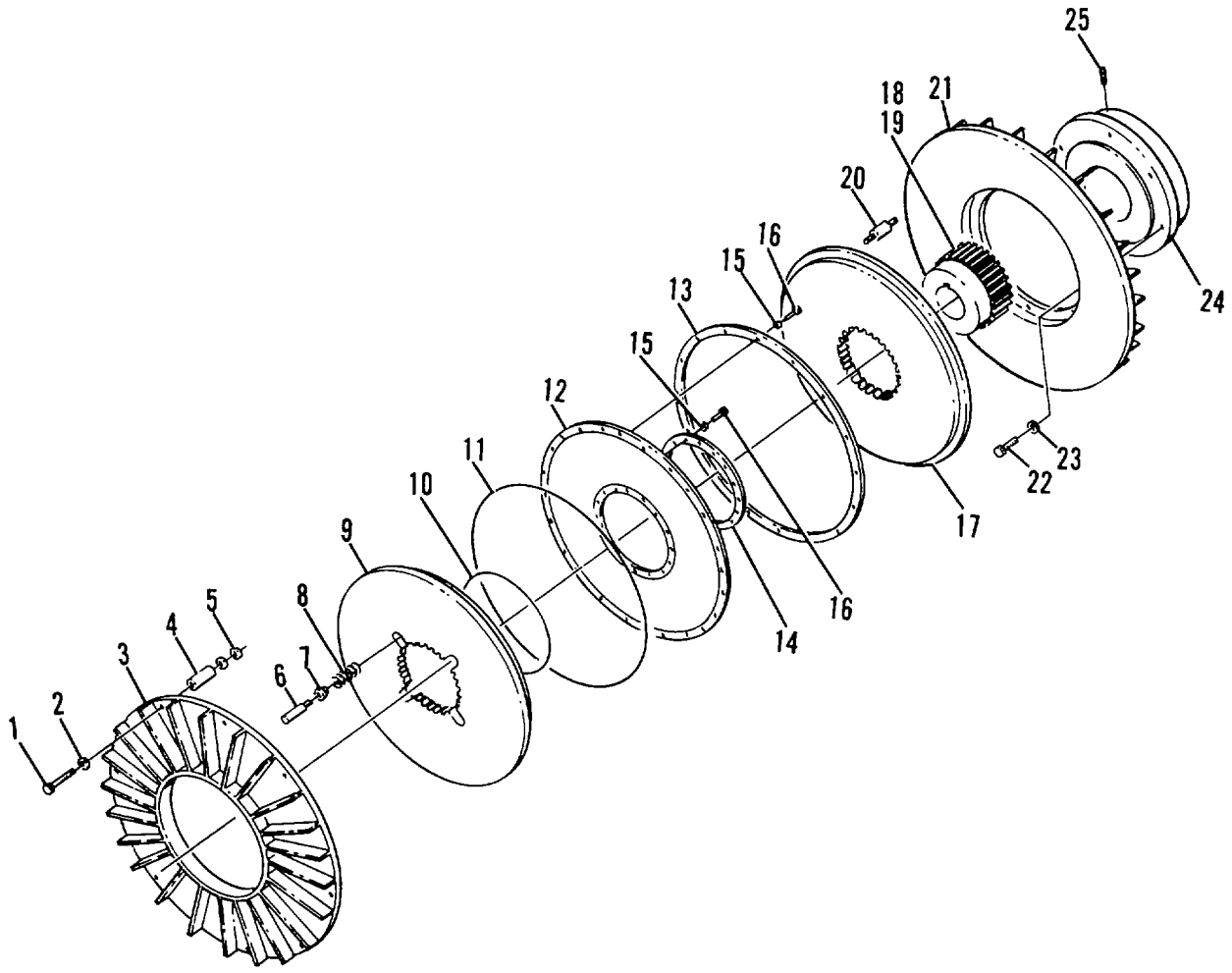
(2) Closely inspect diaphragm (12) for cracks, breaks or holes. Replace if any flaws are found.

(3) When assembling clutch, use new springs (8) and seals (10 and 11).

c. Assembly.

(1) Apply a light coat of petroleum jelly to inner and outer seals (10 and 11) and install them in grooves of outer torque plate (9).

(2) Position the diaphragm (12) on the outer torque plate (9) with the circle located near the outer edge of diaphragm facing out. Position the diaphragm so that the air inlet holes in the outer torque plate line up with black circles on diaphragm.



1. Cap Screw
2. Lockwasher
3. Pressure Plate
4. Spacer
5. Adjustment Spacer
6. Spring Shoulder Bolt
7. Spring Retaining Washer
8. Release Spring
9. Outer Torque Plate Assembly Friction Lining
10. Inner Seal
11. Outer Seal
12. Diaphragm
13. Outer Clamp Ring
14. Inner Clamp Ring
15. Lockwasher
16. Socket Head Cap Screw
17. Inner Torque Plate Assembly Friction Lining
18. Hub
19. Set Screw
20. Register Pin
21. Registered Backplate
22. Cap Screw
23. Lockwasher
24. Keyed Hub
25. Set Screw

Figure 4-21. Air Compressor Drive Clutch

(3) Install the inner clamp ring (14), screws (16), and lockwashers (15), then install outer clamp ring (13) with remaining screws and lockwashers (16 and 15). If required, push diaphragm (12) toward center to align holes, being careful not to disturb seals (10 and 11).

NOTE

If new diaphragm is installed, trim the edges with a sharp blade after the clamping rings have been installed.

(4) Assemble the hub (24) to backplate (21) and install screws (22) and lockwashers (23). Install register pins (20).

(5) Position inner torque plate (17) on hub (18). Install the outer torque plate (9), being sure that threaded holes in inner plate (17) align with counter bores for release springs in outer plate (9).

(6) Install springs (8), washers (7) and shoulder bolts (6). Start all shoulder bolts before tightening.

(7) Position the assembled torque plates on the backplate (21).

NOTE

With new torque plates, two alignment spacers (5) are used at each screw (1). One spacer is removed for each 1/8 inch of friction plate wear.

(8) Place pressure plate (3) in position so that its register holes are aligned with register pins (20). Position spacers (5 and 4).

(9) Lubricate the threads of screws (1) and install screws and lockwashers (2). Tighten screws (1) uniformly.

4-7.2 Oil Cooler Assembly.

4-7.2.1 Oil Filter. (Figure 4-21A)

a. Loosen nut (1) and swing out head of clamp bolt (2) and remove clamp (3).

b. Remove filter bowl (4) and gasket (5).

c. Remove and discard filter element (6).

d. Install new element (6), gasket (5) and bowl (4).

e. Install clamp (3) and engage head of clamp bolt (2). Tighten nut (1).

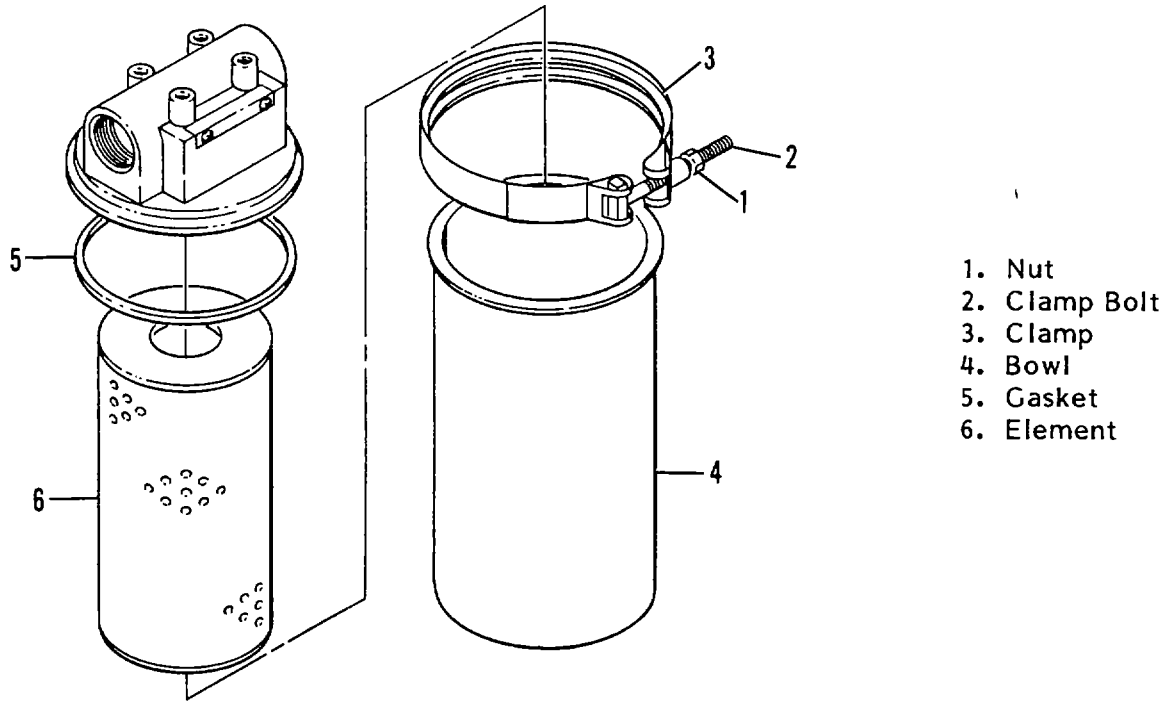


Figure 4-21A. Oil Filter

4-7.2.2 Hydraulic Cooling Fan Motor. (Figure 4-21B)

a. Disassembly. Thoroughly clean the exterior of the pump prior to disassembly.

(1) Clamp the pump body (1) securely in a soft jawed vise. Cover sharp edges of drive shaft with tape, after removing key (2).

(2) Remove screws (3).

CAUTION

Do not use a screwdriver to attempt to pry front cover (4) or rear cover (5) from body (1).

(3) Carefully remove the front cover (4) and rear cover (5) from the pump body (1). Should these be tight on their dowels (6), lightly tap with a mallet to release. Remove seals (7), loading seals (8) and thrust plates (9).

(4) Withdraw the gears (10 and 11) from the body (1) as an assembly and carefully note their original positions.

(5) Remove retaining ring (12), then, supporting the front cover (4) outer face downward, tap out the oil seal (13) with a soft metal drift.

1. Body
2. Key
3. Screw
4. Front Cover
5. Rear Cover
6. Dowel
7. Seal
8. Loading Seal
9. Thrust Plate
10. Driven Gear
11. Drive Gear
12. Retaining Ring
13. Seal

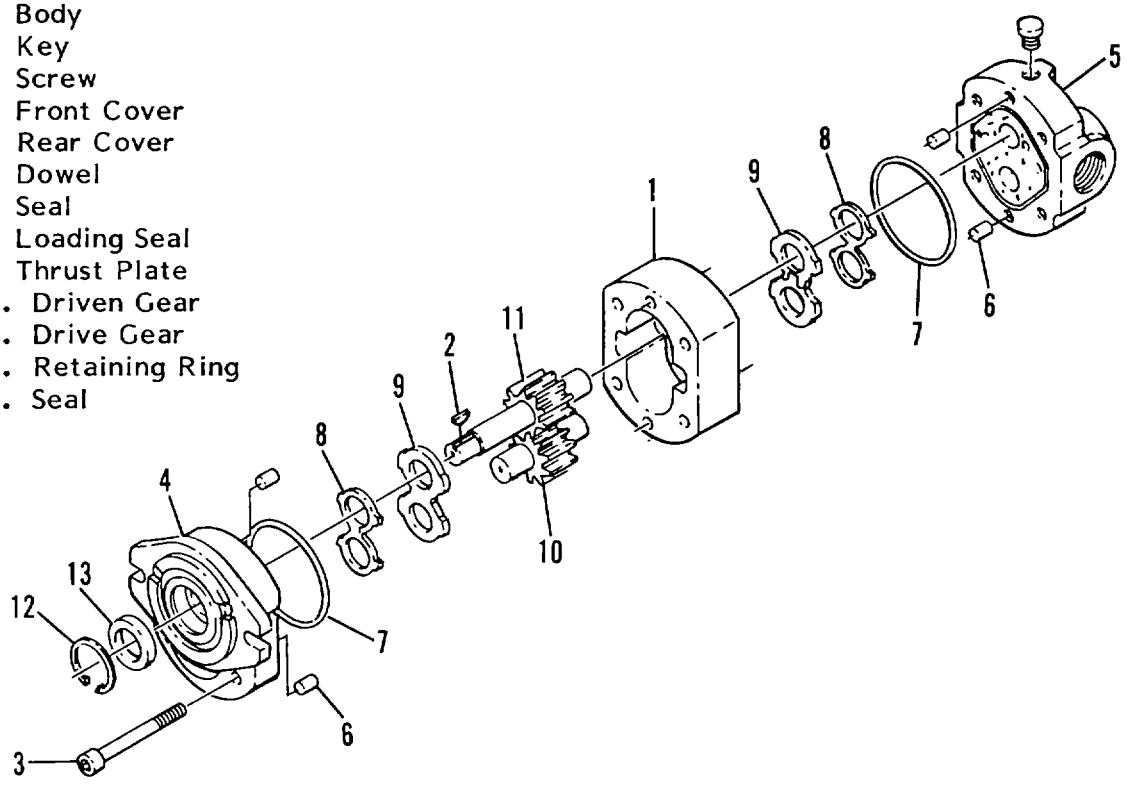


Figure 4-21B. Hydraulic Cooling Fan Motor

b. Inspection and Repair.

(1) Discard all seals and thoroughly clean all parts: check that all machined faces and threads are free from burrs, scores and other damage. Replace any damaged screws, retaining ring, dowels.

(2) Inspect the gears for scored or worn side faces or journals, damaged teeth, thread or keyway, and surface cracks.

(3) While servicing the drive and driven gears, particular attention should be paid to the following points.

(a) Gear widths of drive and driven gears must be within 0.005 mm (0.0002") of each other to endure satisfactory pump efficiency.

(b) Journals must be within 0.013 mm (0.0005") of each other.

(c) Replacement gears are supplied as matched sets.

c. Assembly.

(1) Place the front cover (4), machined surface down, on a clean flat surface. Apply a little grease to the oil seal (13) and, with garter spring facing into pump, use a suitable tool to press seal into cover. Install retaining ring (12).

(2) Install the thrust plates (9), loading seals (8) and seals (7) in front cover (4) and rear cover (5), using a little light grease to aid their retention.

(3) Place the rear cover (5) in a soft jawed vise with machined face up. Be sure that dowels (6) are in place on body (1), then assemble body (1) to rear cover (5).

(4) Insert the gears (10 and 11) into their respective bores in pump body (1).

(5) To avoid damaging seal (13), place a protective sleeve over the drive shaft and gently press the front cover (4) down onto the pump body (1).

(6) Install the screws (3) and torque to 36-40 ft.-lbs.

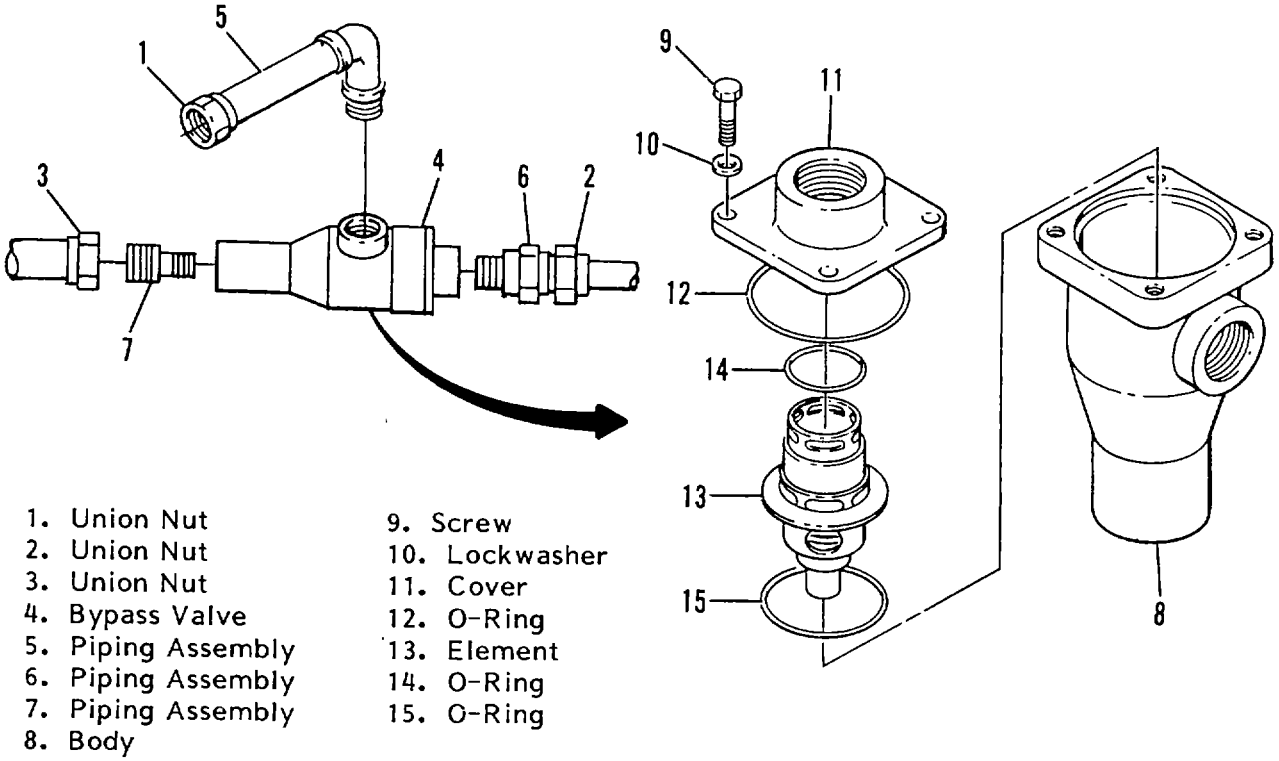
4-7.2.3 Thermostatic Bypass Valve. (Figure 4-21C)

a. Removal and Disassembly.

(1) Unscrew union nuts (1, 2 and 3) and remove bypass valve (4), with piping assemblies (5, 6 and 7) attached, from piping.

(2) Remove piping assemblies (5, 6 and 7) from bypass valve (4).

(3) Clamp the body (8) in a soft-jawed vise and remove screws (9) and lockwashers (10).



1. Union Nut
2. Union Nut
3. Union Nut
4. Bypass Valve
5. Piping Assembly
6. Piping Assembly
7. Piping Assembly
8. Body
9. Screw
10. Lockwasher
11. Cover
12. O-Ring
13. Element
14. O-Ring
15. O-Ring

Figure 4-21C. Thermostatic Bypass Valve

CAUTION

Do not pry cover (11) from body (8). If necessary, tap on cover with wooden mallet to loosen it.

(4) Remove cover (11) and o-ring (12).

(5) Lift element (13) from valve body (8) and remove o-rings (14 and 15).

b. Repair. If bypass valve has failed, the element (13) should be replaced. Inspect o-rings (12 and 14) and replace them if their sealing capabilities are questionable.

c. Assembly and Installation.

(1) Lightly lubricate o-ring (14) with oil and install o-ring on element (13).

(2) Lightly lubricate o-ring (15) and install in body (8). Install element (13) in body.

(3) Lightly lubricate o-ring (12) and install on cover (11).

(4) Install cover (11) on body (8) and secure with screws (9) and lockwashers (10).

(5) Remove the assembled valve (4) from vise and install piping assemblies (5, 6 and 7).

(6) Position valve with piping assemblies and tighten union nuts (1, 2 and 3).

4-7.3 Air Filter Assembly.

4-7.3.1 Air Cleaner. (Figure 4-21D.)

a. Loosen wing nuts (1) and swing the retaining rods (2) out of the brackets.

b. Remove cup assembly (3) from air cleaner.

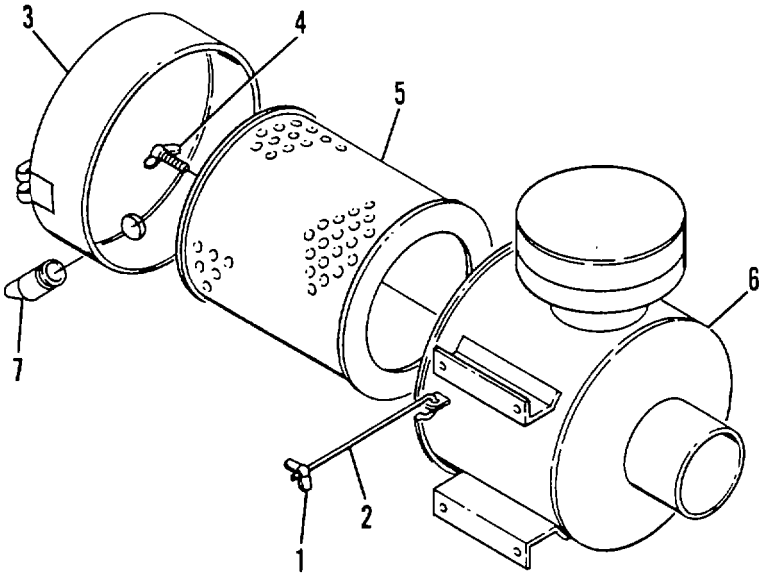
c. Loosen and remove element wing bolt (4) and remove element (5) from air cleaner housing (6).

d. Check that the ejection valve (7) is not damaged or missing. Replace if necessary.

e. To clean the element (5), first use low pressure compressed air and blow through the paper from inside to remove excess dust. Keep air nozzle at least one inch away to avoid damaging the paper.

f. Soak the element in a lukewarm, non-foaming detergent solution for 15 minutes. Using clean water, rinse repeatedly to remove all traces of detergent and dirt from between the paper pleats. Never use solvents, fuel oils, or gasoline to clean an element.

g. Shake excess water from element. Never use compressed air on a wet element. Allow it to dry thoroughly in a dust free area with the gasket end down. NOTE No more than six washings are recommended.



1. Wing Nut
2. Retaining Rod
3. Cup Assembly
4. Wing Bolt
5. Element
6. Housing
7. Ejection Valve

Figure 4-21D. Air Compressor Air Filter

h. Before using a new or reconditioned element, check for holes in the paper by inserting a bright light inside the element. Any bright spot of light indicates the element is not suitable for service and should be replaced.

i. Install the element (5) in the housing (6) and install the wing bolt (4). Be sure the element is properly installed and tighten wing bolt to 50 to 70 in.-lbs.

j. Install the cup assembly (3) with ejection valve (7) on housing (6).

k. Swing the retaining rods (2) into the brackets and tighten wing nut (1) firmly.

4-7.3.2 Inlet Throttle Valve. (Figure 4-21E.)

a. Removal and Disassembly.

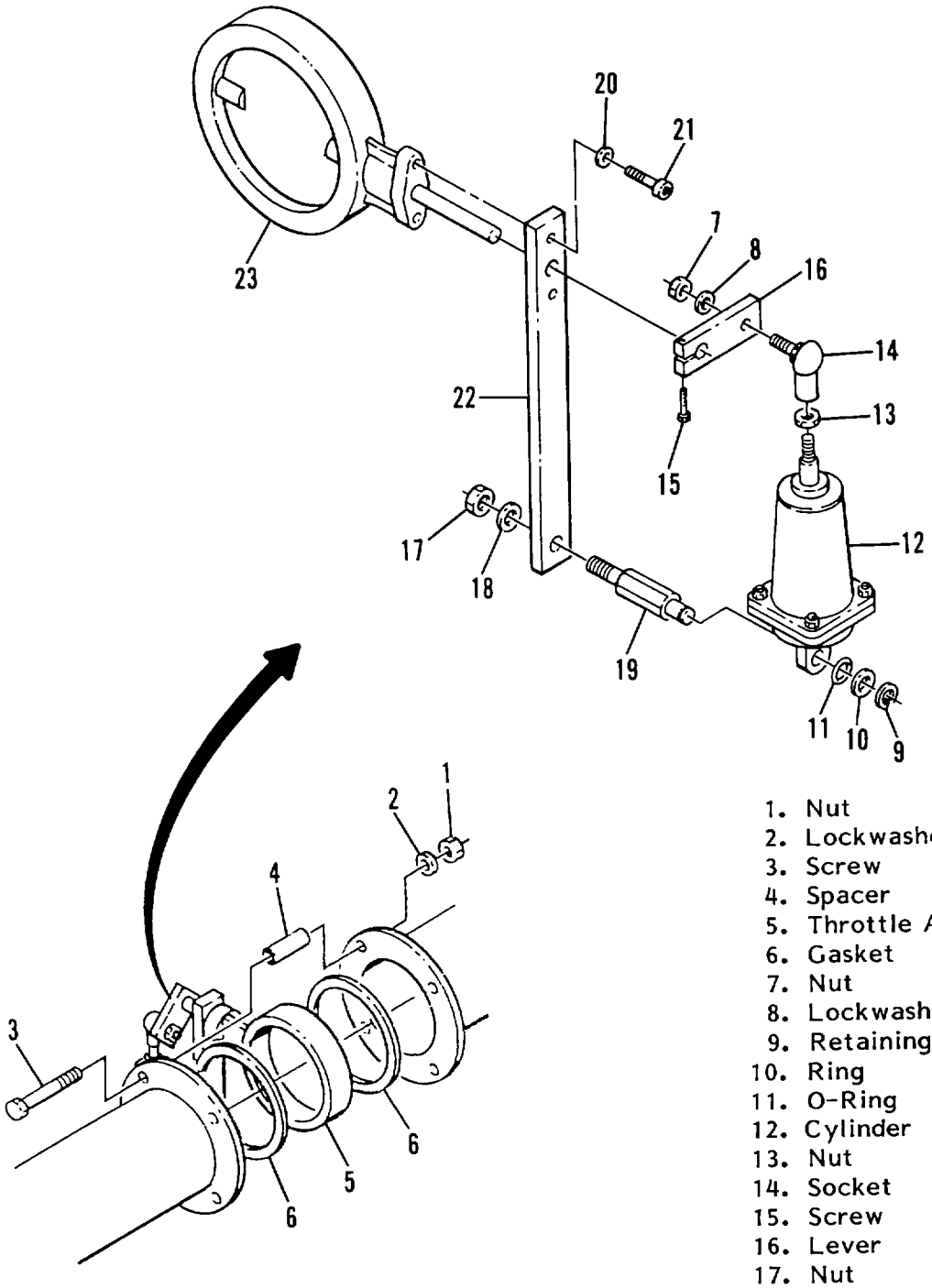
(1) Remove nuts (1), lockwashers (2), screws (3) and spacers (4).

(2) Remove throttle assembly (5) from piping. Remove gaskets (6).

(3) Remove nut (7), lockwasher (8), retaining ring (9), ring (10) and o-ring (11). Remove cylinder (12).

(4) Loosen nut (13) and screw socket (14) off cylinder (12). Remove nut (13).

(5) Loosen screw (15) and remove lever (16). Remove nut (17), lockwasher (18) and bolt (19).



1. Nut
2. Lockwasher
3. Screw
4. Spacer
5. Throttle Assembly
6. Gasket
7. Nut
8. Lockwasher
9. Retaining Ring
10. Ring
11. O-Ring
12. Cylinder
13. Nut
14. Socket
15. Screw
16. Lever
17. Nut
18. Lockwasher
19. Bolt
20. Screw
21. Lockwasher
22. Plate
23. Butterfly Valve

Figure 4-21E. Inlet Throttle Assembly

(6) Remove screws (20) and lockwashers (21) to separate plate (22) from butterfly valve (23).

b. Assembly and Installation.

(1) Assemble plate (22) to butterfly valve (23) and install screws (20) and lockwashers (21).

(2) Install bolt (19), lockwasher (18) and nut (17) on plate (22).

(3) Thread nut (13) onto cylinder (12) rod, then install socket (14).

(4) Install lever (16) on butterfly valve (23) shaft but do not tighten screw (15). Be sure valve (23) is in the closed position.

(5) Assemble the cylinder (12) to bolt (19) and install socket (14) in lever (16). Lever should be 900 to plate (22). If not, screw socket (14) up or down on cylinder rod as needed. Tighten nut (13) against socket.

(6) When properly positioned, install o-ring (11), ring (10) and retaining ring (9). Install lockwasher (8) and nut (7). Tighten screw (15).

(7) Install throttle assembly (5) and gaskets (6) into piping. Install spacers (4), screws (3), lockwashers (2) and nuts (1).

4-7.4 Air/Oil Separator Assembly.

4-7.4.1 Air/Oil Separator. (Figure 4-21F) Perform the following steps to replace the separator element.

a. Disconnect hose assemblies (1 and 2). Disconnect and remove tubing assemblies (3 and 4). Unscrew union nut (5).

b. Remove nut's (6) and lockwashers (7).

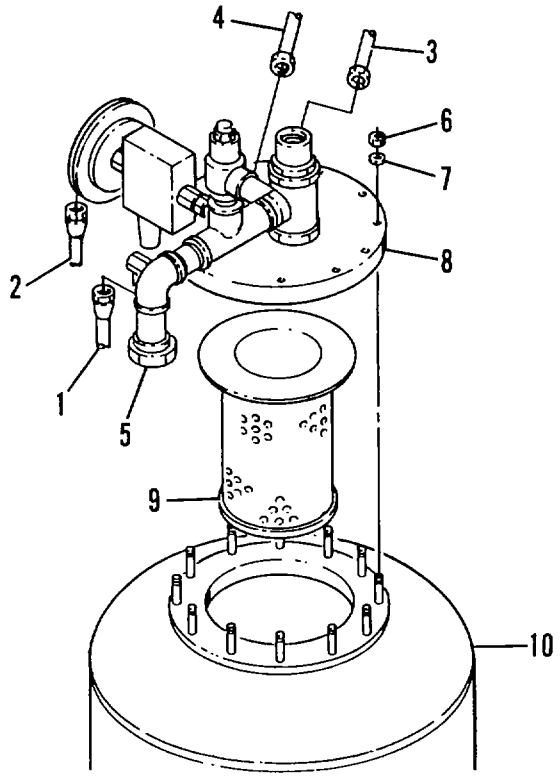
c. Lift cover (8) from vessel (10) with valves and piping assembled.

d. Remove element (9) from vessel.

e. Install a new element (9) in vessel (10) and set the cover (8) onto studs in vessel. Make sure the piping is properly oriented.

f. Install lockwashers (7) and nuts (6). Tighten nuts evenly, then use a torque wrench to tighten nuts, in criss-cross fashion, to 55 ft.-lbs.

g. Tighten union nut (5) and attach hose assemblies (1 and 2). Install tubing assemblies (3 and 4).



1. Hose Assembly
2. Hose Assembly
3. Tubing Assembly
4. Tubing Assembly
5. Union Nut
6. Nut
7. Lockwasher
8. Cover
9. Element
10. Vessel

Figure 4-21F. Air/Oil Separator

4-7.5 Force Feed Lubricator.

4-7.5.1 Removing Lubricator Assembly (Figure 4-21G).

a. Disconnect the copper tube assemblies; do not separate the tube assembly items (1, 2, 3, 4, 5) unless repair to the lines is necessary. Disassemble the fittings and valves (items 6 through 12) as required for repair or replacement.

b. From the top of the lubricator, remove the elbows (13 and 14), tees (15), nipples (8 and 16), elbow (17), and bushing (10). Remove the relief valve (18) and nipple (19) from the lubricator port plate (24). Finally, remove the bolts (21) and lockwashers (22) to remove the lubricator motor guard (23).

4-7.5.2 Removing/Disassembling Lubricator Pump (Figure 4-21H).

a. Remove the pump assembly (1) by first removing two capscrews (2) and washers (3). Lift the pump assembly (1) and gasket (4) from the reservoir.

b. Remove the strainer (5) and suction tube (6). Remove the retaining ring (7) and pull the pin (8) from the rocker arm (9) and roller (10). Pull out the groove pin (11) to remove the rocker arm post (12). Remove the retaining ring (13) to remove the spring retainer (14) and spring (15).

c. Unscrew the plunger assembly (16) and the screw (17) from the pump body. Remove four capscrews (18) to separate the housing assembly (19) from the pump body assembly. With the housing and body separated, remove the packing (20, 21, and 22) and ball (23) from the pump body assembly (24). Repeat these procedures for the other pump.

4-7.5.3 Removing Motor and Drive Assembly (Figure 4-21H).

a. Remove the four capscrews (25), nuts (26), and lockwashers (27) to remove the coupling guard (28). Disconnect the flexible coupling (29). To remove the electric motor (32), first remove the four capscrews (30) and lockwashers (31).

b. Remove the spacer bar (35) and block (36) from the drip pan by removing the capscrews (33, 34) and lockwashers (31). Finally separate the assembled lubricator from the drip pan (42) by removing four capscrews (40), flat washers (41), nuts (38), and lockwashers (39). Blank covers (43) need not be removed unless access to reservoir is required.

c. Loosen a set screw (57) from the coupling (74). Then remove four capscrews (45) and lockwashers (46) and remove the drive housing and gasket (71) from the reservoir.

4-7.5.4 Disassembling Drive Assembly (Figure 4-21 H).

a. Before disassembling the drive assembly, remove the outside woodruff key (55) from the idler shaft. Remove a pipe plug (69) and drain the lubricant from the housing.

b. Begin disassembly by unscrewing four capscrews (45) and lockwashers (46) to remove the housing cover (47) and gasket (48). Remove the oil seal (49). Withdraw the assembled drive shaft (56) and the idler shaft (61) from the housing. Remove the other oil seal (49) from the housing.

c. Remove the spacer (50) from the shaft and then remove the retaining ring (51). Remove the thrust bearing (53) and thrust washer (54) from either side of the worm gear; then remove the worm gear (52) and woodruff keys (55) from the drive shaft (52).

d. Loosen the set screw (57) in the spacer (58) and slide the spacer off the shaft. Then remove the worm gear (59), spacer (60), and woodruff keys (55) from the idler shaft (61).

e. From the top and bottom of the housing, unscrew the two end bearings (62) and remove the gaskets (63). Then remove the assembled transfer shaft from the housing. Unscrew the lock nut (72) and, from the back end of the reservoir and camshaft, remove another end bearing (62) and gasket (63). Then remove the assembled camshaft from the housing. Disassemble thrust bearing (53) and washer (54), spacers (64 and 66), worm gears (65 and 67), and woodruff keys (55) from the transfer shaft (68). Remove the bearing cap (73), loosen the set screw (57), and remove the coupling (74) from the camshaft. Remove the pipe plugs (69) from the housing (70).

f. Note the position of the cams on the shaft for reassembly. Loosen set screws (75) and remove the cams (76) and woodruff keys (77) from the camshaft (78).

4-7.5.5 Cleaning Inspection and Repair.

a. Clean all parts with an approved cleaning solvent. Check and clean any collection of dirt or sludge from the suction strainer.

b. Examine all gears for signs of wear or broken teeth. Check bearing surfaces for evidence of wear or pitting. Check shafts for wear, corrosion, pitting, or damage.

c. Normally, replacement of all gaskets, packing, and oil seals is recommended each time the lubricator is disassembled.

d. Replace all parts found damaged or worn beyond normal wear.

4-7.5.6 Assembling Drive Assembly (Figure 4-21 H).

a. Set up the housing on its back (opening up) leaving room under the housing for idler shaft clearance. Install the spacer (66) onto the transfer shaft (68); then position the woodruff keys (55) in the slots in the shaft. From the top end of the shaft, install worm gear (67). From the bottom end, install worm gear (65). Then install spacers (64) and thrust bearing (53) and washer (54) onto each end of the shaft. Position the assembled transfer shaft in the housing and install the gaskets (63) and end bearings (62).

b. Install the woodruff key (55) in the slot in the shaft (61). Install the worm gear (59); then install spacers (60) and (58). Fasten the set screw (57) to hold the spacer and worm gear in position on the shaft. Install a new oil. seal (49) into the back of the housing in the idler shaft hole. Now position the idler shaft in the housing and, from the back of the housing, insert the other woodruff key (55).

c. Install a new oil seal (49) into the cover (47) in the drive shaft hole. Install a woodruff key (55) in the slot near the middle of the drive shaft (56); then install the worm gear (52). Onto both ends of the shaft, assemble a thrust bearing (53) and thrust washer (54). On the back end of the shaft, install the retaining ring (51) and the end spacer (50). Now position the assembled drive shaft in the housing. Apply some light lubricant on a new gasket (48); the lubricant will hold the gasket correctly positioned on the housing.

d. Before attaching the cover, be sure all worm gears are properly meshed together. Then, carefully, aline the idler and drive shafts while installing the cover (47). Be sure the gasket remains properly positioned (observe the screw holes in the gasket through the screw holes in the cover). Finally, install the four capscrews (45) and lockwashers (46) to secure the cover to the housing.

e. Apply a light lubricant to hold the new gasket (71) to the reservoir and assemble the drive assembly housing (70) onto the reservoir (79), fastening it with the four capscrews (45) and lockwashers (46).

f. Install the woodruff keys (77) and the cams (76) onto the shaft (78) being sure to position the cams as they were. Tighten set screws (75). Install the end bearing (62) and gasket (63) and fasten it with the lock nut (72). Assemble the thrust washer (54) onto the shaft. Install one end of the coupling (74) on the shaft. Position the assembled cam shaft in place and slide the coupling onto the idler shaft, aligning its keyways. Fasten the coupling to both shafts with set screws (57).

4-7.5.7 Assembling Reservoir and Motor (Figure 4-21H).

a. Position the assembled lubricator and drive assembly onto the drip pan (42), fastening it with capscrews (40), flat washers (41), lockwashers (39), and nuts (38). Install the drain plug (37). Assemble the spacer bar (35) to the spacer block (36) and fasten it with capscrews (34). Attach the assembled spacer to the drip pan using capscrews (33) and lockwashers (31).

b. Slide the flexible coupling (29) onto the shaft of the electric motor (32); aline the coupling with the drive assembly shaft. Position the back end of the motor on the spacer block. Connect and fasten the flexible coupling to both electric motor (32) and drive assembly shafts. Fasten the motor to the spacer block (36) with capscrews (30) and lockwashers (31). Finally, install the coupling guard to the drip pan with screws (25), lockwashers (27), and nuts (26).

4-7.5.8 Assembling/Installing Lubricator Pump (Figure 4-21H).

a. Position the ball (23) on the pump body (24) and install new packing (20, 21, 22) on the pump body. Position the housing (19) on the body and fasten with capscrews (18), Install the screw (17) and the plunger (16) in the pump body (24).

b. On the bottom side of the pump body, position the return spring (15); fasten the spring with the spring retainer (14) and the retaining ring (13). Assemble the rocker arm (9), roller (10) and rocker arm post (12), attaching them with pin (8) and retaining rings (7). Install the suction tube (6) and strainer (5).

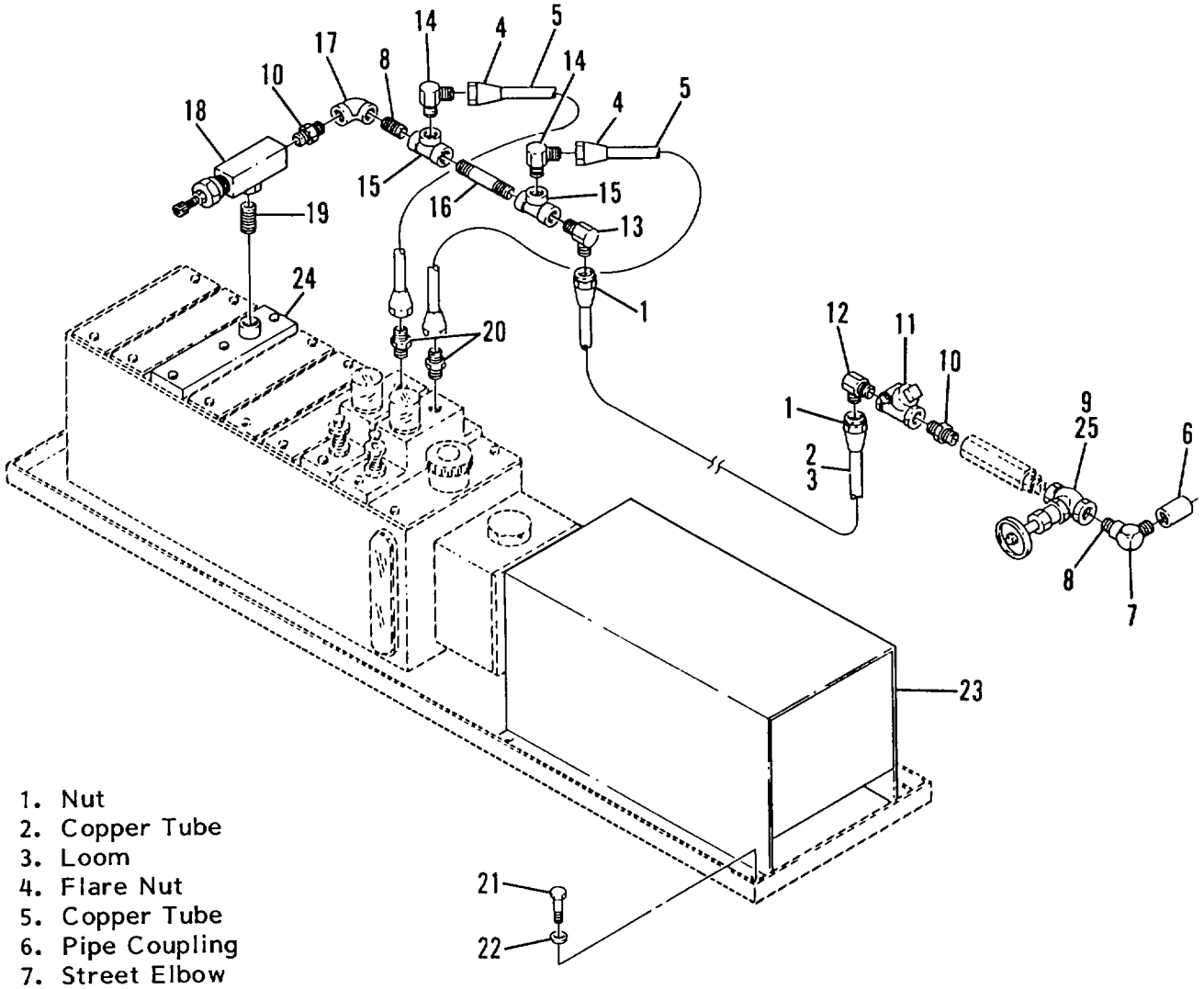
c. Install the gasket (4); then position the assembled pump (1) on the reservoir. Attach the pump with capscrew (2) and washer (3).

4-7.5.9 Installing Lubricator Assembly (Figure 4-21G).

a. Install the lubricator motor guard (23) and fasten it to the drip pan with bolts (21) and lockwashers (22). Install the nipple (19) into the port plate (24); then install the relief valve (18). Assemble the bushing (10) and elbow (17) onto the relief valve; then assemble the tees (15), nipples (8 and 16), and elbows (13 and 14).

b. Reassemble the fittings and valves (items 6 through 12). If the tube assemblies were disassembled, reassemble the tube assemblies (items 1 through 5). Install the tube assemblies and fasten the tube fittings.

c. Add lubricants in reservoir and in drive assembly as directed by lubrication chart.



1. Nut
2. Copper Tube
3. Loom
4. Flare Nut
5. Copper Tube
6. Pipe Coupling
7. Street Elbow
8. Nipple
9. Valve
10. Bushing
11. Check Valve
12. Elbow
13. Elbow
14. Elbow
15. Tee
16. Coupling
17. Elbow
18. Relief Valve
19. Nipple
20. Union
21. Bolt
22. Lockwasher
23. Motor Guard
24. Lubricator Port Plate

Figure 4-21G. Force Feed Lubricator

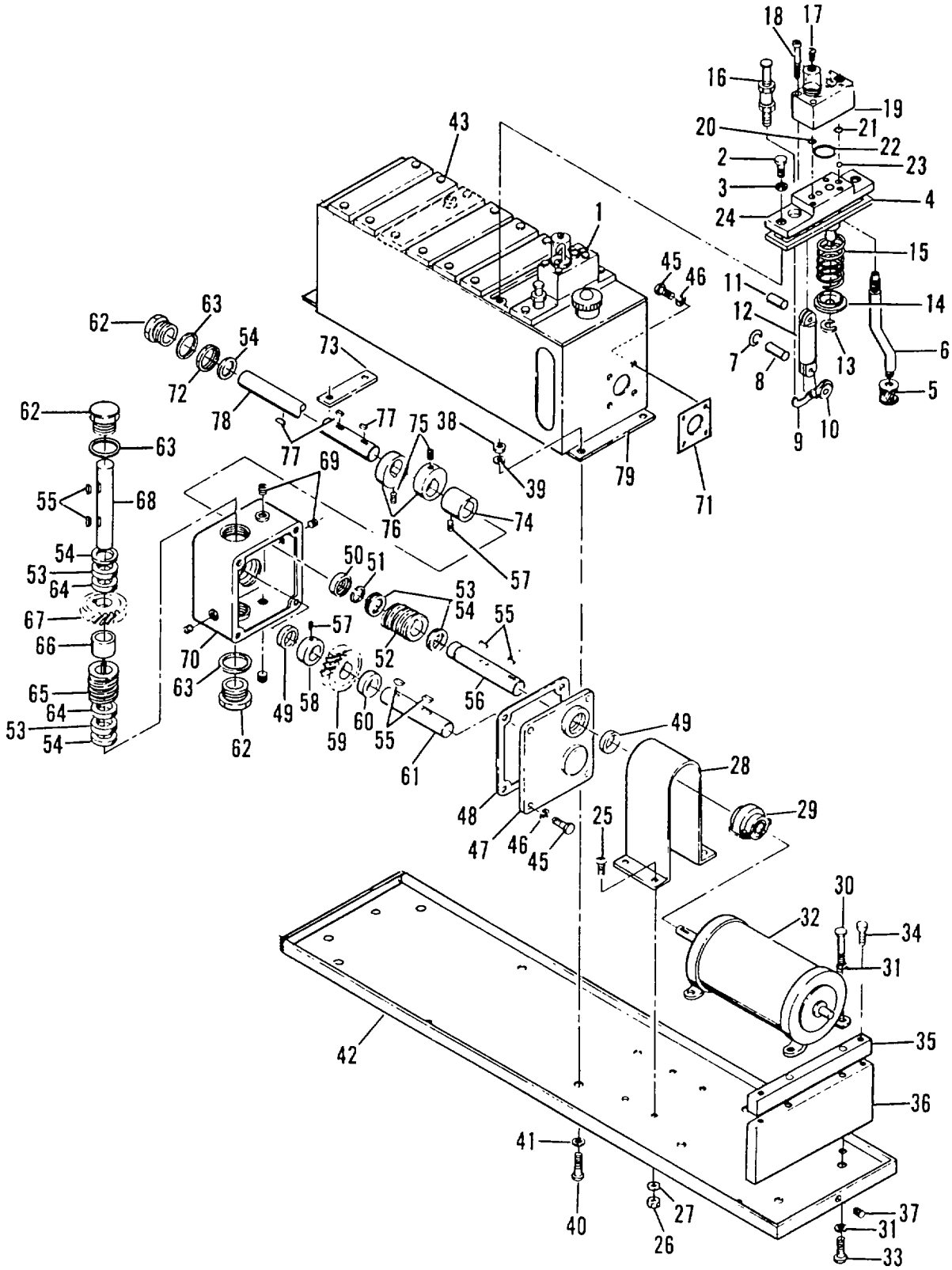


Figure 4-21H. Lubricator Assembly

Legend to figure 4-21H

1. Pump Assembly
2. Capscrew
3. Washer
4. Pump Gasket
5. Strainer
6. Suction Tube
7. Retaining Ring
8. Pin
9. Rocker Arm
10. Roller
11. Groove Pin
12. Rocker Arm Post
13. Retaining Ring
14. Spring Retainer
15. Return Spring
16. Plunger Assembly
17. Screw
18. Capscrew
19. Housing Assembly
20. Preformed Packing
21. Preformed Packing
22. Preformed Packing
23. Ball
24. Pump Body Assembly
25. Machine Screw
26. Hex Nut
27. Lockwasher
28. Coupling Guard
29. Flexible Coupling
30. Capscrew
31. Lockwasher
32. Electric Motor
33. Capscrew
34. Capscrew
35. Spacer Bar
36. Spacer Block
37. Drain Plug
38. Hex Nut
39. Lockwasher
40. Capscrew
41. Flat Washer
42. Drip Pan Base
43. Blank Cover Assembly
44. Drive Assembly
45. Capscrew
46. Lockwasher
47. Cover Assembly
48. Cover Gasket
49. Oil Seal
50. Spacer
51. Retaining Ring
52. Worm Gear
53. Thrust Bearing
54. Thrust Washer
55. Woodruff Key
56. Drive Shaft
57. Set Screw
58. Spacer
59. Worm Gear
60. Spacer
61. Shaft
62. End Bearing
63. Gasket
64. Spacer
65. Worm Gear
66. Spacer
67. Worm Gear
68. Transfer Shaft
69. Pipe Plug
70. Housing Assembly
71. Housing Gasket
72. Lock Nut
73. Bearing Cap
74. Coupling
75. Set Screw
76. Cam
77. Woodruff Key
78. Camshaft
79. Reservoir

4-8 MAINTENANCE OF WATER INJECTION SYSTEM

4-8.1 Water Injection Pump. (Figure 4-22)

4-8.1.1 Servicing the Valve Assemblies.

a. Remove the nuts (1) and lockwashers (2) securing the manifold (3) to the crankcase of the pump.

b. Support the discharge manifold (3) and tap from the backside with a soft mallet to separate from the crankcase and gradually work free from cylinders.

NOTE

Pump models with the o-ring groove on the outside of the valve seat (4) require the assistance of a reverse pliers to remove the valve seat.

c. Valve assemblies will remain in the manifold (3). The valve (5), spring (6), o-ring (7), back-up ring (8), and retainer (9) will then fall out when the manifold (3) is inverted.

NOTE

Pump models without the o-ring groove on the outside of the valve seat (4) permit the seat, valve (5), spring (6), o-ring (7), backup ring (8) and retainer (9) all to fall out when manifold (3) is inverted.

d. Replace retainers (9) in manifold chambers. Next insert spring (6) into center of retainer.

e. Inspect the valves (5) for wear, ridges or pitting and replace if necessary. Note: Seating side of flat valves may be lapped on flat surface using 240 grit paper. Quiet valves due to their shape must be replaced.

f. Insert valve (5) over spring (6) with recessed (dish) side down.

g. Next examine the seating surface of the flat valve seats (4) and lap with 240 grit paper or replace if evidence of excessive wear. Quiet valve seats should be replaced if worn. Lap new quiet valve and seat to assure positive seal.

h. Examine o-rings (7) and back-up rings (8) and replace if worn. Always lubricate o-rings for ease of installation and to avoid damaging elastomers.

NOTE

First install o-ring (7) in groove on seat (4) (towards seating surface), then back-up ring (8).

NOTE

Models without outer groove on seat require the o-ring to be placed on lip of retainer.

i. Insert valve seats (4) into manifold chambers. Position manifold (3) back onto pump.

NOTE

Lubricate o-rings on cylinder and exercise caution when slipping manifold over cylinders to avoid damaging cylinder o-rings.

1. Nut
2. Lockwasher
3. Manifold
4. Seat
5. Valve
6. Spring
7. O-Ring
8. Back-up Washer
9. Retainer
10. Washer
11. Washer
12. Washer
13. Washer
14. Cylinder
15. Manifold
16. Cotter Pin
17. Nut
18. Washer
19. Retainer
20. Spacer
21. Piston Assembly
22. Valve
23. Piston
24. Cup
25. O-Ring
26. Bolt
27. Washer
28. Seal
29. Sleeve
30. Rod
31. Retainer
32. O-Ring
33. Back-up Ring

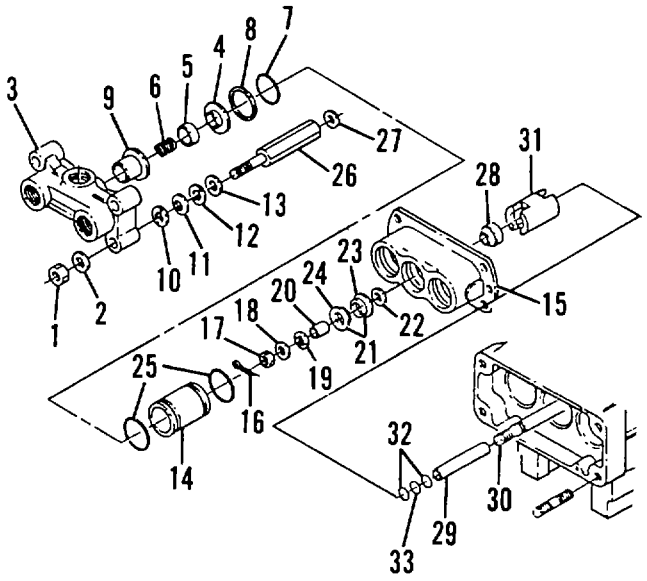


Figure 4-22. Water Injection Pump

j. Replace nuts (1) and lockwashers (2) and torque to 217 in. lbs. in a criss-cross pattern, beginning at lower left.

NOTE

Replace all original shims (10-13) when used. When new manifold is used reshim pump.

CAUTION

When starting the pump, check to see that there is no cylinder motion as this will cause premature failure of the cylinder o-rings. Center cylinder motion can be eliminated by switching with one of the end cylinders.

4-8.1.2 Servicing the Pumping Section.

a. Remove the discharge manifold as described in 4-8.1.1 a and b.

b. Grasp cylinders (14) by hand, and with an up and down motion, pull cylinders from inlet manifold (15).

c. Remove cotterpin (16), nut (17) and washer (18) from piston rod.

d. Next remove retainer (19), spacer (20) and piston/cup assembly (21). Remove inlet valve (22).

e. Examine inlet valve (22) surfaces for pitting, scale or grooves. Reverse valve and sand inlet side of valve using 240 grit paper for clean surface or replace if evidence of excessive wear. Slip onto piston rod.

f. Examine piston (23) seating surfaces and sand clean on flat surface using 240 grit paper. If extreme pitting or sharp edges, replace piston.

g. Examine cup (24) for wear, cracking, tearing or separation from the piston. If worn replace and lubricate before installing on piston (23) NOTE CUP INSTALLATION: Wipe cup inserter with oil. Slip bac-cup ring (when used) onto piston. Push cup over inserter and square with all surfaces. Faulty cup installation causes premature cup failure.

h. Lubricate piston assembly (21) and slip onto piston rod. Replace piston spacer (20) and retainer (19) on rod.

i. Replace washer (18), thread on nut (17) and torque to 60 in. lbs.

NOTE
Always replace with new STAINLESS STEEL COTTERPIN (16) and turn ends under.

j. Examine cylinder (14) walls for scoring or etching which causes premature wear of cups and replace if worn.

k. Lubricate cylinder and replace o-rings (25) if worn or damaged. Carefully slip cylinders over rod ends and push into inlet manifold in their original position. (front to back).

l. Position discharge manifold (3) onto pump, install nuts (1) and lockwashers (2) and torque to 217 in. lbs.

4-8.1.3 Servicing Sleeves and Seals.

a. Remove discharge manifold and piston assemblies as described in 4-8.1.1 and 4-8.1.2.

b. Remove cylinder bolts (26) and washers (27). Remove inlet manifold (15) containing seals (28).

c. Grasp sleeves (29) and with a pulling and twisting motion remove the sleeves from the piston rod (30). Note: Grasp sleeve with pliers only if replacing worn sleeves, as this procedure will mar the sleeves.

d. Next remove seal retainer (31). Remove and examine o-rings (32) and back-up rings (33) on piston rod (30) for wear and replace.

e. Lubricate new o-rings (32) and back-up rings (33) and slip onto piston rod (30). Install the first o-ring in the groove on the piston rod. Next position back-up ring against the shoulder in front of the first o-ring. Then install the second o-ring. Exercise caution as you slip the o-ring over the thread end of the piston rod.

f. While inlet manifold, sleeves and seal retainers are removed, examine crankcase seals for wear.

g. Check oil level and for evidence of water in oil.

h. Rotate crankshaft by hand to feel for smooth bearing movement.

i. Examine crankshaft oil seal externally for drying, cracking or leaking.

j. Consult factory or your local distributor if crankcase service is evidenced.

k. Examine sleeves (29) for scoring or etching and replace. Immerse sleeves in oil and carefully twist and push sleeve onto rod, (machined counter bore end first).

l. Next install seal retainers (31).

m. Place inlet manifold (15) on pair of clearance blocks with CRANKCASE SIDE DOWN and drive out old seals (28).

n. Invert inlet manifold (15) with CRANKCASE SIDE UP and install new seals (28). Lubricate circumference of seal and install seal with GARDER SPRING DOWN.

o. Slip lubricated seal inserters onto piston rod ends, position inlet manifold onto pump and remove seal inserters.

p. Install washers (27) and cylinder bolts (26). Torque to 217 in. lbs.

q. Assemble piston assemblies and discharge manifold as described in 4-8.1.1 and 4-8.1.2.

4-8.2 Foam Pulse Pump. (Figure 4-22A).

4-8.2.1 Replacing Diaphragm. The pulse pump does not need to be removed to replace the diaphragm.

a. Remove nuts (1), washers (2) and screws (3). Lift head (4), with hoses attached, from the pump.

b. Lift diaphragm assembly (5) from pump case (6).

NOTE

The diaphragm assembly (5) may be replaced as an assembly, or the diaphragm (7) only may be replaced. When replacing rubber diaphragm (7) only, perform step c.

c. Remove nut (8) and washer (9) and remove diaphragm (7) from stem. Install a new diaphragm (7) and install washer (9) and nut (8).

d. Install diaphragm assembly (5) in pump case (6).

e. Place head (4) in position and install screws (3), washers (2) and nuts (1).

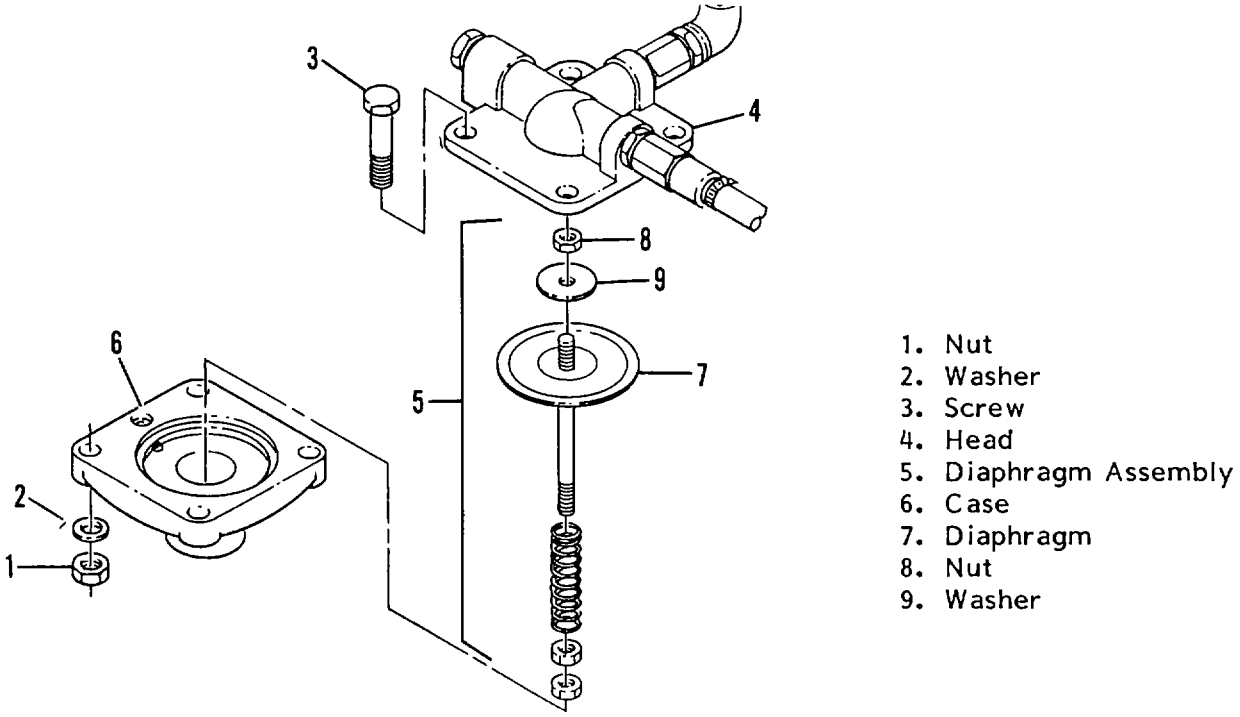


Figure 4-22A. Foam Pulse Pump

4-8.3 Water Injection Drive Motor. (Figure 4-22B)

4-8.3.1 Removal, Disassembly and Inspection.

a. Before disconnecting hydraulic hoses, thoroughly clean off all outside dirt around fittings. Disconnect hoses and immediately plug ports to prevent foreign matter from entering motor.

b. Remove screws (1), and lockwashers (2), then remove the outer guard half (3).

c. Loosen nuts (4) and move injection pump (5) back to loosen belt tension. Remove belt (6) and pulley (7).

d. Remove screws (8) and lockwashers (9) to remove motor (10) and inner guard half (11).

e. Remove the key (12) from motor shaft, then clamp motor in a vise, clamping down firmly on the housing (28) mounting flange with shaft (25) pointed down.

f. Remove screws (1 3). Inspect screws for damaged threads, or the sealing ring under screw head. Replace damaged screws.

g. Remove end cover (14) and seal ring (15). Discard seal ring (15). Thoroughly wash cover in proper solvent and blow dry. Inspect end cover for severe wear, nicks, burrs and spalling, and the screw head recesses for good sealing surfaces. Replace cover as necessary.

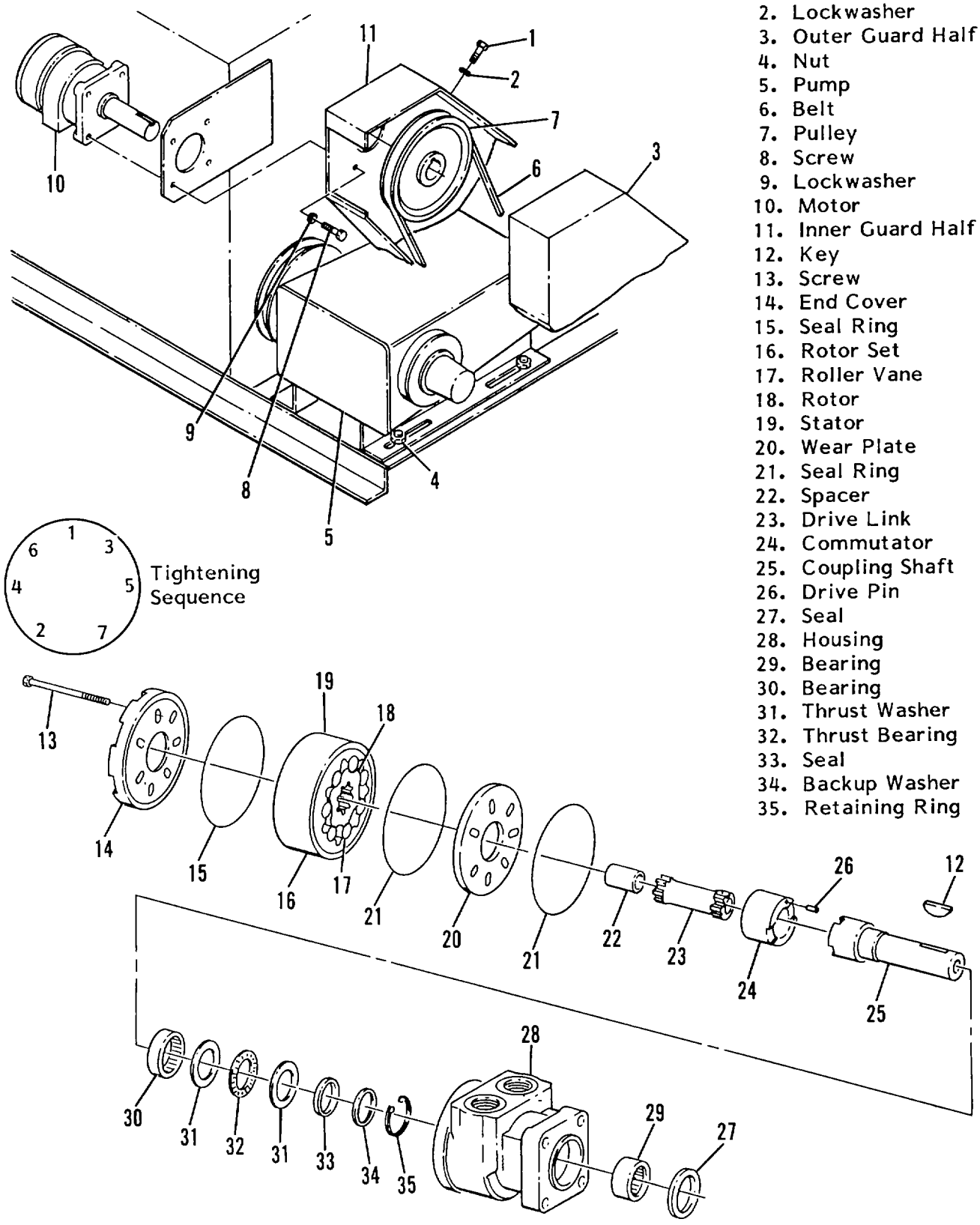


Figure 4-22B. Water Injection Drive Motor

NOTE

A polished pattern on the cover surface from rotation of the rotor (18) is normal. Discoloration would indicate excess fluid temperature, thermal shock or excess speed. Under these conditions make a very close inspection of end cover, rotor set, and wear plate.

h. Remove spacer (22). Inspect it for badly burned or nicked ends.

i. Remove rotor set (16) retaining it in its assembled form, if possible. Inspect the rotor set in its assembled form for nicks, scoring or spalling, on any surface and broken or worn rotor splines. If any component of the rotor set requires replacement, the complete rotor set must be replaced as a matched set.

j. Place rotor set (16) on a flat surface and center rotor (18) in stator (19) such that two rotor lobes (180° apart) and a roller vane (17) centerline are on the same stator centerline. Check the rotor lobe to roller vane clearance with a feeler gage at this common centerline. If there is more than .005 inch (0.13 mm) of clearance, replace rotor set.

k. Remove wear plate (20) and seal rings (21). Inspect the wear plate for cracks, brinelling, or scoring. Discard seal rings (21).

l. Remove drive link (23) from commutator (24) and coupling shaft (25). Inspect drive link (23) for cracks and for worn or damaged splines. No noticeable play should be noted between mating spline parts.

m. Remove commutator (24) by inserting two fingers into its center cavity and lifting. Inspect commutator for cracks, burrs, wear, scoring, spalling, or brinelling. If these conditions exist, the commutator and housing (28) must be replaced as a matched set. Inspect drive pin (26) but do not remove unless damaged.

n. Insert the drive link (23) into mesh with coupling shaft (25) and exert a downward force on it with the palm of one hand while pulling down and rotating the coupling shaft with the other hand. If a roughness is felt or heard, the thrust bearing (32) and thrust washers (31) will need replacement.

o. Remove coupling shaft (11) by pushing on the output end. Inspect shaft bearing and seal surfaces for spalling, nicks, grooves, severe wear or corrosion and discoloration. If seal area wear exceeds .020 inch diametrically, replace shaft. Inspect for damaged or worn splines, drive pin slot and keyway. Replace coupling shaft if any of these conditions exist.

NOTE

If commutator (24) was discarded in step m., above, disassembly is complete at this point. Otherwise, proceed with disassembly.

p. Remove housing (28) from vise and place on a clean flat work surface with wearplate end down. Pry out and discard the seals (20) and (33), using a dull-edged screwdriver. Be careful not to damage other components during this process.

q. Inspect housing (28) assembly for cracks, the machined surfaces for nicks, burrs, brinelling, or corrosion. Remove burrs that can be removed without changing dimensional characteristics. Inspect tapped holes for thread damage. If the housing is defective in these areas, discard the housing assembly, and disassembly is complete.

r. If the housing assembly has passed inspection to this point, inspect the bearings (29, 30 and 32) and thrust washers (31). The bearing rollers must be firmly retained in the bearing cages, but must rotate and orbit freely. All rollers and the thrust washers must be free of brinelling and corrosion. If assembly passes inspection at this point, do not disassemble farther.

s. Place housing back in vise, wearplate end up. Insert a 1.38 in. (35.1 mm) diameter bearing puller through bearing (30). Remove and discard bearing.

t. Remove and discard thrust washers (31), thrust bearing (32) and backup washer (34). Using retaining ring pliers, remove retaining ring (35).

u. Invert housing (28) in vise and clamp on mounting flange. Insert a puller for a 1.00 inch (25.4 mm) diameter bearing through outer bearing (29). Remove and discard bearing.

4-8.3.2 Assembly and Installation.

NOTE

Lubricate all seals and seal rings with hydraulic oil before assembly. Unless-otherwise indicated, do not oil or grease other parts before assembly. If a service housing and commutator assembly is being used, the housing components are already installed. Start with step g.

a. Install retaining ring (35). Be sure the rounded edge of ring is facing the larger housing cavity.

b. Thoroughly grease the rollers of a new bearing (29), then press the bearing into housing (28) using a bearing mandrel against the lettered end of bearing cage. Press bearing squarely to a depth of .135/.125 inch (3.43/3.18 mm) from the flange end of the housing.

c. Place housing (28) on clean flat surface, wear plate end up. Apply a small amount of grease to seal (33). Install backup washer (34) then seal (33) into housing. Seat the backup washer against the retaining ring (35) and seal against washer with seal lip facing out.

d. Install thrust washers (31) and thrust bearing (32) into housing and seat in bore.

e. Using a bearing mandrel against the lettered end of bearing cage, press bearing (30) into housing (28) squarely to a depth of 1.618/1.598 inches (41.10/40.59 mm) from the housing wearplate face.

f. Invert housing (28) on work surface. Apply a small amount of grease to a new seal (27) and press the seal into the housing. Be sure seal is not cock or deformed when installed.

g. Clamp housing (28) in soft-jawed vise, clamping on mounting flange, with coupling shaft bore down.

NOTE

The assembly of the rotor set (16) should be done at this time in order to use the housing in the vise as an assembly "fixture."

h. Place wearplate (20) then stator (19) on the housing (28) and align the screw holes. Insert two screws (13) finger tight approximately 180° apart to retain the parts in place.

i. Assemble the rotor (18) into the stator (19) with six vanes (17), or as many as will readily fit, into the stator vane pockets.

NOTE

The drive link (23), held in large locking pliers between two rods or nails to protect the drive link splines, will be required to rotate the rotor.

j. Rotate the rotor (18) with the drive link (23) to seat the rotor and assembled vanes into the stator (19). Assemble the seventh, or remaining, roller vanes (17) using minimum force.

CAUTION

Too much force used to push the rotor vanes into place could shear off the coating applied to the stator vane pockets. Use care during this procedure to prevent damage to rotor set and the drive link splines.

k. Remove the drive link (23), the two screws (13), then the assembled rotorset (16) and wearplate (20)as a unit from the housing and set them aside for later installation.

NOTE

The coupling shaft (25) has a timing mark on the small (output) end that is radially in line with two internal spline teeth and a "commutator drive pin slot" that transverses the opposite end of the coupling shaft. The "commutator drive pin slot" indicated by the timing mark is the only slot of two oil passage slots across the large end of the coupling shaft, wide enough to engage the commutator drive pin (26) at assembly. This orientation of the coupling shaft splines and drive pin slot is important to subsequent assembly procedures that will produce the required rotor (18) lobe and commutator (24) "fixed" radial relationship at assembly.

Using chalk or marking pencil, extend the timing mark that is on the end of coupling shaft (25) up the side of the coupling shaft so that the timing mark location will be visible for alignment purposes when the coupling shaft is assembled into the housing held in the vise.

l. Be sure that a generous amount of clean wheel bearing grease is applied to housing bearing (29) then install coupling shaft (25) into housing (28) seating it against thrust washer (32). The coupling shaft must rotate smoothly on the thrust bearing.

m. Insert new drive pin (26) if it was removed, into the commutator (24) drive pin hole until it bottoms out.

CAUTION

Do not force commutator into bore. It is a close slip fit and must rotate.

n. Install commutator (24) assembly into housing (28) commutator bore. The commutator must not be cocked as it enters the bore and the drive pin (26) must be in line with the coupling shaft (25) commutator drive pin slot indicated by the timing mark. Engage the drive pin (26) protruding from the commutator into the coupling shaft drive pin slot, rotating the coupling shaft if necessary. The commutator must be below the housing wearplate surface when correctly seated.

NOTE

The commutator drive pin (26) and coupling shaft (25) drive pin slot, at this point in the assembly, are visible through the commutator center cavity for coupling pin engagement purposes in addition to the timing mark.

o. Install either end of the drive link (23) through the commutator (24) cavity and engage the lower drive link splines into mesh with the internal splines in the coupling shaft (25). A spline valley on both ends of the drive link will now be in line with the commutator drive pin (26) and coupling shaft timing mark.

p. Apply a small amount of clean grease to a new seal ring (21) and insert the seal ring into housing (28) seal ring groove.

q. Place assembled rotor set (16) on a clean work surface. Apply a small amount of clean grease to a new seal ring (21) and insert the seal ring into the stator (19) seal ring groove.

r. Place wearplate (20) either side up, onto the rotor set (16) and align wearplate bolt holes with the stator (19) bolt slots.

CAUTION

Be careful not to disengage the rotor, drive link or coupling shaft while aligning bolt holes as this could affect the timing.

The meshing of the precise rotor (18) teeth with the precise drive link (23) spline valleys is absolutely crucial to a correctly timed and functional motor. Misalignment by one spline tooth will be indicated by the timing mark on the coupling shaft (25) being radially 45° from the specified rotor lobe.

s. Locate on the rotor (18) the only two spline teeth, 1800 apart, that are diametrically aligned (on the same center line) with two rotor lobes. Take the rotor set (16), seal ring (21) and wearplate (20) as a unit and align these two just located rotor spline teeth to mesh with the two drive link (23) spline valleys that are diametrically aligned with the timing mark on the coupling shaft (25) and install this unit onto the housing (28) with the wearplate against the housing. With the rotor set (16) now correctly in mesh with the drive link, rotate the rotor set (16), wearplate (20), drive link (23) and coupling shaft (25) to align the stator (19) and wearplate bolt holes with the bolt holes in the housing.

t. Install drive link spacer/washer (22) into the rotor spline cavity onto the end of the drive link (23).

u. Apply a small amount of clean grease to a seal ring (15) and insert the seal ring into the end cover (14) seal ring groove. Install end cover assembly onto the rotor set (16) with seal ring (15) against the stator (19) and align the end cover bolt holes with the stator bolt holes.

v. Install seven bolts (13) into the assembly bolt holes finger tight, then torque the bolts to 22-26 ft.-lbs. Refer to tightening sequence, figure 4-22B.

w. Position assembled motor (10), ports facing down, and inner guard half (11) to mounting bracket and install screws (8) and lockwashers (9).

x. Install key (12) in motor shaft and push pulley (7) onto shaft and key. Place belt (6) around pulley (7) and pulley on injection pump (5). Slide the pump (5) on mounting studs to pull belt (6) tight and tighten nuts (4).

y. Install the outer guard half (3) and secure with screws (1) and lockwashers (2). Attach hydraulic hoses to motor (10).

4-9 MAINTENANCE OF DRAWWORKS.

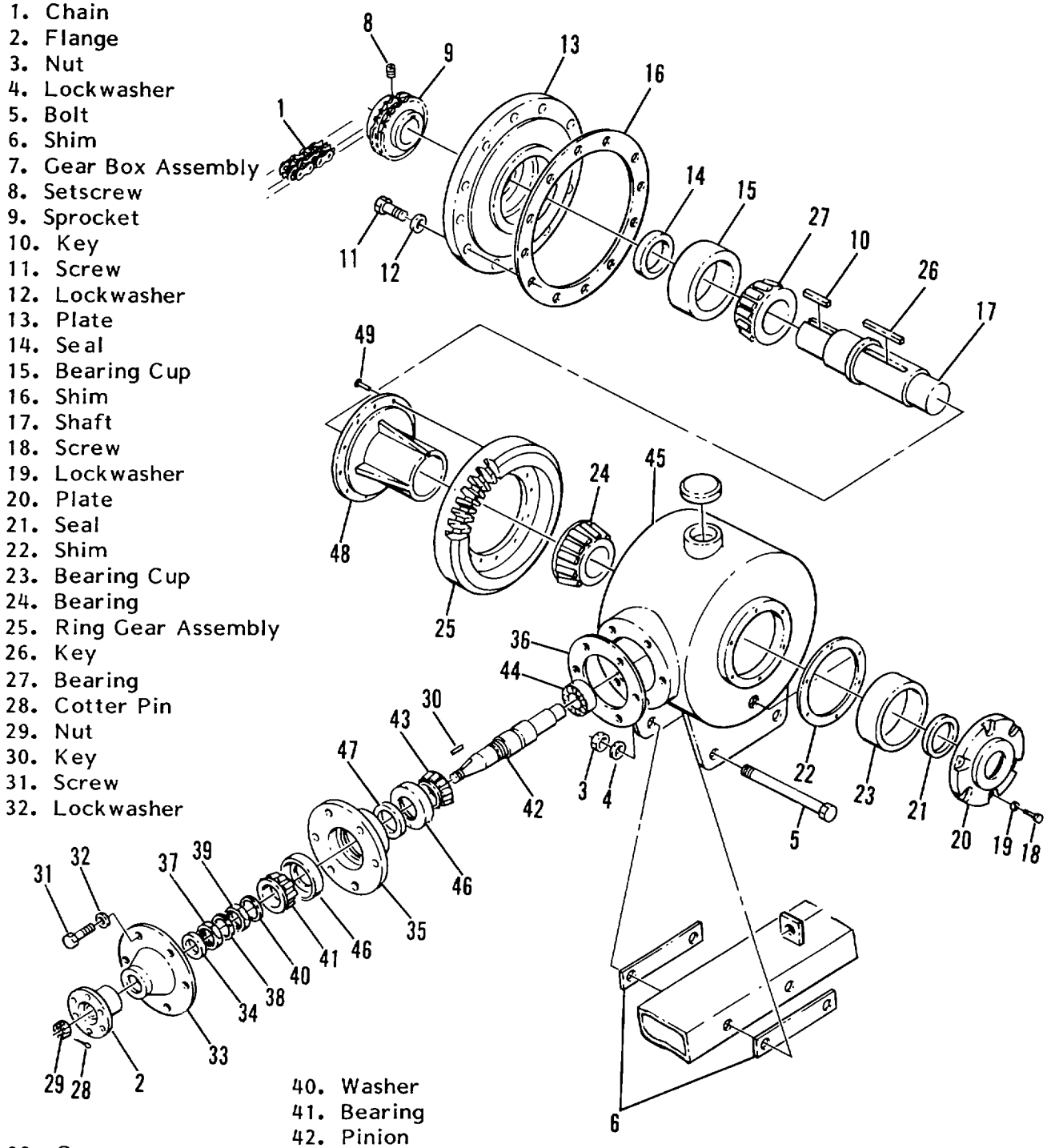
4-9.1 Bevel Gear Box Assembly. (Figure 4-23).

4-9.1.1 Removal and Disassembly.

a. Disconnect and remove chain (1). Disconnect driveshaft from flange (2).

b. Remove nuts (3), lockwashers (4), bolts (5) and shims (6). Attach a hoisting device to the gear box assembly (7) and lift it from the unit.

c. Loosen setscrew (8) and remove sprocket (9). Remove key (10).



1. Chain
2. Flange
3. Nut
4. Lockwasher
5. Bolt
6. Shim
7. Gear Box Assembly
8. Setscrew
9. Sprocket
10. Key
11. Screw
12. Lockwasher
13. Plate
14. Seal
15. Bearing Cup
16. Shim
17. Shaft
18. Screw
19. Lockwasher
20. Plate
21. Seal
22. Shim
23. Bearing Cup
24. Bearing
25. Ring Gear Assembly
26. Key
27. Bearing
28. Cotter Pin
29. Nut
30. Key
31. Screw
32. Lockwasher
33. Cup
34. SEal
35. Cage
36. Shim
37. Nut
38. Washer
39. Nut
40. Washer
41. Bearing
42. Pinion
43. Bearing
44. Bearing
45. Case
46. Bearing Cup
47. Spacer
48. Hub
49. Rivet

Figure 4-23. Bevel Gear Box Assembly

d. Remove screws (11) and lockwashers (12). Remove plate (13), with seal (14) and bearing cup (15), and shim (16).

e. Remove shaft (17), with bearings and ring gear assembled, from case (45).

f. Remove screws (18), lockwashers (19), plate (20), with seal (21), and shim (22). Bearing cup (23) should remain in case unless replacement is necessary.

g. Use a bearing puller to remove bearing (24) from shaft (17). Remove ring gear assembly (25) and key (26).

h. Use a bearing puller to remove bearing (27) from shaft (17).

i. Remove cotter pin (23), nut (29), flange (2) and key (30).

j. Remove screws (31), lockwashers (32) and cup (33) with seal (34). Remove seal (34).

k. Install screws in puller holes of cage (35) and pull cage, with pinion assembled, from case (45). Remove shim (36).

l. Remove nut (37), washer (38), nut (39), washer (40) and bearing (41).

m. Remove the pinion (42), with remaining bearings (43, 44) installed, from cage (35). Remove bearings (43, 44) from pinion (42).

n. The bearing cups (46) and spacer (47) in cage (35) should remain installed unless replacement is necessary.

4-9.1.2 Cleaning, Inspection and Repair.

a. Clean all metal parts with an approved solvent and dry with low pressure filtered compressed air.

b. Inspect bearings for signs of scoring, pitting, loose rollers or overheating. Discard any bearing showing damage and closely inspect its mating bearing cup. If the cup is damaged it shall be replaced.

c. Discard all seals and use new seals at assembly.

d. The ring gear (25) should not be separated from the ring gear hub (48) unless the ring gear, hub or pinion (42) are being replaced. The ring gear and pinion must be replaced as an assembly if either is damaged.

e. Inspect all parts and replace as necessary.

4-9.1.3 Assembly.

a. Install any bearing cups (15, 23, or 46) that were removed. If separated, assemble ring gear (25) to hub (48) and secure with rivets (49).

b. Install bearings (44 and 43) on pinion (42).

c. Install key (26) in shaft (17) and install ring gear assembly (25). Press on bearings (24 and 27).

d. Install pinion (42) in cage (35) and install bearing (41), washer (40) and nut (39). Tighten nut until bearings begin to bind when pinion is rotated, then loosen nut just enough to allow free movement without sideplay.

e. Install washer (38) and nut (37) and, while holding nut (39), tighten nut (37).

f. Install shim (36) on cage (35) and position cage on case (45). See that cage fits squarely in case then, using screws (31), seat cage into case by tightening screws evenly. Remove screws.

g. Install new seal (34) in cup (33), then install cup, screws (31) and lockwashers (32).

h. Install new seal (14) in plate (13). Install shaft (17) assembly in case and install shim (16) and plate (13). Secure with screws (11) and lockwashers (12).

i. Install new seal (21) in plate (20) and install shim (22), plate (20), screws (18) and lockwashers (19).

j. Install key (30), flange (2), nut (29) and cotter pin (28).

k. Install key (10) and sprocket (9). Tighten setscrew (8).

l. Hoist the assembled gear box assembly (7) into position on frame and install shims (6), bolts (5), lockwashers (4) and nuts (3).

m. Connect driveshaft to flange (2) and install and connect chain (1) at sprocket (9).

4-9.2 Third Drum Assembly. (Figure 4-24)

4-9.2.1 Removal and Disassembly.

a. Spool cable off third drum, loosen setscrew (1) and remove cable. Remove covers from third drum.

b. Attach a hoisting device to the drum. Disconnect and remove chains (2). Loosen setscrew (3) and remove sprocket (4) and key (5).

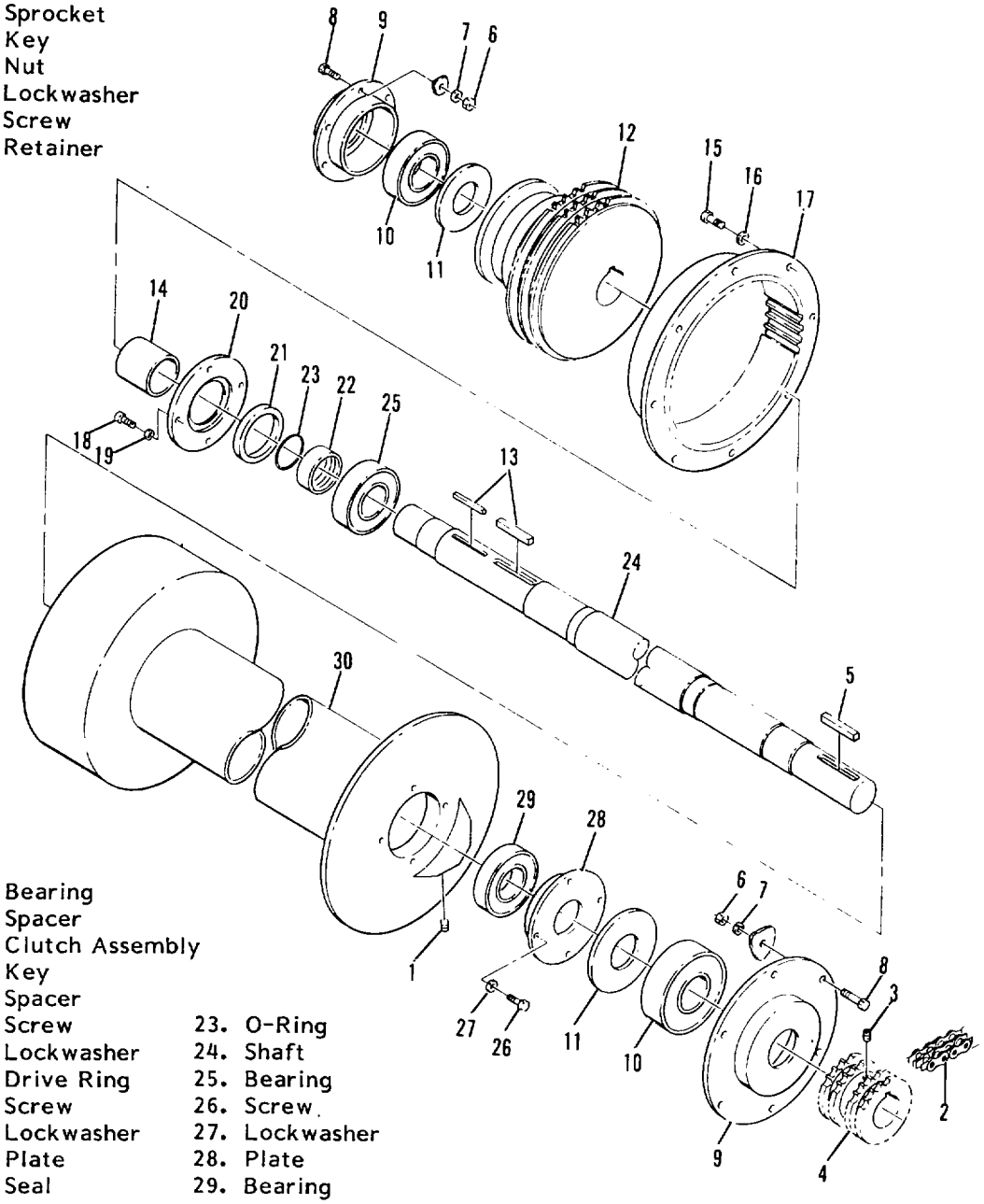
c. Remove nuts (6), lockwashers (7) and screws (8). Remove retainers (9), bearings (10) and spacers (11). Lift third drum assembly out of drawworks frame.

d. Refer to paragraph 4-9.3.1 and remove clutch assembly (12), then remove key (13) and spacer (14).

e. Remove screws (15), lockwashers (16) and drive ring (17).

f. Remove screws (18), lockwashers (19), plate (20) with seal (21) and spacer (22). Remove seal (21) from plate (20) and o-ring (23) from spacer (22).

1. Setscrew
2. Chain
3. Setscrew
4. Sprocket
5. Key
6. Nut
7. Lockwasher
8. Screw
9. Retainer



10. Bearing
11. Spacer
12. Clutch Assembly
13. Key
14. Spacer
15. Screw
16. Lockwasher
17. Drive Ring
18. Screw
19. Lockwasher
20. Plate
21. Seal
22. Spacer
23. O-Ring
24. Shaft
25. Bearing
26. Screw
27. Lockwasher
28. Plate
29. Bearing
30. Drum

Figure 4-24. Third Drum

g. Remove shaft (24) with bearing (25) from drum (30). It may be necessary to tap on the end of shaft.

h. Remove screws (26), lockwashers (27) and plate (28). Use a bearing puller to remove bearing (29) from drum.

i. Discard all seals and replace any worn or damaged parts. Use new seals at assembly.

4-9.2.2 Assembly.

a. Press bearing (29) into bore of drum (30) so that bearing is flush with drum. Position plate (28) and start screws (26) with lockwashers (27).

b. Tighten the screws (26) evenly until plate is seated.

c. Press bearing (25) on shaft (24). Install o-ring (23) in spacer (22) and install spacer on shaft against bearing.

d. Install shaft (24) in drum (30) with bearing (25) square in drum bore.

e. Install seal (21) in plate (20) and position plate over end of shaft. Install screws (18) and lockwashers (19), tightening evenly.

f. Install drive ring (17), screws (15) and lockwashers (16) on drum (30).

g. Install spacer (14), then key (13) in shaft (24). Refer to paragraph 4-9.3.2 and install the clutch assembly (12).

h. Using a hoist, lift the third drum assembly into position on the drawworks frame.

i. Press bearings (10) into plates (9) and install spacers (11). Position plates on shaft ends and install screws (8), lockwashers (7) and nuts (6). Tighten evenly. Remove hoist.

j. Install key (5) in shaft and install sprocket (4) and tighten setscrew (3). Install and connect chains (2).

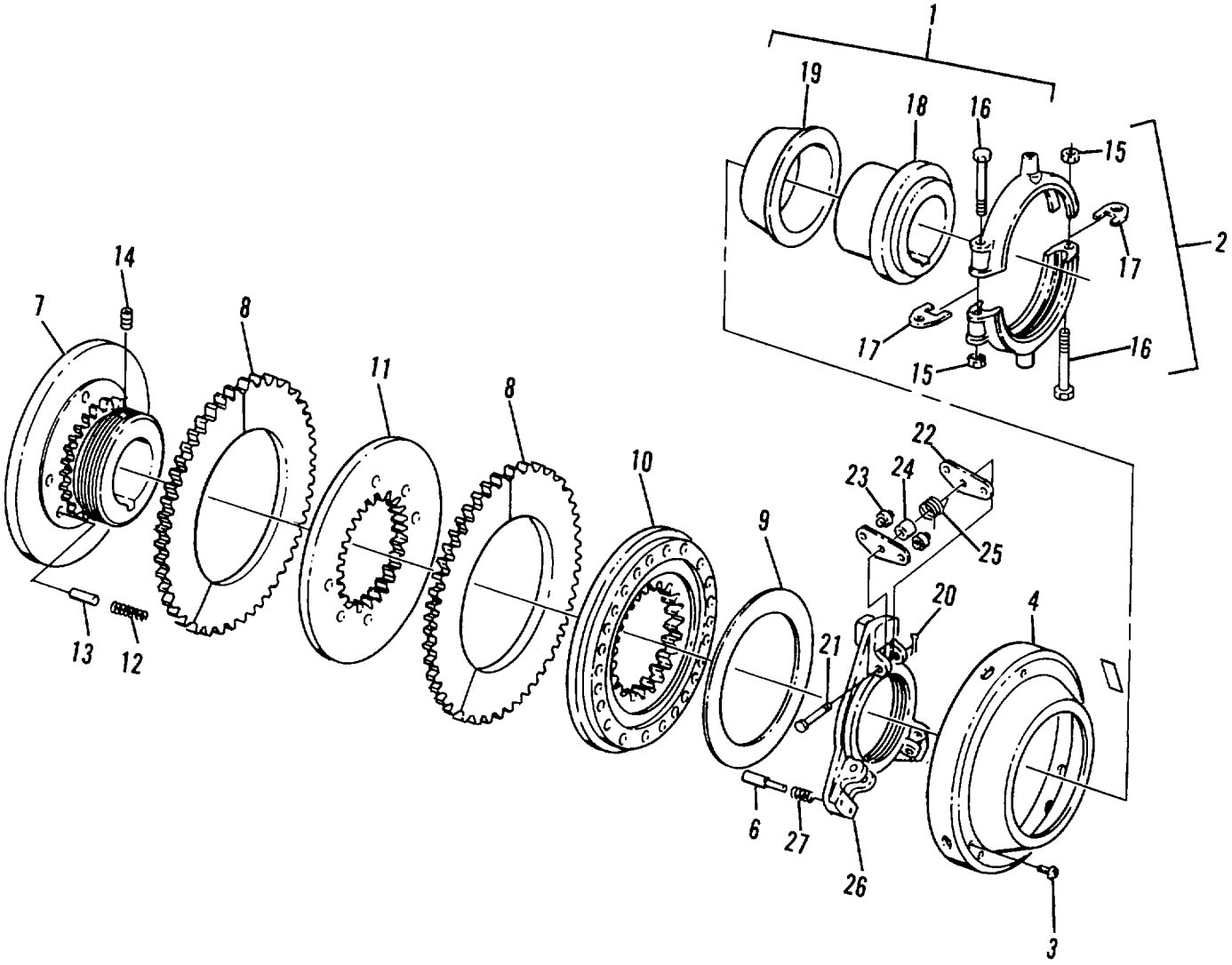
k. Insert end of cable in drum and tighten setscrew (1). Spool cable onto drum. Install covers.

4-9.3 Third Drum Clutch. (Figure 4-25)

4-9.3.1 Removal and Disassembly

a. Place cone assembly (1) in the fully disengaged position with the clutch control lever. Remove the lever linkage and lube hose from the collar assembly (2). Remove cone assembly (1).

b. Remove the screws (3) that secure the clutch cover (4) to the adjusting yoke (5) and remove cover.



1. Cone Assembly
2. Collar Assembly
3. Screw
4. Cover
5. Adjusting Yoke
6. Lock Pin
7. Hub and Back Plate
8. Drive Plate
9. Roller Disc
10. Floating Plate
11. Center Plate
12. Spring
13. Pin
14. Setscrew
15. Nut
16. Screw
17. Shim
18. Sleeve
19. Cone
20. Cotter Pin
21. Pin
22. Lever
23. Roller
24. Spacer
25. Spring
26. Yoke
27. Spring

Figure 4-25. Third Drum Clutch

c. Pull the lock pin (6) out, and lock in position by means of a 1/16 inch thick washer and a piece of wire or small nail pushed through the hole in the pin.

NOTE

The split-type drive plates (8) will be free to fall when adjusting yoke assembly (5) is removed.

d. Rotate the adjusting yoke assembly (5) counterclockwise until it comes off the threaded hub and back plate (7).

e. Slide the roller disc (9), floating plate (10),drive plates (8) and center plates (11) from the hub and back plate (7). Springs (12) will fall from hub and back plate. Pins (13) may remain unless replacement is necessary.

f. Remove setscrew (14) in hub and back plate (7) and remove plate from shaft.

g. Parts of cone assembly (1) and adjusting yoke assembly (5) should only be disassembled if parts replacement is required.

4-9.3.2 Assembly and Installation.

a. Install hub and back plate (7) on shaft. Install and tighten setscrew (14).

b. Install pins (13), springs (12), driving plates (8), center plates (11) and floating plate (10) on hub and back plate (7).

NOTE

The center plate holes must locate over the release pins (13) and springs (12) which index in blind holes of the floating plate.

c. Install the roller disc (9).

d. Assemble the adjusting yoke assembly (5) as needed. The lock pin (6) should be locked "out" as in removal.

e. Screw the adjusting yoke (5) on hub (7). Remove the wire or nail and washer from the lock pin (6).

f. Position the cover (4) and install screws (3).

g. Assemble cone assembly (1) as needed. Install cone assembly (1) on shaft.

NOTE

Relocate roller wear surfaces between rollers radially, when using same cone cover. This is done to expose new wear surfaces to rollers. New cone can be located in any position radially.

4-9.3.3 Adjustment. If the clutch heats, jumps out of engagement, or does not hold, the clutch must be adjusted.

a. Disengage the clutch, and turn the clutch until the adjusting lock pin (6) can be reached. Pull the pin out, and lock in the "out" position by means of a piece of wire or small nail pushed through the cross-drilled hole in the pin.

b. Turn the adjusting yoke (5) clockwise one or two adjusting holes, or until the clutch requires a distinct pressure to engage. Slotted holes are provided in the clutch cover (4) for the insertion of a drift pin for tapping the adjusting yoke should the yoke be too snug to be moved by hand.

4-9.4 Hoisting and Auxiliary Drum. (Figure 4-26).

4-9.4.1 Removal and Disassembly

a. Spool cable off both drums, loosen setscrews (1) and remove cable. Remove covers.

b. Attach a hoisting device to the drum assembly that will support it when end bearings are removed.

c. Disconnect air lines from rotor seal (2). Tag airlines for proper location at assembly. Remove screws (3) and remove rotor seal and bayonet (4) from shaft.

d. Remove screws (5), adapter (6) and o-ring (7).

e. Loosen setscrew (8) and remove sprocket (9) and key (10).

f. Remove nuts (11), lockwashers (12) and screws (13). Remove retainers (14) with bearings (15) and spacers (16) from shaft.

g. Remove nuts (17), lockwashers (18) and screws (19).

h. Lift complete drum assembly out of drawworks frame.

i. Remove screws (20), and remove drive rings (21) from hoisting drum (22) and auxiliary drum (23).

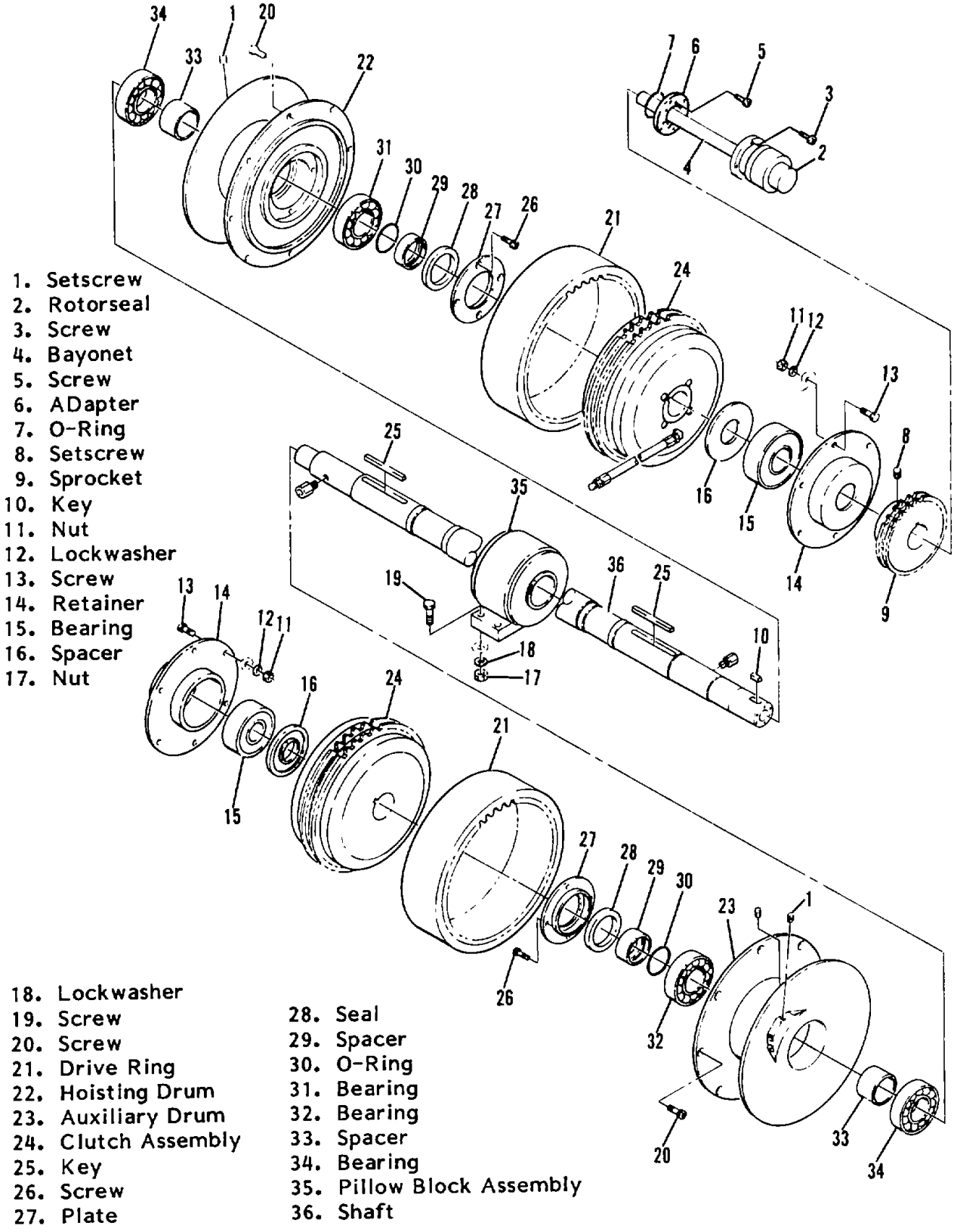
j. Refer to paragraph 4-9.5.1 and remove the two clutch assemblies (24) from the shaft. Remove keys (25).

k. Remove screws (26), plates (27), with seals (28), and spacers (29), with o-rings (30).

l. Pull hoisting drum (22) with bearing (31), and auxiliary drum (23) with bearing (32) from shaft.

m. Remove spacers (33), then pull bearings (34) from shaft (36). Remove pillow block assembly (35).

n. Replace any worn or damaged parts. Use new seals and o-rings at assembly.



1. Setscrew
2. Rotorseal
3. Screw
4. Bayonet
5. Screw
6. ADapter
7. O-Ring
8. Setscrew
9. Sprocket
10. Key
11. Nut
12. Lockwasher
13. Screw
14. Retainer
15. Bearing
16. Spacer
17. Nut
18. Lockwasher
19. Screw
20. Screw
21. Drive Ring
22. Hoisting Drum
23. Auxiliary Drum
24. Clutch Assembly
25. Key
26. Screw
27. Plate
28. Seal
29. Spacer
30. O-Ring
31. Bearing
32. Bearing
33. Spacer
34. Bearing
35. Pillow Block Assembly
36. Shaft

Figure 4-26. Hoisting and Auxiliary Drum

4-9.4.2 Assembly.

a. Install the pillowblock assembly (35) on shaft (36). Press on bearings (34) and install spacers (33).

b. Press bearing (32) in auxiliary drum (23) and bearing (31) in hoisting drum (22). Install drums (22 and 23) on shaft (36), pushing the drums on until bearings (31 and 32) contact spacers (33).

c. Lubricate o-rings (30) with petroleum jelly and install them in spacers (29). Install spacers on shaft.

d. Press seals (28) into plates (27). Install plates and screws (26).

e. Assemble drive rings (21) to drums (22 and 23) and install screws (20).

f. Install keys (25) and refer to paragraph 4-9.5.2 to install clutch assemblies (24).

g. Connect a hoist to drum assembly and lift it into position on the drawworks frame. Position pillowblock to its mount and install screws (19), lockwashers (18), and nuts (17).

h. If bearings (15) were removed, press bearings into retainers (14). Install spacers (161, retainers (14), screws (13), lockwashers (12) and nuts (11).

i. Place key (10) in shaft and install sprocket (9). Tighten setscrew (8).

j. Lubricate o-ring (7) with petroleum jelly and install in groove of adapter (6). Install adapter on shaft and install screws (5).

k. Install bayonet (4) into shaft bore and install rotor seal (2) and screws (3). Connect air lines to rotor seal.

l. Remove hoist from drum assembly. Install cable ends in drums and tighten setscrews (1). Spool cable on drums as necessary. Install covers.

4-9.5 Hoisting and Auxiliary Drum Clutch. (Figure 4-27).

4-9.5.1 Removal.

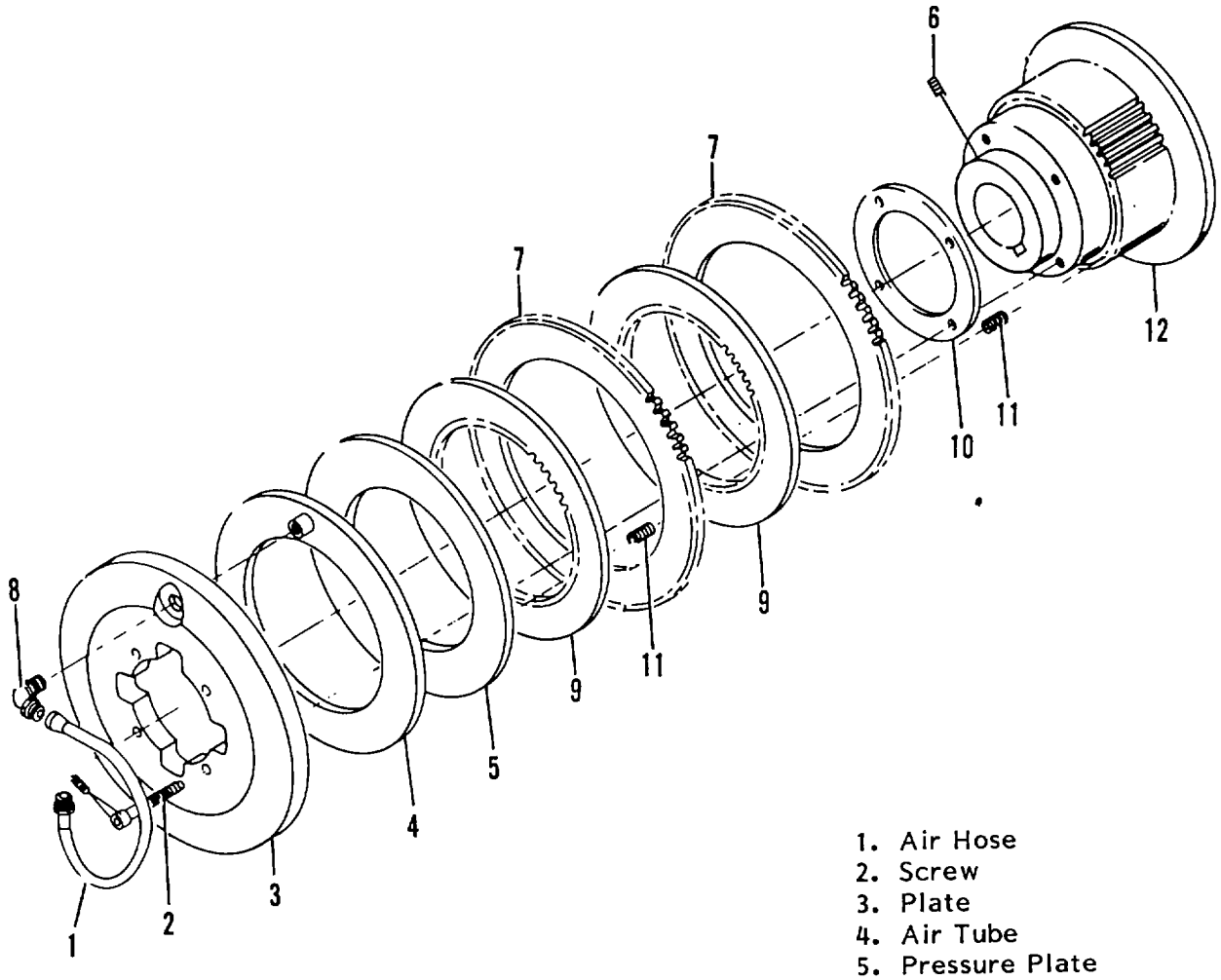
a. Disconnect the air hose (1) from the drum shaft.

b. Remove screws (2), holding plate (3), air tube (4) and pressure plate (5).

c. Loosen setscrew (6) in clutch hub and remove the clutch assembly from the drum shaft.

4-9.5.2 Installation.

a. Slide the clutch assembly (hub with assembled plates and discs) into correct position on the shaft, ensuring that the teeth of the friction discs (7) are registered in the teeth of the driving ring installed on drum.



1. Air Hose
2. Screw
3. Plate
4. Air Tube
5. Pressure Plate
6. Setscrew
7. Friction Disc
8. Valve
9. Plate
10. Gasket
11. Spring
12. Hub

Figure 4-27. Hoisting and Auxiliary Drum Clutch

b. Tighten setscrew (6), then install pressure plate (5), holding plate (3) and air tube (4), and screws (2). Torque screws to 4,400 in.-lbs.

c. Install the air hose (1) in the drum shaft.

4-9.5.3 Replacing Friction Discs. Friction discs should be replaced when the maximum clearance, 1/2 inch, has been reached (see step e.).

NOTE

The replacement of the friction discs does not require that the clutch assembly be removed from shaft.

a. Remove screws (20, figure 4-26) and withdraw driving ring (21) over the air tube holding plate (3, figure 4-27).

b. Remove the split friction discs (7) from the clutch assembly.

c. Place new friction discs (7), in halves, in clutch assembly.

NOTE

If new friction discs have been supplied as a continuous circle, they should be diametrically cut with a hacksaw. Before sawing, mark each side of saw cut so that relative mating faces are correctly positioned in clutch.

d. Replace driving ring (21, figure 4-26) and install screws (20).

e. Check clearance by applying and releasing air pressure to clutch, and measuring the total axial movement of pressure plate (5, figure 4-27). Clearance should be 3/32 to 1/8 inch.

4-9.5.4 Replacing Air Tube.

a. Refer to paragraph 4-9.4.1 and perform steps a. through i.

b. Disconnect air hose (1, figure 4-27) from drum shaft. Hold release valve (8) securely and remove air hose (1) from valve.

c. Unscrew valve (8) from air tube fitting.

d. Remove screws (2), holding plate (3) and air tube (4).

e. Install a new air tube (4) in holding plate (3). Install plate and screws (2). Torque screws to 4,400 in.-lbs.

f. Install release valve (8) and air hose (1). Install air hose in drum shaft.

g. Refer to paragraph 4-9.4.2 and perform steps e. and g. through l., as applicable.

4-9.6 Rotorseal. (Figure 4-28). Replacement kits are available to allow the rebuilding of dual passage rotorseals. These instructions should be followed carefully to assure a properly repaired rotorseal. The rotorseal should be removed from its mounting and repairs should only be made in clean, dust free surroundings.

4-9.6.1 Disassembly

a. Remove the four socket head screws and lock washers (22) and (23) from rear housing (1). Hold flange end of rotorseal in up position and tap to separate housings. When internal parts do not fall free from rear housing (1), the aid of a wire hook may be required to remove same.

b. Where inspection indicates shaft (3) or bearings (18) are in poor condition, either or both must be replaced. If these two parts require disassembly, remove shaft snap ring (19) and press shaft out through bearings. Remove bearings from front housing (2) only if they require replacement.

4-9.6.2 Cleaning and Inspection.

a. Clean and inspect all parts removed and disassemble. Any commercial cleaning solvent is suitable for this purpose.

b. Inspect and check ball bearings. They should be free of rust and contamination, revolve smoothly without binding, and show no signs of excessive play or wear.

NOTE
Do not remove grease from grease packed bearings.

c. Inspect lapped sealing end of shaft. This surface must be free of scoring and excessive wear.

d. If shaft (3) or bearing (18) require replacement, disassemble as instructed above.

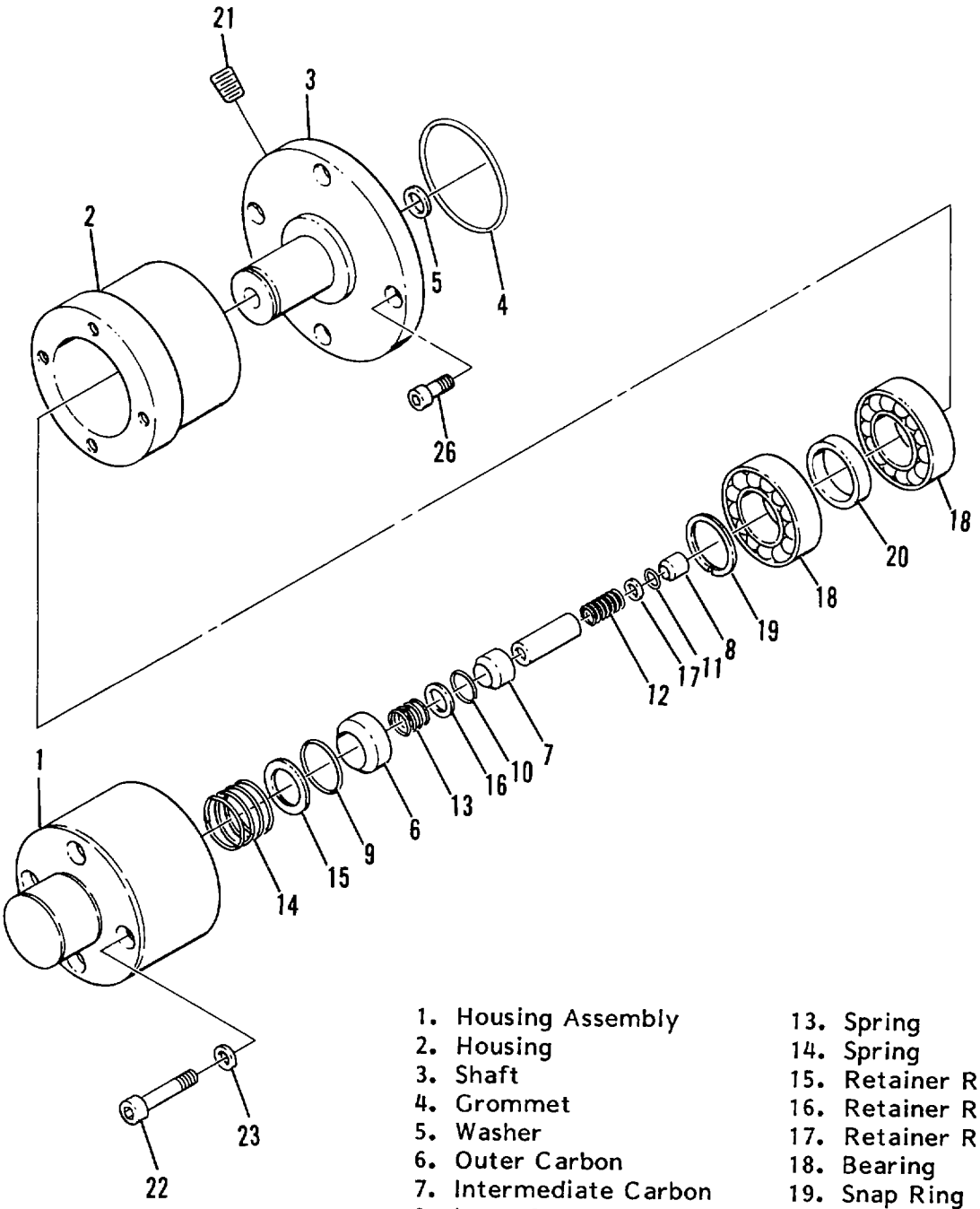
4-9.6.3 Assembly

a. Assemble springs (12), (13) and (14), spring retainer rings (15), (16) and (17), "O" rings (9), (10) and (11) and carbon rings (6), (7) and (8). ("O" rings should firmly seat on chamfered surfaces of carbon seals.)

b. Spacer ring (20) should be re-oiled by submerging in warm engine oil (S.A.E. #10 or #20) for 15 or 20 minutes before assembly.

c. Press bearing (18) with spacer ring (20) into front housing (2) as shown. Enter bearings evenly into housing to prevent binding.

d. Press shaft through bearings until inner race of front bearing is against shaft shoulder. Inner race of rear bearing must be "backed up" during this operation to keep outer races in place in front housing. Assemble shaft snap ring (19).



1. Housing Assembly
2. Housing
3. Shaft
4. Grommet
5. Washer
6. Outer Carbon
7. Intermediate Carbon
8. Inner Carbon
9. O-Ring
10. O-Ring
11. O-Ring
12. Spring
13. Spring
14. Spring
15. Retainer Ring
16. Retainer Ring
17. Retainer Ring
18. Bearing
19. Snap Ring
20. Spacer
21. Pipe Plug
22. Screw
23. Lockwasher

Figure 4-28. Rotorseal

e. Assemble front and rear housings. This should be done with lapped faces of carbon facing upward to prevent internal parts from dropping out of position. Place air inlet holes in desired position. Fasten housings (1) and (2) with socket head screws (22) and (23) lockwashers. Tighten screws securely to equal tension, and check rotorseal for smooth operation.

4-9.7 Drum Brakes. The brake bands for the hoisting, auxiliary and third drum brakes are identical. Use the following procedure to remove and repair the brake bands. Refer to figure 4-28A.

WARNING

All load must be removed from the cable of the drum being repaired. Releasing of the drum brake allows the drum to "free-spool", and any load on cable would fall creating a hazard to personnel. Never operate a drum with worn brakes band.

a. Removal.

(1) Remove all load from drum cable, then release brake control.

(2) Remove drawworks guards as necessary to gain access to brake band.

(3) Remove cotter pins (1) and anchor pins (2) at shaft (4) and anchor bolts (5).

(4) Remove brake band (3) from drum.

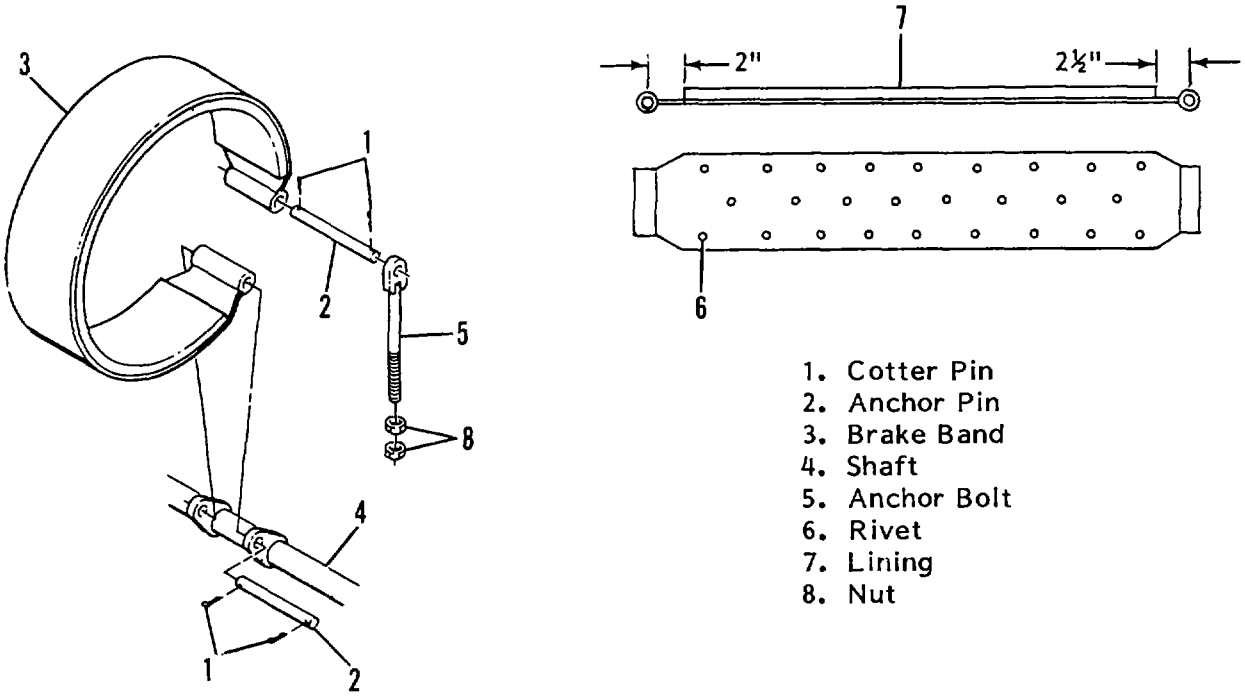


Figure 4-28A. Drum Brakes

b. Repair.

(1) Drill out rivets (6), or use a hammer and chisel to remove rivet heads.

(2) Remove and discard worn lining (7).

(3) Assemble new lining (7) to band and install rivets (6).

c. Installation.

NOTE
Be sure that brake control is released.

(1) Adjust anchor bolts (5) such that there are approximately three turns of threads below lower nuts (8).

(2) Assemble brake band (3) to shaft (4) and install pin (2) and cotter pins (1).

NOTE
The end of brake band with end of lining 2-1/2 inches from end of band anchors to shaft.

(3) Position other end of brake band between anchor bolts (5) and install anchor pins (2) and cotter pins (1).

(4) Set brake lever to approximately mid-point of quadrant, then adjust upper nuts (8) on anchor bolts (5) alternately to pull brake band (3) tight around drum. When band is tight, screw lower nuts (8) against upper nuts.

(5) Test brake by operating drum.

4-9.8 Clutch Control Maintenance. (Figure 4-28B).

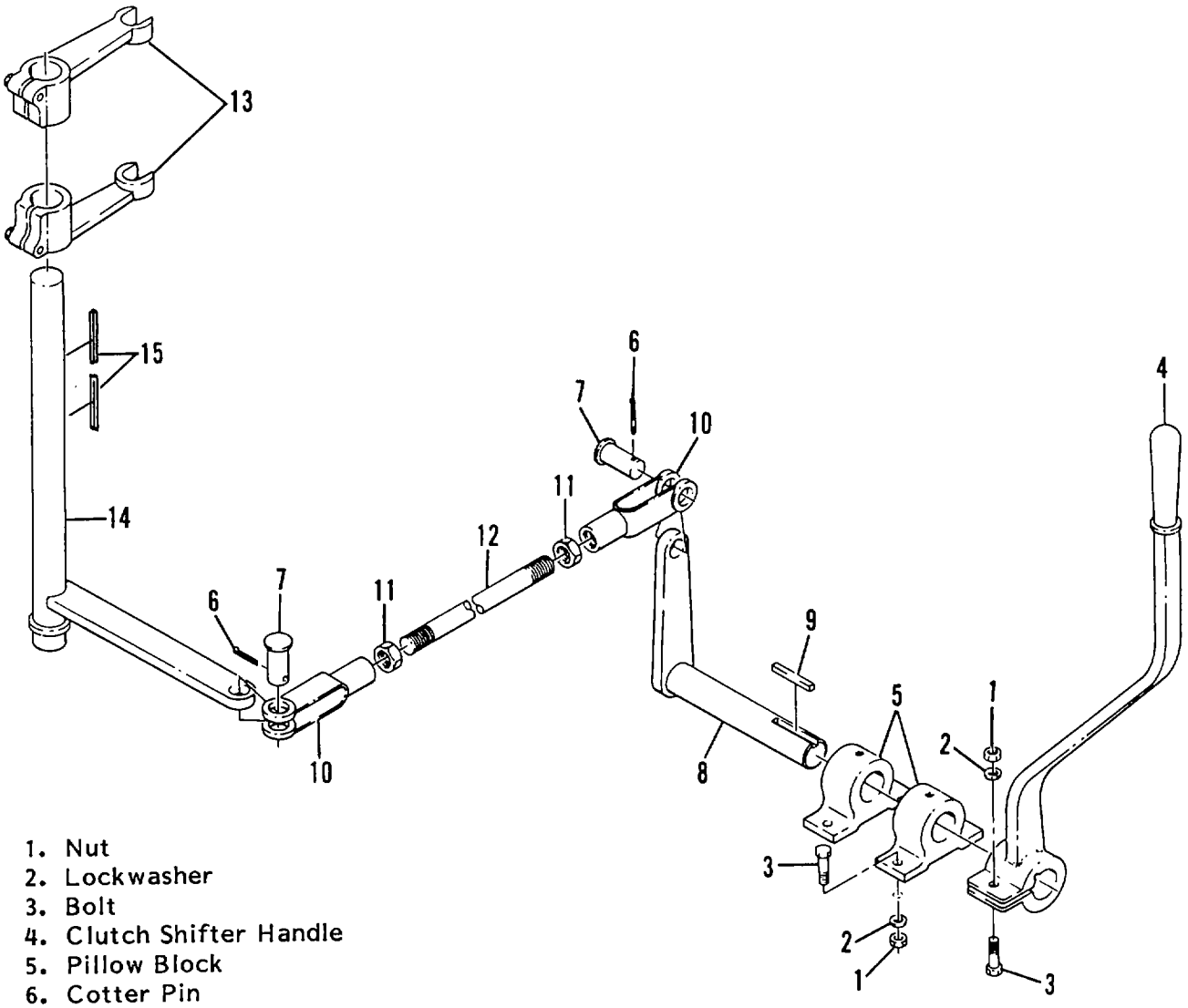
4-9.8.1 Disassembly.

a. Unscrew the nut (1), lockwasher (2), and bolt (3) to remove the clutch shifter handle (4) from the brake and clutch control shaft (8). Remove the cotter pin (6) and yoke pin (7) from each end of the shift linkage. Remove the key (9); then slide the brake and clutch control shaft (8) out of the pillow blocks (5).

b. Remove two nuts (1), lockwashers (2), and bolts (3) to remove the pillow blocks (5) from the mounting surface. Loosen the nuts (11) to unlock them from the adjustable yokes (10); then unscrew the yokes (10) and nuts (11) from the tie rod (12). Complete the disassembly by loosening the set screws in the throwout yokes (13) and slipping the yokes off the clutch control shaft (14); remove the keys (15).

4-9.8.2 Cleaning, Inspection, and Repair.

Clean all parts with an approved cleaning solvent. Examine the parts for breaks or wear. Replace any part found damaged or excessively worn.



1. Nut
2. Lockwasher
3. Bolt
4. Clutch Shifter Handle
5. Pillow Block
6. Cotter Pin
7. Yoke Pin
8. Brake/Clutch Control Shaft
9. Key
10. Adjustable Yoke
11. Nut
12. Tie Rod
13. Throwout Yoke
14. Clutch Control Shaft
15. Key

Figure 4-28B. Third Drum Clutch Control

4-9.8.3 Assembly.

a. Position the keys (15) in the keyway on the clutch control shaft (14). Install the throwout yokes (13) on the shaft, aligning the yokes with the ears on the clutch. Install the pillow blocks (5), fastening them to the rig with nuts (1), lockwashers (2), and bolts (3). Install the brake and clutch control shaft (8) in the pillow blocks; then install the key in the shaft's keyway. Aline the handle (4) with the key and slip it onto the shaft. Fasten the handle with nut (1), lockwasher (2), and bolt (3).

b. Assemble nuts (11) and adjustable yokes (10) on the tie rod (12). Do not tighten at this time. Assemble linkage between the brake arid clutch control shaft (8) and clutch control shaft (14). Install yoke pins (7) and cotter pins (6).

4-9.8.4 Adjustment and Lubrication.

Check for proper clutch engagement. If the clutch does not properly engage, remove cotter and yoke pins and screw the adjustable yokes to shorten or lengthen the linkage for proper clutch engagement. When adjusted, reinstall yoke pins and cotter pins. Finally, tighten the nuts (11) against the yoke (10).

Lubricate the pillow blocks to ensure the shaft turns freely inside the blocks. Also lubricate the pivot points of the clutch control shaft (14). Apply a small amount of lubricant to both levers that are pinned to the adjustable yokes (10).

4-10 MAINTENANCE OF ROTARY TABLE DRIVE

4-10.1 Fixed Displacement Motor. (Figure 4-29)

4-10.1.1 Disassembly

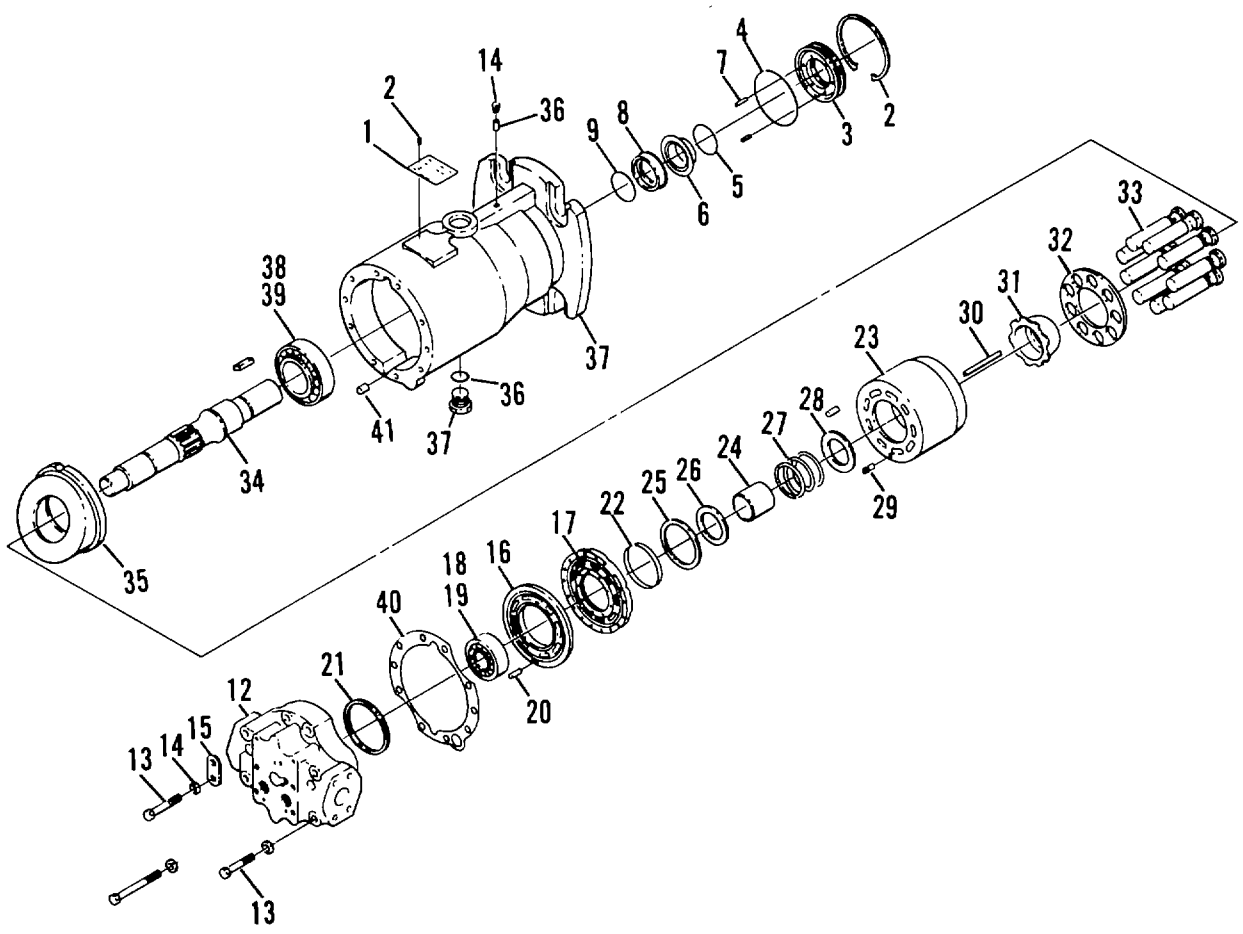
CAUTION
The end cap screws should not be loosened until the shaft seal has been removed.

NOTE
It is recommended that all shaft seal parts (4-9) be replaced. If parts are to be reused, they must be protected from being damaged by the shaft during removal.

a. Remove the large retaining ring (2) located on the shaft end of the motor. Remove the side opposite the tangs from the groove first.

b. The aluminum housing (3) is removed next. It is held in place by the friction of the O-ring (4) on its outside diameter. Pry the housing toward the end of the shaft until the O-ring is free.

c. Remove the housing (3) from the shaft. This part is actually an assembly that is being held together by the friction of an internal O-ring (5). It will normally remain assembled until physically separated.



1. Shaft Seal
2. Ring
3. Housing
4. O-Ring
5. O-Ring
6. Pilot
7. Spring
8. Sealing Ring
9. O-Ring
10. Screw
11. Manifold
12. End Cap
13. Screw
14. Washer
15. Bracket
16. Valve Plate
17. Bearing Plate
18. Race
19. Bearing
20. Pin
21. Shim
22. Pilot Ring
23. Block
24. Spacer
25. Retaining Ring
26. Retainer
27. Spring
28. Seat
29. Pin
30. Spring
31. Guide
32. Retainer
33. Piston
34. Shaft
35. Swashplate
36. Pin
37. Housing
38. Bearing
39. Race
40. Gasket
41. Pin

Figure 4-29. Fixed Displacement Motor

CAUTION

The bronze sealing ring (8) is easily damaged and care must be exercised when handling.

d. The bronze sealing ring (8) is also held in place by internal O-ring (9) friction. Work this part free and carefully slide over the shaft.

e. Remove the screws (10) and lift the manifold (11) off the motor end cap (12). Refer to paragraph 4-9.10.2 to repair the manifold.

f. Remove all but two of the screws (13) and washers (14) holding the end cap (12) to the housing. Make sure the two remaining screws are opposite each other.

g. There is an internal spring loading on the end cap and as the last two screws are loosened, it should begin to separate from the housing. Loosen these screws alternately until the end cap has fully separated from the housing, then remove the screws entirely.

h. The end cap (12) can now be lifted off the motor; however, be certain that the valve plate (16) does not fall and become damaged. If the valve plate tends to lift off with the end cap, hold it in place on the end cap and remove both parts together. If the valve plate remains on the bearing plate (17), remove it at this time.

CAUTION

All surfaces exposed are critical and caution must be used to avoid damage.

i. The end cap (12) is actually an assembly consisting of a tapered bearing race (18) which is a slip fit in the end cap and the valve plate locating pin (20). These parts should be removed from the end cap. There may or may not be a shim (21) located under the bearing race which should be removed.

j. Remove the bronze bearing plate (17) and pilot ring (22) from the cylinder block (23). (If the pilot ring remains with the bearing plate, remove it at this time.) k. The tapered bearing (19) must now be removed from the shaft. A bearing puller should be used that will pull against the inner race of the bearing. Protect the cylinder block face (23) during this operation.

I. After removal of the bearing (19), slip the spacer (24) out of the bore in the cylinder block (23).

m. Place the motor in a horizontal position. Slide the cylinder block assembly (25-33) off the shaft (34) while holding the external end of the shaft.

NOTE

The cylinder block assembly usually comes out in one piece; however, some of the parts can separate. This does not present a problem as these parts can be assembled later.

n. The swashplate (35) has a notch which locates over a pin (36) in the housing (37) to prevent improper assembly; however, mark the housing for proper orientation of the swashplate during assembly.

o. The fixed swashplate (35) and shaft assembly can now be removed by grasping the shaft (34) and lifting both parts out of the housing.

p. The tapered bearing (38) can be pressed off the shaft if required. Be careful not to damage the seal diameter of the shaft while removing the bearing. The bearing race (39) is press fit in the housing (37).

4-10.1.2 Inspection and Repair

a. It is recommended that the entire shaft seal (4-9) be replaced. If, however, the seal is being reused, inspect each part separately for damage.

b. Clean metal parts by using a solvent wash and air drying.

c. If the shaft (34), bearings (19 or 38), end cap (12) or housing is replaced, the shaft end play must be checked.

d. To check the shaft end play, assemble the shaft (34) and bearings (19 and 38), housing (37), end cap (12) and gasket (40). The shaft end play should be from .006" to .016". If adjustment is necessary, a shim (21) can be placed under the bearing race (18) in the end cap (12).

4-10.1.3 Assembly.

a. Place the fixed swashplate (35) over the shaft-bearing (34, 39) assembly and place into housing (37) locating the notch in the swashplate on the pin (36) in the housing.

b. Prior to assembly of the cylinder block, inspect the pistons (33) for contamination or excessively worn slipper pads. Replace any pistons that are found to be defective.

c. To install the cylinder block assembly it is necessary to check the alignment of certain parts. There is no special relationship of pistons to bores, springs, etc. However, the alignment of the ball guide (31) and cylinder block splines is critical. The undersized tooth in the spline of the cylinder block (23) must line up with the missing tooth in the ball guide (31) spline.

d. These in turn line up with a missing tooth on the shaft spline. The hole for the bearing plate (17) locating pin in the cylinder block face is in line with the undersize tooth in the cylinder block and provides an assembly guide.

e. Lubricate the swashplate (35), slippers, pistons (33) and bores with clean hydraulic oil. Hold the shaft (34) on the external end, align the missing shaft tooth with the missing ball guide (31) tooth using the locating pin (29) hole as a guide. Slide the cylinder block assembly onto shaft and against swashplate face. When properly installed a spring load can be felt when pushing against the cylinder block (23).

f. Set the motor vertically and install the spacer (24) in the center bore of the cylinder block (23).

g. The tapered bearing (19) should be installed with an arbor type press for the most satisfactory results. This bearing can not be driven onto the shaft due to the internal spring loading of the cylinder block and shaft. Press on the inner race of the bearing and use care not to damage roller cage.

NOTE

An alternate method of installing this bearing is to use the bearing puller bar and press the bearing onto the shaft with the center screw of the puller bar. A spacer must be used between the center screw and the bearing. The bearing must be pressed on until it rests on the shoulder of the shaft to insure adequate bearing clearance.

h. Install the pilot ring (22) and the locating pin (29) in the cylinder block (23).

i. Install the bearing plate (17) so that the milled slot locates over the pin (29) and the pilot ring (22) fits in the center bore of the cylinder block (23). After installation lubricate the exposed surfaces with clean hydraulic oil.

j. Assemble the bearing race (18), shim (21) (if required) and locating pin (20) in the end cap (12). Lubricate the end cap face with clean hydraulic oil. Install the valve plate (16) so that the milled slot locates over the pin (20) and the center bore fits over the protruding bearing race (18).

k. Place the end cap gasket (40) on the housing (37), being certain the locating pins (41) are in place, then install the end cap (12) and valve plate (16). Hold the valve plate so it does not drop off during assembly. The end cap and gasket will only align with housing mounting holes in one position.

l. Install two end cap screws (13) and washers (14), and alternately tighten them until the internal spring has compressed far enough for the end cap to rest on the housing. Install the remaining screws. Torque to 45-54 ft.-lbs.

m. Place one O-ring (9) in the inside diameter of the bronze sealing ring (8) and one O-ring (5) in the inside diameter of the aluminum housing (3). Place the springs (7) in the cavities in the housing (3). Care must be used to protect the parts from damage by the shaft during assembly.

n. Before installing any shaft seal parts, wrap the shaft with a protective covering to protect parts from damage. Then slide the sealing ring (8) over the shaft and onto the shaft pilot diameter with the O-ring (9) facing the motor. Work the ring into place using hand force only.

o. Insert the stationary seal pilot (6) into the aluminum housing (3), locating the notch in the stationary seal over the pin in the housing.

p. Install the O-ring (4) on the outside diameter of the housing (3) then slide it into place against the bronze sealing ring (8). Since this is a spring loaded assembly, it may be necessary to push against the aluminum housing to expose the retaining ring groove.

q. Install the retaining ring (2) with the beveled side out, putting the side opposite the tangs into the groove first. Be certain that the retaining ring has snapped into its groove completely.

r. Install the manifold (11) on end cap (12) and install screws (10). Torque to 10-11 ft.-lbs.

4-10.2 Motor Manifold Valve Assembly. (Figure 4-30)

4-10.2.1 Repair. The manifold assembly contains the following valves: High Pressure Relief Valve Cartridges (5000 psi), Shuttle Valve, and Charge Relief Valve (160/180 psi).

a. The high pressure relief valves (1) are cartridges that are removed by unscrewing them from the manifold. These valves are factory set and the first two numbers of the pressure setting are stamped on the end of the valve. These valves are interchangeable and can be installed in either side of the manifold. The seals (2) are replaced as a kit.

b. To repair the shuttle valve, remove both hex plugs (3) and o-rings (4), springs (5), washers (6) and spool (7) from the manifold (8). These parts are interchangeable and can be installed on either side of the manifold. The spool (7) and manifold (8) are a select fit and must be replaced together. To install, slide the spool (7) into the bore, place a washer (6) on each end, then slide both springs (5) in place. Install the hex plugs (3) and o-rings (4) and tighten.

c. To repair charge relief valve (9), remove plug (10) with setscrew (11), nut (12) and cap (13), o-ring (14), plunger (15), spring (16), o-ring (17) and valve (18). To install, place new o-rings (14, 17) on plug (10) and plunger (15). Place spring (16) in valve (18) and slide into bore. Install plunger (15) and plug (10).

d. Charge relief pressure is adjusted by removing cap (13), loosening nut (12) and turning setscrew (11) clockwise to increase and counterclockwise to decrease relief pressure.

e. Remove plugs (19) and install new o-rings (20). Install new orifice (21) and o-rings (22 and 23).

1. Valve
2. Seal
3. Plug
4. O-Ring
5. Spring
6. Washer
7. Spool
8. Manifold
9. Valve
10. Plug
11. Setscrew
12. Nut
13. Cap
14. O-Ring
15. Plunger
16. Spring
17. O-Ring
18. Valve
19. Plug
20. O-Ring
21. Orifice
22. O-Ring
23. O-Ring

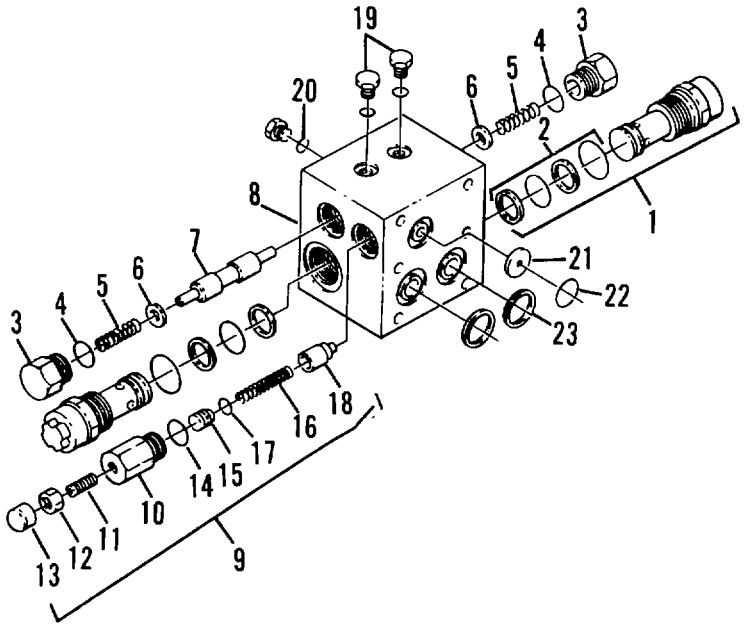


Figure 4-30. Motor Manifold Valve Assembly

4-10.3 Rotary Table Transmission (Figure 4-30A).

4-10.3.1 Removal.

NOTE

The purposes of correct orientation, the illustration in Figure 4-30A views the transmission from the rear.

a. Disconnect the shift linkage from the side of the transmission. Remove the drive shaft that connects between the transmission and the rotary table. Remove the hydraulic motor from the transmission.

b. Remove the drain plug (60) and drain the oil from the transmission. Remove the capscrews (20 and 22) and washers (21) to remove the transmission from its mounting. Retain the shims (24); discard the gasket (23).

4-10.3.2 Disassembly.

a. Remove the safety wire (28) and unscrew two drilled-head capscrews (29). Remove shims (31) and companion flange (32). Unscrew four nuts (34) and washers (35) and two capscrews (36) and sealing washers (37) and remove the output bearing retainer (38) and gasket (39). Remove and discard the oil seal (40).

b. Remove and discard the output shaft o-ring (33) and four o-ring stud seals (41). Do not remove the studs (42) unless the threads are stripped or damaged. Remove the capscrews (25) and sealing washers (26) and remove the side cover (27). Discard the gasket (19).

c. Remove six capscrews (2) and sealing washer (3) and remove the shift cap assembly (1). Discard the gasket (19). Remove shifting forks (9 and 10). Drive out the two retainer pins (4) and remove the shift arms (5); remove oil seals (6).

NOTE

Lay the shift cap assembly in a fixture with the inside of the cap up. In this position the steel balls and springs will better stay in place. As you disassemble the shift cap, take note of how the parts are positioned in the cap. This will aid at reassembly.

d. Remove the safety wire (7) and unscrew two drilled-head capscrews (8). Carefully, remove the inhibitor block (11), then remove the steel ball (12) from between the shift selectors (13). Remove the two assembled shift selectors and two steel balls (12) and springs (14) from the shift cap (17). Do not remove the shift stop pins (15) unless they are damaged and must be replaced. To disassemble the shift selectors, drive out the retainer pin (4) from the selector (13); then separate the selector (13) and shift shaft (16).

e. Remove the output shaft bearing (43), thrust washer (44) and thirty-four roller bearings (45). Begin removing the gears by carefully extracting the countershaft (51) from the case. (Bearing (50) is pressed onto the countershaft and bearing (59) is pressed into the housing.) As you remove the shaft from the rear of the transmission, remove the drive gear (58), third gear (57), shifting collar hub (55), shifting collar (54), and second gear (53) from the side of the transmission. (Four press-fitted bearings (52) and bearing sleeve (56) will come out with the gears.)

f. Complete the disassembly process by removing the output shaft (49) from the front of the transmission while removing the gears (46, 47, 48) from the side.

4-10.3.3 Cleaning, Inspection, and Repair.

a. Clean all parts thoroughly in an approved cleaning solvent. Clean again with clean solvent before reassembling.

b. Handle parts with care. Nicks, scratches, or dents caused by careless handling can cause subsequent transmission failure.

c. Never dry bearings with compressed air and do not spin bearings that are not lubricated.

d. Check shafts and bores for nicks and scratches.

e. Check gears for nicks, burrs, or broken or worn teeth.

f. Replace all gaskets, o-rings, oil seals, and sealing washers each time transmission is disassembled. Replace bushings and bearings worn beyond tolerance.

g. Replace any part found badly worn or otherwise damaged.

4-10.3.4 Assembly.

a. If bearings were removed from shafts, inside gears, or inside the housing, reinstall bearings using a small arbor press. Be sure to apply pressure to the member being installed (inner ring on a shaft; outer ring in housing or gear). Start bearing squarely on shaft or in housing or gear and be sure it seats squarely against shoulder. Oil bearings and bushings during assembly to assure lubrication during the first few moments of operation. Install new oil seals by pressing against the outside diameter.

b. With the housing on its side, begin assembly by setting the low gear (46) in the transmission against the rear wall with its splined hub toward the front. Next place the second gear (47), with the shift collar side toward the front, in front of the low gear. Now place the third gear (48), with its shift collar side toward the rear, in front of the second gear. From the front of the transmission, insert the output shaft (49) into the housing and through the gears. Work the shaft in until all gears are splined on the shaft.

c. Carefully set the housing upside down and continue assembly with the countershaft. If not already assembled, press-fit bearings (52) into second and third countershaft gears (53, 57). (Bearings must be flush to 0.003" below the machined edge of the gear.) Install the bearing sleeve (56) into third gear (57). With bearing (50) installed on the countershaft (51), and bearing (59) installed in the housing, insert the countershaft through the rear of the housing as you install second gear (53), with its splined hub facing the front. Next, install the shifting collar hub (55), then the shifting collar (54) onto the hub. Install third gear (57) with its splined hub facing the rear. Finally, install the drive gear (58). Be sure the countershaft is fully seated in the housing.

d. Carefully set the housing upright. Install the thirty-four loose roller bearings (45) under the output shaft low gear (46), rotating the shaft as required to get all the bearings to seat into place. Then install the thrust washer (44) and the output shaft bearing (43).

e. Position the shift cap (17) in a fixture to assemble the shift cap. If any were removed, install shift stop pins (15). Install two springs (14) and steel balls (12) in the shift cap. Assemble the shift selectors (13) and shafts (16), attaching shafts to selectors with retaining pins (4). Install the assembled shift arms into the shift cap. Position the steel ball (12) between the shift selectors. Carefully place the inhibitor block (11) in position and install two drilled-head screws (3). Tighten the capscrews and install the safety wire (7) in the capscrew's heads.

f. Turn the shift cap over and install two new oil seals (6). Install the two shifting arms (5), fastening each with a retaining pin (4). Install the shifting forks (9, 10). Install a new shift cap gasket (19); then aline the shifting forks with the shifting collars in the transmission and install the assembled shift cap (1) onto the housing (64). Install six capscrews (2) and sealing washers (3).

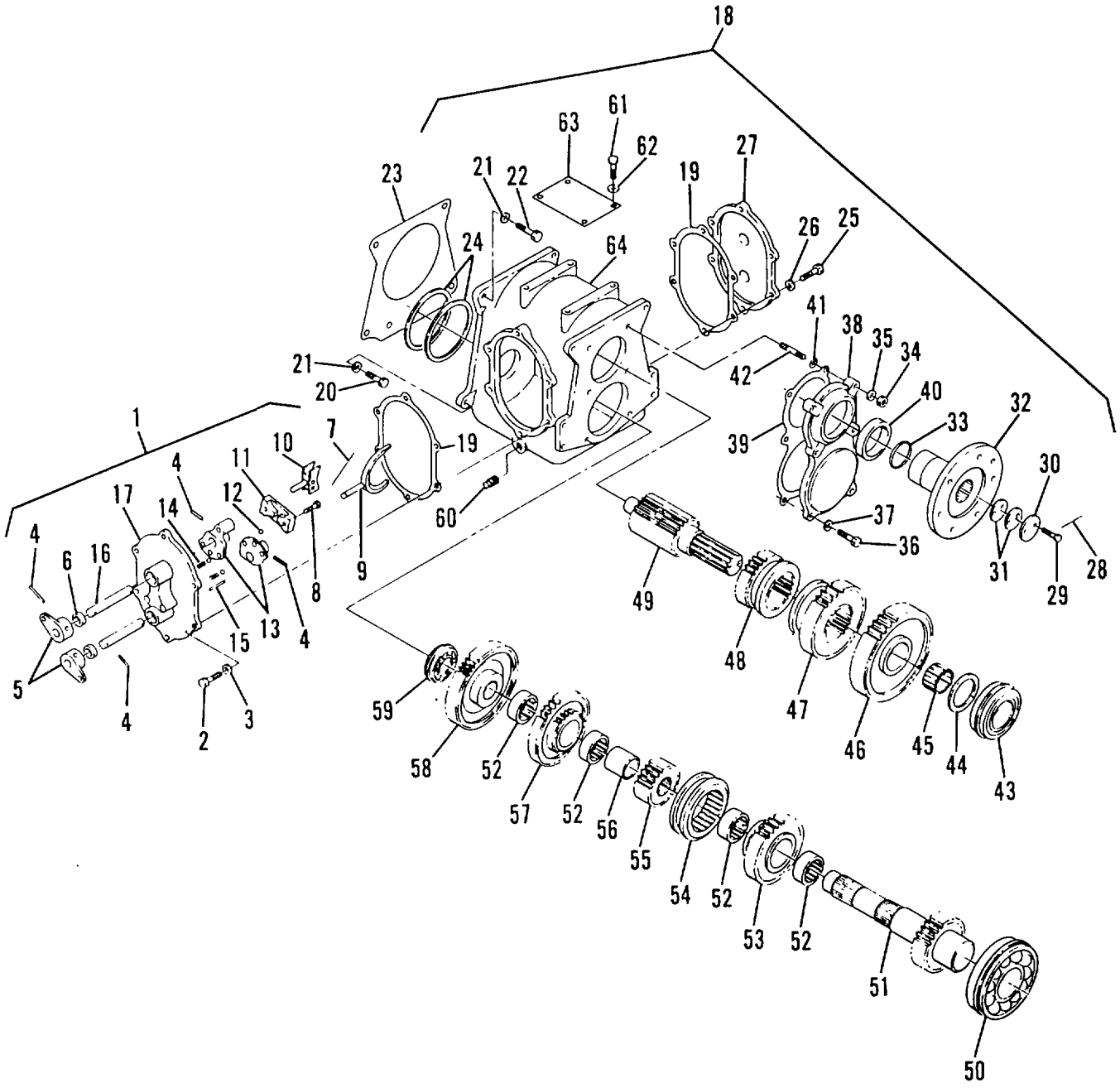


Figure 4-30A. Rotary Table Transmission

Legend to Figure 4-30A.

1. Side Cap Assembly
2. Capscrew
3. Washer
4. Retainer Pin
5. Shift Arm
6. Oil Seal
7. Safety Wire
8. Capscrew
9. Shifter Fork (2 & 3)
10. Shifter Fork (1 & 4)
11. Inhibitor Block
12. Steel Ball
13. Shift Selector
14. Detent Spring
15. Retainer Pin
16. Shaft
17. Shift Cap
18. Transmission Assembly
19. Gasket
20. Capscrew
21. Washer
22. Capscrew
23. Gasket
24. Shim
25. Capscrew
26. Washer
27. Side Cover
28. Safety Wire
29. Capscrew
30. Washer
31. Shim
32. Companion Flange
33. O-ring
34. Hex Nut
35. Washer
36. Capscrew
37. Sealing Washer
38. Bearing Retainer
39. Gasket
40. Oil Seal
41. O-ring Stud Seals
42. Stud
43. Bearing
44. Thrust Washer
45. Roller
46. Low Gear
47. Second Gear
48. Third Gear
49. Output Shaft
50. Bearing
51. Countershaft
52. Bearing
53. Second Gear, Counter Shaft
54. Shifting Collar
55. Hub
56. Bearing Sleeve
57. Third Gear, Counter Shaft
58. Drive Gear, Counter Shaft
59. Front Bearing, Counter Shaft
60. Drain Plug
61. Capscrew
62. Washer
63. Plate, Shift Pattern
64. Case

g. Install a new gasket (19) on the side cover (27) and attach the cover to the housing with six capscrews (25) and sealing washers (26).

h. Install four new o-rings (41) on the studs (42). Install the output shaft o-ring (33) on the output shaft. If not previously installed, press the oil seal (40) in the output bearing retainer. Install a new bearing retainer gasket (39). Install the bearing retainer (38) and install two capscrews (36) and sealing washers (37). Install and tighten four washers (35) and nuts (34) on the studs (42).

i. Install the companion flange (32), shims (31), retainer washer (30), and fasten with two drilled-head capscrews (29). Install safety wire (28) through the capscrews.

4-10.3.5 Installation.

a. Install the drain plug (60) and fill the transmission with oil as directed in the lubrication chart. Install a new gasket (23) and position the shims (24). Set the transmission in its mounting and install capscrews (20 and 22) and washers (21). Retain the shims (24); discard the gasket (23).

b. Connect the shift linkage to the shift arms on the side of the transmission. Install the drive shaft between the transmission and the rotary table. Install the hydraulic motor on the transmission.

4-10.4 Rotary Table Sliding Base (Figure 4-30B).

4-10.4.1 Removal.

a. Disconnect the drive shaft from the transmission to the rotary table. Disconnect the table transfer cylinder. To remove the rotary table, remove four nuts (1), lockwashers (2), and bolts (3).

b. Remove the gib pins (4), bolts (5), lockwashers (6) to remove the table anchor plate (7). Remove grease fittings (8, 9). Remove twelve bolts (10) and lockwashers (6). Now, disassemble sliding bases (11, 12), top guide rails (13), guide spacers (14), and base guide shim (15).

4-10.4.2 Inspection and Repair.

Inspect parts for unusual wear or damage. Replace any part found to be unusually worn or damaged.

4-10.4.3 Installation.

a. Position the shims (15), guide spacers (14), top guide rails (13), and sliding bases (11, 12) and fasten to the drilling rig with twelve bolts (10) and lockwashers (6). Install the table anchor plates (7) and attach them with eight bolts (5) and lockwashers (6). Install gib pins (4).

b. Install the rotary table in the sliding base and fasten it with four bolts (3), lockwashers (2), and nuts (1). Connect the drive shaft and transfer cylinder to the rotary table.

4-11 MAINTENANCE OF ROTARY TABLE TRANSFER CYLINDER

4-11.1 Rotary Table Transfer Cylinder. (Figure 4-31)

4-11.1.1 Removal.

a. Disconnect hydraulic lines from the cylinder barrel (23).

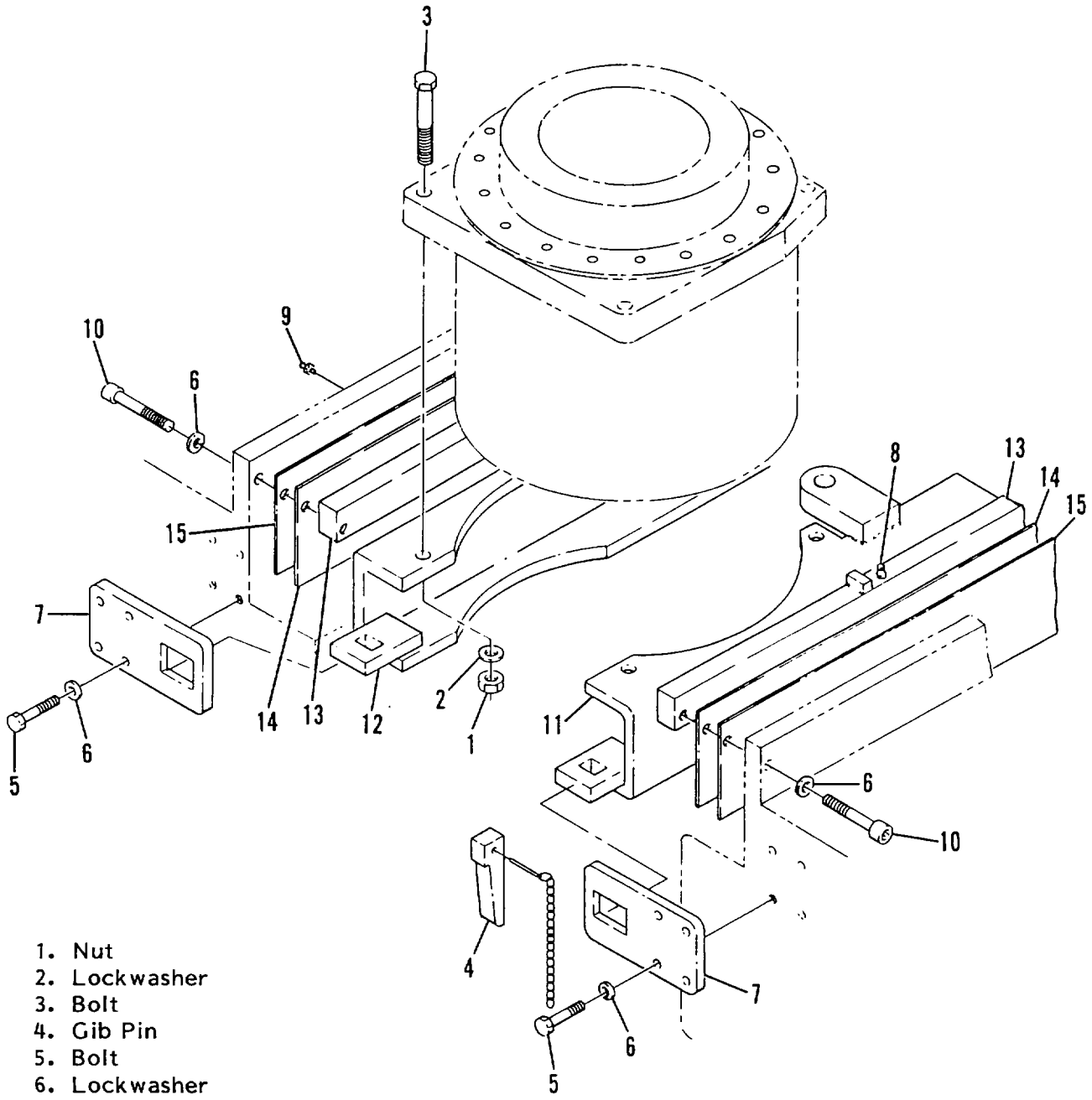
b. Remove spring pin (1), anchor pin (2), spring pin (21), anchor pin (22), and remove the transfer cylinder.

4-11.1.2 Disassembly.

a. Remove the setscrew (7), plug (8) and unscrew the cap (9) from the cylinder barrel (23).

b. Pull the rod (6), with all attached components, out of the barrel (23).

c. Remove the nut (3), bolt (4), lug (5) and protector (15).



1. Nut
2. Lockwasher
3. Bolt
4. Gib Pin
5. Bolt
6. Lockwasher
7. Table Anchor Plate
8. Grease Fitting
9. Grease Fitting
10. Bolt
11. Sliding Base
12. Sliding Base
13. Top Guide Rail
14. Guide Spacer
15. Base Guide Shim

Figure 4-30B. Rotary Table Sliding Base

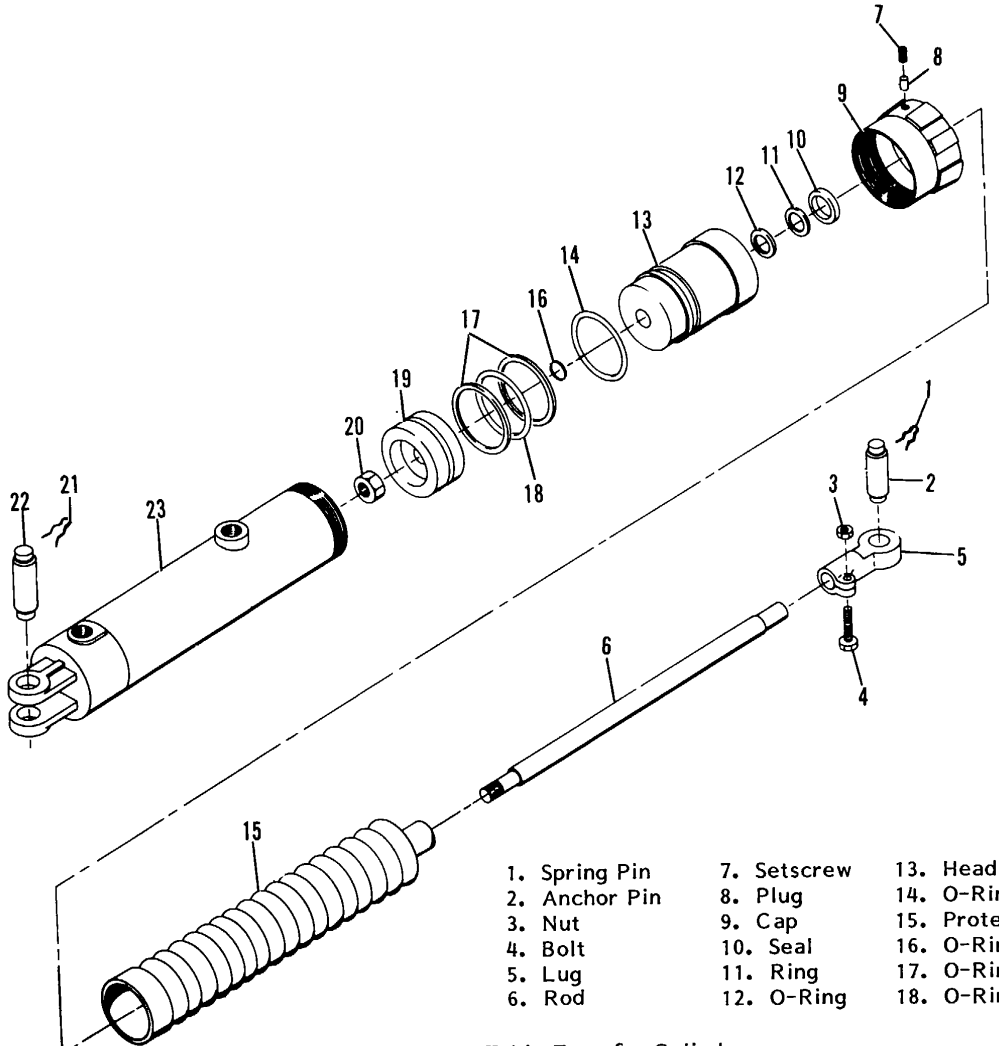


Figure 4-31. Rotary Table Transfer Cylinder

d. Remove the seal (10), ring (11), o-ring (12) and head (13).

e. Remove the nut (20) from the rod (6).

f. Remove the piston (19) and o-rings (14, 16, 17 and 18).

4-11.1.3 Cleaning, Inspection and Repair.

a. Clean all metal parts in an approved solvent.

b. Inspect the interior of the barrel. The interior surface must be smooth.

c. Inspect all parts for excessive wear or damage.

CAUTION
Do not use a wire brush or abrasive material for cleaning.

d. Thoroughly clean all grooves in which o-rings are installed.

e. Replace all o-rings and seals, and any other parts considered unserviceable.

4-11.1.4 Assembly.

a. Install o-rings (16, 17 and 18) on piston (19) and o-rings (12 and 14), ring (11) and seal (10) on head (13).

b. Assemble head (13) and piston (19) on rod (6) and install nut (20).

c. Insert the assembled rod and piston into bore of cylinder barrel (23).

d. Install cap (9) over rod and thread onto barrel (23). Install plug and setscrew (8, 7).

e. Install protector (15) on rod (6), then install lug (5), bolt (4) and nut (3).

4-11.1.5 Installation.

a. Position cylinder on mount and install anchor pin (22) and spring pin (21).

b. Position lug (5) on rotary table and install anchor pin (2) and spring pin (1).

c. Connect hydraulic lines to cylinder.

4-12 MAINTENANCE OF LEVELING JACKS

4-12.1 Hydraulic Leveling Jack. (Figure 4-32)

NOTE
Instructions for front and rear leveling jacks are the same.

4-12.1.1 Disassembly.

a. Disconnect hose (1) at elbow (2). Remove elbow (2) and nipple (3).

b. Unscrew check valve (4), with fittings, from nipple (5). Remove nipple (5) from jack.

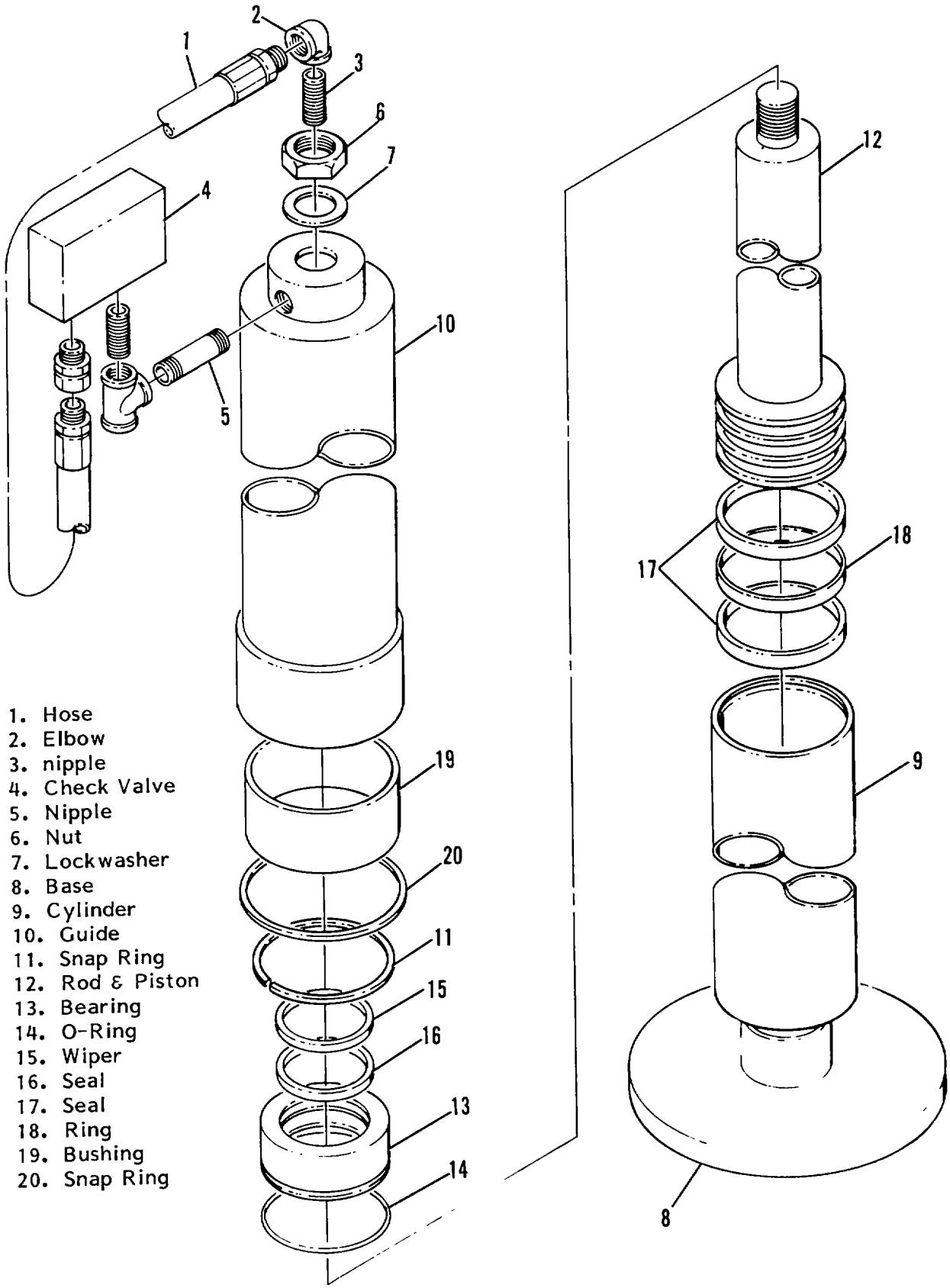


Figure 4-32. Hydraulic Leveling Jack

c. Remove nut (6) and lockwasher (7).

d. Pulling from the base (8) end, remove the cylinder (9) from the guide (10).

e. Remove snap ring (11) and withdraw rod and piston (12) and bearing (13). Slide the bearing (13) off the rod (12).

f. Remove o-ring (14), wiper (15) and seal (16) from bearing (13), and remove seals (17) and ring (18) from piston (12). Discard rings and seals.

g. Examine bushing (19) to see if there is wear or damage. If replacement is required, remove snap ring (20) and pull bushing (19) from guide (10).

h. Examine all parts and replace parts as required. Use new seals at assembly.

4-12.1.2 Assembly.

a. If new bushing (19) is being used, position the bushing squarely in the bore of the guide (10) and push the bushing in evenly. The old bushing may be used as a drift to push the new bushing in. Install snap ring (20).

b. Install seals (17) and ring (18) in the grooves of the piston (12).

c. Lightly coat the piston and seals with clean hydraulic fluid and insert the rod and piston (12) into the cylinder (9).

d. Install o-ring (14), wiper (15) and seal (16) in bearing (13).

e. Lightly coat the inside and outside diameters of the bearing (13) and slide it over the end of the rod (12) and into the cylinder (9). Use care that the o-ring (14) is not damaged on the snap ring groove in the cylinder.

f. Push bearing (13) in far enough to pass the snap ring groove, and install snap ring (11) in cylinder (9).

g. Install assembled cylinder (9) in guide (10).

h. Rotate rod (12) so that the threaded hole in rod is aligned with the opening guide. Install nipple (5).

i. Install the lockwasher (7) and nut (6). Screw the elbow (2) and nipple (3) into rod (12).

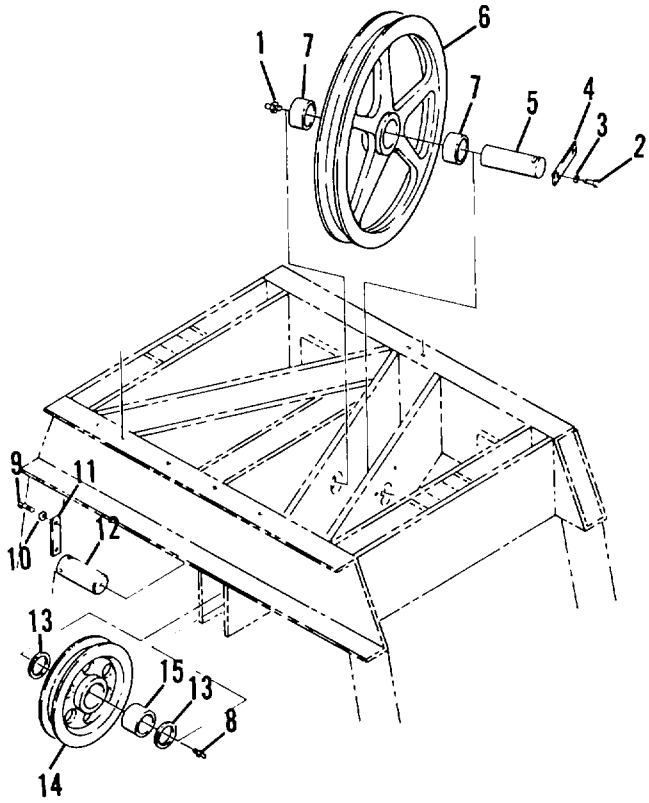
j. Install check valve (4) and connect hose (1).

4-13 MAINTENANCE OF THE MAST

4-13.1 Crown Block Assembly. (Figure 4-33)

4-13.1.1 Hoisting and Auxiliary Sheaves.

a. Remove grease fitting (1), screws (2), lockwashers (3) and lockplate (4).



1. Grease Fitting
2. Screw
3. Lockwasher
4. Lockplate
5. Shaft
6. Sheave
7. Bearing
8. Grease Fitting
9. Screw
10. Lockwasher
11. Lockplate
12. Shaft
13. Spacer
14. Sheave
15. Bearing

Figure 4-33. Crown Block Assembly

CAUTION

When the shaft (4) is removed, the sheave (5) is free to fall. Take precautions to prevent injury.

b. Use a pry bar in the lockplate slot of shaft (5) to being removal. Remove shaft (5) and sheave (6) from crown block.

c. Place sheave (6) on workbench and press out bearings (7).

d. Install new bearings (7) so that they are flush on each side of sheave (6).

e. Place sheave (6) in position on crown block frame and install shaft (5).

f. Install lockplate (4) in shaft slot and install screws (2) and lockwashers (3). Install grease fitting (1).

4-13.1.2 Third Drum Sheaves.

a. Remove grease fitting (8), screws (9), lockwashers (10) and lockplate (11).

CAUTION

When the shaft (12) is removed, the sheave (4) is free to fall. Take precautions to prevent injury.

b. Use a pry bar in the lockplate slot of shaft (12) to begin removal. Remove shaft (12).

c. Slowly remove sheave (14) from crown block, pay particular attention to spacers (13), as they may fall out.

d. Place sheave (14) on a workbench and press out bearing (15).

e. With the sheave (14) lying flat, place a spacer (13) in the bore of sheave so that it is flush with the bottom side.

f. Install a new bearing (15) in sheave (14) and use the other spacer (13) against the bearing to push it firmly in place.

g. Place sheave (14) in position in crown block frame and install shaft (12).

h. Install lockplate (11) in shaft slot and install screws (9) and lockwashers (10). Install grease fitting (8).

4-13.2 Chain Feed Sprocket Assembly. (Figure 4-34)

4-13.2.1 Disassembly.

a. Remove grease fitting (1), screws (2), lockwashers (3) and lockplate (4).

CAUTION

When the shaft (5) is removed, the sprocket (6) is free to fall. Take precautions to prevent injury.

b. Use a pry bar in the lockplate slot of shaft (5) to begin removal. Remove shaft (5).

c. With shaft (5) removed, slowly remove sprocket (6), pay particular attention to spacers (7), as they may fall out.

d. Remove spacers (7), seals (8) and bearing (9). Discard seals.

e. The hanger (10) should not be removed unless it must be replaced because of damage. If replacement is required, perform following step.

f. Support hanger (10) so it does not fall, and remove locknut (11), washer (12), spring (13), stop (14) and hanger (10). Discard nut (11).

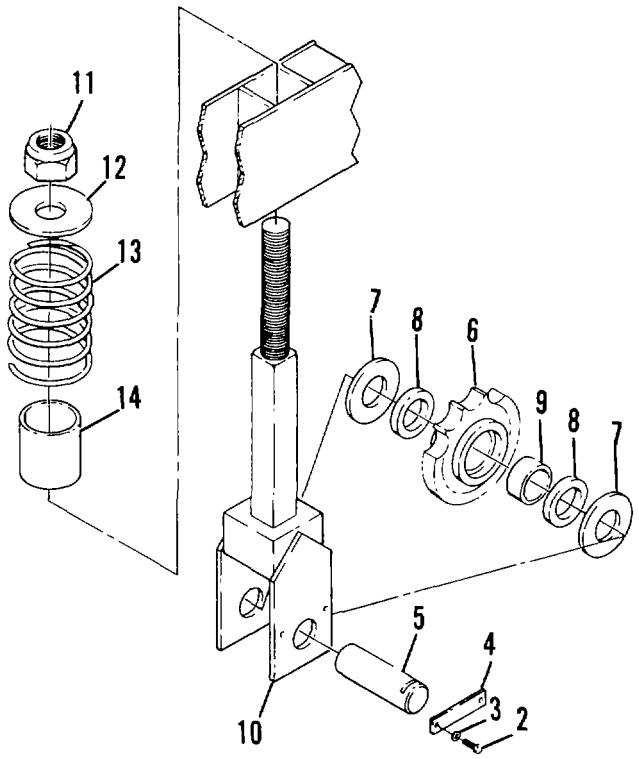
4-13.2.2 Assembly.

a. If hanger was removed, install hanger (10), stop (14), spring (13), washer (12) and a new locknut (11). Do not tighten the nut to compress spring (13).

b. Press new bearing (9) into sprocket (6) and install new seals (8).

c. Assemble spacers (7) with sprocket (6) and position in hanger (10). Install shaft (5).

d. Install lockplate (4) in slot of shaft (5) and install screws (2) and lockwashers (3). Install grease fitting (1).



1. Grease Fitting
2. Screw
3. Lockwasher
4. Lockplate
5. Shaft
6. Sprocket
7. Spacer
8. Seal
9. Bearing
10. Hanger
11. Locknut
12. Washer
13. Spring
14. Stop

Figure 4-34. Chain Feed Sprocket

4-13.3 Chain Pulldown Yoke (Figure 4-34A).

4-13.3.1 Disassembly.

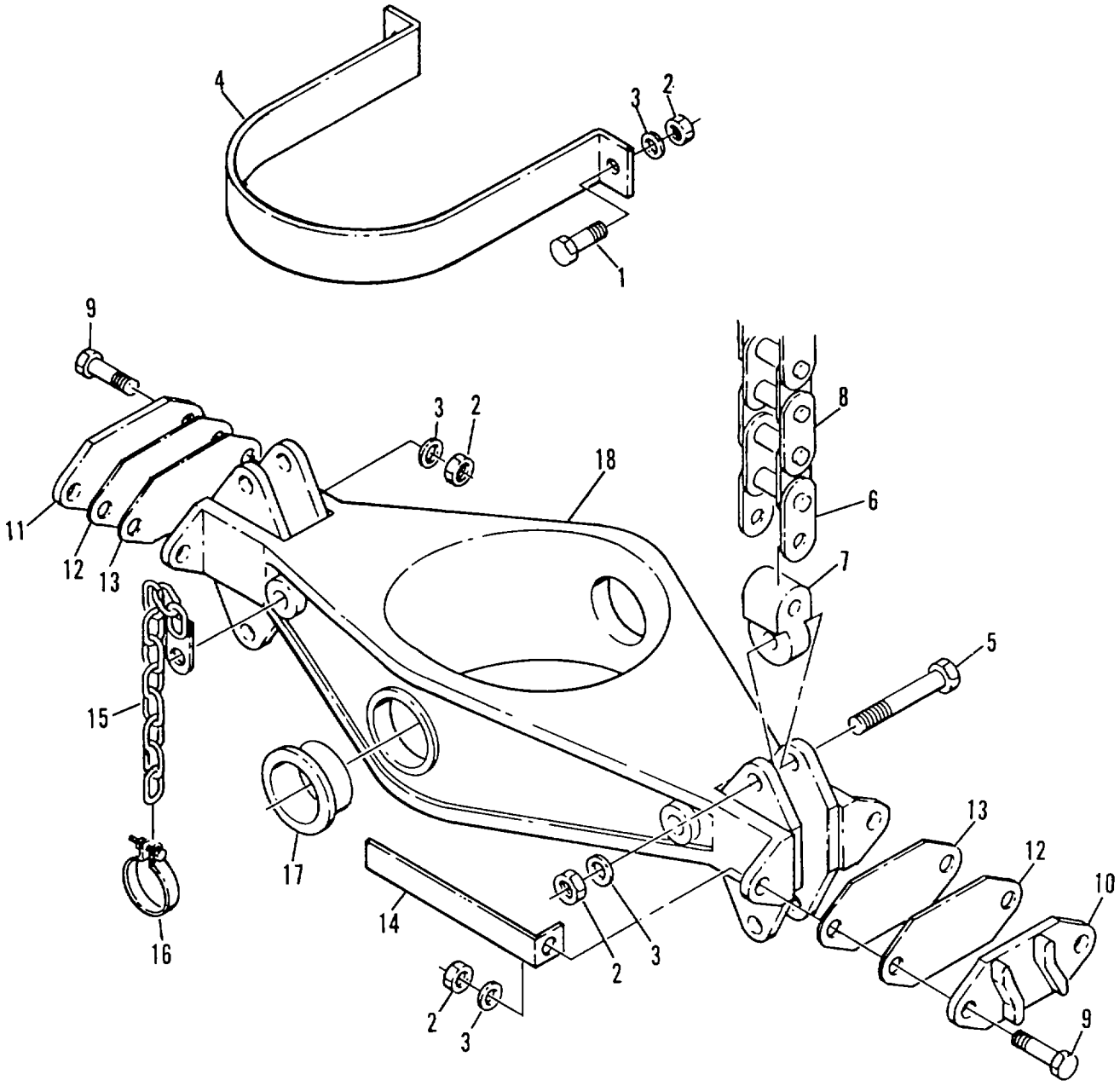
a. Remove the two hex head bolts (1), nuts (2), and lockwashers (3) to remove the chain guide (4). To separate the chain from the yoke, remove the long bolts (5), nuts (2), and lockwashers (3) from each side of the yoke. Separate the chain links (6) and chain connectors (7) from the chain (8).

b. From either side of the pulldown yoke, remove two bolts (9), nuts (2), and lockwashers (3) to disassemble the yoke guides (10 and 11), yoke adjusting shims (12) and yoke guide shims (13). Line guide (14) may also be removed at this time. Remove the safety chain (15) and hose clamp (16). Complete the disassembly procedure by removing the yoke bushings (17) from the yoke (18).

4-13.3.2 Cleaning, Inspection, and Repair.

a. Clean all parts using an approved cleaning solvent. Remove any rust or corrosion with a wire brush.

b. Inspect all parts for signs of wear or evidence of corrosion or rust. Inspect bushings for signs of wear or pitting. Inspect chain for wear or damaged links; also, check chain for free link movement. Check threaded parts for stripped or damaged threads.



1. Bolt
2. Nut
3. Lockwasher
4. Guide
5. Bolt
6. Link
7. Connector
8. Chain
9. Bolt
10. Yoke Guide
11. Yoke Guide
12. Shim
13. Shim
14. Line Guide
15. Chain
16. Hose clamp
17. Bushing
18. Yoke

Figure4-34A. Chain Pulldown Assembly.

c. Replace any parts found to be unusually worn or damaged. If the yoke has rusted or corroded, repaint after thoroughly cleaning; if badly rusted or corroded, replace the yoke. If chain links do not move freely, use a penetrating lube oil on the frozen links.

4-13.3.3 Reassembly.

a. Install the yoke bushings (17) in the yoke (18). Install the safety chain (15) and hose clamp (16). Install the line guide (14). Install the yoke guides (10 and 11), yoke adjusting shims (12) and yoke guide shims (13) onto both sides of the pulldown yoke, fastening with the two bolts (9), nuts (2), and lockwashers (3).

b. Install the chain links (6) and chain connectors (7) to the chain (8). To attach the chain to the yoke, install the long bolts (5), nuts (2), and lockwashers (3) on each side of the yoke. Install the chain guide (4) and fasten with the two hex head bolts (1), nuts (2), and lockwashers (3).

c. Perform any lubrication specified in the lubrication chart.

4-14. MAINTENANCE OF CHAIN FEED DRIVE

4-14.1 Hydraulic Motor.

4-14.1.1 Service Tools.

a. Special tools required for maintenance are a shaft seal driver and an adapter extractor.

b. The seal driver can be made from round stock machined as shown in Figure 4-35.

c. The adapter extractor (p/n 322457 [32705]) may be purchased, or fabricated as shown in figure 4-35.

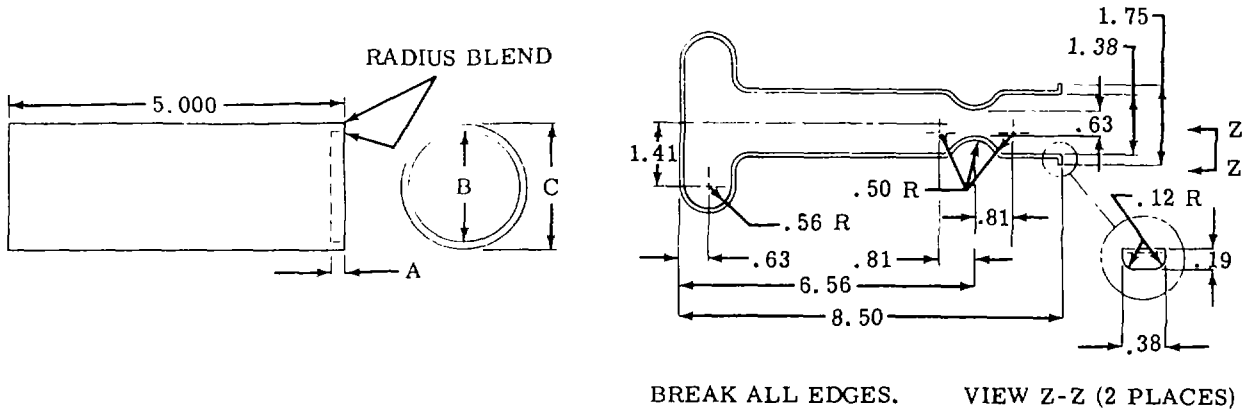


Figure 4-35. Service Tools

4-14.1.2 Disassembly. (Figure 4-36)

a. Clamp the motor in a vise with protective jaws, cover (2) end up.

b. Remove bolts (1) and lift off cover (2). Lift out the cartridge assembly (3).

NOTE

If cartridge parts need replacement, a cartridge kit may be used. In this case, the cartridge assembly (3) will not require disassembly, proceed to step g.

c. Remove back-up rings (4) and o-rings (5).

d. Lay the cartridge assembly (3) on pressure plate (12) end, and remove screws (6) and pressure plate (7).

NOTE

Use a standard piston ring compressor when disassembling the cartridge components.

e. Carefully pull the rotor (8) and vanes (9) assembly halfway out of ring (10) and install the ring compressor. Compress the vanes (9) into rotor (8) and remove this assembly from ring (10). Release the ring compressor and the vanes (9) and springs (11) can be removed from rotor (8).

f. Separate the ring (10) from pressure plate (12) and remove pins (13).

g. Remove o-rings (14, 15) from body (27). Remove key (16) from shaft.

h. Using the adapter extractor (see figure 4-35), carefully pull the hub adapter (17) from the body. The extractor tool engages between the bearing (22) and the adapter (17).

i. Remove the o-ring (18) and back-up ring (19).

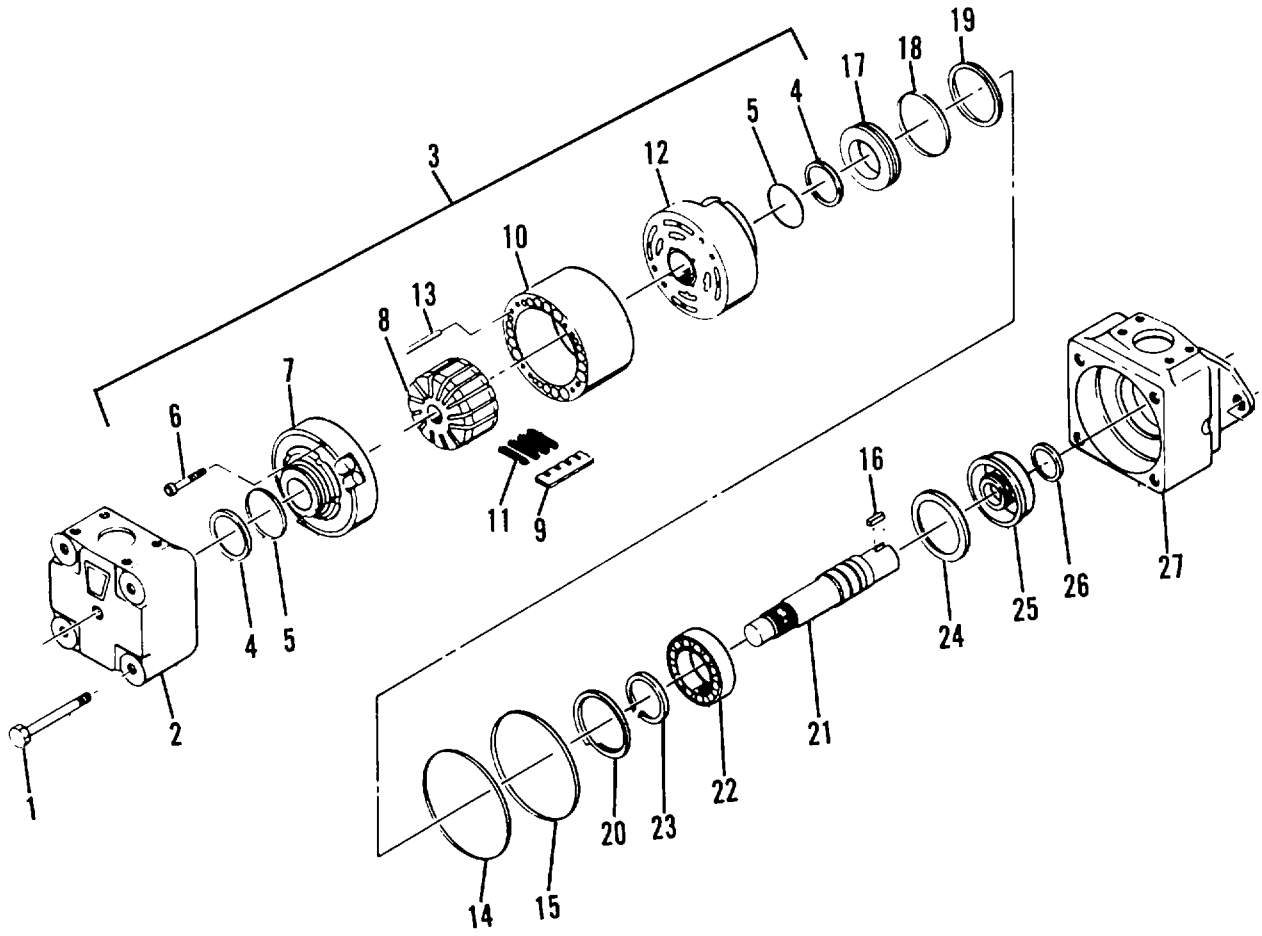
j. Remove the lock ring (20), then tap the shaft (21) and bearing (22) out of the body (27).

k. Support the bearing (22) inner race in an arbor press, remove snap ring (23) and press bearing off shaft.

l. Remove washer (24), seal (25) and wiper (26) from body (27).

4-14.1.3 Inspection and Repair.

a. Discard all seals, o-rings and back-up rings.



1. Bolt
2. Cover
3. Cartridge Assembly
4. Back-up Ring
5. O-Ring
6. Screw
7. Pressure Plate
8. Rotor
9. Vane
10. Ring
11. Spring
12. Pressure Plate
13. Pin
14. O-Ring
15. O-Ring
16. Key
17. Adapter
18. O-Ring
19. Back-up Ring
20. Lockring
21. Shaft
22. Bearing
23. Snap Ring
24. Washer
25. Seal
26. Wiper
27. Body

Figure 4-36. Chain Feed Drive Motor

b. Wash metal parts in an approved solvent and dry with low pressure, filtered, compressed air.

c. Check the wearing surfaces of pressure plates (7, 12) and ring (10) for scoring and excessive wear. Remove light scores by lapping. Replace scored or worn parts.

d. Inspect the vanes (9) for burrs, wear and excessive play in the rotor slots. Replace damaged vanes with a vane and spring kit. Replace the rotor (8) if slots are worn.

e. Rotate the bearing (22) on shaft (21) while applying pressure to check for wear, looseness, roughness and pitted or cracked races.

f. Inspect the seal and bushing mating surfaces on the shaft (21) for scoring or wear. Replace the shaft if marks cannot be removed by light polishing.

g. Be sure that any paint or burrs raised on the body (27) and cover (2) are removed before assembly.

4-14.1.4 Assembly. (Figure 4-36).

NOTE

Coat all parts with clean hydraulic fluid to facilitate assembly and provide initial lubrication. Use small amounts of petroleum jelly to hold o-rings in place during assembly. Soak the shaft wiper (26) in oil before assembly.

a. Install the wiper (26) in body (27). Grease the shaft seal (25) and press it into the body using seal driver (see figure 4-35). The spring on seal must be toward the bearing (22). Place the washer (24) in the body against the seal.

b. Support the bearing (22) inner race and press in the shaft (21). Install snap ring (23).

c. Lightly tap the shaft and bearing (21, 22) assembly into the body (27) with a plastic hammer. Install the lockring (20) to secure shaft. Be sure the lockring is properly installed.

NOTE

If an assembled cartridge kit is being installed, proceed to step k.

d. With the rotor (8) lying on a clean, flat surface, slide the vanes and springs (9, 11) into the rotor slots. Lift the vanes slightly to insure the springs are positioned in the spring recesses of the rotor.

CAUTION

Be certain the springs remain seated as the vanes are compressed.

e. Using a piston ring compressor, compress the vanes (9) in the slots of the rotor (8).

f. Position the ring (10) on a flat surface and insert the rotor and vane assembly 1/4 way into the ring. Use a hardwood plug 3.95 inches in diameter and approximately 2.50 inches long for positioning the rotor and vane assembly.

g. Release the ring compressor carefully so the vanes do not snap out against the ring (10) surface. With the hardwood plug, press the rotor and vanes (8, 9) flush with ring.

NOTE

Vanes may become cocket it not pushed down uniformly.

h. Install pins (13) on pressure plate (12). Place the rotor (8), ring (10) and vane (9) assembly over the pins on the plate.

i. Install pressure plate (7) against the rotor and ring. The porting in this plate will be 90 degrees from the other plate (12).

j. Carefully install the screws (6), being certain the outer edges of the ring (10) and plates (7, 12) are flush. Tap with a plastic hammer if necessary to effect alignment. Torque screws (6) to 8-12 ft.-lbs.

k. Install o-rings (5) and back-up rings (4) in plates (7, 12). Insure that o-ring is positioned in the concave side of the back-up ring.

l. Assemble the hub adapter (17) on the pressure plate (12). Install o-ring (18), then back-up ring (19) on the adapter. Grease with petroleum jelly.

m. Clamp the body (27) in a vise with protective jaws. Install the cartridge assembly (3) on the shaft (21) with hub adapter (17) toward the body. Tap the cartridge into position.

n. Install o-ring (15) in the body and the teflon o-ring (14) in the cover (2), greasing liberally.

o. Carefully install the cover (2), being sure the pin in pressure plate (7) engages the pin hole in cover. To check, turn the cover 30 degrees in both directions and be certain the cartridge moves with it.

p. Install bolts (1) and torque to 190-210 ft.-lbs. Remove motor from vise and install key (16) in shaft.

4-14.2 Pulldown Transmission. (Figure 4-37)

4-14.2.1 Disassembly.

a. Remove key (1) from shifting shaft. Remove drain plug (4) to drain lubricant.

b. Remove cotter pin (2) and nut (3) to remove flange from shaft (40).

c. Remove plug (8) and, with a wire, lift out spring (10).

d. Use a 10-24 NC screw, at least 2i inches long, as a puller tool. Thread the screw into plunger (11) and pull it from cover (9).

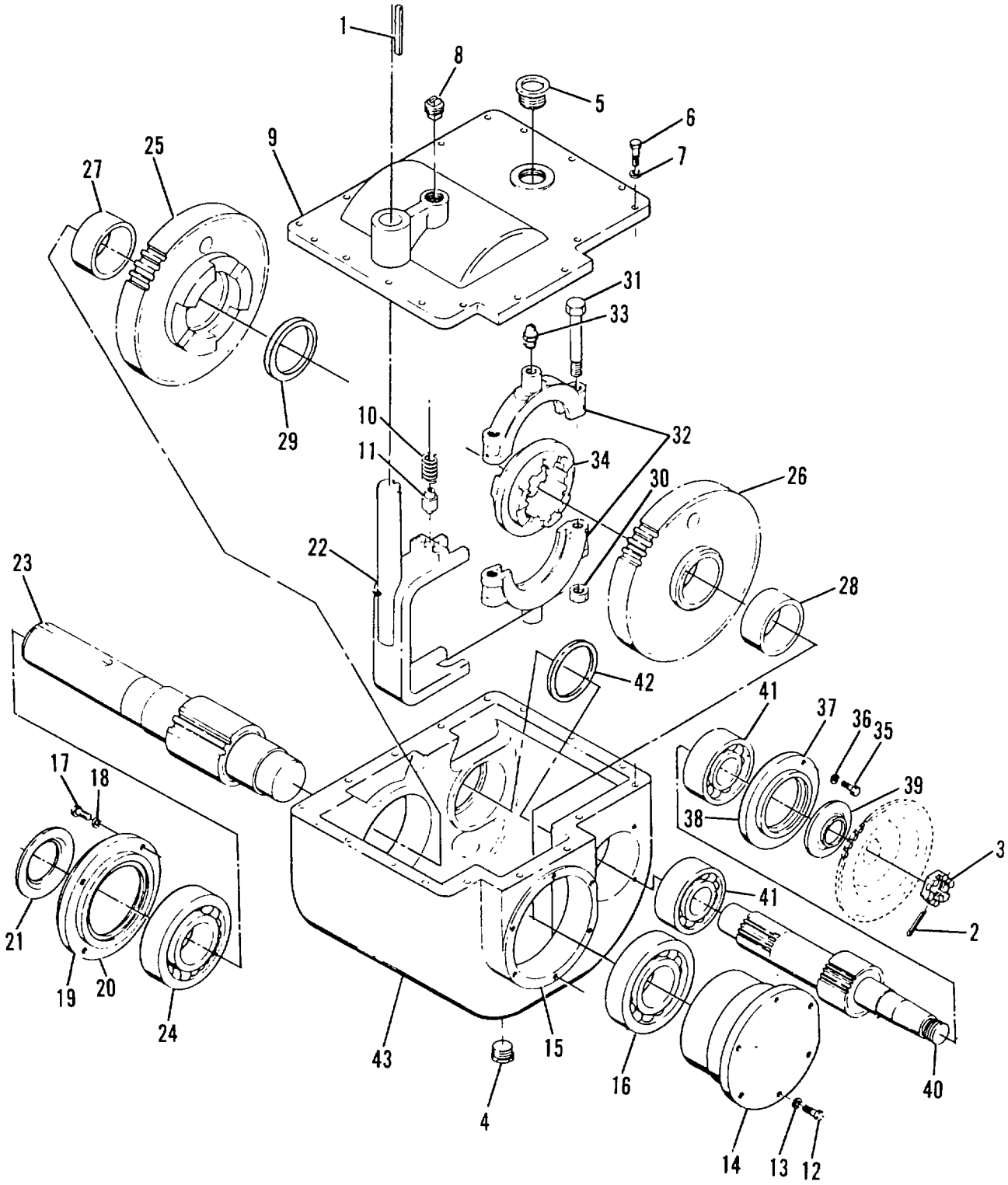


Figure 4-37. Pulldown Transmission

Legend for Figure 4-37

1. Key
2. Cotter Pin
3. Nut
4. Drain Plug
5. Fill Plug
6. Screw
7. Lockwasher
8. Plug
9. Cover
10. Spring
11. Plunger
12. Screw
13. Lockwasher
14. Bearing Retainer
15. Gasket
16. Bearing
17. Screw
18. Lockwasher
19. Seal Retainer
20. Gasket
21. Seal
22. Shifter Yoke
23. Output Shaft
24. Bearing
25. Gear
26. Gear
27. Bushing
28. Bushing
29. Wear Ring
30. Nut
31. Screw
32. Collar Half
33. Fitting
34. Jaw Clutch
35. Screw
36. Lockwasher
37. Retainer
38. Gasket
39. Seal
40. Input Shaft
41. Bearing
42. Spacer Seal
43. Case

e. Remove screws (6) and lockwashers (7), then remove cover (9) from case (43). Fill plug (5) can remain installed.

f. Remove screws (12) and lockwashers (13). Remove bearing retainer (14) and gasket (15). Bearing (16) should remain in retainer (14). Use a bearing puller to remove bearing from retainer.

g. Remove screws (17), lockwashers (18), seal retainer (19) and gasket (20). Remove and discard seal (21) from retainer (19).

h. Move shifter yoke (22) out to disengage from collar and maneuver the yoke to remove it from the case.

i. Grasp the output shaft (23) assembly and work it back and forth to push bearing (24) outward in case bore. Continue until output shaft (23) is loose enough to lift out of transmission case.

NOTE
Bearing (24) will likely be damaged and should be discarded and replaced with a new bearing.

j. Remove gears (25, 26) with bushings (27, 28) from shaft (23). Inspect bushings for wear or damage and remove only if replacement is required. The inside diameter of bushings is not to be less than 1.878 inches. Remove wear rings (29).

k. Remove nuts (30) and screws (31) to separate and remove collar halves (32). Do not remove fitting (33) unless replacement is necessary. Remove jaw clutch (34) from shaft (23).

l. Remove screws (35), lockwashers (36), retainer (37) and gasket (38). Remove seal (39) from retainer (37).

m. Pull input shaft (40) with bearings (41) from case (43). Pull bearings (41) off of shaft (40).

n. Remove spacer seal (42) from case (43).

4-14.2.2 Inspection and Repair.

a. Clean all parts in an approved solvent.

b. Inspect all bearings for damaged rollers. Replace defective bearings.

c. Inspect contact surfaces of gears, shafts and clutch for excess wear or damage.

d. Replace all seals and gaskets, and any parts found defective on inspection.

4-14.2.3 Assembly.

a. Install a new spacer seal (42) in case (43).

b. Press bearings (41) onto shaft (40) then install shaft in case (43). Use a wooden mallet to tap the bearings (41) into the case bores, being sure the bearings enter the bores squarely.

c. Place a new seal (39) into retainer (37). Cut a new gasket (38) from 1/32 inch gasket material. Install gasket, retainer with seal, lockwashers (36) and screws (35).

d. If bushings (27, 28) were removed from gears (25, 26), press in new bushings. Face bushing flush with gear hub and ream to 1.880 inches.

e. Assemble the collar halves (32) on jaw clutch (34) and install screws (31) and nuts (30). Slide the assembly onto output shaft (23).

f. Install wear rings (29) into gears (25, 26) with beveled surface facing out. Install gear (26) the gear (25) onto shaft (23).

g. Cut new gaskets (15, 20) from 1/32 inch gasket material. Install a new seal (21) in retainer (19).

h. Press bearing (16) into retainer (14) and install gasket (15) on retainer (14).

i. Position output shaft (23) assembly in case with gears (25, 26) in mesh with splines on input shaft (40).

j. Assemble the retainer (14) to case (43) push the end of shaft (23) into bearing (16). Install screws (12) and lockwashers (13).

k. Position bearing (24) in case bore over output shaft (23). Being sure that bearing is squared in bore, push bearing into case bore.

l. Install gasket (20), retainer (19), lockwashers (18) and screws (17).

m. Install shifter yoke (22) around output shaft (23) assembly and engage the yoke with collar (32).

n. While holding shaft of yoke (22) position cover (9) over yoke and then install cover on case (43). Install lockwashers (7) and screws (6).

o. Thread plunger (11) on a 2-1/2 inch long 20-14 NC screw. Insert the plunger into bore of cover and remove the screw. Install the spring (10) and plug (8) in cover (9).

p. Install drain plug (4), then remove fill plug (5) and fill the transmission with lubricant. Install plug (5).

4-14.3 Pulldown Transmission Control (Figure 4-37A).

4-14.3.1 Removal.

Remove the cotter pins (1) and yoke pins (2) to remove the shift tie rod assembly. Loosen the nuts (4); then unscrew the adjustable yokes (3) from the tie rod (5). Remove bolt (6) and lockwasher (7) to remove the shifter (8) from the transmission. Finally, remove cotter pin (9) to remove shifter handle (10).

4-14.3.2 Cleaning, Inspection and Repair.

Clean parts with an approved cleaning solvent and inspect for any damage or wear. Replace any damaged parts.

4-14.3.3 Assembly.

Install the shifter handle (10) and secure it with the cotter pin (9). Install shifter (8) to the transmission shift shaft and fasten it with capscrew (6) and lockwasher (7). Screw the nuts (4) onto the tie rod shaft (5); then screw on the adjustable yokes (3). Before tightening the nuts, make sure the shift tie rod assembly is the correct length, adjusting yokes as necessary. Then install the yoke pins (2) and cotter pins (1).

4-15 MAINTENANCE OF DISCHARGE PIPING ASSEMBLY

4-15.1 Shear Relief Valve. The shear relief valve relieves excessive pressure in the mud circulating system by shearing the nail installed through stem. The relief pressure is determined by the size of nail used. Size to pressure are as follows:

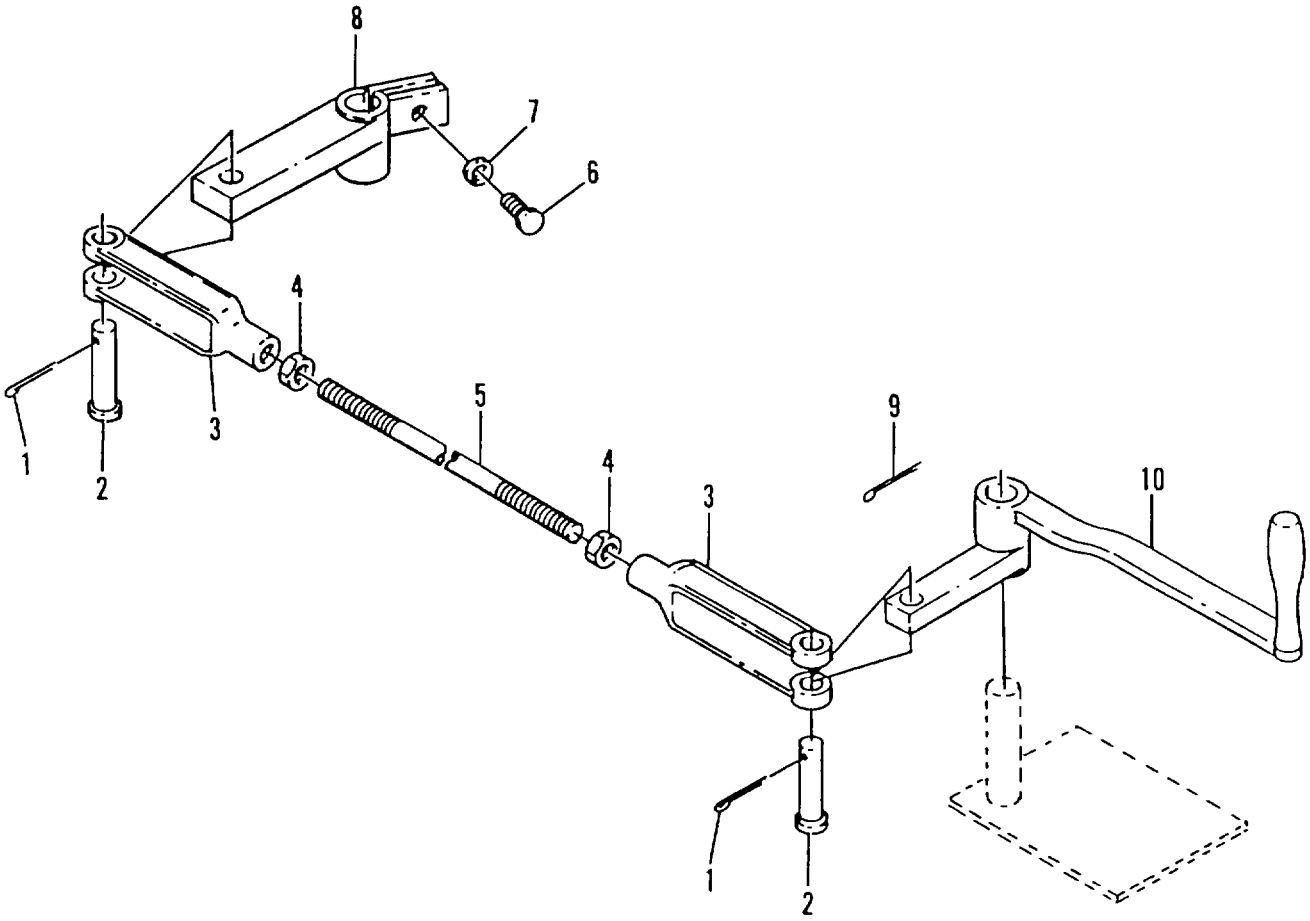
16 Penny relieves at 1000 lbs.
10 Penny relieves at 850 lbs.
8 Penny relieves at 650 lbs.
6 Penny relieves at 500 lbs.
4 Penny relieves at 400 lbs.
3 Penny relieves at 250 lbs.

CAUTION

Never install a hex key or any other high strength material in the shear nail hole. This usually results in pump damage.

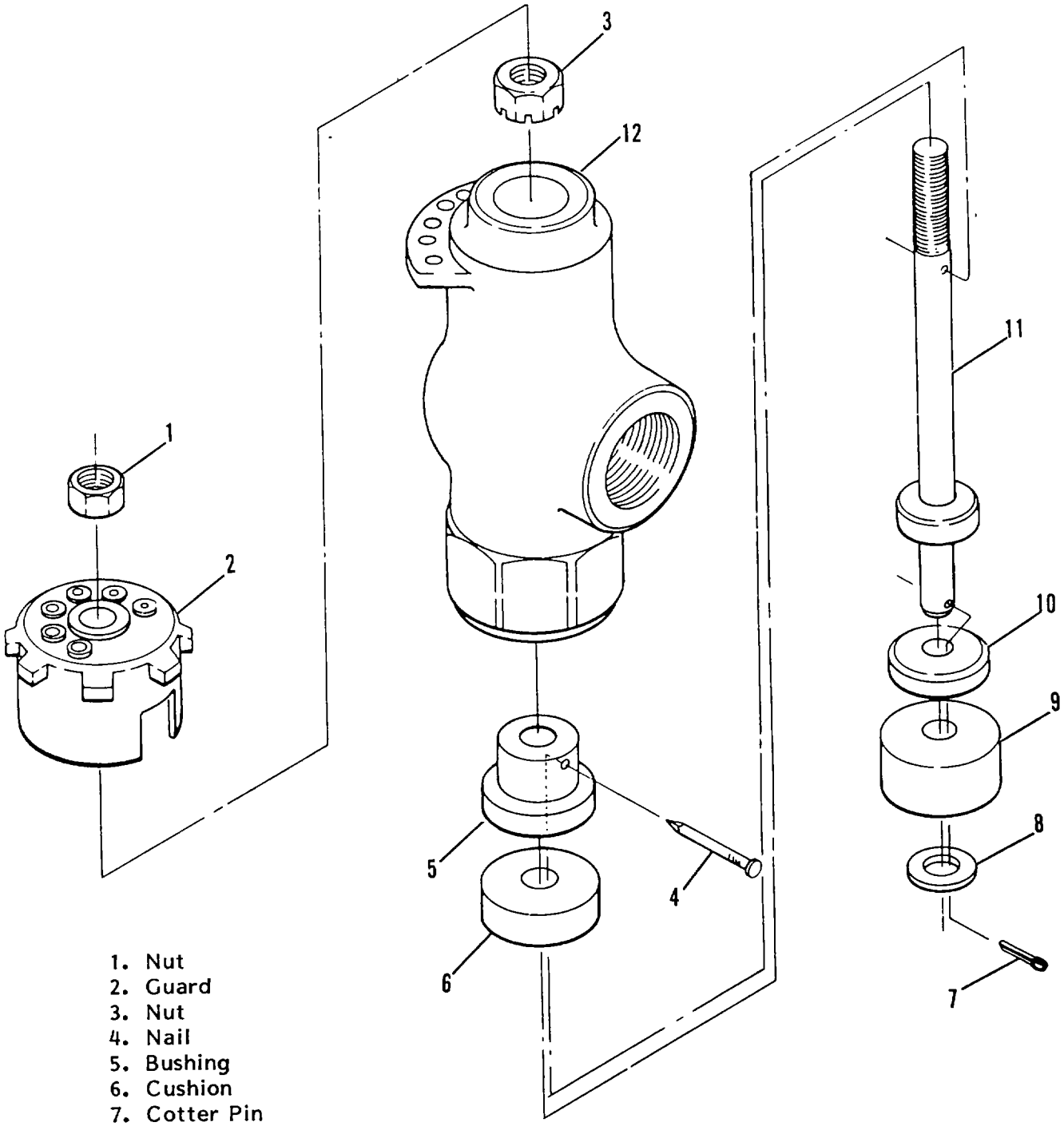
4-15.1.1 Resetting Valve.

a. After relieving the blockage that has caused overpressure condition, push the guard (2, figure 4-38) down to close relief valve.



1. Cotter Pin
2. Yoke Pin
3. Adjustable Yoke
4. Nut
5. Tie Rod
6. Bolt
7. Lockwasher
8. Shifter
9. Cotter Pin
10. Shifter Handle

Figure 4-37A. Pulldown Transmission Control



1. Nut
2. Guard
3. Nut
4. Nail
5. Bushing
6. Cushion
7. Cotter Pin
8. Washer
9. Piston
10. Ring
11. Stem
12. Valve Body

Figure 4-38. Shear Relief Valve

b. Turn guard as necessary to align nailhole in bushing (5) with hole in stem (11).

c. Insert new nail through holes.

4-15.1.2 Disassembly.

a. Unscrew and remove valve assembly from piping.

b. Remove nut (1, figure 4-38), guard (2) and nail (4).

c. Push down on stem (11), forcing piston (9) out through bottom of valve body (12).

d. Grasp piston end of stem (11) and pull stem, with attached parts, from valve body (12).

e. Remove nut (3), bushing (5) and cushion (6) from stem (11).

f. Remove cotter pin (7), washer (8), piston (9) and ring (10) from stem (11).

4-15.1.3 Assembly.

a. Use new piston (9), cushion (6), bushing (5) and nuts (1, 3) when assembling valve.

b. Install cushion (6) and bushing (5) on stem (11).

c. Insert stem through bottom of valve body (12). Grasp threaded end of stem as it appears through top of body, then pull stem up until the bushing (5) and cushion (6) are seated inside valve body. Push stem (11) back out of body (12).

d. Install ring (10), piston (9), washer (8) and cotter pin (7) on stem (11).

e. Position stem so that nail hole is oriented to bushing (5) nail hole, then install stem into valve body (12). When nail holes are in line, install nail (4).

f. Screw a new nut (3) onto stem (11) so that it stops just above the top of bushing (5).

g. Assemble the guard (2) to stem, positioning the opening in guard at nail location, and install nut (1).

h. Screw the assembled valve onto piping.

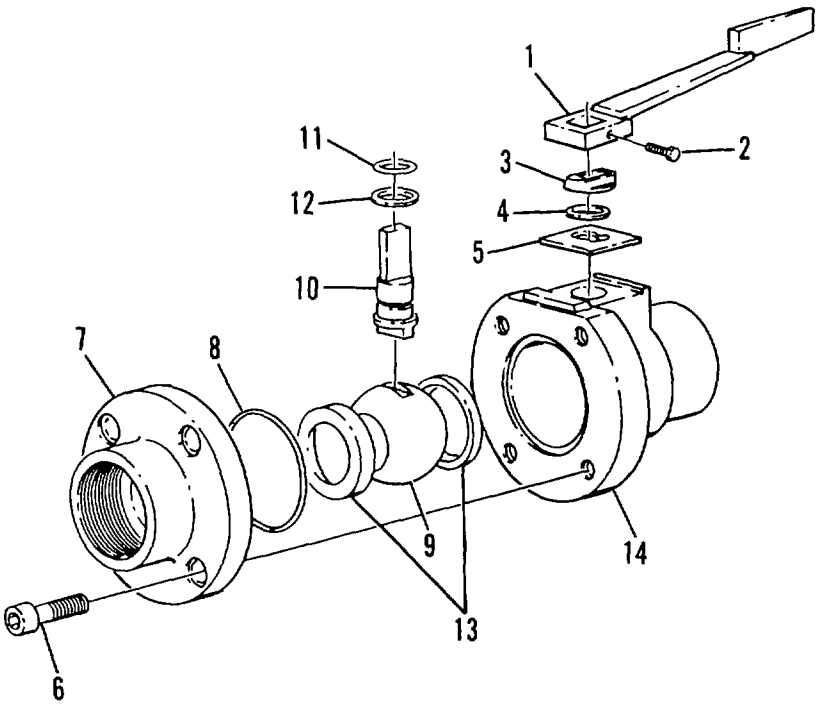
4-15.2 Discharge Ball Valve. (Figure 4-39)

4-15.2.1 Disassembly.

a. Loosen screw (2) and remove handle (1) from stem (10).

b. Remove dust cover (3), retainer (4) and stop plate (5).

c. Remove screws (6), end adapter (7) and o-ring (8).



1. Handle
2. Screw
3. Dust Cover
4. Retainer
5. Stop Plate
6. Screw
7. End Adapter
8. O-Ring
9. Ball
10. Stem
11. O-Ring
12. Washer
13. Ball Seat
14. Body

Figure 4-39. Discharge Ball Valve.

d. Remove ball (9) and stem (10) from body (14). Remove o-ring (11) and washer (12) from stem.

e. Remove ball seats (13) from adapter (7) and body (14).

4-15.2.2 Repair.

a. Discard o-rings (8 and 11), washer (12), ball seats (13), dust cover (3), retainer (4) and stop plate (5) and replace with new parts.

b. Clean all remaining valve components thoroughly.

4-15.2.3 Assembly.

a. Install ball seats (13) in adapter (7) and body (14) and apply grease to seat faces.

b. Apply grease to o-ring (11), then install washer (12) and o-ring (11) on stem (10). Install stem in body (14) and extend through top of body.

c. Install ball (9) in body so that it is engaged by stem (10).

d. Install stop plate (5) and retainer (4) on stem. Make sure retainer is seated in lower groove of stem.

e. Apply grease to o-ring (8) and place o-ring on body (14).

f. Assemble end adapter (7) to body (14), take care not to pinch or damage o-ring (8). Install screws (2).

g. Install dust cover (3), handle (1) and tighten screw (2). Cycle valve to assure free and easy operation.

4-16 MAST RAISING CYLINDER ASSEMBLY

4-16.1 Mast Raising Cylinder. (Figure 4-40)

4-16.1.1 Disassembly.

a. Unscrew head (11) from outer rod (19), then pull piston rod (7) with assembled components from outer rod (19).

b. Remove back-up rings (2) and packing (3) from piston (4). Remove nut (1), piston (4) and stop tube (5). Remove packing (6).

c. Pull rod (7) out of head (11) and remove packing (8), wiper (9) and seal (10) from head (11).

d. Unscrew rod head (15) from barrel (16), then pull outer rod (19) with assembled components from barrel (16). Remove stop ring halves (17).

e. Remove head (15) from outer rod (19) and remove packing (12), wiper (13) and seal (14) from head (15).

f. Remove snap ring (18) from outer rod (19).

4-16.1.2 Repair.

a. Items 2, 3, 6, 8, 9, 10, 12, 13 and 14 are contained in the seal kit and shall be replaced any time cylinder is disassembled.

b. Clean all remaining parts thoroughly with an approved solvent.

c. Inspect all parts for wear, burrs, scoring or other damage. Replace parts as needed.

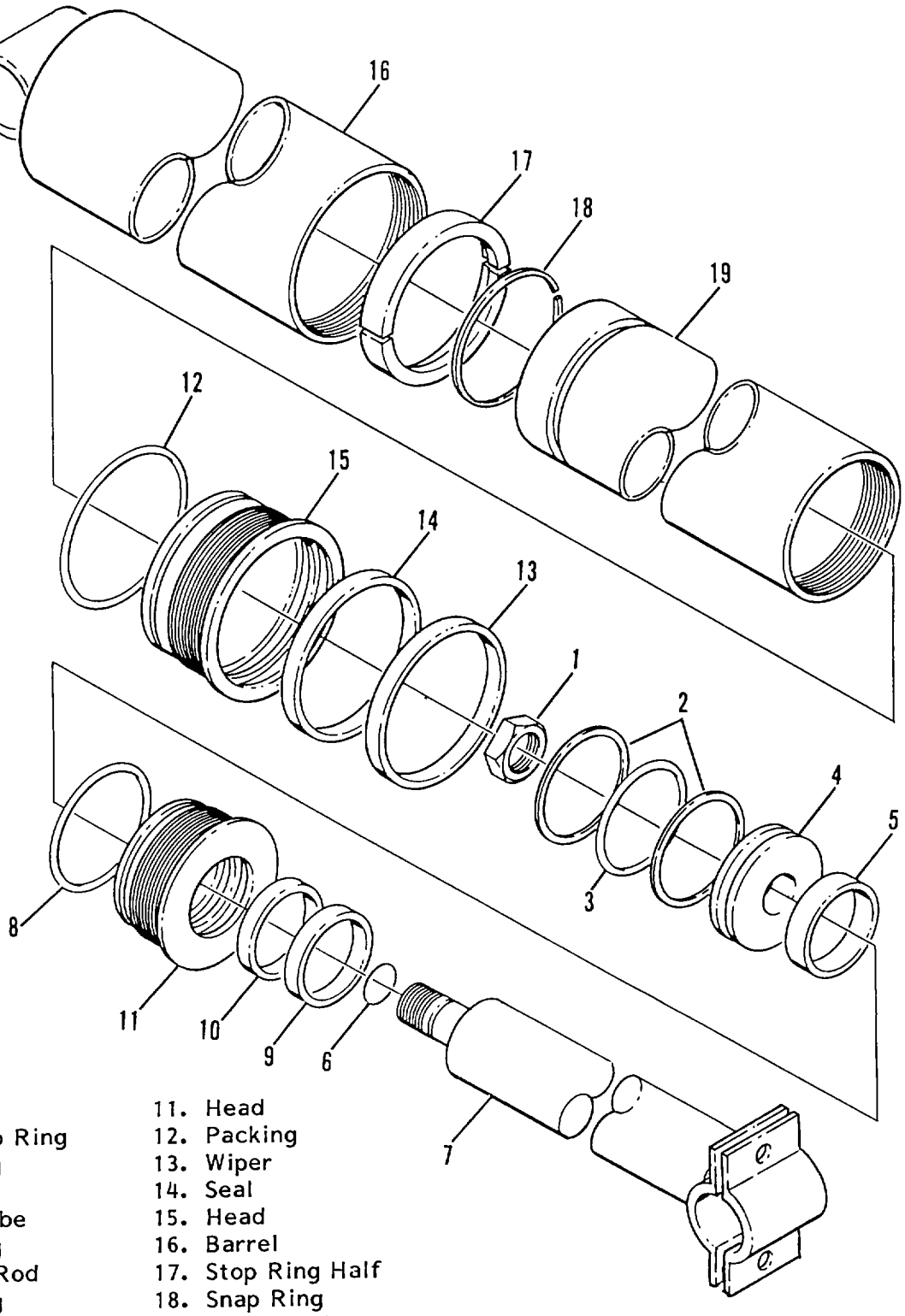
4-16.1.3 Assembly.

a. Coat seal (14), wiper (13) and packing (12) with a light layer of hydraulic oil and install them on head (15). Slip head over the end of outer rod (19).

b. Install the snap ring (18) in the groove inside outer rod (19). Apply oil to outer surface of stop ring halves (17) and assemble them on outer rod (19).

c. Install outer rod (19) assembly in barrel (16). Screw head (15) into barrel.

d. Coat back-up rings (2) and packing (3) with oil and install them in piston (4). Coat seal (10), wiper (9) and packing (8) with oil and install them in head (11). Oil the packing (6) and install it on piston rod (7).



1. Nut
2. Back-up Ring
3. Packing
4. Piston
5. Stop Tube
6. Packing
7. Piston Rod
8. Packing
9. Wiper
10. Seal
11. Head
12. Packing
13. Wiper
14. Seal
15. Head
16. Barrel
17. Stop Ring Half
18. Snap Ring
19. Outer Rod

Figure 4-40. Mast Raising Cylinder

e. Slide head (11) over end of piston rod (7), then install stop tube (5) and piston (4). Install nut (1).

f. Insert the piston rod (7) assembly into the outer rod (19) and screw head (11) into outer rod.

4-17 MAINTENANCE OF HYDRAULIC BREAKOUT ASSEMBLY

4-17.1 Breakout Tong (Figure 4-40A).

4-17.1.1 Removal and Disassembly.

a. Unhook the spring (5); then remove the tong assembly (6) by removing the outermost cotter pin (1) and drive pin (2). Remove the tong links (3 and 4) by removing the other two cotter pins (1) and drive pins (2).

b. By removing the four drive pins (7), you totally disassemble the tong assembly, except for the tong dies (11 and 13). Remove the dies by tapping up and sliding the dies out.

4-17.1.2 Cleaning and Repair.

Clean all parts with an approved cleaning solvent. Replace any part that is extremely worn or which is damaged in such a way that the tongs do not function freely. The tong dies (11 and 13) teeth need frequent cleaning and are also subject to wear during normal operation. The dies will need to be replaced frequently.

4-17.1.3 Assembly.

a. Install the tong dies (11 and 13). Position the tong components as shown in the illustration, and attach the latch (8) and jaws (10, 12, 14) to the arm by inserting the drive pins (7). Replace the latch spring (9).

b. Assemble the tong assembly (6) and tong links (3 and 4) and insert the drive pins (2) and cotter pins (1). Install the counterbalance spring (5).

4-17.2 Breakout Cylinder (Figure 4-41).

4-17.2.1 Removal and Disassembly.

a. Disconnect hydraulic hoses. Remove cotter and clevis pins (1) from both ends. Remove the cylinder assembly.

b. Remove the set screw (2) and ball (3). Unscrew the clevis (4) from the piston rod.

c. Remove the nuts (5) and rod guides (9). Slide rod guide (6) from the tube (13) and off the piston rod. Remove wiper (7) from the outside of the rod guide and remove seal (10), backup washer (11), and packing (12) from inside the rod guide.

d. Remove the bottom clevis (8) from the end of the tube. Remove backup washer (11) and packing (12) from the clevis.

1. Cotter Pin
2. Pin
3. Outer Tong Link
4. Inner Tong Link
5. Spring
6. Tong Assembly
7. Pin
8. Tong Latch
9. Latch Spring
10. Long Jaw
11. Tong Die
12. 3-1/2 to 4-1/4" Jaw
13. Tong Die
14. Short Jaw
15. Tong Arm

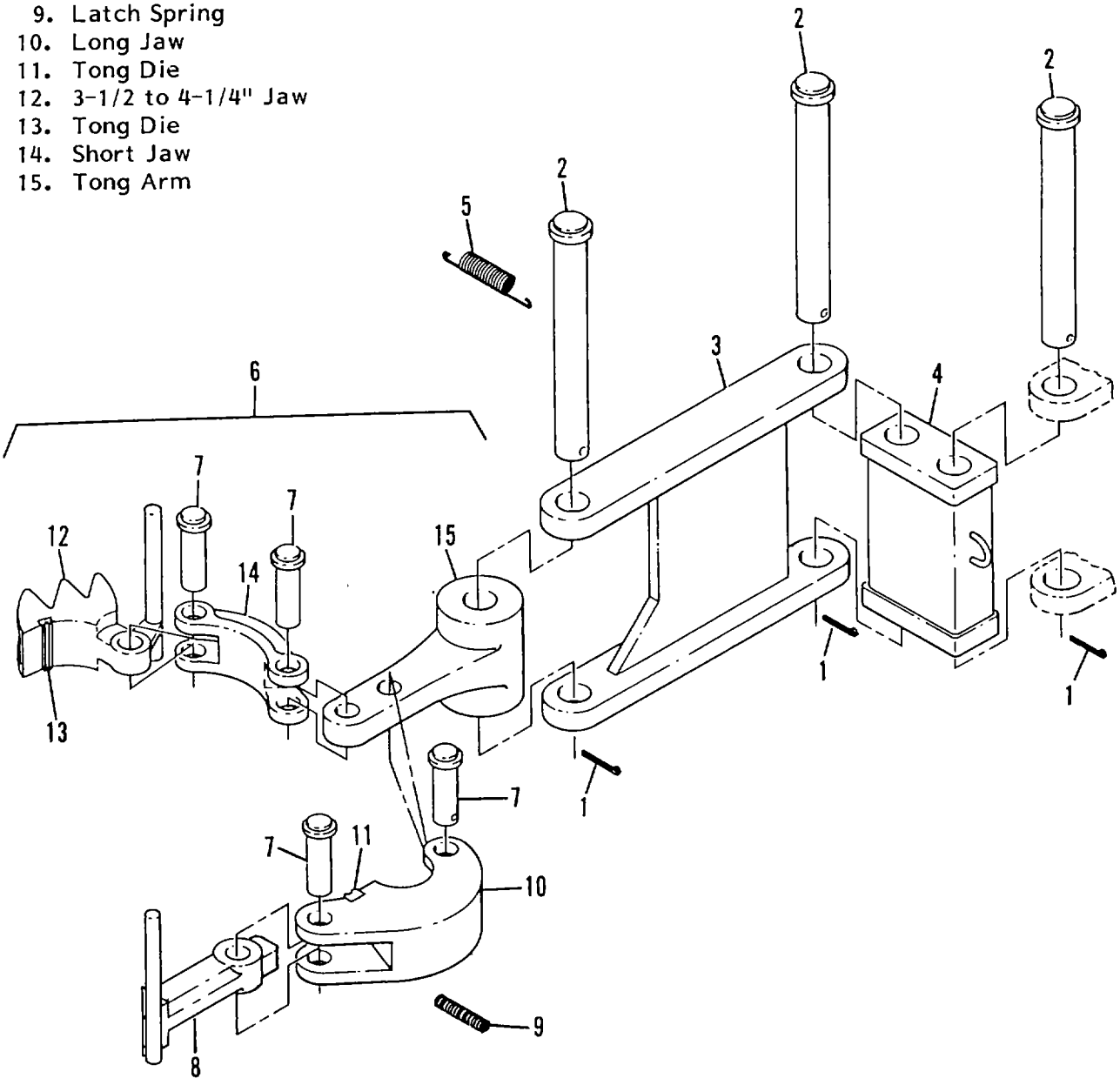
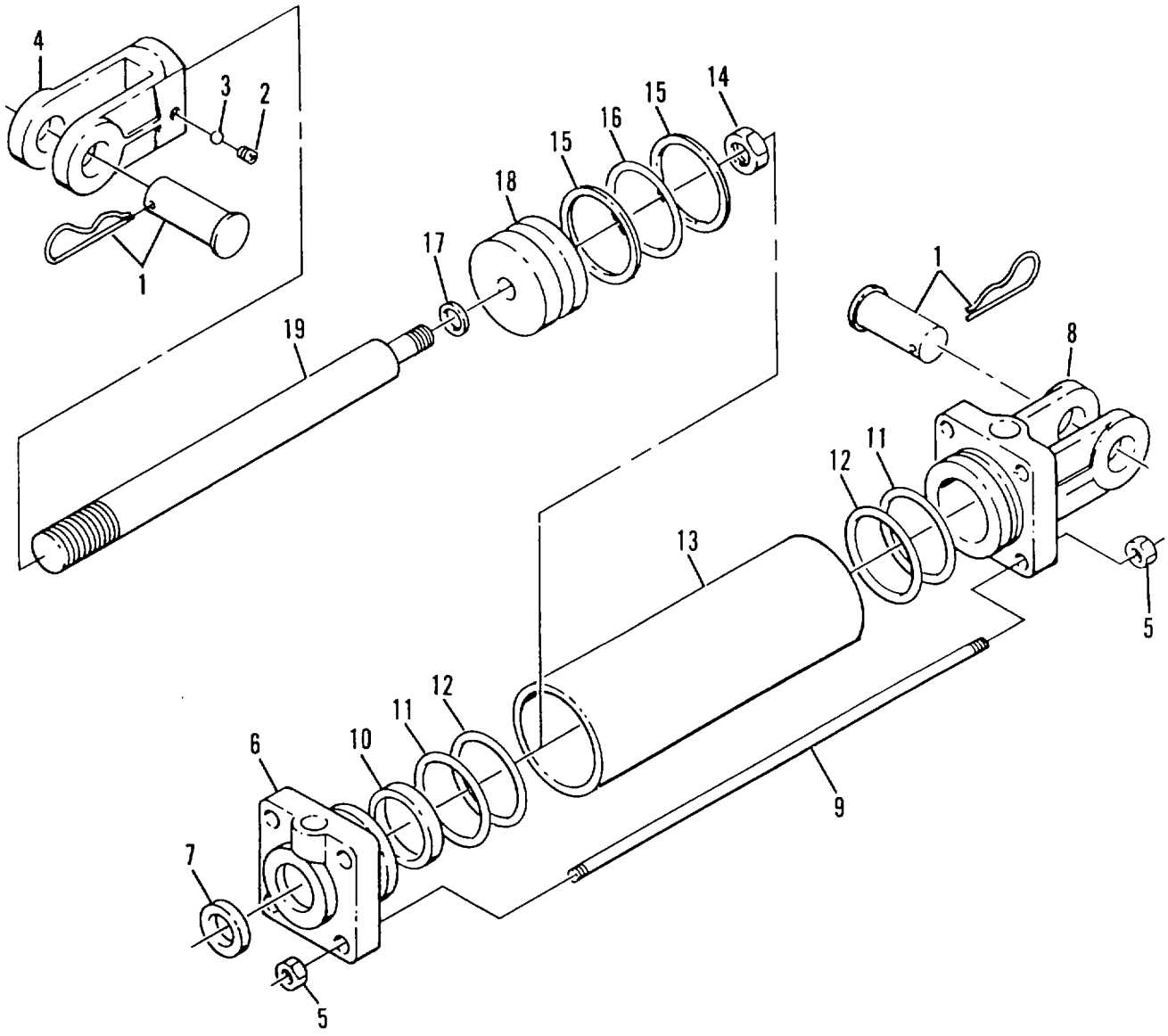


Figure 4-40A. Breakout Tong Assembly



1. Cotter and Clevis Pin
2. Set Screw
3. Ball
4. Clevis
5. Nut
6. Rod Guide
7. Wiper
8. Bottom Clevis
9. Tie Rod
10. Seal
11. Backup Washer
12. Packing
13. Tube
14. Nut
15. Backup Washer
16. Packing
17. Seal
18. Piston
19. Piston Rod

Figure 4-41. Breakout Cylinder

1. Subdrive Assembly
2. Hydraulic Tank
3. Breakout Cylinder
4. Rear Leveling Jacks
5. Chain Feed Drive Motor
6. Control Valve (Holdback, Pulldown)
7. Control Valve (Mast Raise, Pulldown)
8. Control Panel
9. Control Valve(Table Retract, Breakout, Water Injection)
10. Return Manifold
11. Leveling Jacks Control Valve
12. Water Injection Drive Motor
13. Rotary Table Drive Motor
14. Oil Cooler
15. Rotary Table Retract Cylinder
16. Flow Control Valve
17. Oil Cooler Motor
18. Relief Valve
19. Flow Control Valve
20. Thermostatic Bypass Valve
21. Front Leveling Jacks
22. Hydraulic Oil Filter
23. Mast Cylinder

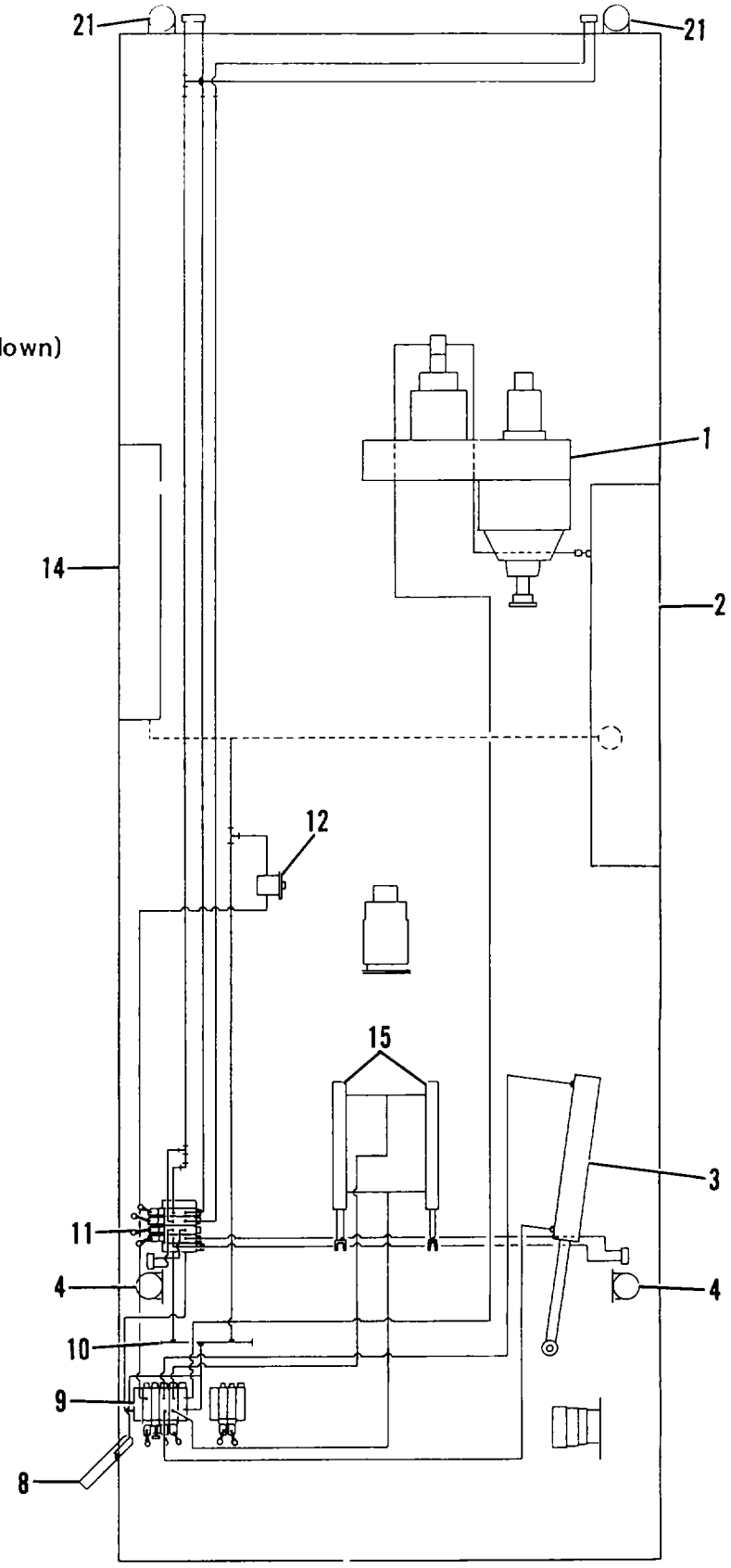


Figure 4-42. Hydraulic Piping (Sheet 1 of 2)

1. Subdrive Assembly
2. Hydraulic Tank
3. Breakout Cylinder
4. Rear Leveling Jacks
5. Chain Feed Drive Motor
6. Control Valve (Holdback, Pulldown)
7. Control Valve (Mast Raise, Pulldown)
8. Control Panel
9. Control Valve(Table Retract, Breakout, Water Injection)
10. Return Manifold
11. Leveling Jacks Control Valve
12. Water Injection Drive Motor
13. Rotary Table Drive Motor
14. Oil Cooler
15. Rotary Table Retract Cylinder
16. Flow Control Valve
17. Oil Cooler Motor
18. Relief Valve
19. Flow Control Valve
20. Thermostatic Bypass Valve
21. Front Leveling Jacks
22. Hydraulic Oil Filter
23. Mast Cylinder

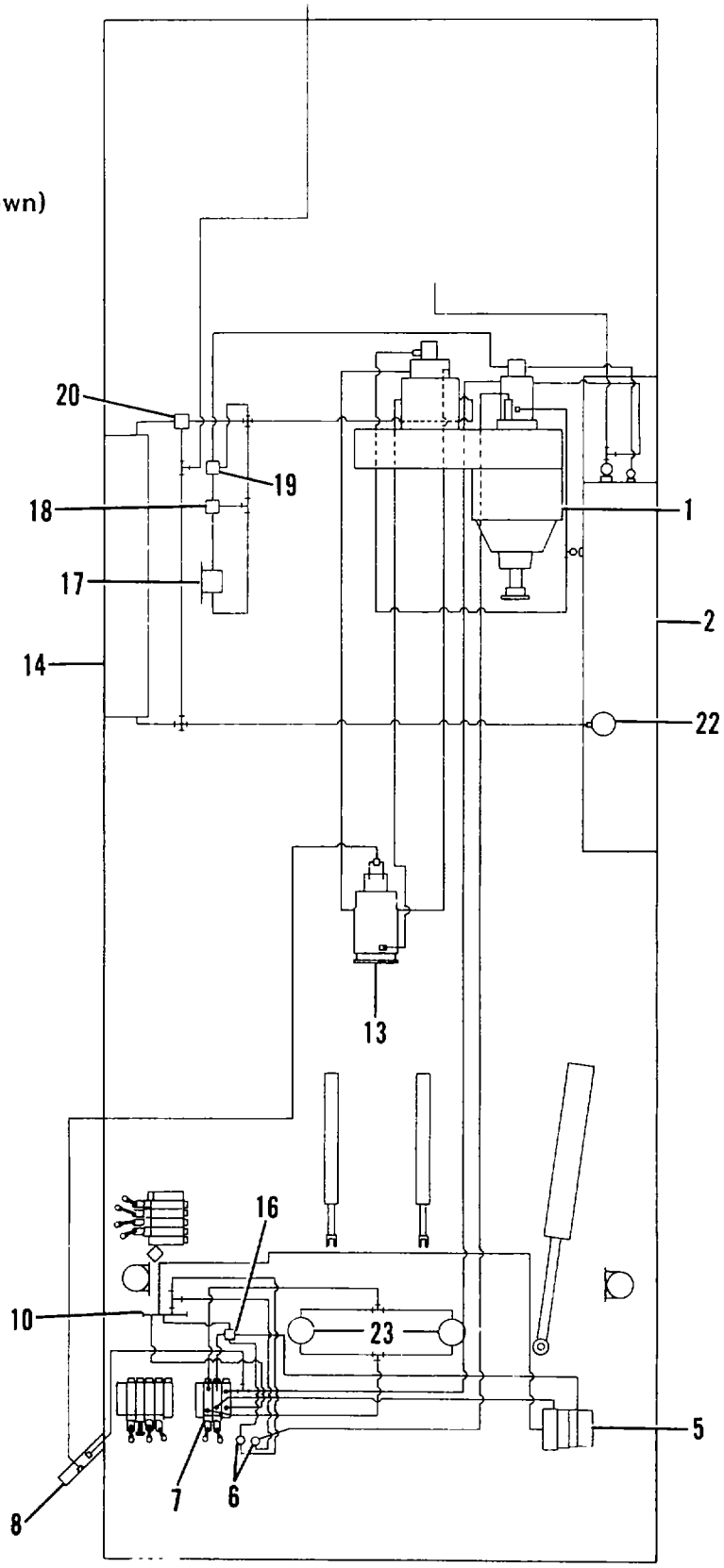


Figure 4-42. Hydraulic Piping (Sheet 2 of 2)

e. Slide the piston and rod out of the tube. Remove the nut (14) to remove the piston (18) from the rod (19). Remove the packing (17) from the piston rod. Remove the backup washers (15) and packing (16) from the piston.

4-17.2.2 Cleaning, Inspection, and Repair.

Discard all packing (12 and 16), wiper (7), backup washers (11 and 15), and seals (10 and 17) and use new parts each time cylinder is disassembled. Clean all other parts with an approved cleaning solvent. Inspect the piston and rod for burrs, wear, scoring, pitting or other damage. Check the nylon ball (2) for damage or wear. Replace parts as needed.

4-17.2.3 Assembly and Installation.

a. Coat all packing, seals, wiper, and backup rings with hydraulic oil before assembly.

b. Clamp the bottom clevis (8) in a vice with the cylinder end up. Install the packing (11) and backup washer (12) on the bottom clevis (8); assemble the tube onto the clevis.

c. Install the packing (16) and backup washers (15) on the outside diameter of the piston (18). Install packing (17) onto the piston rod (19).

d. Install wiper (7) in the inside diameter of the rod guide (6); then install seal (10) packing (11) and backup washer (12) on the outside diameter of the rod guide.

e. Insert piston rod (19) through the rod guide (6). Install assembled piston onto the rod. Install nut (14) on the piston rod.

f. Insert the piston end of the assembly into the tube, lowering it until the rod guide mates inside the tube. Fasten nuts (5) onto one end of the tie rods (9) and insert the tie rods through the rod guide (6) and clevis (8). Aline the rods and install the other nuts (5). Tighten the nuts securely.

g. Screw the clevis (4) onto the piston rod. Install the cylinder, inserting the clevis and cotter pins (1). Aline the clevis (4), adjusting as necessary; then install the ball (3) and set screw (2),

4-18 MAINTENANCE OF HYDRAULIC SYSTEM

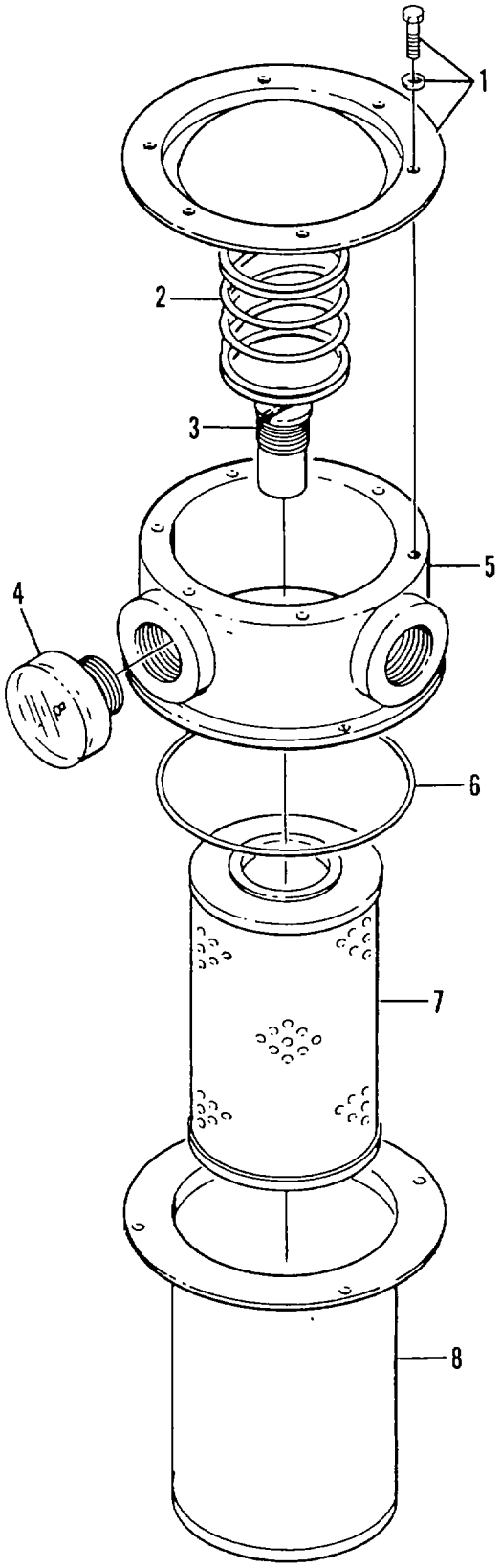
4-18.1 Hydraulic Piping Assembly (Figure 4-42).

Maintenance of the hydraulic piping consists of periodically checking the system for evidence of any leakage. Tighten any loose connections and replace any ruptured hoses or piping.

4-18.2 Hydraulic Filter (Figure 4-43).

4-18.2.1 Cleaning and Inspection.

Check the dirt alarm gage (4) daily. When the gage indicates a dirty filter, replace the element. Before disassembling the filter, clean the cap assembly (1) and the area around the cap to ensure dirt does not fall into the bowl while the cap is removed.



1. Cap ASsembly
2. Compression Spring
3. Bypass Valve Assembly
4. Dirt Alarm Gage
5. Head Assembly
6. Filter Seal
7. Filter Element
8. Bowl Assembly

Figure 4-43. Hydraulic Oil Filter

4-18.2.2 Disassembly.

a. To replace the filter element, remove the six screws and lockwashers and remove the cap assembly (1). Remove the compression spring (2) and by-pass valve assembly (3). Remove the element (7) from the bowl assembly (8).

b. Do not remove the head (5) or the bowl assembly (8) from the reservoir unless repair or replacement of either item is required or if the filter seal (6) is leaking and needs to be replaced.

4-18.2.3 Assembly.

a. Before assembling the new filter, examine the by-pass valve (3), compression spring (2), and the underside of the cap assembly for evidence of any metal filings. If any are found, this may indicate a part failure in one of the pumps, motors, or cylinders. Clean the filter parts of dirt or any other particles before assembly.

b. Install the new element (7) in the bowl (8). Position the bypass valve (3) and compression spring (2) on the filter and replace the cap assembly (1) on the head. Replace and tighten the six screws and lockwashers on the cap assembly.

4-19 MAINTENANCE OF WINCH ASSEMBLY

4-19.1 Winch Assembly (Figure 4-44).

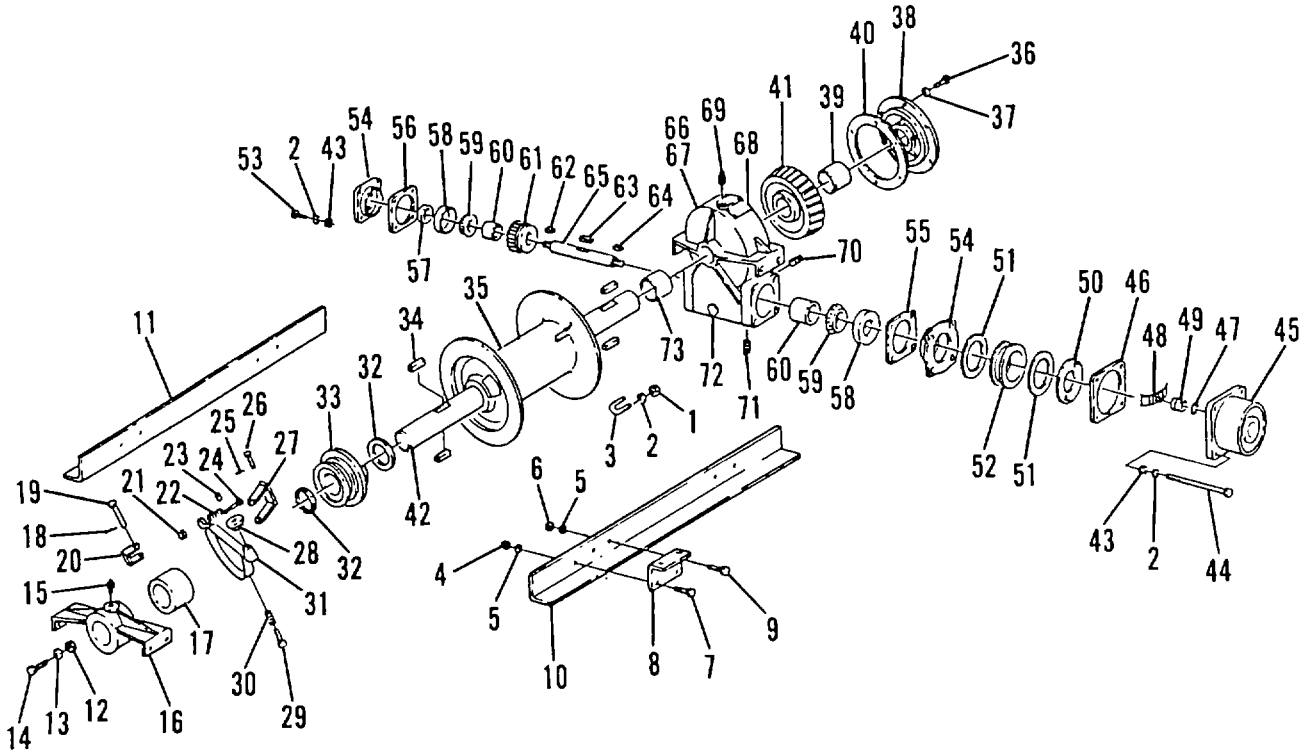
4-19.1.1 Disassembly.

a. Unwind all wire rope from the winch and loosen the nuts (1) to release the cable clamp and remove the wire rope from the drum. Remove the winch from its mounting. Remove the hydraulic motor. Remove drain plug (71) and drain the lubricant from the housing.

b. Remove nuts (1), lockwashers (2), and cable clamp (3). Remove nuts (4, 6), lockwashers (5), and capscrews (7, 9) to separate the winch from its bracket (8) and front base angle (10) and rear base angle (11).

c. Remove two nuts (12), lockwashers (13), and capscrews (14). Then remove bearing leg assembly (16). Do not remove grease fitting (15). Slide bushing (17) out of bearing leg. Remove cotter pin (18) and pivot pin (19); then remove bracket (20). Disassemble drag brake by removing nut (21), drag brake spring (22), washer (23), link (24), cotter pin (25), link pin (26), and drag brake shoe (27). Remove knob (28), stem (29), spring (30), and shifter fork (31).

d. Remove two retaining rings (32) to remove clutch hub (33); then remove woodruff keys (34) and the drum (35) from the shaft. From the opposite side of the housing, remove six capscrews (36) and lockwashers (37). Then remove worm housing cover (38) and gasket (40), bushing (39) and worm gear (41) from shaft (42).



1. Nut
2. Lockwasher
3. Cable Clamp
4. Nut
5. Lockwasher
6. Nut
7. Capscrew
8. Bracket
9. Capscrew
10. Front Base Angle
11. Rear Base Angle
12. Nut
13. Lockwasher
14. Capscrew
15. Grease Fitting
16. Bearing Leg Assembly
17. Bushing
18. Cotter Pin
19. Pivot Pin
20. Bracket
21. Nut
22. Drag Brake Spring
23. Washer
24. Link
25. Cotter Pin
26. Link Pin
27. Drag Brake Shoe
28. Knob
29. Stem
30. Spring
31. Shifter Fork
32. Retaining Ring
33. Clutch
34. Key
35. Cable Drum
36. Capscrew
37. Lockwasher
38. Worm Housing Cover
39. Bushing
40. Gasket
41. Worm Gear
42. Cable Drum Shaft
43. Nut
44. Capscrew
45. Safety Brake Housing
46. Gasket
47. O-ring
48. Brake Spring Assembly
49. Adjusting Nut
50. Pressure Plate
51. Friction Disc
52. Rotor Assembly
53. Capscrew
54. Bearing Container
55. Gasket
56. Gasket
57. Grease Seal
58. Bearing Cup
59. Bearing Cone
60. Spacer
61. Worm
62. Key
63. Key
64. Key
65. Worm Shaft
66. Nut
67. Warning Plate
68. Plate
69. Fill Plug
70. Oil Level Plug
71. Drain Plug
72. Worm Housing
73. Bushing

Figure 4-44. Winch Assembly

e. Remove four nuts (43), lockwashers (2), and capscrews (44) to remove the safety brake housing (45) and gasket (46). Remove o-ring (47), brake spring housing (48), adjusting nut (49); then disassemble pressure plate (50), two friction plate (51), and rotor assembly (52).

f. From the other end of the worm housing, remove four nuts (43), capscrews (53), and lockwashers (2). Now you can remove the two bearing containers (54) and gaskets (55, 56). Remove grease seal (57). Working from both ends, remove bearing cups (58) and cones (59), and spacers (60). Remove worm gear (61) and keys (62, 63, 64) from worm shaft (65).

g. Do not remove nuts (66) and plates (67, 68). Remove fill plug (69) and level plug (70); finally, remove bushing (73) from housing (72).

4-19.1.2 Cleaning, Inspection, and Repair.

a. Clean all parts in an approved cleaning solvent. Discard all gaskets, o-rings, and seals each time the winch is disassembled. Clean the housing thoroughly, checking for metal shavings, dirt particles, or other evidence of foreign matter in the residue solvent.

b. Check the worm gear teeth for signs of wear, damage, or distortion caused by overloading. Distorted teeth will appear to "lean" in one direction. Replace any worm gears that are worn or otherwise damaged.

c. Check the brake's friction disc and plate for signs of excessive wear and replace excessively worn parts; check brake spring; replace if tension lost. Check rotor for damage or wear; replace if worn or damaged.

d. Check bushings and bearing surfaces for scratches, scoring, or pitting; replace damaged bearings. Do not spin bearings that have not been lubricated.

e. Replace any damaged or badly worn parts.

4-19.1.3 Assembly.

a. Assemble the keys (62, 63, 64) onto the worm shaft (65). Install the worm gear (61), then assemble spacers (60), bearing cones (59) and cups (58) onto the shaft. Position the assembled shaft in the housing (72); apply a small amount of lubricant to and install gaskets (55, 56) on the housing; then install bearing containers (54). Fasten the back end container with capscrews (53), lockwashers (2), and nuts (43).

b. On the front end of the housing, install the brake parts: rotor assembly (52), friction discs (51), pressure plate (50), brake spring assembly (48), and adjusting nut (49). Install o-ring (47), gasket (46), and safety brake housing (45), fastening the housing with capscrews (44), lockwashers (2), and nuts (43).

c. Install bushing (73) in housing, and bushing (39) in worm gear (41). Install shaft (42) in housing; then install worm gear (41) onto shaft. Install new gasket (40) and cover (38). Fasten cover with capscrews (36) and lockwashers (37).

d. Install woodruff keys (34) and the drum (35) onto the shaft. Install clutch hub (33) and two retaining rings (32).

e. Install knob (28), stem (29), spring (30), and shifter fork (31). Install drag brake by assembling nut (21), drag brake spring (22), washer (23), link (24), cotter pin (25), link pin (26), and drag brake shoe (27). Install bracket (20); then install pivot pin (19) and cotter pin (18). Install bushing (17) in bearing leg; then install bearing leg assembly (16), fastening with two nuts (12), lockwashers (13), and capscrews (14).

f. Position the base angles (10, 11) and bracket (10) on the winch and fasten using nuts (4, 6), lockwashers (5), and capscrews (7, 9). Loosely, install cable clamp (3), nuts (1), and lockwashers (2).

g. Install drain plug (71). Pour in the lubricant in the top fill plug (69) port. Add lubricant, per lubrication chart, to the level plug (70) port; then install plugs (69, 70). Install the hydraulic motor. Install the winch in its mounting and connect and tighten the hydraulic lines. Start the wire rope onto the drum and into the cable clamp (3). Tighten the nuts (2). Rewind the wire rope onto the winch drum.

4-19.2 Winch Motor (Figure 4-45).

4-19.2.1 Disassembly

a. Before disconnecting lines, clean the port area of the motor. Remove hydraulic hoses and remove motor from winch.

b. Set the motor in a vise with the output shaft down. Clamp across the edge of the bearing housing mounting flange, NOT on the housing. Use some protective material, such as hard rubber or a strip of wood, between the vise jaws and the flange.

c. Remove four bolts (1, 2) from the valve housing end of the motor. Carefully, lift valve housing (3) straight up, taking care not to disturb the springs (12) and balance ring (13). (During disassembly, observe how the motor comes apart to facilitate reassembly.)

d. From the valve housing, remove plug assembly (4), o-ring (5), check plug assembly (6), o-ring (7), spring (8), and steel ball (9). Also, remove the small o-ring (10) and the large seal (11).

e. Remove three balance ring springs (12) and the balance ring subassembly (13). Remove the inner and outer face seals (15, 16) from the balance ring. Lift off valve (17) and valve plate (18). Remove one seal (19) from the valve plate. Remove valve drive (20), geroler (21). Retain the rollers in the geroler ring if they come loose. Remove one seal (22) from each side of the geroler.

f. Remove drive (23) and the other large seal (19) from the bearing housing (31). Then turn the bearing housing with output shaft up and re-clamp it in the vise. Loosen six bolts (24); remove bolts, retainer (25), seal (26), and shaft seal (27). Use a small screwdriver and remove dust seal (28), being careful not to damage the bore of the retainer. Remove the shaft and bearing assembly (using a press if required); then, being careful not to damage the housing bore, remove the shaft face seal (30) from the bearing housing (31).

4-19.2.2 Cleaning, Inspection, and Repair

a. Check all mating surfaces. Replace any parts that have scratches or burrs that may cause leakage. Clean all metal parts in an approved cleaning solvent.

b. Blow dry parts with air; do not wipe dry with paper towel or cloth because lint or other matter could get into the hydraulic system and cause damage.

c. Do not use a coarse grit or try to file or grind motor parts. Check around the keyway and chamfered areas of the shaft for burrs, nicks, or sharp edges that can damage the seals when reassembling the retainer.

d. Lubricate all seals prior to installation with a light petroleum jelly. Use only new seals when reassembling the motor.

4-19.2.3 Assembly.

a. Place the bearing housing (31) on a smooth, flat surface with the largest open end of the housing up. Aline the small inside diameter end of a seal driver (Tool No. 600469) with the shaft face seal (30) and press the seal into the seal seat of the bearing housing.

b. Install the shaft and bearing kit (29) in the bearing housing. Be careful not to damage the seal in the housing. It may be necessary to use a press to install the shaft and bearing kit. Using a press, install the dust seal (28) in the front retainer (25). Then, install the shaft seal (27) and seal (26) in the retainer. Apply a light petroleum jelly to the inside diameter of the shaft seal and dust seal.

c. Place a protective sleeve over the shaft. To prevent damage to seals, install retainer (25) over shaft part of shaft and bearing kit (29) with a twisting motion. Do not cut or distort shaft seal-such would cause external leakage. Lightly oil the threads of six bolts (24) and install through retainer holes into the bearing housing. Tighten bolts, first to 50 inch pounds in the following sequence: first12 o'clock, second--6 o'clock, third--10 o'clock, fourth--4 o'clock, fifth--8 o'clock, and sixth-2 o'clock; final torque to 300 inch pounds, repeating the sequence.

d. Position the motor in vise with output shaft down, clamping as described for disassembly. Pour a small amount of light oil inside the output shaft.

e. Apply a light film of petroleum jelly on the seal (19) and install in bearing housing (31). Install drive (23) in output shaft, longer splined end first. Apply petroleum jelly to two small seals (22) and install seals in geroler. Apply petroleum jelly to the valve plate seal (19) and install in valve plate (18).

f. Assemble the valve (17), valve plate (18), valve drive (20), and geroler (21) as shown in Detail A of Figure 4-45A to correctly time the motor. This is important to the correct rotation of the output shaft.

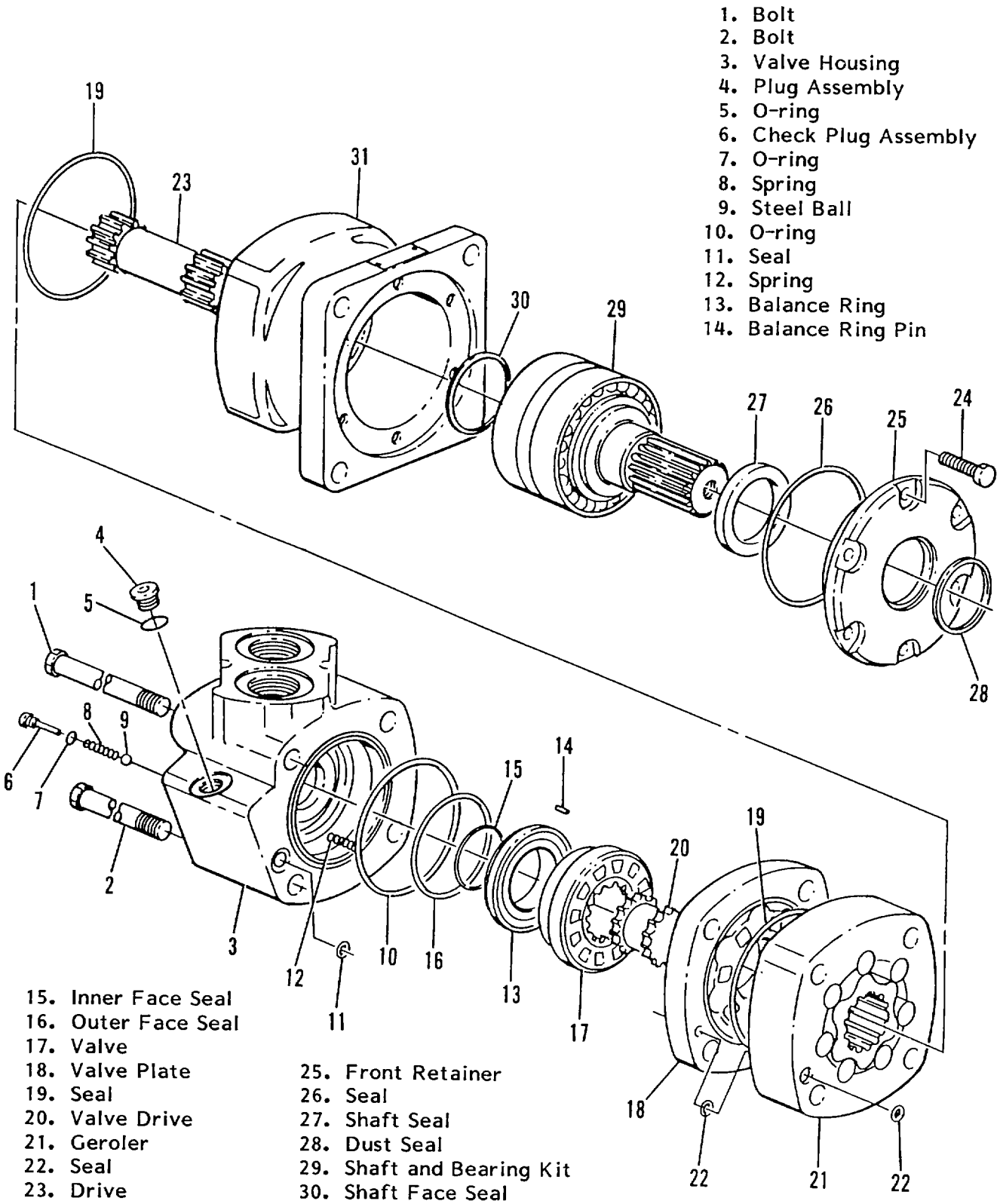


Figure 4-45. Winch Motor

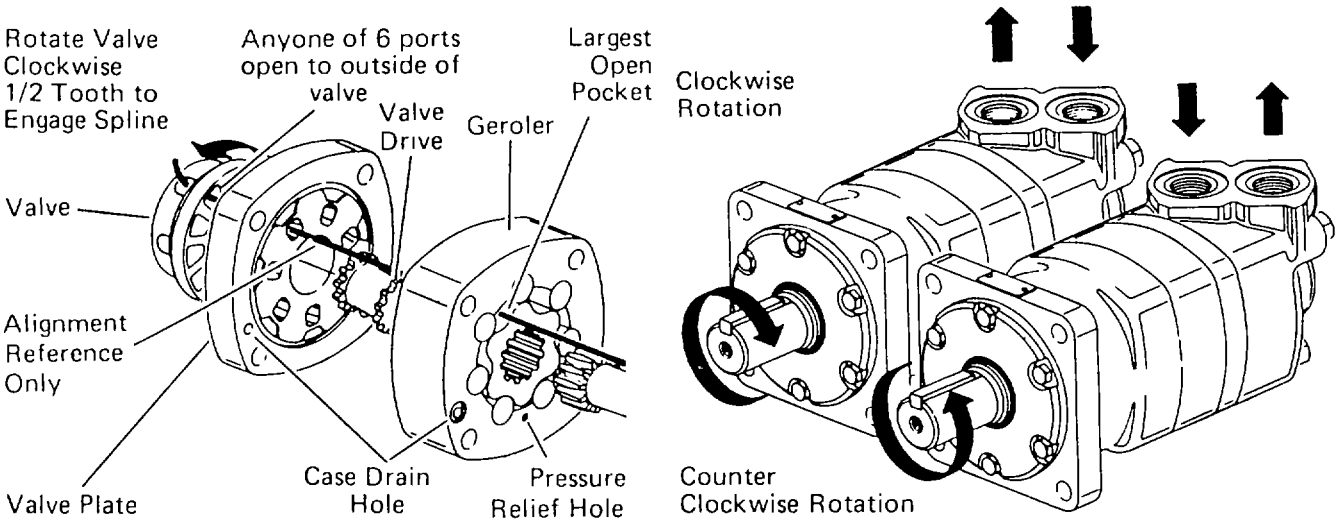


Figure 4-45A. Timing the Winch Motor

(1) The first step in timing is to locate the largest open pocket in the geroler; mark the location on the outside edge of the geroler. Aline case drain hole and pressure relief hole in geroler with similar holes in bearing housing. Install geroler on bearing housing. (Retain rollers in outer geroler ring if they are loose.) Install valve drive in geroler. Aline case drain hole valve plate with case drain hole in geroler. Install valve plate (seal side toward geroler) on geroler.

(2) The second step is to locate the slot opening in the valve plate which is in line with the largest open pocket of the geroler.

(3) Finally, locate any one of side openings of the valve that goes through to the face of the valve. Line up this side opening with open slot of valve plate that is in line with largest open pocket of geroler. Rotate valve clockwise (one-half spline tooth) to engage spline teeth of valve drive. This provides the rotation shown when pressurized as shown in Detail B.

g. Apply clean grease on three balance ring springs (12, Figure 4-45) and install in three holes located inside boreface of valve housing (3). Apply petroleum jelly to small seal (11) and install in case drain groove of valve housing. Apply petroleum jelly to o-ring (10) and install in outside groove of valve housing.

h. Apply petroleum jelly to inner and outer face seals (15, 16). Lay the balance ring (13) with the seal surfaces up and install the inner seal with the outside diameter facing down and install outer seal with the outside diameter facing up.

i. Aline balance ring pins (14) with two holes in valve housing. Install balance ring (13) in valve housing (3). Insert your finger through port of housing. Apply pressure to side of balance ring assembly. Hold ring in position until valve housing is in place. Aline case drain hole in housing with case drain hole in valve plate (18). Install valve housing against valve plate.

j. Install and finger tighten four bolts (1, 2). Torque to 750 inch pounds, tightening two opposing corners first, then the other two opposing corners.

k. Install two check plug assemblies: steel balls (9), springs (8), plugs (6), and seal (7). Install case drain plug (4) and seal (5).

4-19.3 Winch Power Take-Off (Figure 4-46).

4-19.3.1 Removal and Disassembly.

a. Disconnect the hydraulic pump lines and remove the pump. Disconnect the wire control cable assembly (8) from the shifter bracket (7). Remove the power takeoff from the transmission by removing six nuts (45) and copper gaskets (46). Remove the assembled power take-off, gaskets (49, 50), and the filler block (51).

b. Remove the screw (2), swivel bracket (3), and nut (4) from the bracket (7) to remove the wire control mount (1). Remove set screw (5) and pivot pin (6) from bracket. Remove four screws (9) to remove the wire shift cover assembly (10), gaskets (21), and fiber spacer (22).

c. Disassemble the cover assembly by removing screw (11), lockwasher (12), shifter lever (13), flat washer (14), and indicator switch (15). Remove the post and plate assembly (16), o-ring (17), poppet (18), and spring (19).

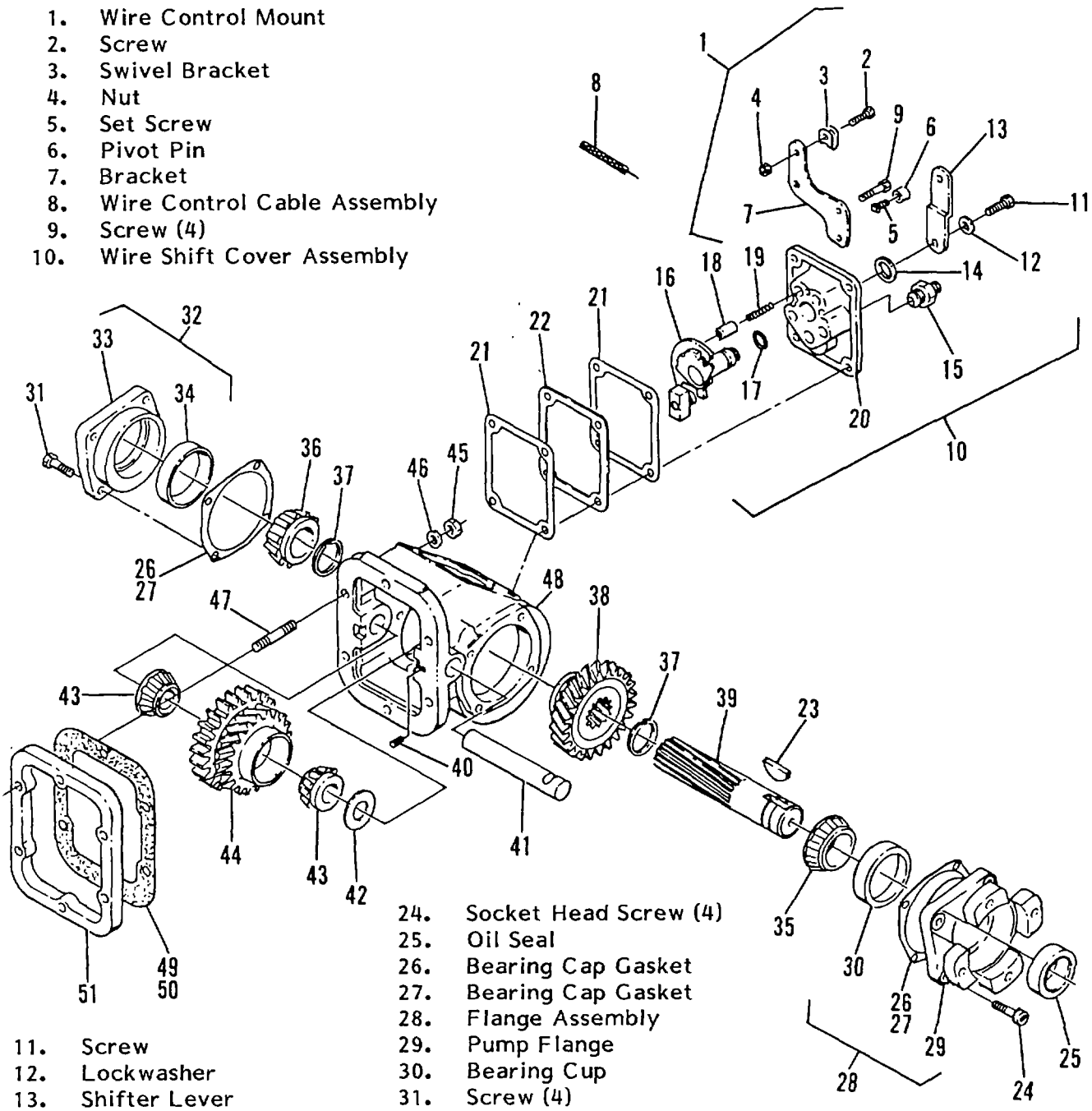
d. Remove the woodruff key (23) from the output shaft (39). Remove four socket head screws (24) and remove the pump flange assembly (28), bearing cap gaskets (26, 27), and bearing cup (30). Use a small screwdriver to remove the oil seal (25) from the pump flange (29), being careful not to scratch the flange bore.

e. Working from the opposite end of the pump, remove four screws (31) to remove the bearing cap assembly (32) and gaskets (26, 27). Disassemble the bearing cap by removing the bearing cup (34) from the closed end bearing cap (33). Remove the assembled shaft from the housing; then remove bearings (35, 36) from both ends of the shaft. Remove two lock rings (37) to remove the sliding gear (38) from the output shaft (39).

f. Remove set screw (40) and carefully remove the idler shaft (41) from the housing (48) while holding the cluster gear (44) from falling. Remove gear spacer (42) and two input bearing cones (43) from the cluster gear (44).

4-19.3.2 Cleaning, Inspection and Repair.

a. Clean all parts with an approved cleaning solvent. Check all mating surfaces. Replace any parts that have scratches or burrs that cannot be easily removed using crocus cloth or a fine grit sandpaper.



1. Wire Control Mount
2. Screw
3. Swivel Bracket
4. Nut
5. Set Screw
6. Pivot Pin
7. Bracket
8. Wire Control Cable Assembly
9. Screw (4)
10. Wire Shift Cover Assembly
11. Screw
12. Lockwasher
13. Shifter Lever
14. Flat Washer
15. Indicator Switch
16. Post and Plate Assembly
17. O-ring
18. Poppet
19. Shifter Spring
20. Shifter Cover
21. Shifter Cover Gasket (2)
22. Fiber Spacer
23. Woodruff Key
24. Socket Head Screw (4)
25. Oil Seal
26. Bearing Cap Gasket
27. Bearing Cap Gasket
28. Flange Assembly
29. Pump Flange
30. Bearing Cup
31. Screw (4)
32. Bearing Cap Assembly
33. Closed End Bearing Cap
34. Bearing Cup
35. Output Bearing Cone
36. Closed End Bearing Cone
37. Lock Ring (2)
38. Sliding Gear
39. Output Shaft
40. Set Screw
41. Idler Shaft
42. Gear Spacer Kit
43. Input Bearing Cone (2)
44. Cluster Gear
45. Nut (6)
46. Copper Gasket (6)
47. Stud (6)
48. Housing
49. Housing Gasket
50. Housing Gasket
51. Filler Block

Figure 4-46. Power Take-Off, Winch

b. Discard gaskets, o-rings, and seals each time power take-off is disassembled. Check the gear teeth for signs of wear, damage or distortion. Replace any damaged gears.

c. Check bearing surfaces for scratches, scoring, or pitting; replace damaged bearings. Do not spin bearings that have not been lubricated.

4-19.3.3 Assembly and Installation.

a. Install bearings (43) in the cluster gear. Holding gear spacer (42) in place next to the bearing, position the cluster gear in the housing and insert idler shaft (41) in the housing and through the spacer (42), bearings (43), and cluster gear (44). Install set screw (40).

b. Assemble sliding gear (38) onto output shaft (39) and attach lock rings (37). Install bearing cones (35, 36) on the shaft and insert shaft into housing (48). Apply a light weight oil on the cups and oil seal; install bearing cup (34) into bearing cap (33); press in oil seal (25) and install bearing cup (30) into pump flange (29).

c. Apply a light petroleum jelly on the gaskets (26, 27) and position them onto housing. Install closed end bearing cap (33) onto housing and fasten with screws (31). With gaskets (26, 27) in place, install pump flange (29) onto housing and fasten with socket head screws (24).

d. Assemble the wire shift cover assembly (10). Install spring (19), poppet (18), o-ring (17), post and plate assembly (16), and indicator switch (15) onto cover (20). Install flat washer (14), shifter lever (13), and fasten with screw (11) and lockwasher (12). Apply a light petroleum jelly on the gaskets (21) and position them and the fiber spacer (22) onto housing. Position the shift cover assembly (10) and bracket (7) onto housing and fasten with four screws (9).

e. Assemble the wire mount control (1). Install pivot pin (6) and set screw (5). Attach swivel bracket (3) and attach it to bracket (7) using nut (4) and screw (2).

f. Apply a light petroleum jelly on the gaskets (49, 50) and position them onto housing. Position the filler block (51) and gaskets, along with the power take-off assembly on the mounting studs (47) on the transmission. Fasten the power takeoff using six nuts (45) and copper washers (46). Connect the wire control cable assembly (8).

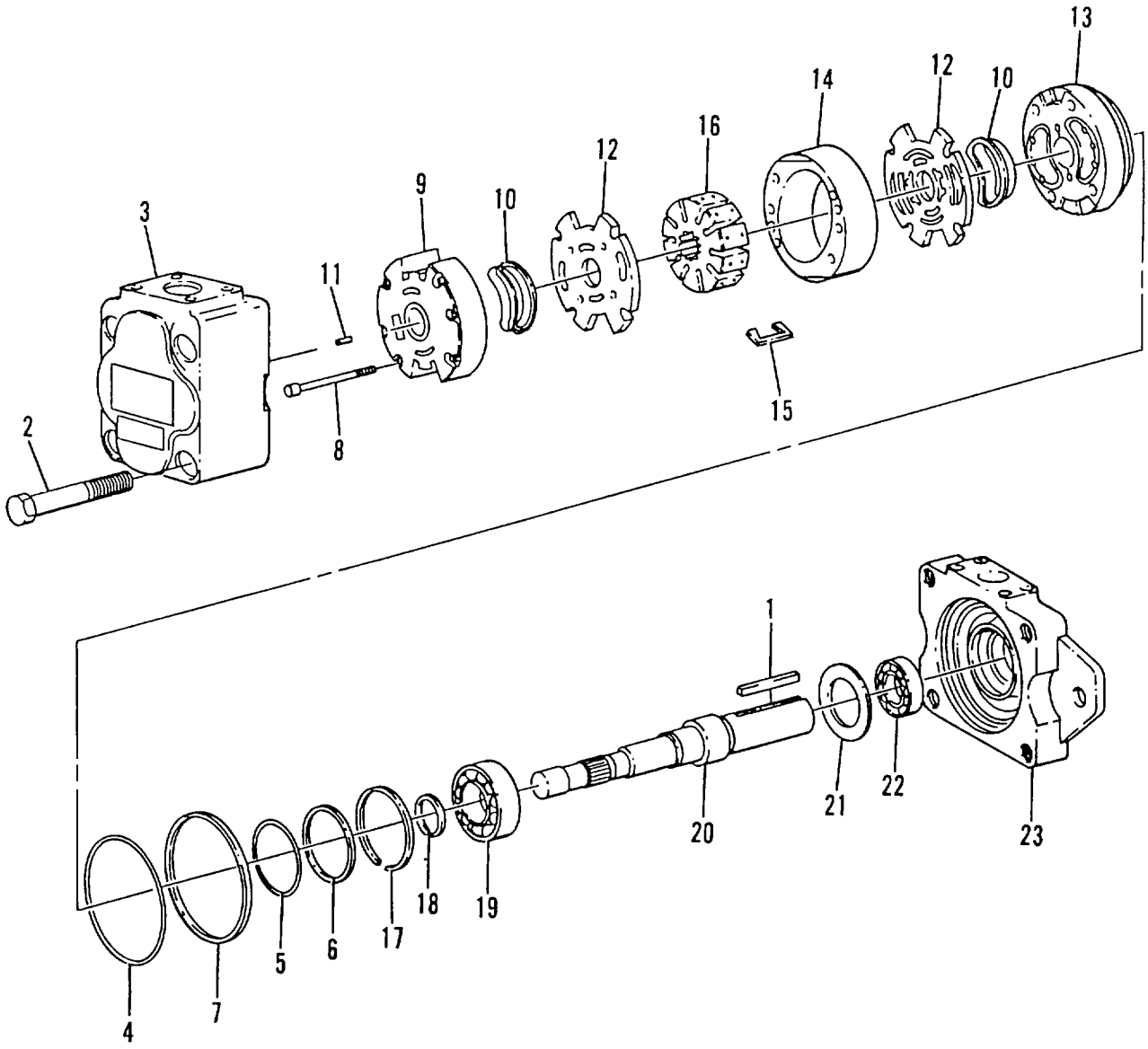
g. Install the hydraulic pump on the power take-off and reconnect the hydraulic lines.

4-19.4 Winch Pump (Figure 4-47)

4-19.4.1 Removal and Disassembly.

a. Disconnect the hydraulic lines from the pump. Remove two mounting bolts and remove the pump from the power take-off flange.

b. Remove the shaft key (1). Support the pump on blocks or clamp the body (23) in a vise with the shaft down. Index mark the pump body and cover for assembly



1. Key
2. Screw (4)
3. Cover
4. O-ring
5. O-ring
6. Back-Up Ring
7. Sealing Ring
8. Screw (2)
9. Inlet Support Plate
10. Seal Pack
11. Pin (2)
12. Flex-Side Plate Kit
13. Outlet Support Plate
14. Ring
15. Vane Kit (10 ea-Vanes & Inserts)
16. Rotor
17. Snap Ring
18. Snap Ring
19. Bearing
20. Shaft
21. Washer
22. Shaft Seal
23. Body

Figure 4-47. Winch Pump

reference. Remove four screws (2) and lift the cover (3) off the pump.

c. Remove the cover o-ring (7). Pry or pull out the cartridge from the pump body (23). Remove the snap ring (17) and pull the shaft (20) and bearing (19) from the pump body. Drive the shaft seal (22) out of the body. If you need to remove the bearing (19), first remove the small snap ring (18) and then press the shaft (20) out of the bearing (19) while supporting the bearing inner race.

d. Disassemble the cartridge. Remove the o-ring (5), back-up ring (6), and square sealing ring (7) from the outlet support plate (13). Scribe a line across the outer surface of the cartridge kit. (The mark will help during assembly.) Place the cartridge on a flat surface with outlet support plate (13) down and remove the two socket head screws (8).

CAUTION

Do not slide flex side plates across the ring and rotor. Burrs on the ring or rotor can cause deep scratches in the soft brass surface.

e. Slide the inlet support plate (13) and seal packs (10) off the cartridge. Move the flex side plate (12) off center just enough to grab the edge and lift up and away without sliding. Place a small flat piece of wood over the ring (14) and rotor (16) and reverse the cartridge to have the outlet support plate (13) pointing up. Slide the outlet support plate (13) and seal packs (10) off the cartridge while preventing the flex side plate (12) from sliding with the support plate (13).

f. Move the flex side plate (12) off center just enough to lift up and away without sliding. Remove the cam ring (14) from the rotor and vanes. Locate the arrow stamped into the rotor periphery. Remove the vanes and inserts in order, starting at the arrow. Keep them in order during inspection. Do not remove the cartridge locating pins (11) unless they are damaged. The pins are a drive-lock type and may be difficult to remove.

4-19.4.2 Cleaning, Inspection, and Repair.

a. Clean all parts thoroughly and keep them clean during inspection and assembly. The close tolerance of the parts makes this requirement very important. Use an approved solvent for cleaning and filtered, compressed air for cleaning and drying.

b. Discard shaft seals, o-rings, back-up rings, and seal packs. Use a new seal kit for reassembly.

c. Check the cartridge wear surfaces for scratches, scoring, pitting and excessive wear. Slight heat discoloration of the flex side plate bronze surface is normal. Scoring deeper than .001 inch and scratches deeper than .002 inch indicate a new part is needed. Slight scoring and/or scratches can be removed with a crocus cloth or an oiled arkansas stone. DO NOT use a dry stone on the bronze surface or scratches will result.

d. Inspect both sides of each vane and insert in order. If heavy wear or scoring is found, check the appropriate rotor slot. Replace scored parts. Inspect the cam ring for vane chatter marks, wear and/or scratches. Replace if scoring is evident. Use the stone to remove any burrs.

e. Vane and rotor wear can be checked by inserting the vane in the rotor slot and checking for excessive play. Replace the rotor and vanes if wear is evident.

f. Rotate the bearing while applying pressure to check for wear, looseness, and pitted or cracked races. Check seal and bushing mating surfaces on the shaft for scoring or wear. Replace shaft if marks cannot be removed by light polishing.

4-19.4.3 Assembly and Installation

a. Coat all parts except seals and back-up rings with clean hydraulic fluid to facilitate assembly and provide initial lubrication. Use small amounts of petroleum jelly to hold the o-rings in place during assembly.

b. During handling and shipping of precision machines cartridge parts, it is possible to raise burrs on the sharp edges. All sharp edges on the parts of a new cartridge kit should be stoned prior to installation.

c. Assemble the cartridge. The direction of rotation is as viewed from the shaft end; right hand rotation is clockwise; left hand, counterclockwise.

NOTE

If pins (11) were removed from inlet support plate, install new pins, driving them with a rubber or plastic hammer.

d. Place the inlet and outlet support plates (9, 13) on a flat surface. Install seal packs (10) into cavities with seal retainer surface up. Place flex side plate (12) over each of the support plates with bronze wear surface facing up. Aline scribe marks to make sure the correct flex side plate (12) is used with the correct support plate (9 or 13).

NOTE

Flex side plates develop a wear pattern with the rotor and vanes and should not be interchanged.

e. Set the rotor (16) on a flat wood strip with the arrow pointing right. Assemble the vane kit (15) vanes and inserts into the rotor, in reverse order of disassembly. Make sure the sharp chamfer edge of each vane leads in the direction of rotation. All vanes must move freely in the rotor slots with no evidence of binding.

f. Assemble the cam ring (14) over the rotor and vanes with the arrow pointing in the same direction as the rotor. Lubricate the top surface of the rotor and vanes liberally with hydraulic fluid. Locate the scribe mark on the cam ring (14) the outlet support plate (13), and the flex side plate (12).

g. Hold the outlet support plate (13) and flex side plate (12) together and assemble over the cam ring (14) and rotor (16) with the scribe marks in-line. Hold the cartridge together to prevent movement and turn the assembly over so the outlet support plate rests on a flat surface and the wood strip is on top. Remove the wood strip.

h. Lubricate the exposed surface of the rotor and vanes with hydraulic fluid. Locate the scribe mark on the inlet support plate (9) and flex side plate (12). Hold the inlet support plate and flex side plate together and assemble over the cam ring (14) and rotor (16) with scribe marks in-line.

i. Thread two socket head screws (8) into the cartridge until snug (hand-tight).

NOTE

The outside diameter of all components of the cartridge kit must be in-line with each other or the cover cannot be installed.

j. Install the cover (3) over the cartridge. Tap lightly on the cover with your hand until each part centers. Remove the cover gently so as not to disturb alignment. Torque socket head screws (8) to 45 inch pounds and recheck kit alignment with the cover. Repeat until cartridge kit is aligned.

k. Check rotor (16) for binding by inserting your index finger through the shaft opening of the inlet support plate (9). Hold the cartridge kit in a horizontal shaft position and lift the rotor with your finger. The rotor should move freely back and forth within the cartridge. If the rotor binds, open the kit. Clean and stone all possible areas of bind, then reassemble using the above procedure. The rotor MUST move freely within the cartridge when assembled.

l. Assemble the basic pump. Clamp the body (23) in a vise as before. Lubricate the primary shaft seal (22) with petroleum jelly and place in position with the body, garter spring up. Use a seal installation tool to prevent damaging seal. Press the seal into the body until it bottoms out.

m. If the bearing (19) was removed from the shaft (20), install the shaft (20) in the bearing (19) while supporting the bearing inner race. Afterward, install small snap ring (18).

n. Place the bearing spacer washer (21) over the shaft (20) against the front of the bearing (19). Lubricate the shaft with petroleum jelly and carefully push the shaft through the seals (22) until the bearing and spacer are in location in the body (23). Install the large snap ring (17) in the body snap ring groove behind the bearing.

o. Install the square sealing ring (7) into the body (23). Install the o-ring (5) and back-up ring (6) on the hub of the outlet support plate (13). Carefully install the cartridge into the body so one of the chamfers on the cam ring is alined with the cover (3) inlet port. Lubricate and install the large o-ring (4) in the cover.

p. Install the cover (3) in position; move back and forth until the cartridge pins (11) drop into the cover holes. Oil and install the cover-to-body bolts (2). Torque to 70 inch pounds. Turn the pump shaft by hand to verify freedom of the cartridge.

q. Install the pump on the power take-off flange and fasten it with its two mounting bolts. Torque the bolts to 75 inch pounds. Connect and tighten the hydraulic hoses.

4-20 MAINTENANCE OF FRAME COMPONENTS

4-20.1 Drill Platform Assembly (Figure 4-48).

Unhook the double end snap (5). Remove the center platform (6); then remove nuts (1, 2), lockwashers (3), and bolts (4) to remove drillers platform (7) and helpers platform (8).

Clean the platforms frequently to prevent excessive build-up of mud. Use a wire brush to remove corrosion or rust; repaint as necessary. Repair minor damage by welding; replace platforms if major damage has occurred.

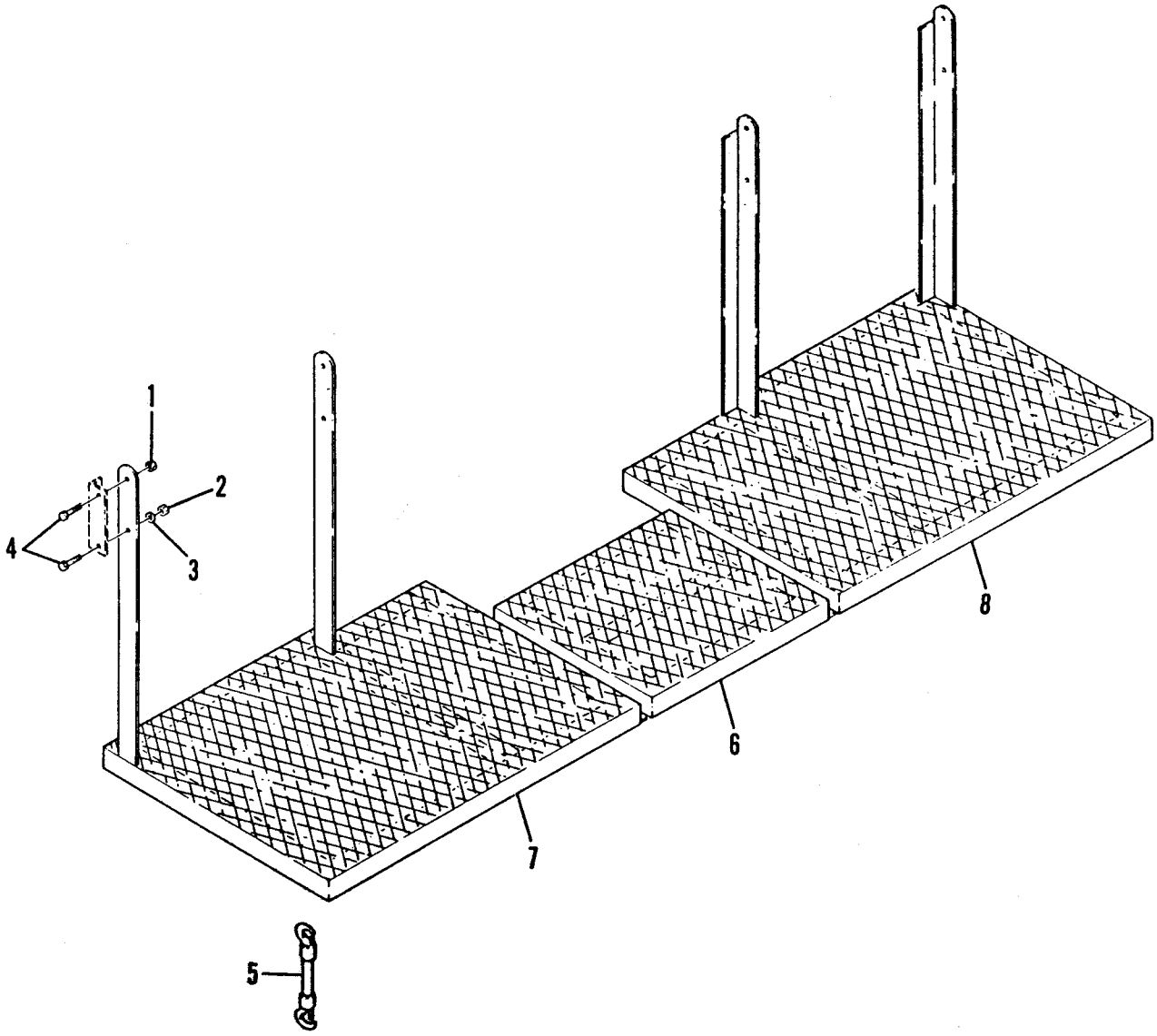
Hold the platforms (7, 8) in place and fasten to the rig with bolts (4), lockwashers (3), and nuts (1, 2). Finally, place the center platform (6) between the other two. Hook up the double end snap.

4-20.2 Mud Flap Assembly.

If mud flaps are worn, damaged, partially gone, remove their fasteners (bolts, washers, and nuts) and replace with new flaps. No other maintenance is required.

4-20.3 Frame Assembly.

Keep the rig as clean as time will permit. Examine the frame components periodically for evidence of corrosion, rusting, broken welds, dents, or other damage. Hammer out any minor dents or bends. Repair minor damage by welding; remove rust and corrosion with a wire brush. Keep the rig well-painted at all times.



1. Nut
2. Nut
3. Lockwasher
4. Bolt
5. Double End Snap
6. Center Platform
7. Driller's Platform
8. Helper's Platform

Figure 4-48. Drill Platform Assembly

CAUTION

Do not use a wrench to tighten nut. Excess force against bearing will cause wear and failure of the bearing.

e. Install nut (2) and tighten hand tight. Back the nut off to aline a slot in nut with the hole in body stem and install cotter pin (1).

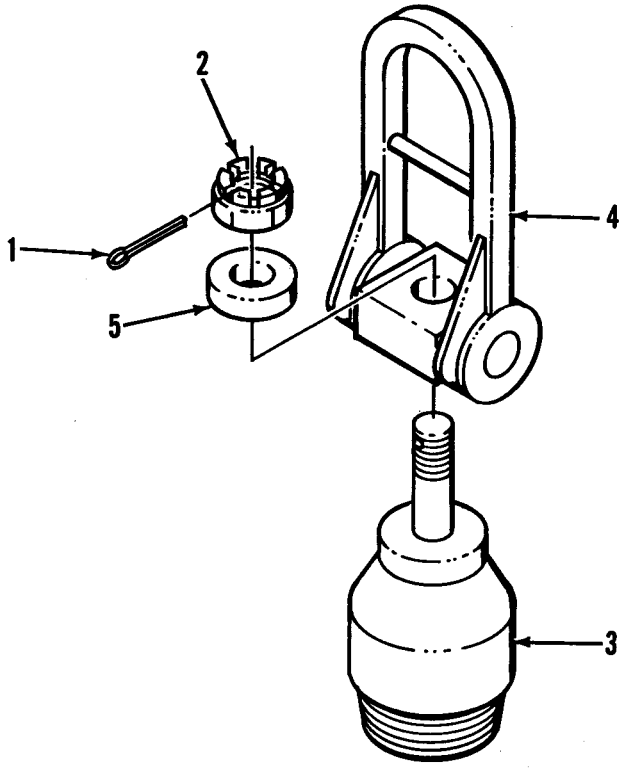
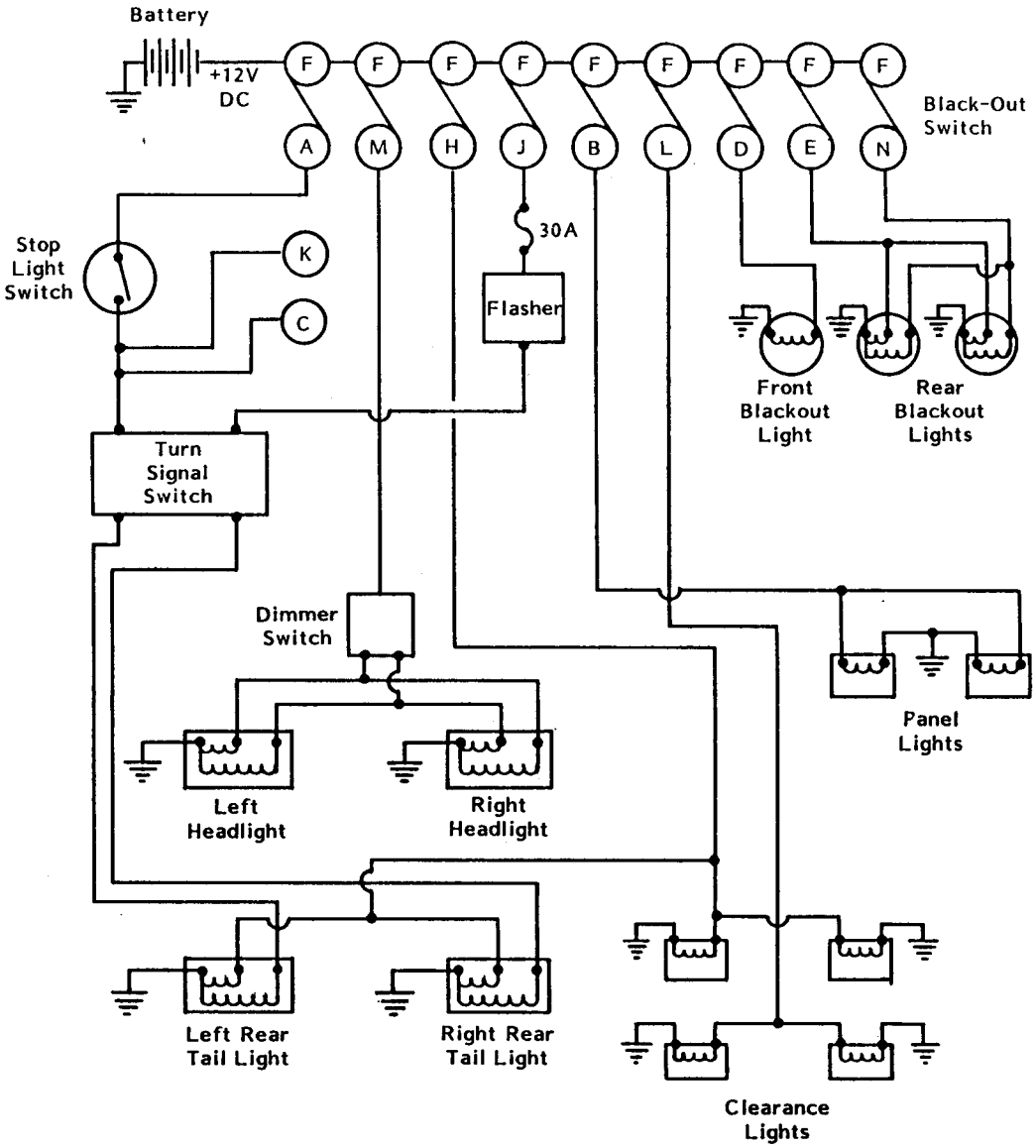
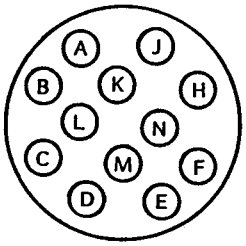


Figure 4-48.1. Auxiliary Kit Hoisting Plug





A To Stop Light Switch
B To Instrument Lamps
C To Stop Light Wire to Turn Signal Switch
D To Front Blackout Light
E To Rear Blackout Lights
F Power Supply for Switch
H To Clearance and Tail Lights
J To Turn Signal Switch
K To Stop Light Switch - dead side
L To Parking Lights
M To Dimmer Switch
N To Blackout Stop Lights

Figure 4-49. Wiring Diagram, Truck Lighting

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 decagram = 10 grams = .35 ounce
acres
1 hectogram = 10 decagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47

1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

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°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

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