TECHNICAL MANUAL

UNIT, INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT MAINTENANCE MANUAL (INCLUDING SUPPLEMENTAL OPERATING, MAINTENANCE AND REPAIR PARTS INSTRUCTIONS)

FOR

CRANE, WHEEL-MOUNTED, SELF-PROPELLED FOR AIRCRAFT MAINTENANCE AND POSITIONING (SCAMP): 4 TON

GROVE MANUFACTURING COMPANY

MODEL RT41 AA

NSN 3810-01-144-4885

HEADQUARTERS, DEPARTMENT OF THE ARMY

29 JANUARY 1987

WARNING

Use only manufacturer's recommended tires. Use of incorrect tires will void warranty and may cause tire failure. Correct tires are: 9.00 x20, Tube Type, Bias Ply (TM 302-24P, Fig 85, item 1).

WARNING

Once turntable bolts are removed, or loosened, replace with NEW BOLTS ONLY. (TM Fig 160, item 3).

Technical Manual
No.5-3810-302-24

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., 29 *January* 1987

UNIT, INTERMEDIATE
DIRECT SUPPORT AND INTERMEDIATE
GENERAL SUPPORT MAINTENANCE MANUAL
FOR

CRANE, WHEEL-MOUNTED, SELF-PROPELLED FOR AIRCRAFT MAINTENANCE AND POSITIONING (SCAMP): 4 TON

GROVE MANUFACTURING COMPANY
MODEL RT41AA

NSN 3810-01-144-4885

REPORTING ERRORS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in back of this manual direct to Commander, US Army Tank-Automotive command, ATTN: AMSTA-MBS, Warren, Michigan 48397-5000. A reply will be furnished direct to you.

This technical manual is an authentication of the manufacturer's commercial literature and does not conform with the format and content specified in AR310-3, Military Publications. This technical manual does, however, contain available information that is essential to the operation and maintenance of the equipment.

Distribution Restriction: Approved for public release; distribution is unlimited.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

TABLE OF CONTENTS (CONT'D)

SECTION 1

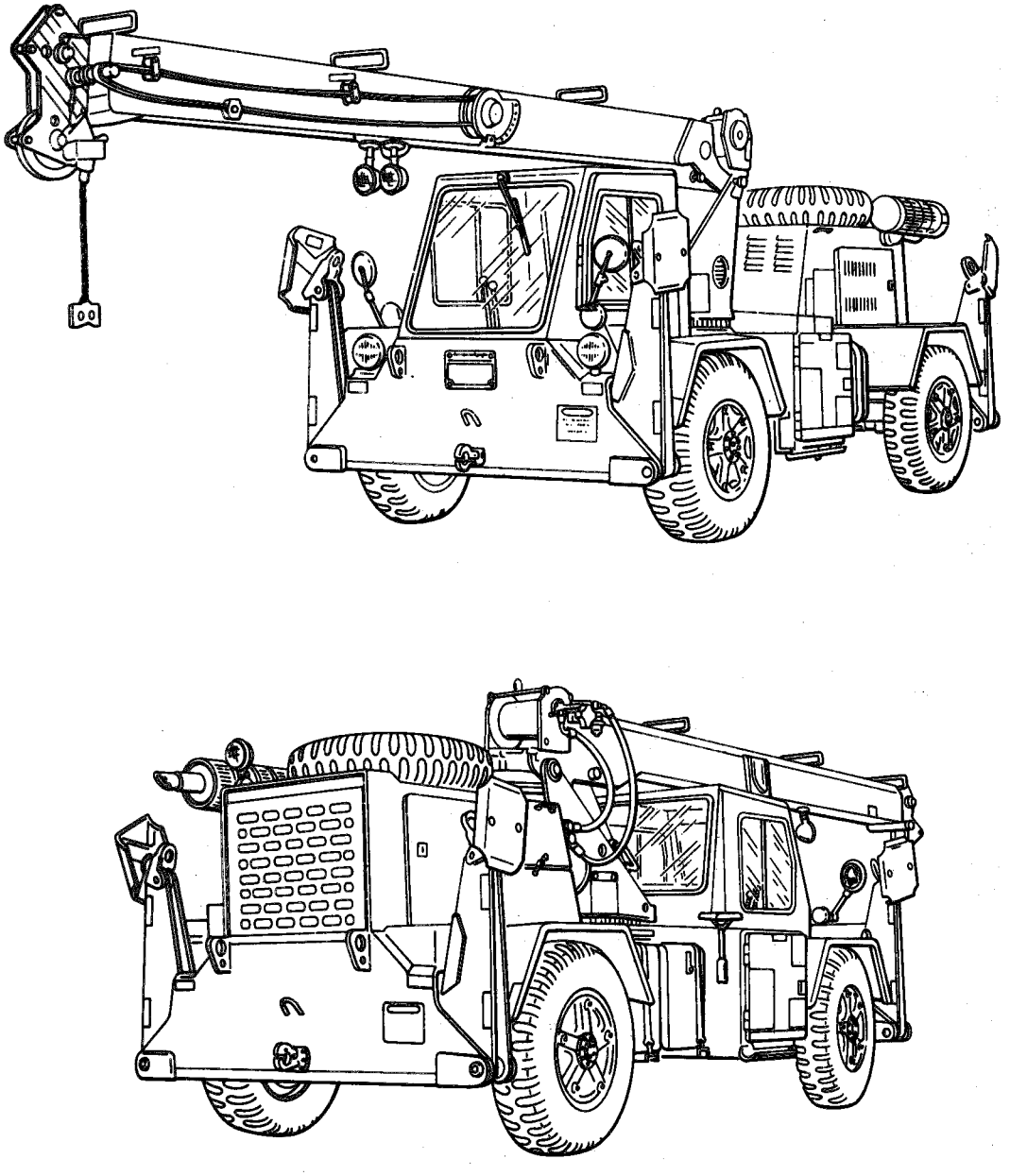
INTRODUCTION

1-1. PURPOSE.

This manual provides unit intermediate direct support and intermediate general support maintenance instructions for the Self-Propelled Aircraft Maintenance Crane (SCAMP). The SCAMP is a 4-ton rough terrain crane manufatured be Grove Manufacturing, Shady Grove, PA 17201.

1-2. TOOLS AND TEST EQUIPMENT.

There are no special tools or test equipment required to perform maintenance instructions in this manual.



TA209222

1-3. WARRANTY INFORMATION.

WARRANTY STATEMENT

ISSUED TO U.S. ARMY TANK AUTOMOTIVE COMMAND UNDER CONTRACT DAAEO7-82-C-6602

WARRANTY

THERE ARE NO WARRANTIES EXPRESS, OR IMPLIED MADE BY EITHER THE DISTRIBUTOR OR THE MANUFACTURER ON NEW GROVE EQUIPMENT EXCEPT THE MANUFACTURERS WARRANTY AGAINST DEFECTS, MATERIAL AND WORKMANSHIP SET OUT BELOW.

NEW EQUIPMENT WARRANTY

THE MANUFACTURER WARRANTS EACH NEW PRODUCT MADE BY THE MANUFACTURER TO BE FREE FROM DEFECTS IN MATERIAL AND WORKMANSHIP, ITS OBLIGATION LIABILITY UNDER THIS WARRANTY BEING LIMITED TO REPLACING FREE OF CHARGE ANY PART PROVING DEFECTIVE UNDER NORMAL USE AND SERVICE FOR A PERIOD OF 15 MONTHS FROM THE DATE OF ACCEPTANCE AS INDICATED ON D.D. FORM 250, MATERIAL INSPECTION AND RECEIVING REPORT, OR 1500 HOURS OF OPERATION WHICHEVER OCCURS FIRST, PROVIDED, HOWEVER, THAT SHOULD THE GOVERNMENT ELECT TO PUT THE UNITS WARRANTED HEREUNDER INTO STORAGE PRIOR TO PLACING IN SERVICE AND SHALL HAVE NOTIFIED GROVE IN WRITING OF THIS FACT. THEN THE WARRANTY TIME PERIOD WILL NOT BEGIN UNTIL EACH UNIT IS WITHDRAWN FROM STORAGE (SAID DATE TO BE NOTIFIED IN WRITING TO GROVE) OR UNTIL SIX MONTHS FROM THE DATE OF ACCEPTANCE WHICHEVER SHALL FIRST OCCUR.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED AND THE OBLIGATION AND LIABILITY OF THE MANUFACTURER UNDER THIS WARRANTY SHALL NOT INCLUDE ANY TRANSPORTATION OR OTHER CHARGES OR THE COST OF INSTALLATION OR ANY LIABILITY FOR DIRECT INDIRECT OR CONSEQUENTIAL DAMAGES OR DELAY RESULTING FROM THE DEFECT, ANY OPERATION BEYOND RATED CAPACITY OR THE IMPROPER USE OR APPLICATION OF THE PRODUCT OR THE SUBSTITUTION UPON IT OF PARTS NOT APPROVED BY THE MANUFACTURER OR FAILURE TO ADHERE TO THE MANUFACTURERS STORAGE MAINTENANCE REQUIREMENT DURING ANY GOVERNMENT STORAGE PERIOD SHALL VOID THIS WARRANTY.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES EXPRESS OR IMPLIED INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE AND OF ANY OTHER OBLIGATIONS OR LIABILITY ON THE PART OF THE MANUFACTURER AND GROVE MANUFACTURING COMPANY NEITHER ASSUMES NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR IT ANY OTHER LIABILITY IN CONNECTION WITH SUCH EQUIPMENT.

1517

1-4. WARNINGS AND CAUTIONS.

The following warnings and cautions are used in maintenance procedures throughout this manual.

The following Warning is used many times throughout the manual.

WARNING

Solvent fumes are toxic. Use solvent in a well ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

The following is a list of all Warnings contained in this manual and the page in which the Warning is located.

WARNING

The cab assembly (2) weighs approximately 250 pounds. Use caution when removing the cab assembly. (2-1)

WARNING

Before performing maintenance or inspection (except operating tests), disconnect power source. (2-3)

WARNING

The cooling system is pressurized. Personal injury may result when removing the radiator cap after operating temperature is reached. Use proper protection when removing the radiator cap. (3-14, 3-15 and 3-17)

WARNING

When removing the cap, loosen it slowly and then pause a moment. This will avoid possible burning by hot water or steam. Continue to turn the cap to the left until it can be removed. (3-15 and 3-17)

WARNING

Exercise caution when removing radiator (1) to avoid personal injury or equipment damage. (3-17)

WARNING

Do not attempt to remove and disassemble a tire and wheel assembly without proper training. The high pressures involved can cause the tire and rim parts and tools to fly apart with explosive force. Proper procedures must be utilized to avoid severe injury or death. (5-1)

WARNING

Do not mix one type of rim base (5, figure 5-1) with a different type of rim ring (1). Improper seating of these parts can cause rim ring and rim base to fly apart with explosive force.

Always use a rubber, lead, plastic, or brass faced mallet if it is necessary to tap components together. (5-1)

WARNING

Always use a safety cage to inflate tire and wheel assembly to avoid serious injury or death from exploding rim parts. (5-1)

WARNING

Each axle (12, figure 5-3) weighs approximately 900 pounds. Use caution when removing the axle. (5-3)

WARNING

Minor concentrations of acetic acid vapor may be produced during the application of silicone RTV gasket material. Provide adequate ventilation when working in a confined area. (5-6)

WARNING

Eye contact with silicone RTV gasket material can cause irritation. Flush eyes immediately with fresh water for 15 minutes. Obtain medical attention immediately. (5-9)

WARNING

Axle weighs approximately 900 pounds. (5-10)

WARNING

Use only enough air pressure to ease piston out of bore. Do not place hand in front of piston when applying air pressure. This could result in serious personal injury. (7-2)

WARNING

The hydraulic brake booster and master cylinder unit weighs approximately 25 pounds. Use caution when removing the unit. (7-4 and 7-9)

WARNING

The spring load on the primary piston assembly (5) is approximately 60 to 70 pounds force (27.22 to 31.75 kg force). Use special spring compression tool. (7-4)

WARNING

Never point the open end of the bore at anyone when applying air pressure. Serious injury may occur if the piston comes out of the bore. (7-4)

WARNING

Do not loosen fittings in pressurized lines or while hydraulic pumps are in operation.

Use extreme care when removing plugs or restrictions in hydraulic lines suspected of having trapped air that might be pressurized. (8-3)

WARNING

Ensure that all hydraulic systems are shut-down and pressure is relieved. (8-6)

WARNING

Spools (14) housed under mounting plate (10) are spring loaded to 30 pounds (13.6 kg) force. (8-10)

WARNING

The 2-Section Pump (Figure 8-6) weighs 29 pounds. Exercise caution when removing the pump assembly. (8-14)

WARNING

Ensure the blocking and lifting devices are capable of supporting the boom assembly. (10-6 and 10-8)

WARNING

Failure to properly support the boom lift cylinder could result in death or injury to personnel. (10-6)

WARNING

Shutdown the crane before proceeding. (10-6)

WARNING

Do not use air pressure to remove cylinder rod assembly. (10-12 and 10-16)

WARNING

The bearing gear (12, figure 10-8) weighs 115 pounds. (10-20)

WARNING

The turntable (3) weighs 450 pounds. (10-20)

WARNING

Release the press or compression tool slowly to ascertain the retaining ring has been installed properly. An improper ring fit could result in a free-fly condition which could inflict death or injury to personnel. (11-8)

WARNING

Batteries generate explosive gases. Keep sparks, flames or other ignition sources away at all times. Always shield eyes when working near batteries. (13-12)

WARNING

Electrolyte splashed into eyes is extremely dangerous. If this should happen, force eye open and flood with cool, clean water for approximately five minutes. Call doctor immediately. (13-12)

WARNING

Cable reel weighs approximately 50 pounds. Use care when removing the cable reel assembly. (13-15)

The following is a list of all Cautions contained in this manual and the page on which the Caution is located.

CAUTION

Ensure that arrow on oil pump gear is aligned with arrow on fuel pump attaching pad. (3-23)

CAUTION

Do not immerse the shaft and bearing (5) in cleaning solvent. This may wash dirt into the bearings and contaminate the lubricant. The solvent cannot be removed entirely from the assembly after immersion. (3-24)

CAUTION

Do not attempt to straighten badly bent fan blades. Straightening blades may weaken them, resulting in failure during operation. (3-24)

CAUTION

When a pump is removed from an engine for repair, secure the throttle in the wide open position after removal. This will prevent the governor weights from dislodging inside the pump housing while the pump is in transit or storage. (3-28)

CAUTION

Do not rotate the pump shaft backwards to align the internal timing marks. Always rotate it in the same direction as the engine crankshaft, when viewed from the front or timing gear end of the engine. (3-29)

CAUTION

The cylinder head nuts must be retightened and the valve clearance reset after 1 hour of service. (3-35)

CAUTION

Driving the differential carrier into the housing with a steel hammer will damage the carrier flange. (5-9)

CAUTION

Do not use excessive pressure to install oil seal (51, figure 5-5) or tap seal after it has bottomed. This will crush the seal retainer resulting in seal damage. (5-9)

CAUTION

Do not use excessive pressure to install oil seal (14) or tap seal after it has bottomed. This will crush the seal retainer resulting in seal damage. (5-9)

CAUTION

Do not use excessive pressure to install oil seal (23) or tap seal after it has bottomed. This will crush the seal retainer resulting in seal damage. (5-9)

CAUTION

Do not bind the spool and sleeve in the housing, Rotate the spool and sleeve assembly slowly when removing it from the housing. (6-5)

CAUTION

Disassemble the steering control valve on a clean bench. Use clean, lint-free cloth, cleaning solvent, and low-pressure air to clean parts. (6-5)

CAUTION

Be careful that parts do not tilt out of position while installing the control spool and sleeve. (6-6)

CAUTION

Do not stretch seals. (6-7)

CAUTION

Never use mineral base cleaning solvents such as gasoline, kerosene, acetone, or paint thinner to clean caliper. These solutions will damage rubber parts. (7-2)

CAUTION

Do not use a metal tool to remove seal (6). This could damage caliper bore. (7-2)

CAUTION

If it is necessary to use air pressure to remove the secondary piston assembly (13), ensure the pressure is controlled and no more than 20 psi (1.41 kg/cm^2). Place the bore approximately one-inch (2.45 cm) from a padded workbench or other surface to catch the piston assembly (13) when it comes out of the bore. (7-4)

CAUTION

Do not use brake fluid or any other solvent to clean the brake boost unit. (7-6)

CAUTION

When removing piston assembly (1), pull piston straight out without scraping bore of housing (33). (7-6)

CAUTION

Oil supply lines must be connected to the cylinders when flushing the system. (8-3)

CAUTION

Use care when handling valve bank to avoid damage to faces and O-ring grooves. (8-8)

CAUTION

A pinched O-ring will cause leakage between sections and spool binding. (8-10)

CAUTION

Do not hold the relief valve open for more than one minute at a time. (8-12)

CAUTION

Do not overtighten the adjustment screw or locknut. (8-12)

CAUTION

Pull straight down on the motor assembly to avoid damaging the splined shaft. (9-4)

CAUTION

Clamp across the front of the motor flange. Excessive pressure on the housing will cause distortion. (9-4)

CAUTION

Use care when engaging the swing motor drive gear. Do not force the shaft to engage. (9-6)

CAUTION

Removal of the teflon back-up rings (14 and 16) may cause damage to the teflon rings and should not be attempted unless replacing them. (9-10)

CAUTION

Extend the cylinder rod end only enough to align it with the holes in the lift cylinder attach fitting. (10-8)

CAUTION

Before installing the lift cylinder rod end anchor shaft, ensure the lift cylinder rod end is aligned with the lift cylinder attach fitting. (10-8)

CAUTION

Shut down the engine before proceeding. (10-8)

CAUTION

When removing seals and rings, avoid scratching the grooved and gland surfaces. (10-12)

CAUTION

Do not damage seals and rings when installing head plate (4), head (9), and piston (20). (10-14)

CAUTION

Do not damage the O-rings during installation of the holding valve. If the holding valve turns freely then gets hard to turn, then easy to turn; remove the holding valve and check the O-rings. They have probably been damaged by a sharp edge of a port. (10-16)

CAUTION

When removing the seals and rings, avoid scratching the grooved and gland surfaces. (10-16)

CAUTION

Exercise extreme care when handling or setting down the cylinder rod. Damage to the rod surface may cause unnecessary maintenance and expense. (10-16)

CAUTION

Avoid scratching or damaging the grooved and gland surfaces: or the rings and seals. (10-18)

CAUTION

Exercise extreme care when handling the cylinder rod. Damage to the rod surface may cause unnecessary maintenance and expense. (10-18)

CAUTION

Avoid stretching seals and rings. Make certain seals and rings are installed in the proper order. Make certain components are clean prior to and during assembly. (10-18)

CAUTION

Make certain threaded rod of the compression tool fully engages the lower plate. If a press is used, care must be exercised that damage to any parts by exertion on the spring plate is to be avoided. After removing the spiral retaining ring, release compression tool by holding threaded rod stationary while backing off nut. (11-6)

CAUTION

Care must be taken not to scratch the surfaces in the O-ring grooves. (11-6)

CAUTION

Make certain the snap ring (14) is seated in the groove in the splined hole in the cam. Since the snap ring positions the brake clutch assembly, it is imperative that the snap ring be installed. (11-9)

CAUTION

If the end cover (15) will not lift off, pry it off using care to avoid damaging machined surfaces. (11-11)

CAUTION

Avoid distorting thrust plate (9). (11-11)

CAUTION

If the gear housing (12) will not lift off, pry it off using care to avoid damaging machined surfaces. (11-11)

CAUTION

Avoid pinching the gasket seal. (11-12)

CAUTION

Ensure index marks are properly aligned. (11-12).

CAUTION

When securing motor in a vise, do not grip on or near machined surfaces. (11-12)

CAUTION

If gears are replaced, bearings must be replaced also. (11-12)

CAUTION

An outrigger cylinder (1) weighs approximately 125 pounds. Ensure that wood support ramp will support the cylinder. (12-3)

CAUTION

Battery weight is approximately 80 pounds. Use care when lifting. (13-12)

EQUIPMENT IMPROVEMENT REPORT and MAINTENANCE DIGEST (EIR MD)

The quarterly Equipment Improvement Report and Maintenance Digest, TB43-0001-39 series, contains valuable field information on the equipment covered in this manual. The information in the TB43-0001-39 series is compiled from some of the Equipment Improvement Reports that you prepared on the vehicles covered in this manual. Many of these articles result from comments, suggestions, and improvement recommendations that you submitted to the EIR program. The TB43-0001-39 series contains information on equipment improvements, minor alterations, proposed Modification Work Orders (MWO's), warranties (if applicable), actions taken on some of your DA Forms 2028 (Recommended Changes to Publications), and advance information on proposed changes that may affect this manual. The information will help you in doing you job better and will help in keeping you advised of the latest changes to this manual. Also refer to DA PAM 310-1, Consolidated Index of Army Publications and Blank Forms, and Appendix A, References, of this manual.

SECTION 2

FRAME AND CAB MAINTENANCE

2-1. CAB.

2-2. REMOVAL.

a. Disconnect wiring harness to wiper motor (39, figure 2-1), dome light (46), defroster fan (27), and pump (22).

b. Remove locknuts (32), door strap (31), and door (12).

c. Remove nuts (35), lockwashers (34), and washers (33).

d. Pull emergency door cable (5) and lift off emergency door (3).

WARNING

The cab assembly (2) weighs approximately 250 pounds. Use caution when removing the cab assembly.

e. Lift off cab assembly (2).

2-3. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Inspect all glass for damage. Replace as needed.

2-4. REPAIR.

a. Repair shall be limited to the replacement of all worn or damaged parts. Refer to figure 2-2 for repair of window assemblies (1 and 30, figure 2-1).

2-5. INSTALLATION.

a. Position cab assembly (2, figure 2-1) on frame aligning studs on frame with drilled holes in cab.

b. Install washers (33), lockwashers (34),. and nuts (35).

c. Connect to wiper motor (39), dome light (46), defroster fan (27), and pump (22).

d. Install door (12), door strap (31), and locknuts (32).

2-6. WIPER MOTOR.

2-7. REMOVAL.

a. Tag and disconnect electrical leads to wiper motor (39, figure 2-1).

b. Remove wiper arm (38).

c. Remove nut and spacer part of wiper motor (39).

d. Remove nut (41), lockwasher (43), and washer (42).

e. Remove wiper motor (39) and washers (40).

2-8. INSPECTION.

a. Inspect all parts for wear and deterioration.

2-9. REPAIR.

a. Repair of the wiper motor shall be limited to the replacement of the wiper motor, wiper arm, wiper blade, and their attaching parts.

2-10. INSTALLATION.

a. Position wiper motor (39, figure 2-1) with washers (40) at mounting hole in cab.

b. Install washer (42), lockwasher (43), and nut (41).

c. Install spacer and nut.

d. Install wiper arm (38).

e. Remove tags and connect electrical leads.

2-11. DEFROSTER.

2-12. REMOVAL.

a. Tag and disconnect electrical leads at defroster (27, figure 2-1).

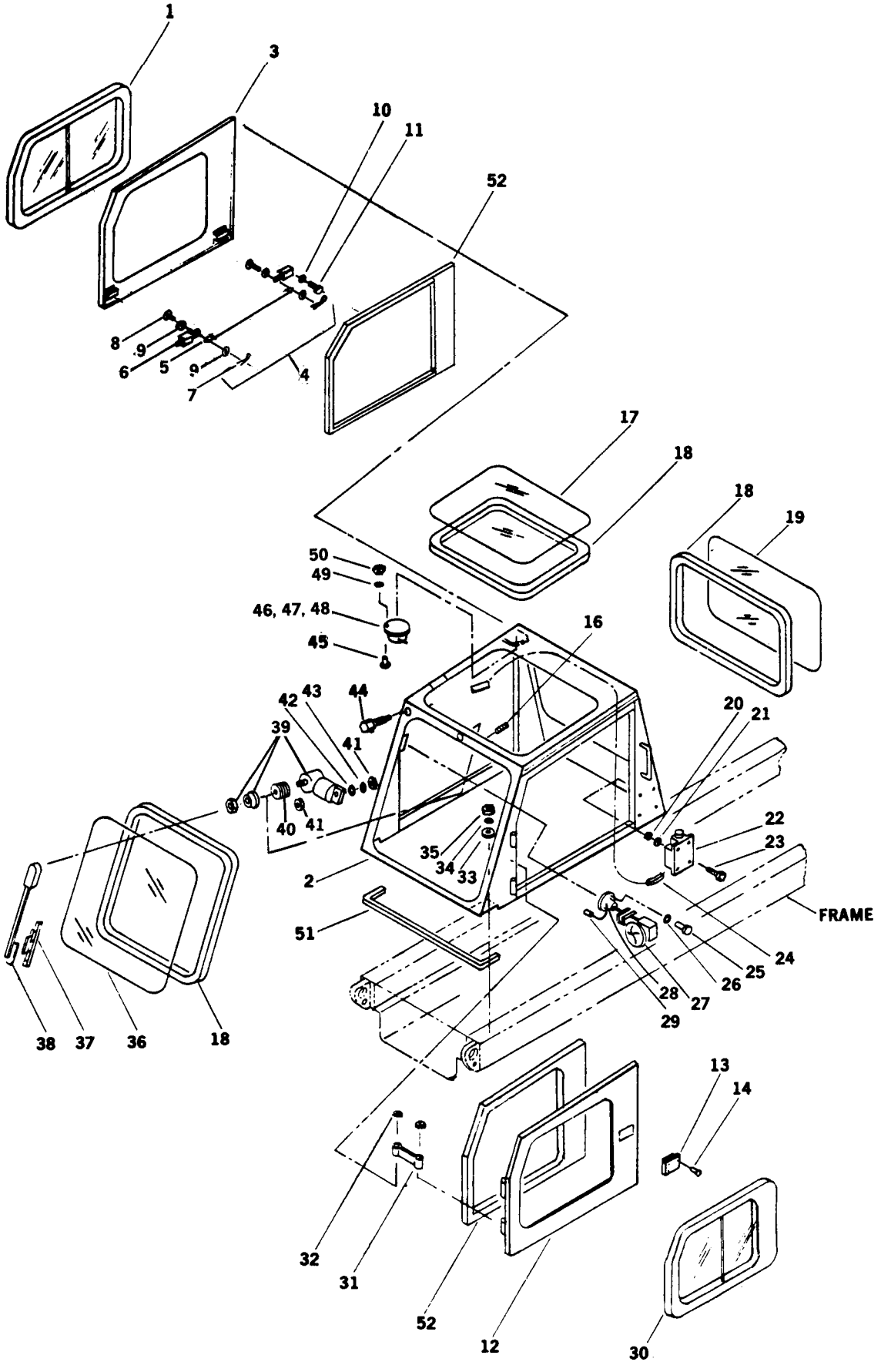


Figure 2-1. Cab Assembly

LEGEND FOR FIGURE 2-1

1. Window Assembly
2. Cab
3. Emergency Door
4. Door Latch Kit
5. Cable
6. Latch
7. Cotter Pin
8. Clevis Pin
9. Washer
10. Lockwasher
11. Screw
12. Door
13. Latch
14. Rivet
15. Not Used
16. Stud
17. Skylight
18. Weatherstrip
19. Rear Glass
20. Nut
21. Lockwasher
22. Pump
23. Screw
24. Hose
25. Screw
26. Lockwasher
27. Defroster Fan
28. Defroster Switch
29. Coupler
30. Window Assembly
31. Door Strap
32. Locknut
33. Washer
34. Lockwasher
35. Nut
36. Windshield
37. Wiper Blade
38. Wiper Arm
39. Wiper Motor
40. Washer
41. Nut
42. Washer
43. Lockwasher
44. Nozzle
45. Screw
46. Dome Light
47. Bulb
48. Switch
49. Washer
50. Nut
51. Weatherstrip
52. Moulding

b. Remove screws (25) and lockwashers (26),

c. Remove defroster (27).

2-13. REPAIR.

a. Repair shall be limited to the replacement of the defroster switch (28, figure 2-1).

2-14. INSTALLATION.

a. Position defroster (27, figure 2-1) in cab.

b. Install screws (25) and lockwashers (26).

c. Remove tags and connect electrical leads at defroster.

2-15. SEAT ASSEMBLY.

2-16. REMOVAL.

a. Remove seat cushion (2, figure 2-3).

b. Remove capscrews (11) and lockwashers (12). Lift out plate (10).

c. Remove nuts (4) and washers (9). Remove seat (1).

2-17. REPAIR.

a. Repair of seat assembly (1, figure 2-3) shall be limited to replacement of seat cushion (2) and seat back (3).

2-18. INSTALLATION.

a. Position assembled seat (1, figure 2-3) less seat cushion (2) in cab.

b. Install lockwashers (9) and nuts (4).

c. Install plate (10), capscrews (11), and lockwashers (12).

d. Install seat cushion (2).

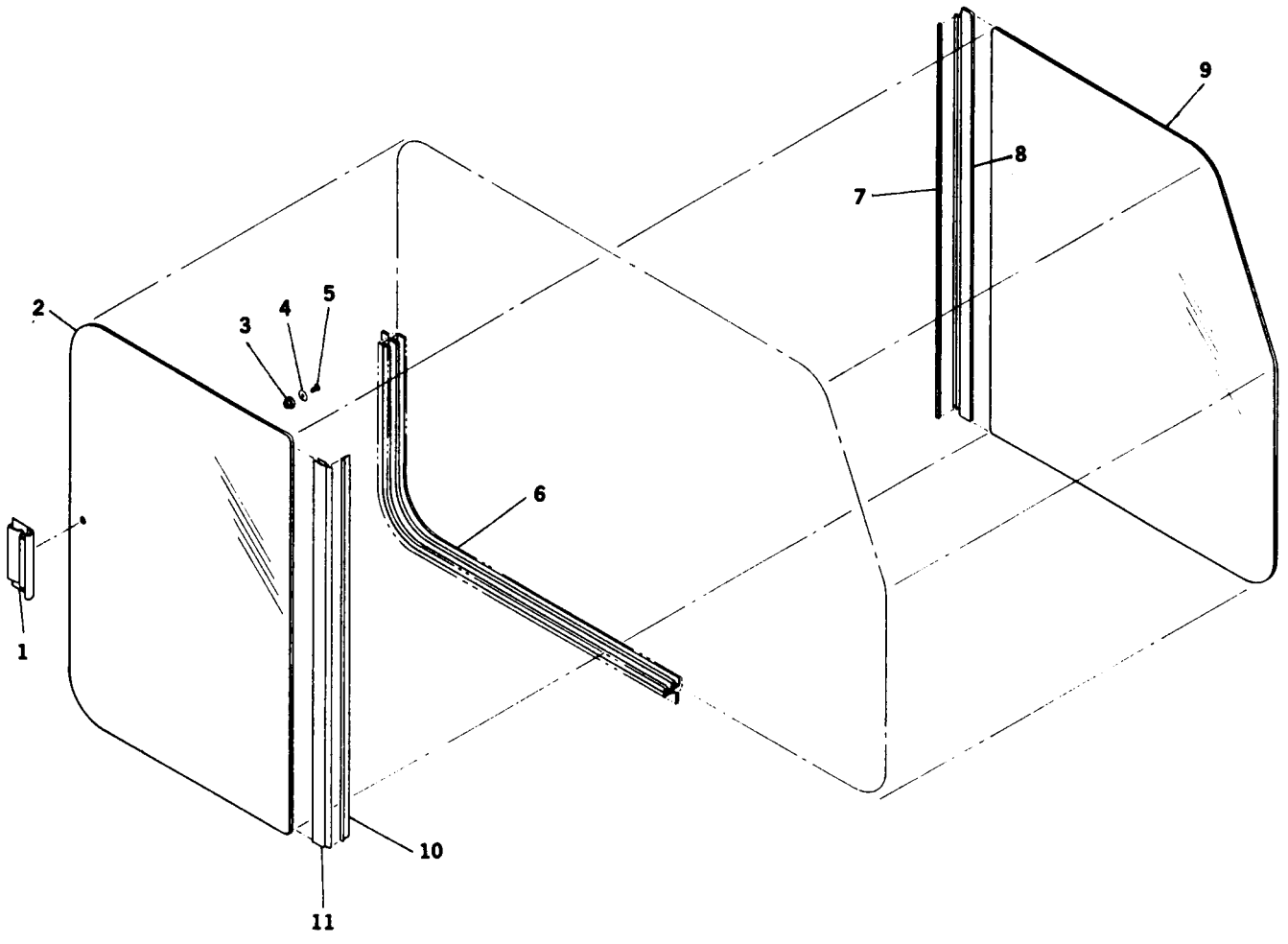
2-19. HEATER

2-20. REMOVAL AND DISASSEMBLY.

WARNING

Before performing maintenance or inspection (except operating tests), disconnect power source.

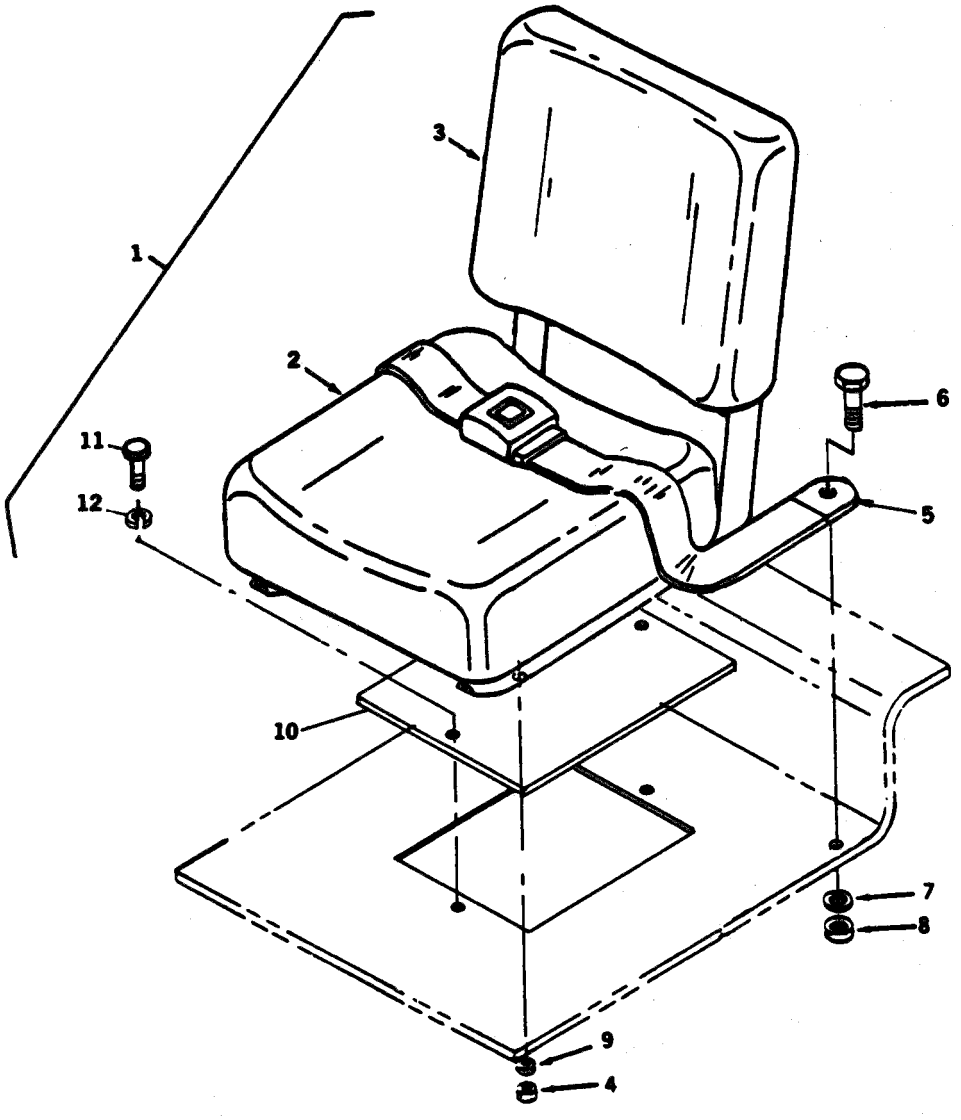
a. Disconnect power source. Tag and disconnect electrical leads to motor (13, figure 2-4).



LEGEND

1. Latch
2. Sliding Glass
3. Grommet
4. Washer
5. Screw
6. Rubber
7. Weatherstrip
8. Bar
9. Stationary Glass
10. Wiper
11. Wiper Bar

Figure 2-2. Window Assembly



LEGEND

1. Seat Assembly
2. Seat Cushion
3. Seat Back
4. Nut
5. Seat Belt
6. Capscrew
7. Washer
8. Nut
9. Washer
10. Plate
11. Capscrew
12. Lockwasher

Figure 2-3. Seat Installation

NOTE

A suitable container should be used to catch draining coolant.

b. Tag and disconnect heater hoses from heater.

c. Cap or plug all openings.

d. Remove nuts (1) and lockwashers (2) securing heater to mounting plate. Remove heater from crane.

e. Remove bolts (3), nuts (4) and front heater cover (5).

f. Remove heater core (7) and core pads (8).

g. Loosen setscrew (9), and remove fan (10).

h. Remove rubber gasket (11) and spacer plate (12) from motor (13) by sliding them over motor assembly.

i. Remove nuts (14), lockwashers (15), gasket (16), washers (17), and motor (13).

j. Remove screws (18), nuts (19), and fan grill (20).

2-21. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Inspect fan (10, figure 2-4) for any damage.

c. Inspect heater core (7) for any signs of leakage or other damage.

d. Inspect pads (8) for any signs of wear or other damage.

2-22. ASSEMBLY AND INSTALLATION.

a. Install fan grill (20, figure 2-4) on front heater cover (5) using screws (18) and nuts (19).

b. Install heater motor (13), washers (17), and motor gasket (16) on base plate (6) using nuts (14) and lockwashers (15).

c. Slide rubber gasket (11) and spacer plate (12) onto motor (13).

d. Install fan (10) on motor shaft and secure with setscrew (9).

e. Install core pads (8) and heater core (7) to base plate (6).

f. Secure front heater cover (5) to base plate (6) using bolts (3) and nuts (4).

g. Secure heater to mounting plate with hex nuts (1) and lockwashers (2).

h. Remove tags and secure heater hoses to heater with hose clamps.

i. Remove tags and connect electrical leads to motor (13) and connect power source.

j. Check heater for proper operation and ensure there are no leaks.

2-23. FUEL TANK

2-24. REMOVAL AND DISASSEMBLY.

a. Disconnect power at negative battery terminal.

NOTE

The fuel tank capacity is 31 gallons.

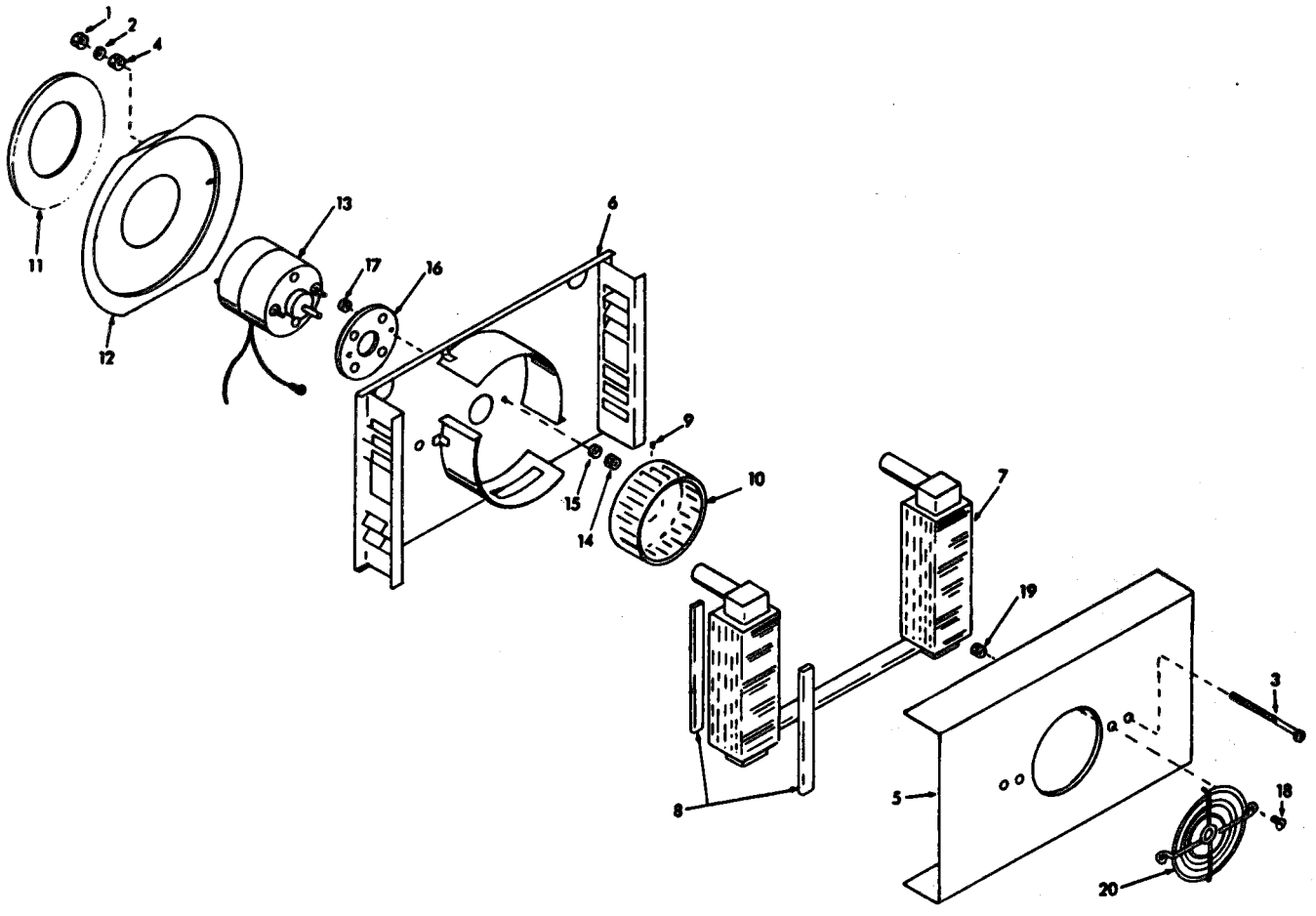
b. Use suitable container(s) to drain fuel tank. Remove fuel cap (2, figure 2-5) and siphon out fuel. Remove pipe plug (8) and drain remaining fuel.

c. Tag and disconnect electrical lead to fuel level sender (4).

d. Tag and disconnect fuel inlet and outlet lines at fuel tank.

e. Remove fuel level sender (4) and fuel check valve (5).

f. Remove locknuts (6), washers (7), straps (3), and fuel tank (1),



LEGEND

1. Hex Nut
2. Lockwasher
3. Bolt
4. Hex Nut
5. Front Cover
6. Base Plate
7. Heater Core
8. Core Pads
9. Setscrew
10. Fan
11. Rubber Gasket
12. Spacer Plate
13. Motor
14. Hex Nut
15. Lockwasher
16. Motor Gasket
17. Washer
18. Screw
19. Nut
20. Fan Grill

Figure 2-4. Hot Water Heater

LEGEND

1. Fuel Tank
2. Fuel Cap
3. Strap
4. Fuel Level Sender
5. Fuel Check Valve
6. Locknut
7. Washer
8. Pipe Plug

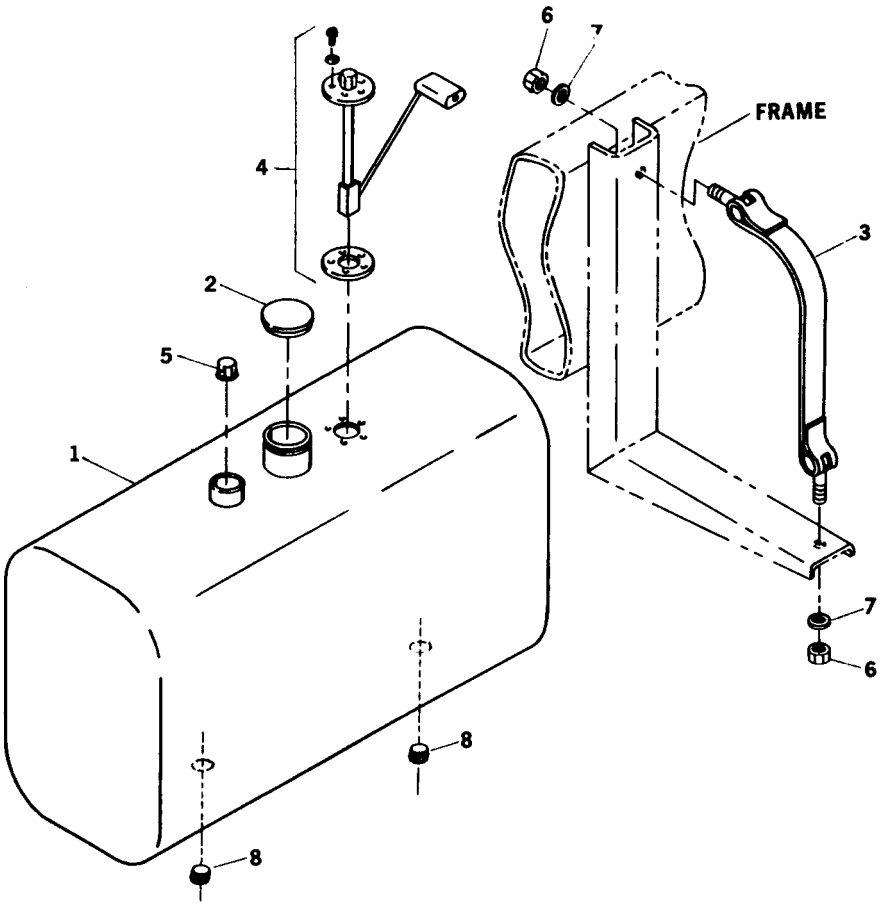


Figure 2-5. Fuel Tank Installation

2-25. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Inspect all parts for corrosion and damage.

2-26. REPAIR.

a. Repair of the fuel tank installation shall be limited to the replacement of all worn or damaged parts.

2-27. ASSEMBLY AND INSTALLATION.

a. Secure fuel tank (1, figure 2-5) to frame with straps (3), washers (7), and locknuts (6).

b. Install fuel level sender (4) and fuel check valve (5).

c. Remove tags and install inlet and outlet fuel lines at fuel tank.

d. Remove tags and install electrical leads at fuel level sender (4).

e. Install pipe plugs (8) and fill fuel tank with diesel fuel. Install fuel cap (2).

SECTION 3

ENGINE ASSEMBLY MAINTENANCE INSTRUCTIONS

3-1. TROUBLESHOOTING.

NOTE

Refer to figure 3-0 for the location of major components of the engine and transmission.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Engine will not start.	a. Engine too cold to ignite fuel properly.	a. Depress COLD START button for two seconds and turn ignition switch to START.
	b. Fuel tank empty.	b. Fill with correct fuel. (+40 to -25°F use arctic diesel fuel.)
	c. Electric fuel shutoff not functioning.	c. Inspect electrical connections at solenoid in fuel injection pump,
	d. Battery cables - loose connections.	d. Tighten cable connections.
	e. Battery weak or discharged.	e. Charge or replace battery (para. 3-12).
	f. Air inlet restricted.	f. Check air inlet and clear restriction.
	g. Fuel filters dirty or plugged.	g. Replace fuel filters.
	h. Air leaks in fuel system.	h. Tighten fuel tube nuts. Replace worn or damaged parts.
	i. Fuel injection pump incorrectly timed.	i. Time fuel injection pump (para. 3-106).
	j. Valves incorrectly adjusted.	j. Adjust valve clearances (para. 3-105).
	k. Fuel contamination.	k. Drain and flush fuel system, Refill tank with proper fuel.
	l. Fuel transfer pump worn.	1. Replace fuel transfer pump (para. 3-33).
	m. Valves sticking.	m. Replace valves (para. 3-68).
	n. Low cylinder compression.	n. Repair cylinders (para. 3-64).
	o. Excessive thrust pressure on shafts.	o. Repair engine.
	p. Fuel incorrect for conditions,	p. Drain fuel tank and refill with correct fuel.
	q. Coolant in cylinders.	q. Repair cylinder head (para. 3-64).

SYMPTOM	PROBABLE CAUSE	SOLUTION
2. Hard starting.	a. Engine too cold to ignite fuel properly.	a. Depress COLD START button for two seconds and turn ignition switch to START.
	b. Battery cables-loose connections.	b. Tighten cable connections.
	c. Battery weak or discharged.	c. Charge or replace battery (para. 13-12).
	d. Air inlet restricted.	d. Check air inlet and clear restriction.
	e. Air cleaner dirty.	e. Replace air cleaner (para. 3-2).
	f. Fuel contamination.	f. Drain and flush fuel system. Refill tank with proper fuel.
	g. Fuel incorrect for conditions.	g. Drain tank and refill with fuel.
	h. Fuel filters dirty or plugged.	h. Replace fuel filters.
	i. Sticking or fouled fuel injection nozzle.	i. Replace fuel injection nozzle (para. 3-44).
	j. Fuel return plugged or restricted.	j. Check fuel return and remove any restrictions.
	k. Air leaks in fuel system.	k. Tighten fuel tube nuts. Replace worn or damaged parts.
	l. Fuel injection pump incorrectly timed.	l. Time fuel injection pump (para. 3-106).
	m. Luboil level too high.	m. Drain luboil as needed.
	n. Wrong type of luboil.	n. Drain luboil. Replace with proper grade.
	o. Fuel transfer pump worn.	o. Replace fuel transfer pump (para. 3-33).
	p. Valves incorrectly adjusted.	p. Adjust valve clearances (para. 3-105).
	q. Valves sticking.	q. Replace valves (para. 3-68).
	r. Valves leaking.	r. Repair valve seats (para. 3-68).
	s. Excessive thrust pressure on shafts.	s. Repair engine.
	t. Coolant in cylinders.	t. Repair cylinder head (para. 3-64).

SYMPTOM	PROBABLE CAUSE	SOLUTION
2. Hard starting (cont'd).	u. Low cylinder compression.	u. Repair cylinders (para. 3-64).
	v. Worn pistons, rings, etc.	v. Replace pistons and rings (para. 3-91).
3. Engine stops.	a. Fuel tank empty.	a. Fill with correct fuel. (+40 to -25°F use arctic diesel fuel.)
	b. Fuel return plugged or restricted.	b. Check fuel return and remove any restrictions.
	c. Battery cables - loose connections.	c. Tighten cable connections.
	d. Battery weak or discharged.	d. Charge or replace battery (para. 13-12).
	e. Exhaust system restricted.	e. Check system and free restricted areas. Replace damaged parts.
	f. Fuel incorrect for conditions.	f. Drain fuel tank and refill with correct fuel.
	g. Electric fuel shutoff not functioning.	g. Inspect electrical connections at solenoid in fuel injection pump.
	h. Fuel filters dirty or plugged.	h. Replace fuel filters.
	i. Air leaks in fuel system.	i. Tighten fuel tube nuts. Replace worn or damaged parts.
	j. Excessive thrust pressure on shafts.	j. Repair engine.
4. Erratic engine performance.	a. Engine too cold to ignite fuel properly.	a. Depress COLD START button for two seconds and turn ignition switch to START.
	b. Fuel tank vent plugged.	b. Clean or replace tank vent.
	c. Air inlet restricted.	c. Check inlet and clear the restriction.
	d. Air cleaner dirty.	d. Replace air cleaner (para. 3-2).
	e. Battery cables - loose connections.	e. Tighten cable connections.
	f. Battery weak or discharged.	f. Charge or replace battery (para. 13-12).
	g. Exhaust system restricted.	g. Check system and free restricted areas (para. 3-113).

SYMPTOM	PROBABLE CAUSE	SOLUTION
4. Erratic engine performance (cont'd).	g. Exhaust system restricted.	g. Check system and free restricted areas (para. 3-113).
	h. Fuel incorrect for conditions.	h. Drain fuel tank and refill with correct fuel.
	i. Fuel contamination.	i. Drain and flush fuel system. Refill tank with proper fuel.
	j. Fuel filters dirty or plugged.	j. Replace fuel filters.
	k. Air leaks in fuel system.	k. Tighten fuel tube nuts. Replace worn or damaged parts.
	l. Fuel injection pump incorrectly timed.	l. Time fuel injection pump (para. 3-106).
	m. Sticking or fouled fuel injection nozzle.	m. Replace fuel injection nozzle (para. 3-44).
	n. Fuel return plugged or restricted.	n. Check fuel return and remove any restrictions.
	o. Incorrect fuel setting.	o. Adjust idle speed (para. 3-107).
	p. Fuel injection nozzle opening pressure incorrect.	p. Replace fuel injection nozzle (para. 3-44).
	q. Fuel injection nozzle incorrectly torqued.	q. Torque fuel injection nozzle from 25 to 30 foot pounds.
	r. Fuel transfer pump worn.	r. Replace fuel transfer pump (para. 3-33).
	s. Valves incorrectly adjusted.	s. Adjust valve clearances (para. 3-105).
	t. Valves sticking.	t. Replace valves (para. 3-68).
	u. Valves leaking.	u. Repair valve seats (para. 3-68).
	v. Coolant in cylinders.	v. Repair cylinder head (para. 3-64).
	w Foreign matter on pistons.	w. Clean or replace pistons (para. 3-91).
	x. Low cylinder compression.	x. Repair cylinders (para. 3-64).
	y. Scored pistons.	y. Clean or replace pistons (para. 3-91).
	z. Bearings failed - main, rod, cam.	z. Replace bearings (para. 3-87 and 3-95).

SYMPTOM	PROBABLE CAUSE	SOLUTION
5. Black exhaust smoke.	a. Fuel tank vent plugged.	a. Clean or replace tank vent.
	b. Air inlet restricted.	b. Check air inlet and clear the restriction.
	c. Air cleaner dirty.	c. Replace air cleaner (para. 3-2).
	d. Exhaust system restricted.	d. Check system and free restricted areas.
	e. Fuel incorrect for conditions.	e. Drain fuel tank and refill with correct fuel.
	f. Sticking or fouled fuel injection nozzle.	f. Replace fuel injection nozzle (para. 3-44).
	g. Inoperative thermostat.	g. Replace thermostat (para. 3-56).
	h. Engine overloaded.	h. Shift transmission to lower gear setting.
	i. Engine overspeeded.	i. Apply service brakes to slow crane.
	j. Incorrect fuel setting.	j. Adjust idle speed (para. 3-104).
	k. Fuel injection nozzle opening pressure incorrect.	k. Replace fuel injection nozzle (para. 3-44).
	l. Fuel injection pump incorrectly timed.	l. Time fuel injection pump (para. 3-106).
	m. Valves sticking.	m. Replace valves (para. 3-68).
6. Blue exhaust smoke.	a. Luboil level too high.	a. Drain luboil as needed.
	b. Wrong type of luboil.	b. Drain luboil. Replace with proper grade.
	c. Air inlet restricted.	c. Check inlet and clear the restriction.
	d. Air cleaner dirty.	d. Replace air cleaner (para. 3-2).
	e. Fuel contamination.	e. Drain and flush fuel system. Refill tank with proper fuel.
	f. Fuel incorrect for conditions.	f. Drain fuel tank and refill with correct fuel.
	g. Valves leaking.	g. Repair valve seats (para. 3-68).
	h. Low cylinder compression.	h. Repair cylinders (para. 3-64).

SYMPTOM	PROBABLE CAUSE	SOLUTION
6. Blue exhaust smoke (cont'd).	i. Worn pistons, rings, etc.	i. Replace pistons and rings (para. 3-91).
	j. Scored pistons.	j. Clean or replace pistons (para. 3-91).
	k. Rocker arm shaft upside down.	k. Remove and install rocker arm shaft correctly (para. 3-60).
	l. Bearings failed - main, rod, cam.	l. Replace bearings (para. 3-87 and 3-95).
7. White exhaust smoke.	a. Inoperative thermostat.	a. Replace thermostat (para. 3-56).
	b. Fuel injection pump incorrectly timed.	b. Time fuel injection pump (para. 3-106).
	c. Coolant in cylinders.	c. Repair cylinder head (para. 3-64).
8. Low power.	a. Engine too cold to ignite fuel properly.	a. Warm-up engine for five minutes.
	b. Fan belt loose or slipping.	b. Check belt and tighten or replace. Belt should deflect 3/4-inch at midspan between pulleys.
	c. Low coolant level.	c. Add coolant.
	d. Inoperative thermostat.	d. Replace thermostat (para. 3-56).
	e. Radiator fins or tubes dirty or restricted.	e. Clean with low pressure air and water.
	f. Air inlet restricted.	f. Check air inlet and clear the restriction.
	g. Air cleaner dirty.	g. Replace air cleaner (para. 3-2).
	h. Exhaust system restricted.	h. Check system and free restricted areas. Replace damaged parts.
	i. Luboil level too high.	i. Drain luboil as needed.
	j. Throttle linkage adjustment incorrect or sticking.	j. Replace parts as needed.
	k. Fuel contamination.	k. Drain and flush fuel system. Refill tank with proper fuel.
	l. Fuel incorrect for conditions.	l. Drain fuel tank and refill with correct fuel.

SYMPTOM	PROBABLE CAUSE	SOLUTION
8. Low Power (cont'd).	m. Fuel filters dirty or plugged.	m. Replace fuel filters.
	n. Air leaks in fuel system.	n. Tighten fuel tube nuts. Replace worn or damaged parts.
	o. Fuel injection pump incorrectly timed.	o. Time fuel injection pump (para. 3-106).
	p. Sticking or fouled fuel injection nozzle.	p. Replace fuel injection nozzle (para. 3-44).
	q. Fuel return plugged or restricted.	q. Check fuel return and remove any restrictions.
	r. Incorrect fuel setting.	r. Adjust idle speed (para. 3-107).
	s. Fuel injection nozzle opening pressure incorrect.	s. Replace fuel injection nozzle (para. 3-44).
	t. Fuel injection nozzle incorrectly torqued.	t. Torque fuel injection nozzle bolts from 25 to 30 foot pounds.
	u. Bearings failed - main, rod, cam.	u. Replace bearings (para. 3-87 and 3-95).
	v. Engine overloaded.	v. Shift transmission to lower gear setting.
	w. Coolant in cylinders.	w. Repair cylinder head (para. 3-64).
	x. Fuel transfer pump worn.	x. Replace fuel transfer pump (para. 3-33).
	y. Valves incorrectly adjusted.	y. Adjust valve clearances (para. 3-105).
	z. Valves leaking.	z. Repair valve seats (para. 3-68).
	aa. Valves sticking.	aa. Replace valves (para. 3-68).
	bb. Foreign matter on pistons.	bb. Clean or replace pistons (para. 3-91).
	cc. Low cylinder compression.	cc. Repair cylinders (para. 3-64).
	dd. Worn pistons, rings, etc.	dd. Replace pistons and rings (para. 3-91).
	ee. Scored pistons.	ee. Clean or replace pistons (para. 3-91).
9. Engine overheating.	a. Fan belt loose or slipping.	a. Check belt and tighten or replace. Belt should deflect 3/4-inch at midspan between pulleys.

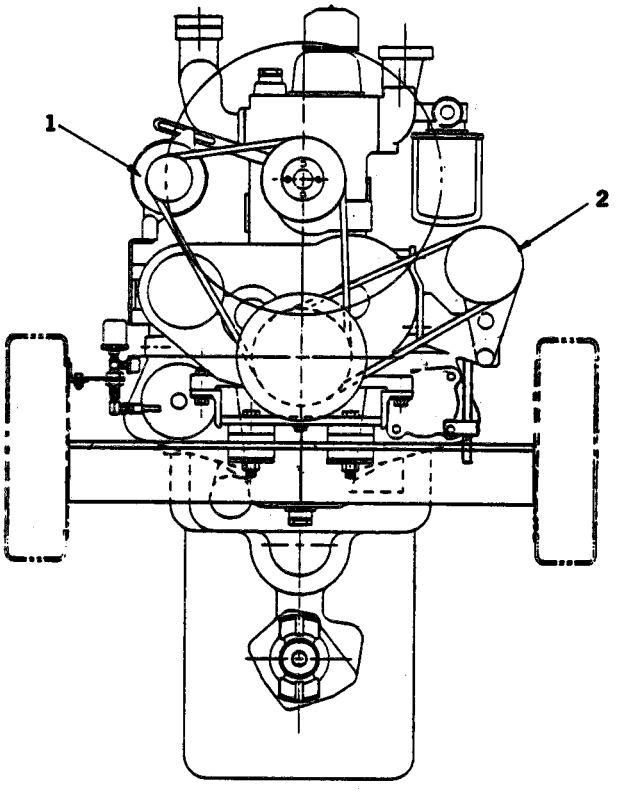
SYMPTOM	PROBABLE CAUSE	SOLUTION
9. Engine overheating (cont'd).	b. Radiator fins or tubes dirty or restricted.	b. Clean with low pressure air and water.
	c. Low coolant level.	c. Add coolant.
	d. Inoperative thermostat.	d. Replace thermostat (para. 3-56).
	e. Fuel injection pump incorrectly timed.	e. Time fuel injection pump (para. 3-106).
	f. Exhaust system restricted.	f. Check system and free restricted areas. Replace damaged parts.
	g. Scored pistons.	g. Clean or replace pistons (para. 3-91).
	h. Engine overloaded.	h. Shift transmission to lower gear setting.
	i. Engine overspeeded.	i. Apply service brakes to slow crane.
	j. Coolant in cylinders.	j. Repair cylinder head (para. 3-64).
10. Engine overcooking.	a. Inoperative thermostat.	a. Replace thermostat (para. 3-56).
11. Engine knocking.	a. Fuel contamination.	a. Drain and flush fuel system. Refill tank with proper fuel.
	b. Luboil level too low.	b. Add luboil to FULL line on dipstick.
	c. Fuel injection pump incorrectly timed.	c. Time fuel injection pump (para. 3-106).
	d. Sticking or fouled fuel injection nozzle.	d. Replace fuel injection nozzle (para. 3-44).
	e. Fuel return plugged or restricted.	e. Check fuel return and remove any restrictions.
	f. Fuel injection nozzle opening pressure incorrect.	f. Replace fuel injection nozzle (para. 3-44).
	g. Fuel injection nozzle incorrectly torqued.	g. Torque fuel injection nozzle bolts from 25 to 30 foot pounds.
	h. Engine overloaded.	h. Shift transmission to lower gear setting.

SYMPTOM	PROBABLE CAUSE	SOLUTION
11. Engine knocking (cont'd).	i. Engine overspeeded.	i. Apply service brakes to slow crane.
	j. Coolant in cylinders.	j. Repair cylinder head (para. 3-64).
	k. Foreign matter on pistons.	k. Clean or replace pistons (para. 3-91).
	l. Worn pistons, rings, etc.	l. Replace pistons and rings (para. 3-91).
	m. Scored pistons.	m. Clean or replace pistons (para. 3-91).
	n. Valves sticking.	n. Replace valves (para. 3-68).
	o. Valves incorrectly adjusted.	o. Adjust valve clearances (para. 3-105).
	p. Oil pump inlet screen plugged.	p. Clean oil pump inlet screen (para. 3-25).
	q. Pressure regulator not functioning.	q. Replace pressure regulator (para. 3-25).
	r. Luboil contaminated.	r. Drain and flush system. Replace with proper grade luboil.
	s. Bearings failed - main, rod, cam.	s. Replace bearings (para. 3-87 and 3-95).
12. Low oil pressure.	a. Luboil level too low.	a. Add luboil to FULL line on dipstick.
	b. Wrong type of luboil.	b. Drain luboil. Replace with proper grade.
	c. Oil pump inlet screen plugged.	c. Clean oil pump inlet screen (para. 3-25).
	d. Pressure regulator not functioning.	d. Replace pressure regulator (para. 3-25).
	e. Luboil contaminated.	e. Drain and flush system. Replace with proper grade luboil.
	f. Rocker arm shaft upside down.	f. Remove and install rocker arm shaft correctly (para. 3-60).
	g. Oil header plug missing or loose.	g. Tighten or replace oil header plug.
	h. Bearings failed - main, rod, cam.	h. Replace bearings (para. 3-87 and 3-95).

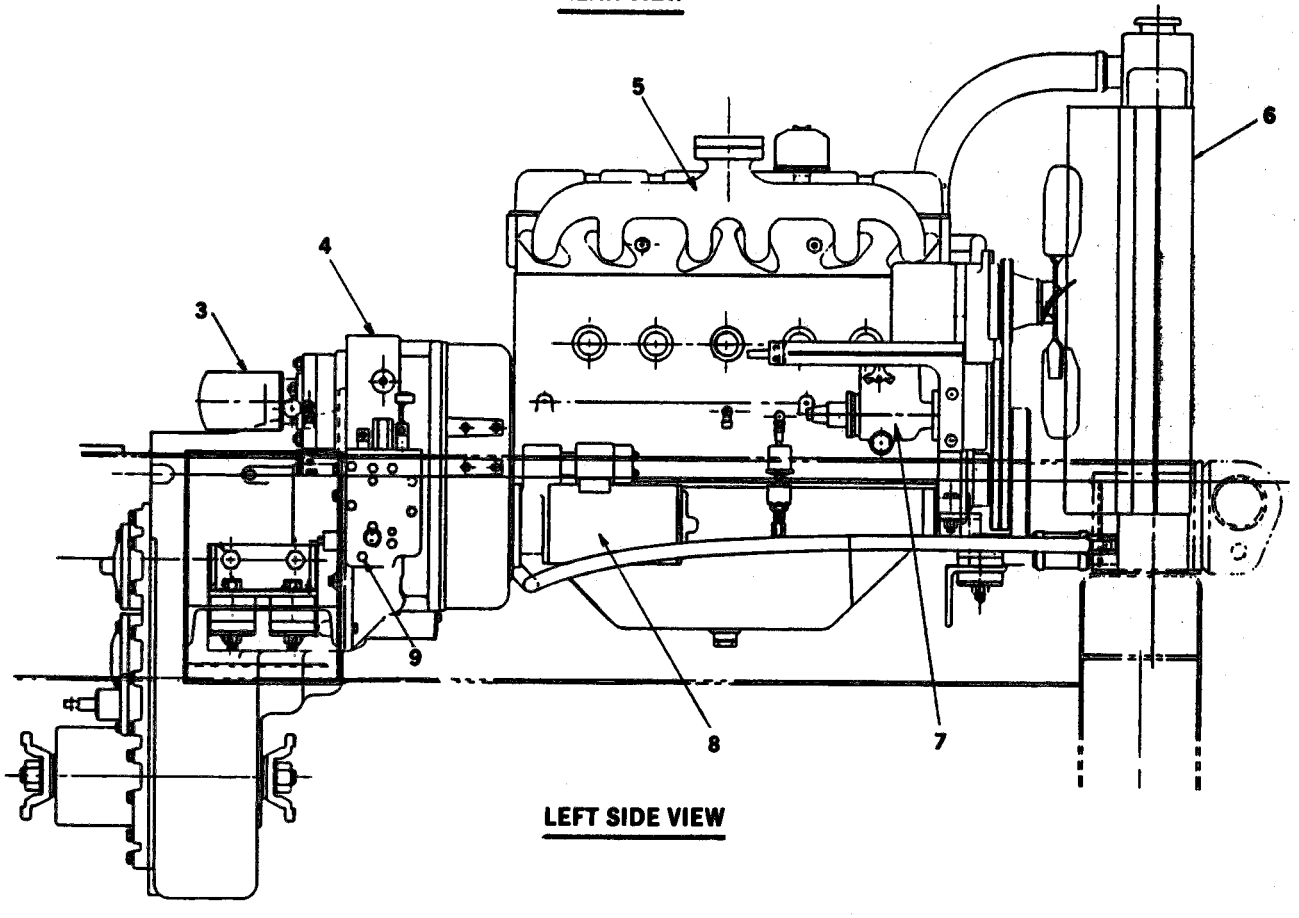
SYMPTOM	PROBABLE CAUSE	SOLUTION
12. Low oil pressure (cont'd).	i. Excessive thrust pressure on shafts.	i. Repair engine.
13. Bearing facilities.	a. Luboil level too low.	**a.** Add luboil to FULL line on dipstick.
	b. Wrong type of luboil.	b. Drain luboil. Replace with proper grade.
	c. Oil pump inlet screen plugged.	c. Clean oil pump inlet screen (para. 3-25).
	d. Pressure regulator not functioning.	d. Replace pressure regulator (para. 3-25).
	e. Luboil contaminated.	e. Drain and flush system. Replace with proper grade luboil.
	f. Oil header plug missing or loose.	f. Tighten or replace oil header plug.
	g. Excessive thrust pressure on shafts.	g. Repair engine.
	h. Scored pistons.	h. Clean or replace pistons (para. 3-91).

LEGEND FOR FIGURE 3-0

1. Alternator
2. Steering Pump
3. Transmission Oil Filter
4. Transmission/Torque Converter
5. Exhaust Manifold
6. Radiator
7. Fuel Injection Pump
8. Cranking Motor
9. Transmission Control Valve
10. 2 Section Hydraulic Pump
11. Water Pump
12. Thermostat Housing
13. Water Separator
14. Fuel Filter
15. Intake Manifold
16. Oil Filter
17. Transmission Charging Pump
18. Oil Pan
19. Tachometer Drive
20. Dipstick
21. Fuel Pump



REAR VIEW



LEFT SIDE VIEW

Figure 3-0. Engine/Transmission General Arrangement (Sheet 1 of 2)

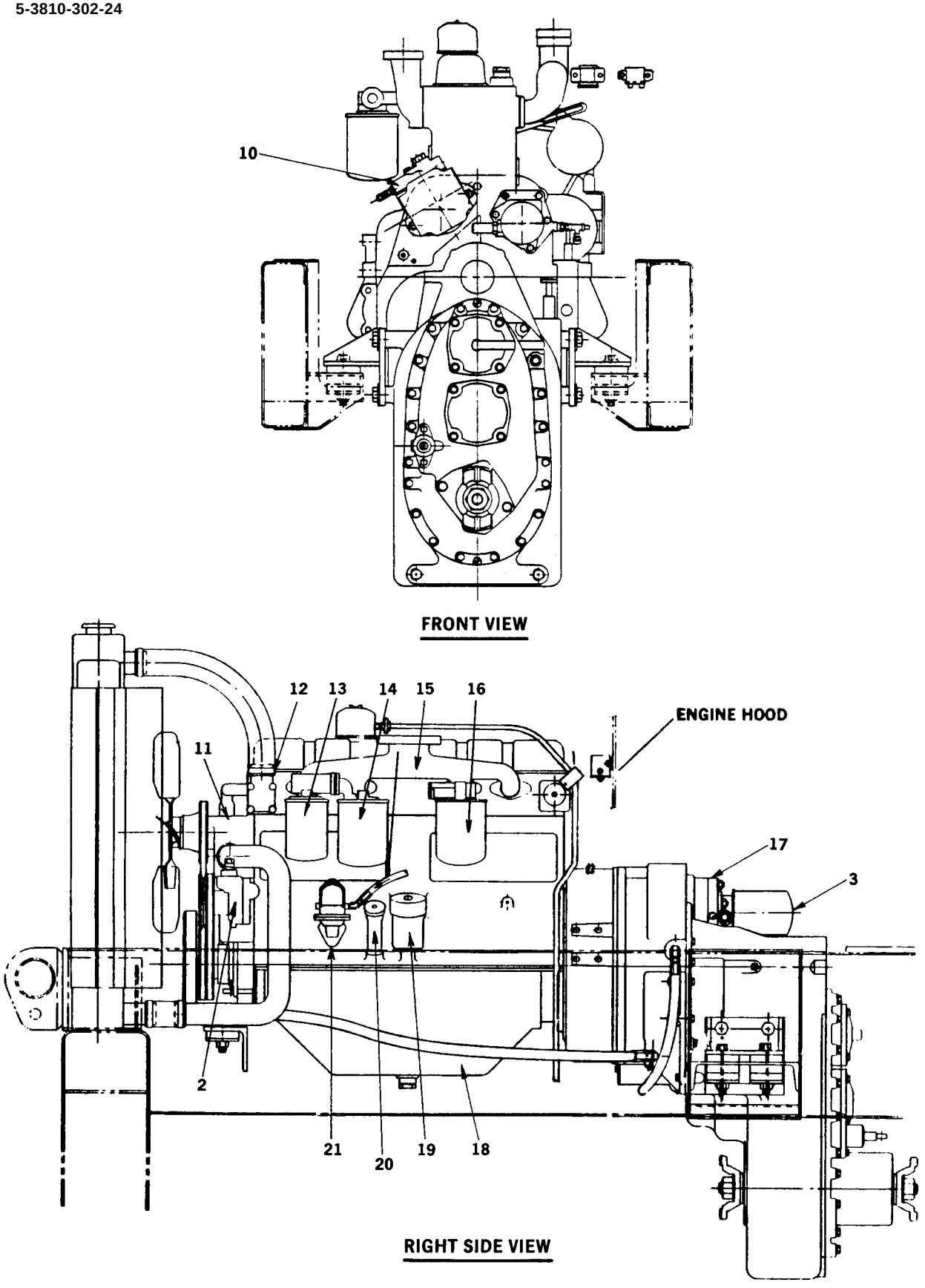
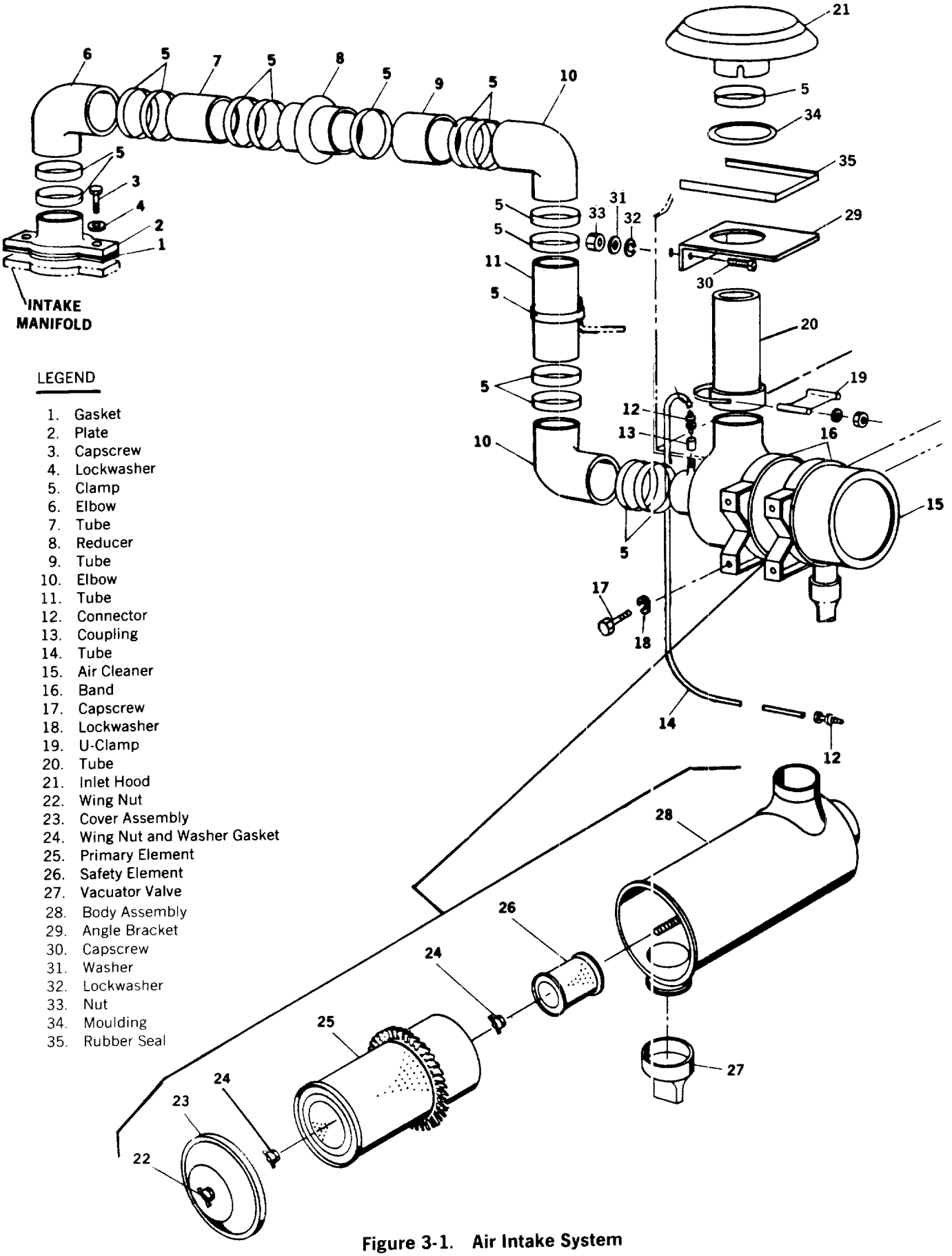


Figure 3-0. Engine/Transmission General Arrangement (Sheet 2 of 2)



LEGEND

1. Gasket
2. Plate
3. Capscrew
4. Lockwasher
5. Clamp
6. Elbow
7. Tube
8. Reducer
9. Tube
10. Elbow
11. Tube
12. Connector
13. Coupling
14. Tube
15. Air Cleaner
16. Band
17. Capscrew
18. Lockwasher
19. U-Clamp
20. Tube
21. Inlet Hood
22. Wing Nut
23. Cover Assembly
24. Wing Nut and Washer Gasket
25. Primary Element
26. Safety Element
27. Vacuator Valve
28. Body Assembly
29. Angle Bracket
30. Capscrew
31. Washer
32. Lockwasher
33. Nut
34. Moulding
35. Rubber Seal

Figure 3-1. Air Intake System

3-2. AIR INTAKE SYSTEM.

3-3. REMOVAL AND DISASSEMBLY.

a. Loosen clamp (5, figure 3-1) and remove inlet hood (21).

b. Remove battery box cover.

c. Remove u-clamps (19) and tube (20).

d. Remove connector (12) and coupling (13).

e. Remove clamps (5), elbows (10), tubes (9 and 11), reducer (8), tube (7), and elbow (6). If necessary, remove capscrews (3), lockwashers (4), plate (2), and gasket (1).

f. Remove capscrews (17), lockwashers (18), and air cleaner (15).

g. Remove wing nut (22) and cover assembly (23) from body assembly (28).

h. Remove first wing nut and washer gasket (24).

i. Withdraw primary element (25) from body assembly.

j. Remove second wing nut and washer gasket (24).

k. Remove safety element (26).

l. Remove vacuator valve (27).

3-4. CLEANING AND INSPECTION.

NOTE

Never attempt to clean a safety element (26, figure 3-1). Replace safety element if contaminated.

a. Cleaning primary element with air:

1. Remove loose dust and soot by directing a jet of clean, dry air from inside filter element perpendicular to pleats while rotating element.

b. Cleaning primary element with water.

1. Immerse and soak element for at least fifteen minutes in a cleaning solution of warm water and detergent. Agitate element occasionally to loosen attached dirt.

2. Remove element from detergent solution and rinse with clean water until water coming through element is clean.

3. Air dry element thoroughly before putting back in service.

c. Inspect primary element for ruptures and similar damage. Any hole or material rupture is cause for element replacement.

d. Check condition of vacuator valve and lips. Ensure lips are clean.

3-5. ASSEMBLY AND INSTALLATION

a. Secure vacuator valve (27, figure 3-1) to body assembly (28) with lips pointing down.

b. Install safety element (26) in body assembly. Secure with wing nut.

c. Install primary element (25) in body assembly. Secure with wing nut.

d. Install cover assembly (23) and secure with wing nut (22).

e. Install air cleaner (15) with capscrews (17) and lockwashers (18).

f. Install plate (2) and new gasket (1) with capscrews (3) and lockwashers (4).

g. Assemble elbow (6), tube (7), reducer (8), tube (9), elbows (10), and tube (11) with clamps (5).

h. Install tube (20) and secure with u-clamp (19).

i. Install coupling (13) and connector (12).

j. Install inlet hood (21) with clamp (5).

k. Install battery box cover.

l. Ensure all gaskets and seals are properly seated and intake air to the engine is being drawn through the filter assembly.

3-6. COOLANT SYSTEM.

3-7. SYSTEM MAINTENANCE.

3-8. At intervals of no more than one year apart, flush out radiator cooling system as follows:

WARNING

The cooling system is pressurized. Personal injury may result when removing the radiator cap after operating temperature is reached. Use proper protection when removing the radiator cap.

WARNING

When removing the cap, loosen it slowly and then pause a moment. This will avoid possible burning by hot water or steam. Continue to turn the cap to the left until it can be removed.

a. Coolant shut-off valve to heater should be open to allow complete circulation during cleaning, flushing, and draining. Run engine with radiator covered, if necessary until temperature is up to operating range 160 to 180 degrees F (71 to 82 degrees C). Stop engine, remove radiator cap, (13, figure 3-2), and drain system by opening drain cocks on radiator and engine block.

b. Allow engine to cool, close drain cocks, and pour cleaning compound into radiator according to directions. Fill system with water.

c. Place a clean drain pan to catch water overflow, and use to maintain level in radiator. Do not spill solution on vehicle paint.

d. Replace radiator cap (13) and run engine at moderate speed, covering radiator if necessary, so system reaches a temperature of 180 degrees F (82 degrees C) or above, but does not reach boiling point. Allow engine to run at least two hours, or according to recommendations of manufaturer of cleaning compound, at 180 degrees F (82 degrees C). Do not drive vehicle or allow the liquid level in radiator to drop low enough to reduce circulation. Stop engine as often as necessary to prevent boiling.

e. With engine stopped, feel radiator core with bare hands to check for cold spots, and then observe temperature gauge reading. Where there is no change in temperature for some time, drain cleaning solution.

f. If clogging of core is relieved but not fully corrected, allow engine to cool, pressure-flush system and repeat cleaning operation.

g. If clogging of core, indicated by low temperature spots on core, is not relieved, radiator core must be removed for mechanical cleaning. Mechanical cleaning requires removal of upper and lower tanks, and rodding out accumulated rust and scale from water passages of core.

3-9. PRESSURE FLUSHING.

a. Disconnect upper radiator hose and remove thermostat.

b. Clamp a convenient length of hose to radiator core outlet opening, and attach another suitable length of hose to the radiator inlet opening to carry away flushing stream.

c. Connect flushing gun to compressed air and water pressure, and clamp gun nozzle to hose attached to radiator outlet opening.

d. With radiator capon tight, (13, figure 3-2), fill core with water. Turn on air pressure in short blasts to prevent core damage.

e. Continue filling radiator with water and applying air pressure as above until water comes out clear.

f. Clamp flushing gun nozzle firmly to a hose attached securely to engine water outlet opening. Fill engine block with water, partly covering water inlet opening to permit complete filling.

g. Turn on compressed air to blow out water and loosen sediment. Continue filling with water and blowing out with air until flushing stream comes out clear.

h. For badly clogged water jackets that do not respond to regular pressure flushing, remove engine cylinder head and core hole plugs, and with a suitable length of small copper tubing attached to flushing gun nozzle, flush water jackets through openings.

i. Flush cab heater, following same procedure as for radiator core.

j. After completing flushing operation, clean out radiator overflow pipe and inspect water pump. Check thermostat for proper operation by immersing thermostat and a thermometer in a pan of water so both are raised from bottom of container. Heat the water. Check that thermostat starts to open at about 180°F, and is fully open at 200°F ±5°. Replace a damaged or defective thermostat.

k. Clean radiator air passages with water.

3-10. REMOVAL AND DISASSEMBLY.

WARNING

The cooling system is pressurized, Personnel injury may result when removing the radiator cap after operating temperature is reached. Use proper protection when removing the radiator cap.

WARNING

When removing the cap, loosen it slowly and then pause a moment. This will avoid possible burning by hot water or steam. Continue to turn the cap to the left until it can be removed.

a. Remove twelve bolts that secure radiator grill. Remove grill.

LEGEND

1. Radiator
2. Hex Nut
3. Flat Washer
4. Lockwasher
5. Elbow
6. Stud
7. Coupling
8. Drain Cock
9. Hex Nut
10. Lockwasher
11. Clamp
12. Capscrew
13. Radiator Cap
14. Hose
15. Plug

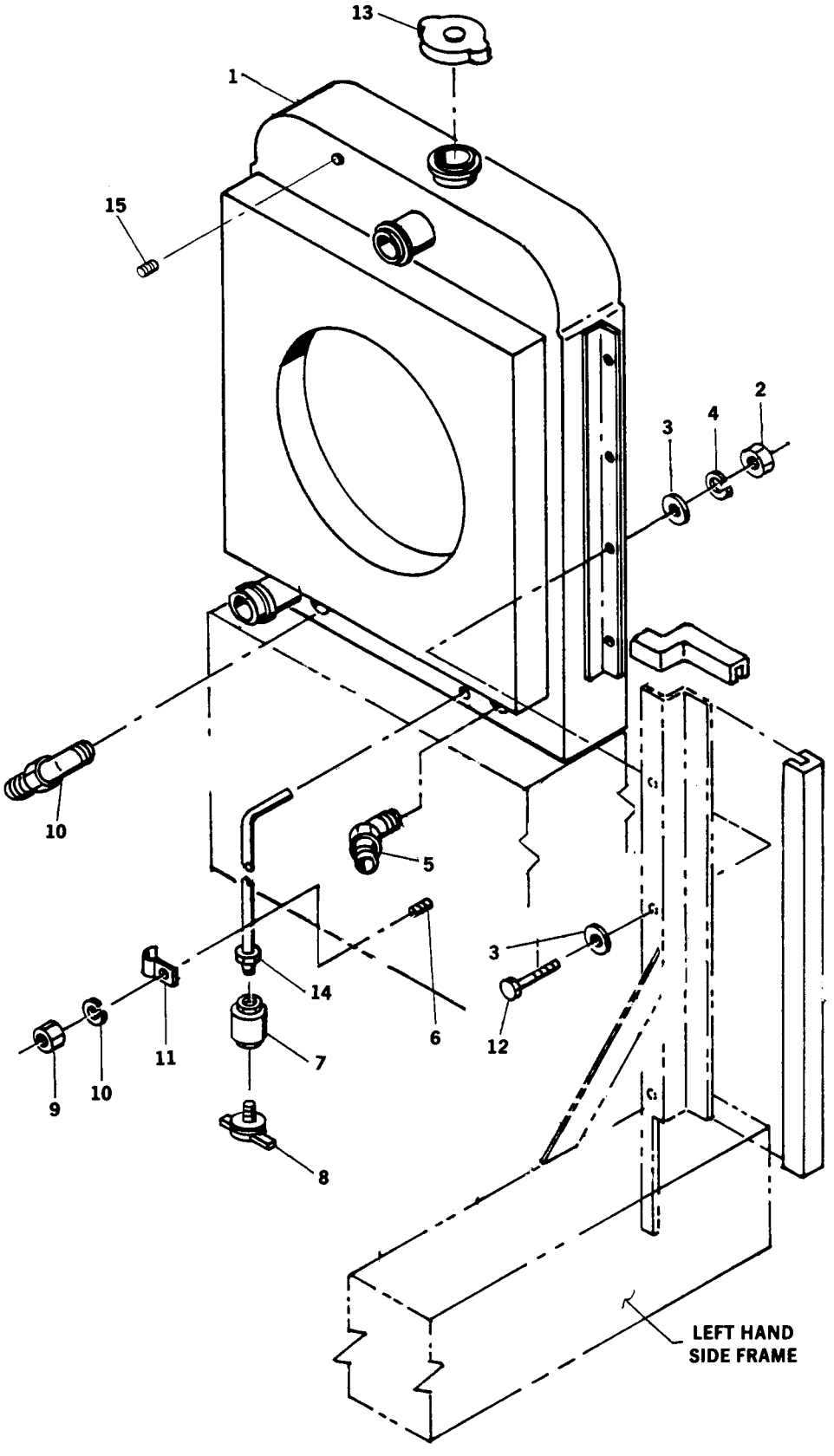


Figure 3-2. Radiator Cooling Installation

b. Remove radiator cap (13, figure 3-2) open drain cock (8) and drain coolant into 10 gallon container.

c. Tag and disconnect transmission oil cooler piping from elbows (5).

d. Disconnect upper and lower radiator hoses.

e. Remove hex nut (9), lockwasher (10), and clamp (11).

WARNING

Exercise caution when removing radiator (1) to avoid personal injury or equipment damage.

f. With a suitable lifting device, lift radiator (1) from frame after removing hex nuts (2), lockwashers (4) flat washers (3), and capscrews (12). Move radiator to a suitable work area.

g. Remove drain cock (8), coupling (7), and elbows (5).

3-11. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Clean interior of radiator by flushing with a radiator cleaning solution and flush with clean water.

c. Inspect hoses for breaks, cuts, cracks, or deterioration.

d. Inspect radiator for loose tubes or evidence of leaks.

e. Inspect all threaded items for damaged threads.

f. Inspect radiator cap (13, figure 13-2) for signs of gasket deterioration, bent holding prongs, and faulty or no valve spring action.

g. Check welds of support angles to radiator.

3-12. REPAIR AND REPLACEMENT.

a. Replace hoses that are damaged or defective.

b. Replace all threaded items which have damaged threads.

c. Bend holding prongs to allow radiator cap (13, figure 3-2) to seat snugly on filler neck. Replace cap if gasket or valve spring action is faulty.

d. Repair broken welds on radiator support angles.

e. Repair a leaking radiator by soldering. Use very small amounts of solder to prevent blocking of tube. Replace a radiator which is beyond repair.

f. Straighten bent cooling fins using extreme care to prevent damage to radiator.

3-13. ASSEMBLY AND INSTALLATION.

Install elbows (5, figure 3-2), coupling (7), and drain cock (8).

b. With a suitable lifting device, position radiator (1) to frame and install capscrews (12), flat washers (3), lockwashers (4), and hex nuts (2).

c. Install clamp (11), lockwasher (10), and hex nut (9) on weld stud.

d. Connect upper and lower radiator hoses.

e. Remove tags and connect transmission oil cooler piping to elbows (5).

f. Ensure drain cock (8) is closed and fill radiator with recommended antifreeze solution. Install radiator cap (13). Run engine until operating temperatures reached. Coolant level will fall as thermostat opens.

WARNING

The cooling system is pressurized. Personal injury may result when removing the radiator cap after operating temperature is reached. Use proper protection when removing the radiator cap.

WARNING

When removing the cap, loosen it slowly and then pause a moment. This will avoid possible burning by hot water or steam. Continue to turn the cap to the left until it can be removed.

g. Carefully remove radiator cap (13) and fill radiator to full level. Install radiator cap and operate engine while checking for leaks as coolant pressure increases.

h. Install radiator grill and secure with twelve capscrews.

3-14. ENGINE ASSEMBLY.

3-15. REMOVAL.

a. Disconnect and remove batteries.

b. Disconnect exhaust outlet flange at exhaust manifold and air inlet flange at intake manifold.

c. Remove four nuts and lockwashers that secure engine oil cooler to hood. Lay oil cooler back on engine. Remove engine hood assembly.

d. Remove oil pan plug (1, figure 3-3) and drain engine oil into five gallon container. Remove transmission drain plug (2) and drain transmission oil into a five gallon container.

e. Remove radiator cap, open draincock, and drain coolant into 10 gallon container.

f. Tag and disconnect coolant and heater hoses.

g. Tag and disconnect hydraulic lines to pump mounted on rear of torque converter.

h. Tag and disconnect fuel supply and return lines. Disconnect cold weather start system.

i. Tag and disconnect leads to starter, alternator, and temperature and pressure sending units.

j. Remove accelerator control cable at fuel injection pump. Remove nuts, u-bolts, cotter pins, and clevis pin securing shift linkage at transmission control valve. Disconnect axle disconnect linkage.

k. Disconnect front and rear drive shafts.

l. Attach hoist to engine and transmission assembly. Remove capscrews (3) washers (4) nuts (5), and lockwashers (6), securing engine and transmission to frame. Remove engine and transrmission. Secure engine to maintenance stand.

m. Remove cover on flywheel housing (opposite starter). Manually rotate crankshaft until capscrew (7) is visible. Remove capscrew (7).

n. Rotate crankshaft and remove next capscrew (7). Repeat step until total of eight capscrews (7) have been removed.

o. Support transmission with overhead hoist and remove twelve capscrews (8) and lockwashers (9).

p. Transport engine to work area.

3-16. INSTALLATION.

a. Support transmission with overhead hoist. Mate drive plates on torque converter with flywheel on engine.

b. Install one capscrew (7, figure 3-3) through access hole in flywheel housing attaching engine flywheel with drive plates.

c. Install capscrews (8) and lockwashers (9). Torque capscrews (8) to 30 foot-pounds.

d. Torque capscrew (7) to 35 ft lbs. Manually rotate crankshaft until next tapped hole in flywheel is visible through access hole. Install capscrew (7). Repeat step until a total of eight capscrews (7) have been installed.

e. Install cover on flywheel housing.

f. Hoist engine and transmission assembly and position on frame mounting brackets.

g. Install capscrews (3), washers (4), lockwashers (5), and nuts (6).

h. Connect front and rear drive shafts, axle disconnect linkage, and transmission shift linkage. Install clevis pins, cotter pins, u-bolt, and nuts.

i. Install accelerator control cable at fuel injection pump.

j. Remove tags and install leads to starter, alternator, and temperature and pressure sending units.

k. Remove tags and install fuel supply and return lines.

l. Remove tags and install hydraulic lines to pump. Connect cold weather start system.

m. Remove tags and install coolant and heater hoses.

n. Close draincock and fill radiator with a solution of one part fresh water and one part anti-freeze MIL-C-11755.

o. Install drain plug (2) and fill transmission sump with oil MIL-L-2104 SAE 10.

p. Install oil pan plug (1) and fill engine with oil MIL-L-2104 SAE 30 (+32° to 100°F) or SAE 10 (0° to +32°F).

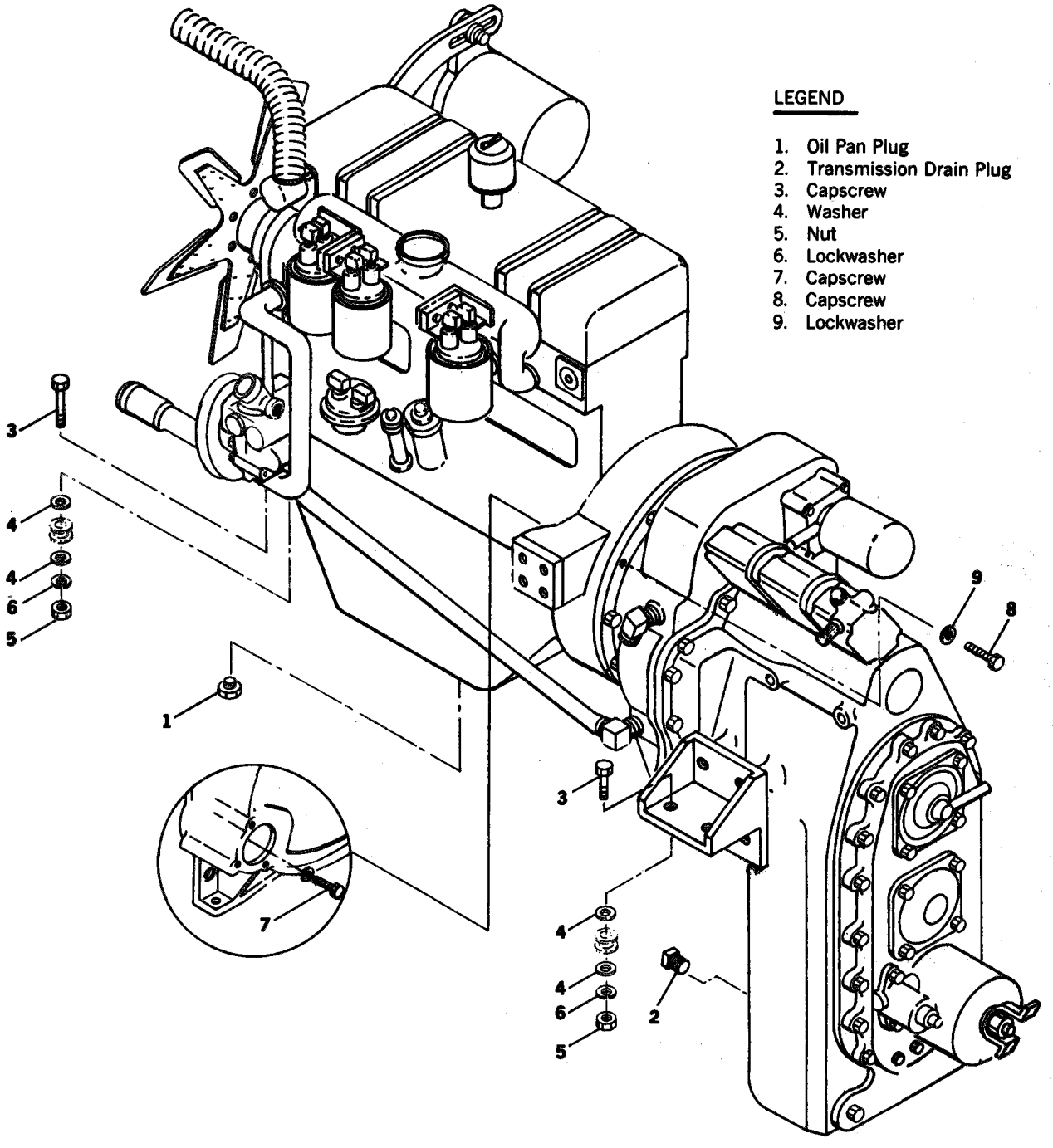


Figure 3-3. Engine Removal

q. Install engine hood assembly.

r. Connect exhaust outlet flange and air intake flange.

s. Install batteries and connect.

3-17. OIL FILTER AND LINES.

3-18. Removal.

a. Remove oil pan plug (1, figure 3-3) and drain oil from crankcase.

b. Disconnect and remove oil line assemblies (13 and 15, figure 3-4).

c. Remove oil filter element (2).

d. Remove base assembly (4) by removing capscrews (10), nuts (11), lockwashers (12), and base (4).

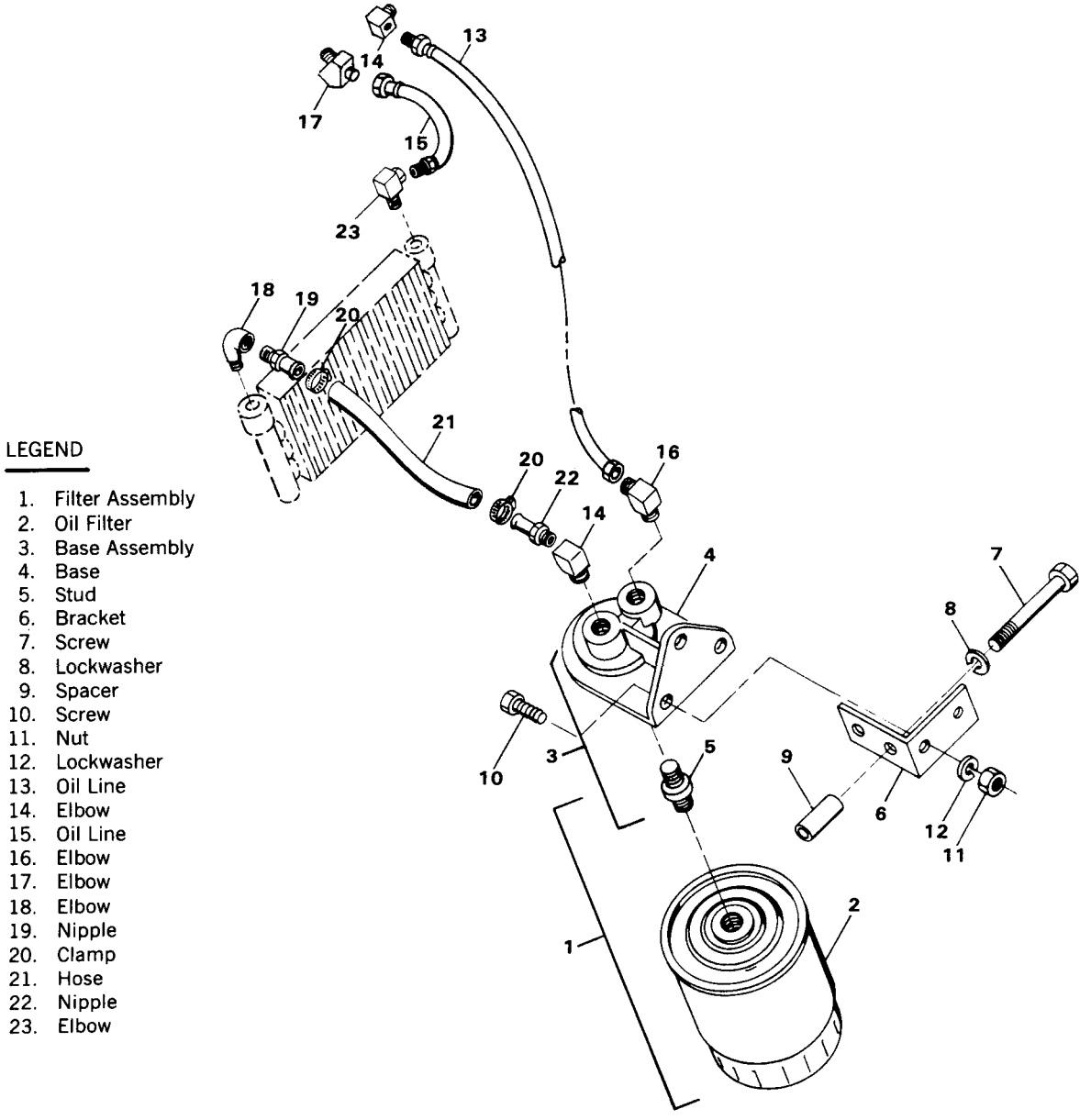


Figure 3-4. Oil Filter and Lines

3-19. Cleaning and Inspection.

a. Discard and replace oil filter element (2, figure 3-4).

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

b. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

c. Inspect oil lines (13 and 15) for cracked, frayed, cut, or deteriorated hoses, worn or damaged threads.

d. Inspect base (4) for cracks, clogged passages, damaged filter gasket seat, stripped threads, and other damage.

e. Remove and replace stud (5) if damaged. Use loctite at installation of stud.

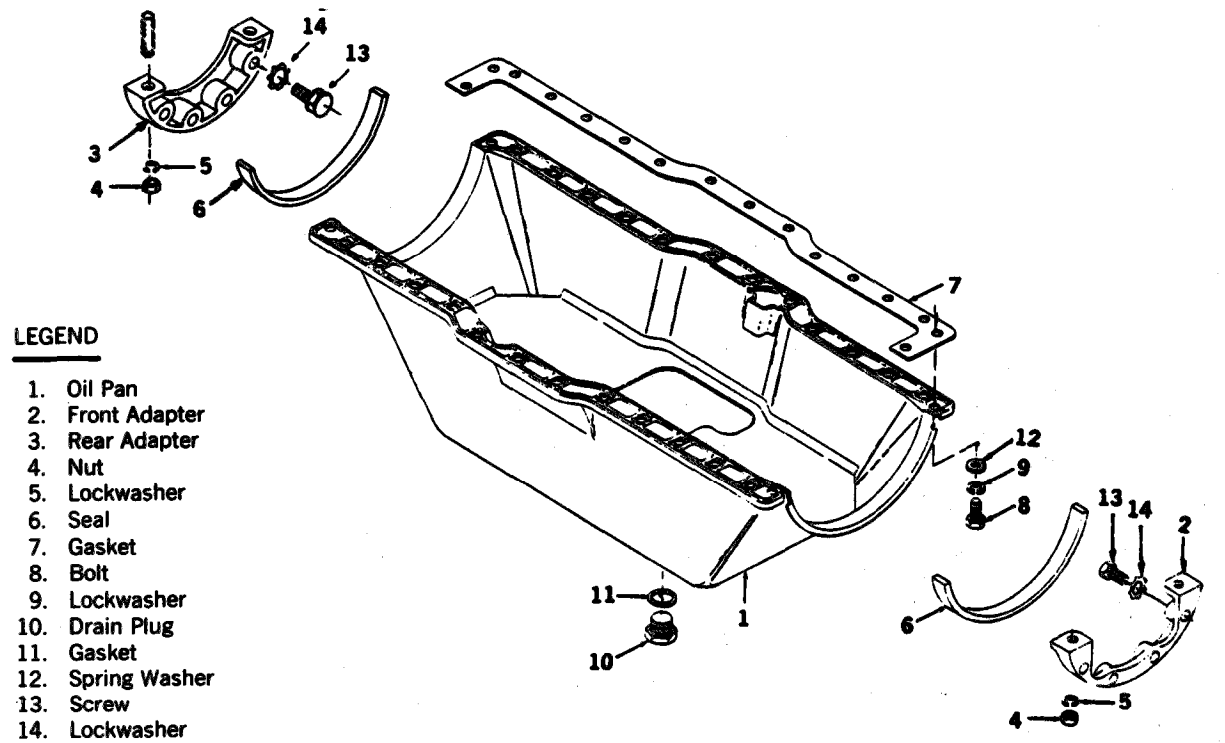


Figure 3-5. Oil Pan

3-20. Installation.

a. Install base (4, figure 3-4) mounting bracket (6) and secure with two each capscrews (10), nuts (11), and lockwashers (12).

b. Connect oil lines (13 and 15).

c. Install new oil filter element (2).

3-21. OIL PAN.

3-22. Removal.

Remove oil drain plug (10, figure 3-5) and gasket (11). Drain crankcase oil into suitable container. If possible, drain oil when engine is at operating temperature.

b. Support oil pan (1) and remove bolts (8), lockwasher (9), and spring washers (12). Remove oil pan (1) and gaskets (7).

c. Remove front and rear pan seals (6).

3-23. Cleaning and Inspection.

a. Discard all gaskets and seals. Make sure the gasket mounting surfaces on oil pan (1, figure 3-5), cylinder block, and oil pan adapters (2 and 3) are clean and free from burrs.

b. Steam-clean pan (1) and all mounting parts.

c. Inspect oil pan (1) for distortion, dents, and cracks. Check for signs of leakage. Repair small cracks in pan by welding. Do not weld finished surfaces.

d. Check threaded holes and bolts for damaged threads.

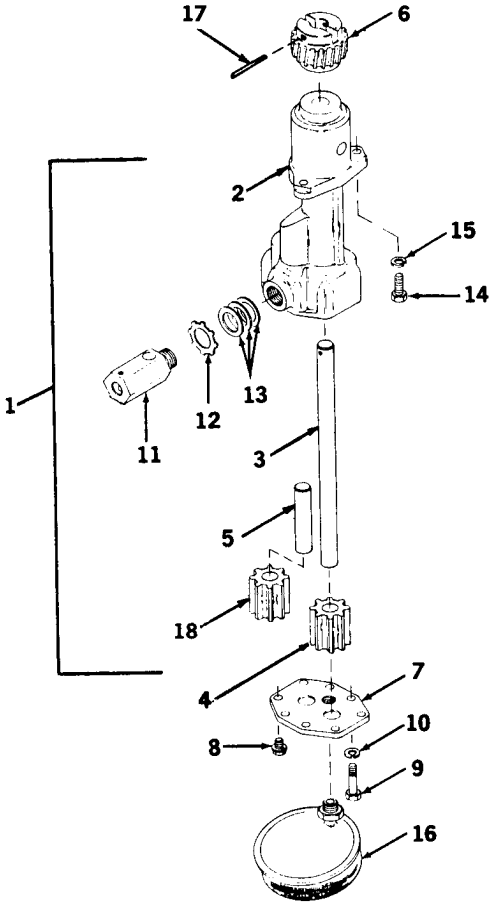
e. Repair damaged oil pan plug hole by drilling it out. and tapping for one size larger pipe plug.

3-24. Installation.

a. Before installing oil pan, (1, figure 3-5) inspect inside of engine for loose nuts, screws, cotter pins, and lock wires; tighten or replace.

b. Remove all gasket particles from gasket mounting surface before applying new gasket (7). Cement new oil pan gasket to cylinder block using shellac, or equivalent.

c. Remove protective coverings from oil pan adapter seals (6) and apply seals to adapters (2 and 3). Make sure both ends of seal contact pan gaskets (7) on each side. Seal surfaces on adapters must be free of oil end dirt.



LEGEND

1. Pump Assembly	10. Lockwasher
2. Body	11. Regulator
3. Drive Shaft	12. Lockwasher
4. Drive Impeller	13. Shim
5. Idler Shaft	14. Bolt
6. Drive Gear	15. Lockwasher
7. Pump Impeller Cover	16. Strainer
8. Assembled Washer Bolt	17. Roll Pin
9. Bolt	18. Idler Impeller

Figure 3-6. Oil Pump

d. Put oil pan (1) in place and carefully start all the bolts (8) with lockwashers (9), and spring washers (12). Tighten all bolts evenly and progressively. Do not overtighten oil pan bolts.

e. Install the drain plug (10) and gasket (11).

f. Fill engine with oil MIL-L-2104 SAE 30 (+32°F to 100°F) or SAE 10 (0° to +32°F).

3-25. OIL PUMP.

3-26. Removal and Disassembly.

a. Drain oil from the crankcase and remove the oil pan.

b. Turn engine crankshaft so that No. 1, 4, or 6 piston is in firing position. In this position the piston assembly is fully extended above the crankshaft.

c. Remove tachometer drive.

d. Remove bolts (14, figure 3-6) and lockwashers (15). Pull oil pump.

NOTE

Rotate the crankshaft and, at the same time, remove the oil pump with a spiral motion.

e Bend up tangs on lockwasher (12) and remove regulator assembly (11) and shims (13).

f. Remove oil pump strainer (16) from pump impeller cover by turning counterclockwise. Do not turn on screen portion of strainer.

g. Remove roll pin (17) and use gear puller to remove drive gear (6) from shaft (3).

h. Remove bolts (9), assembled washer bolts (8), and washers (10), Remove cover (7).

i. Remove impeller (4) and shaft (3) as an assembly. Press impeller from shaft if necessary.

j. Remove impeller (18) from idler shaft (5). Press shaft (5) from pump body (2).

3-27. Cleaning and Inspection.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. if solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Inspect strainer (16, figure 3-6) for clogged screen, holes, damaged threads, dents, or other damage. Make sure oil passage is clear and unobstructed. Replace damaged or distorted strainer.

c. Inspect all gears (4, 6, and 18) and replace if teeth are worn or broken.

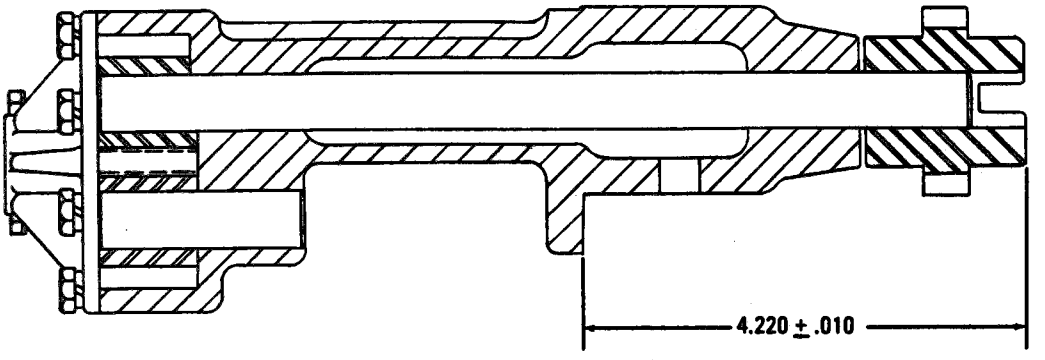


Figure 3-7. Oil Pump Drive Gear Installation Dimensions

d. Inspect all parts for burrs, pitting, rust, scoring, cracks, breaks, and damaged threads. Replace any damaged parts.

e. Replace idler shaft (5) if shaft shows evidence of turning in pump body or is worn smaller than 0.6220-inch diameter at gear bearing area.

f. Replace drive shaft (3) if shaft has turned in gears or is worm smaller than 0.6220-inch diameter at bearing points.

g. Test piston in regulator body; replace regulator if piston binds.

3-28. Assembly and Installation.

a. Press impeller (4, figure 3-6) onto drive shaft (3) so that the outside face of impeller and end of the shaft are flush. Once removed, do not press old parts back together.

b. Insert shaft and impeller assembly into the pump body (2). Press drive gear (6) onto shaft. Replace gear that can be pressed onto shaft with less than 35 pounds gauge pressure. Press gear onto shaft to dimensions shown in figure 3-7.

c. install idler shaft (5, figure 3-6), if removed, and install idler impeller (18).

d. Install pump impeller cover (7) and secure with bolts (9), assembled washer bolts (8), and washers (10). Tighten bolts progressively and evenly.

CAUTION

Ensure that arrow on oil pump gear is aligned with arrow on fuel pump attaching pad.

e. When inserting oil pump (1) into cylinder block, make sure arrow on oil pump gear is aligned with arrow on fuel pump attaching pad. Positions of arrows are same when timing to cylinder number one, four, or six. Secure pump (1) with two bolts (14) and lockwashers (15). Tighten bolts securely but not excessively.

f. Install oil pump strainer (16) on pump impeller cover by turning in clockwise. Do not apply force against screen.

g. Install 65 psi oil pressure regulator (11) with a new lockwasher (12). Regulator must be turned so that relief hole is aligned within 30° of horizontal (see figure 3-8). This position will prevent oil from spraying up into cylinder bore, and will direct the spray toward the center of engine and against oil pan surface. If oil pressure regulator is in an incorrect position when tightened, add shims (13, figure 3-6) until proper alignment is achieved.

h. Install the oil pan.

i. Install the tachometer drive.

j. Fill engine with oil MIL-L-2104 SAE 30 (+32°F to +100°F) or SAE 10 (0°F to +32°F).

3-29. WATER PUMP AND FAN ASSEMBLY.

3-30. Removal and Disassembly.

a. Drain radiator and remove radiator, hoses, and radiator support brackets.

b. Remove fan (23, figure 3-9) and spacer (27) by removing four bolts (12) and lockwashers (13).

c. Remove fan belt(s) (22) by loosening alternator attaching bolts and moving alternator until belt(s) can be removed.

d. Remove bypass hose (24) and disconnect water inlet hose.

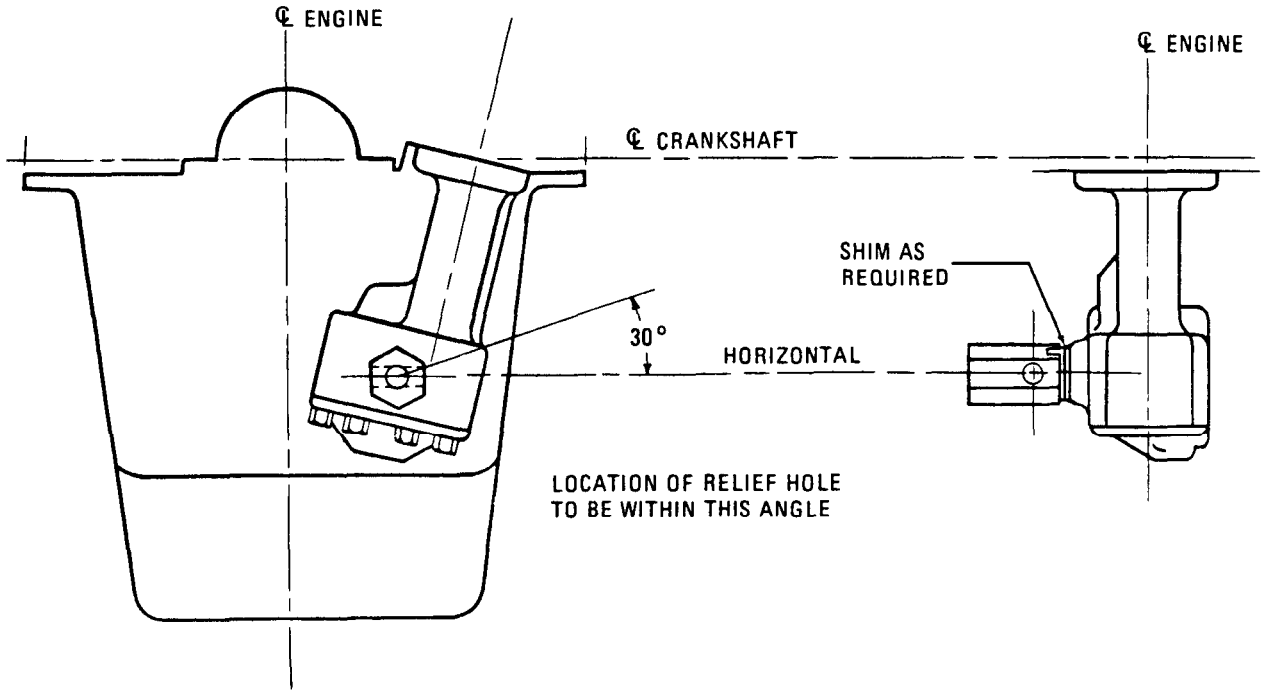


Figure 3-8. Oil Pressure Regulator Installation

e. Remove bolts (15) and lockwashers (16). Remove assembly from engine. Remove water pump gasket (14).

f. Remove bolts (19 and 20) and lockwashers (21). Remove water inlet pipe (17) and gasket (18).

g. Disassemble water pump by removing pulley (11).

h. Remove cover plate (8) and gasket (9) by removing screws (10).

i. Place front of pump on a support in an arbor press, remove the retaining ring (6), and press shaft and bearing assembly (5) out of pump body (3) and impeller (4). Do not attempt to disassemble these parts.

j. Press seal (7) out of pump body.

3-31. Cleaning and Inspection.

a. Discard gaskets and seals.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

b. Clean all metal parts except shaft and bearing (5, figure 3-9) with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

CAUTION

Do not immerse the shaft and bearing (5) in cleaning solvent. This may wash dirt into the bearings and contaminate the lubricant. The solvent cannot be removed entirely from the assembly after immersion.

c. Inspect fan (23) for cracks and for bent blades; replace if damaged.

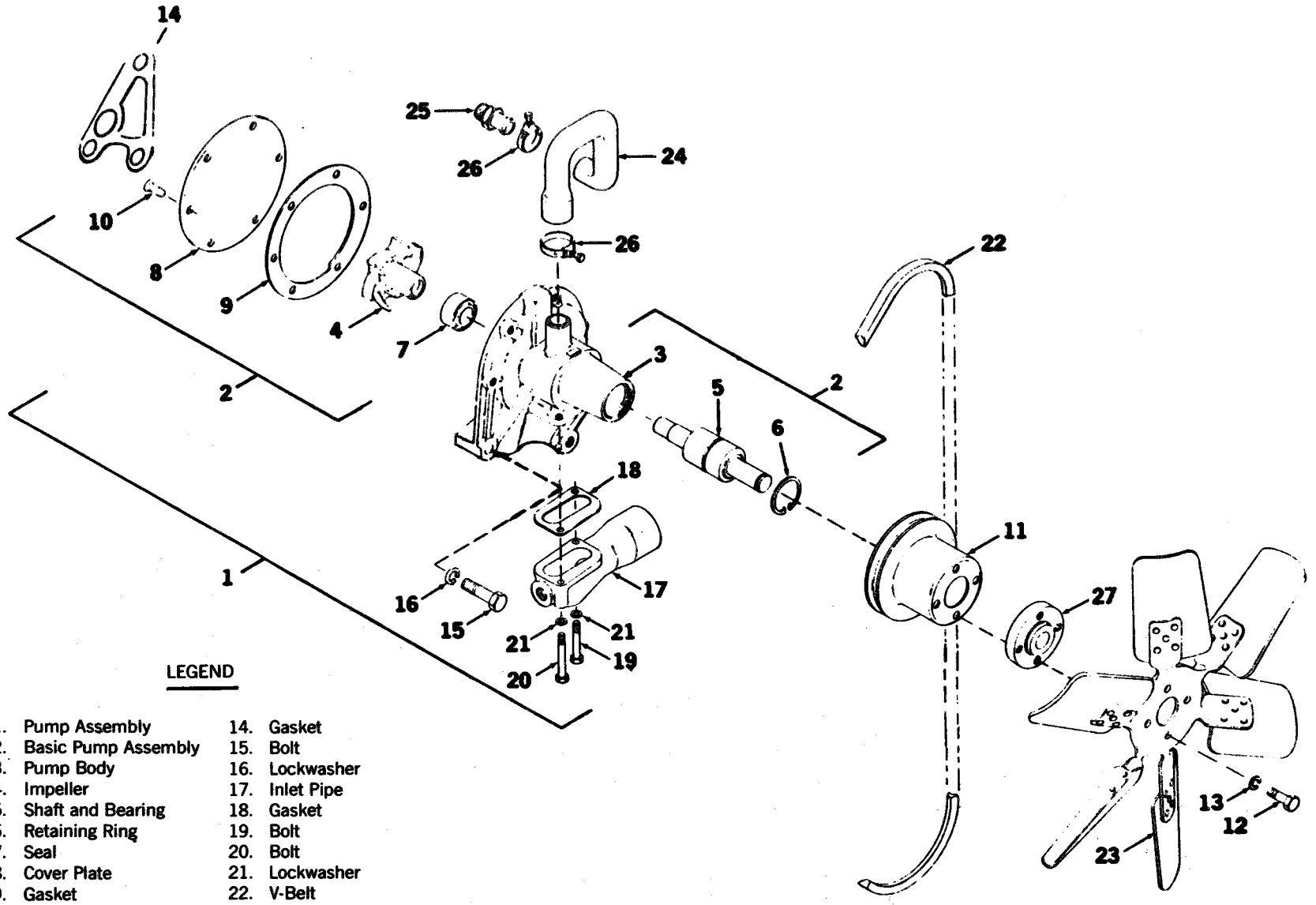
CAUTION

Do not attempt to straighten badly bent fan blades. Straightening blades may weaken them, resulting in failure during operation.

d. Inspect pulley (11) for cracks and distortion. Check pulley groove(s) for rust and for rough spots. Clean up roughness or rust with fine emery cloth. Replace a worn or damaged pulley.

e. Inspect fan belt(s) (22) for cracks, deterioration, fraying, and wear. If more than one belt is used, replace as a matched set.

f. Inspect bypass hose (24) for cracks, dents, clogging, and other damage; replace a damaged bypass hose.



LEGEND

1. Pump Assembly
2. Basic Pump Assembly
3. Pump Body
4. Impeller
5. Shaft and Bearing
6. Retaining Ring
7. Seal
8. Cover Plate
9. Gasket
10. Screw
11. Pulley
12. Bolt
13. Lockwasher
14. Gasket
15. Bolt
16. Lockwasher
17. Inlet Pipe
18. Gasket
19. Bolt
20. Bolt
21. Lockwasher
22. V-Belt
23. Fan
24. Bypass Hose
25. Nipple
26. Hose Clamp
27. Spacer

Figure 3-9. Water Pump and Fan Assembly

g. Inspect shaft and bearing (5) for cracks, distortion, and signs of overheating. Check bearings by rotating them on shaft. If rough spots are detected, replace shaft and bearing.

h. If bearings can be reused, check seal surface of shaft for a rough or grooved condition. If these conditions exist, a new shaft and bearing (5) must be installed.

i. Inspect impeller (4) for cracks, broken vanes, and wear. Replace a damaged impeller.

j. Inspect pump body (3) and inlet pipe (17) for cracks and for worn or damaged threads. Replace if damaged beyond repair.

3-32. Assembly and Installation.

a. Press a new seal (7, figure 3-9) into pump body (3). Press only on outer flange of seal to avoid damaging seal.

b. Coat seal surface of the shaft with grease and press shaft and bearing (5) into body. Press only on outer bearing race and not on end of the shaft.

c. Install retaining ring (6), and support pump shaft on outer shaft end. Press impeller (4) onto shaft. There must be 0.010-inch clearance between impeller and a straightedge placed across rear face of pump body. See figure 3-10.

d. Install new cover gasket (9, figure 3-9) and cover plate (8); and stake screws securely.

e. Press fit pulley (11) on shaft and bearing (5).

f. Use bolts (19 and 20) and lockwashers (21) to mount water inlet pipe (17) and new gasket (18).

g. Install assembled water pump, inlet pipe, and gasket (14) on engine. Secure with bolts (15) and lockwashers (16). Tighten attaching bolts evenly and alternately to prevent possible damage.

h. Connect water inlet hose to water pump and connect bypass hose (24).

i. Install fan belt(s) (22) but do not adjust belt tension at this time.

j. Install fan (23), and spacer (27) to pulley (11) with four bolts (12) and lockwashers (13). Rotate fan and check for binding or excessive resistance. If excessive resistance is felt, remove water pump and check for proper rotation of shaft and bearing assembly and for proper impeller clearance.

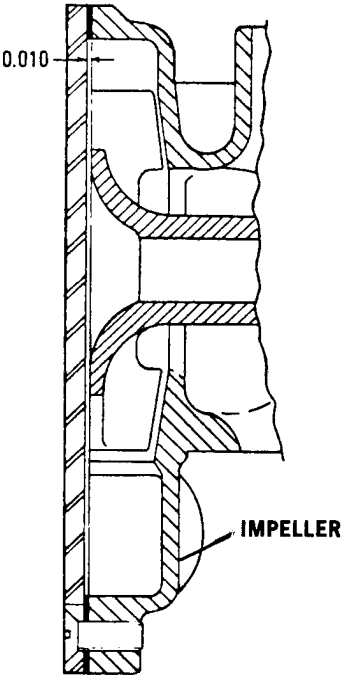


Figure 3-10. Water Pump Impeller Installation Dimension

k. Adjust fan belt tension by positioning alternator in or out from engine. Tighten adjusting bolts. When properly tensioned, belt deflects 3/4 inch with thumb pressure at a point midway between pulleys.

1. Install radiator hoses, and support brackets. Fill radiator with water and antifreeze.

3-33. FUEL TRANSFER PUMP.

3-34. Removal.

a. Disconnect fuel inlet line (not shown) at pump.

b. Disconnect outlet fuel lines at the pump (1, figure 3-11). Be careful not to lose eyelets (21).

c. Remove fuel transfer pump (1) and gasket (2) by removing capscrews (3).

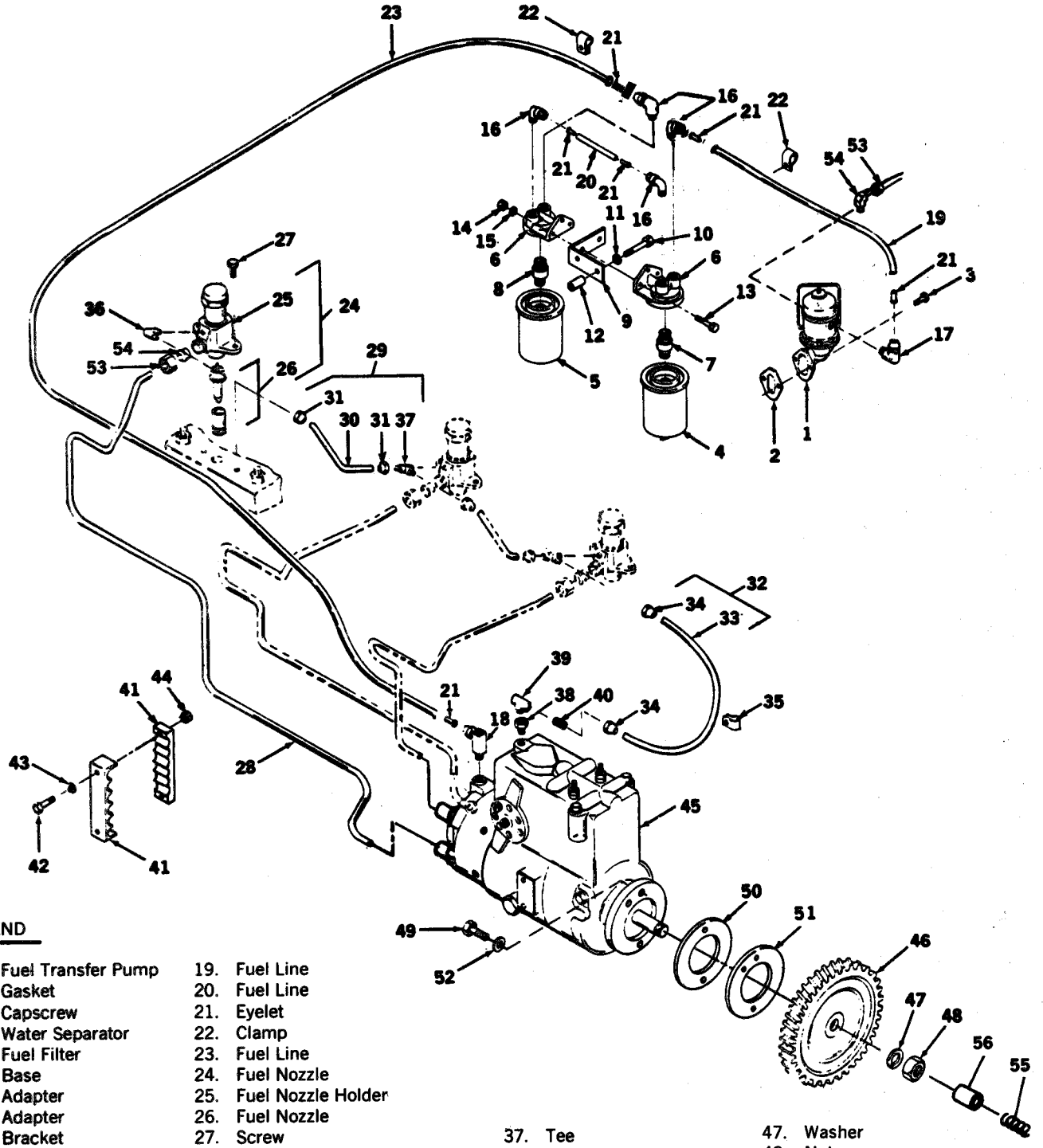
3-35. Cleaning and Inspection.

a. Discard gaskets (2, figure 3-11).

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.



LEGEND

1. Fuel Transfer Pump
2. Gasket
3. Capscrew
4. Water Separator
5. Fuel Filter
6. Base
7. Adapter
8. Adapter
9. Bracket
10. Screw
11. Lockwasher
12. Spacer
13. Screw
14. Nut
15. Lockwasher
16. Elbow
17. Elbow
18. Tee
19. Fuel Line
20. Fuel Line
21. Eyelet
22. Clamp
23. Fuel Line
24. Fuel Nozzle
25. Fuel Nozzle Holder
26. Fuel Nozzle
27. Screw
28. Fuel Injection Line
29. Fuel Leakoff Tube Assembly
30. Fuel Leakoff Tube
31. Tube Nut
32. Drain Tube Assembly
33. Leakoff Manifold Line
34. Tube Nut
35. Clamp
36. Elbow
37. Tee
38. Adapter
39. Tee
40. Union
41. Clamp
42. Screw
43. Washer
44. Nut
45. Fuel Injection Pump
46. Gear
47. Washer
48. Nut
49. Screw
50. Seal
51. Adapter
52. Washer
53. Nut
54. Ferrule
55. Spring
56. Thrust Button

Figure 3-11. Fuel System

b. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

c. Check fuel pump rocker arm for free operation and excessive wear. Check that the priming lever operates freely without binding. Check for damaged threads.

d. Inspect fuel line for cracks, missing eyelets, kinks, and other signs of damage. Replace a damaged fuel line.

e. Inspect fittings to make sure they are clear and check for damaged threads.

3-36. Installation.

a. With new gasket (2, figure 3-11), install fuel transfer pump (1) and secure with two bolts (3).

b. Remove tags and connect fuel lines to fuel transfer pump. Make sure eyelet (21) is in fuel line end.

c. Disconnect fuel line from the fuel filter and install a 3/8-18 NPTF tee in fuel filter base. Connect fuel line and a pressure gauge to pipe tee.

d. Start engine and run it at approximately 1800 rpm. Gauge should register a pressure of 3 to 4-1/2 psi. Replace the fuel pump if pressure is less than 3 psi.

3-37. FUEL FILTER AND STRAINER.

3-38. Removal.

a. Shutoff fuel supply to engine at fuel tank.

b. Remove filter (5, figure 3-11) or water separator (4) by turning element counterclockwise.

3-39. Installation.

a. Coat gasket on filter (5, figure 3-11) or water separator (4) with oil MIL-L-2104.

b. Install filter (5) or water separator (4) by hand until gasket makes contact.

c. Tighten element(s) one full turn by hand.

d. Turn on fuel supply at fuel tank.

3-40. FUEL INJECTION PUMP.

3-41. Removal.

a. Shut off the fuel supply at fuel tank.

b. Clean engine adjacent to fuel injection equipment to prevent dirt from entering fuel system when lines are disconnected.

c. Remove cover plate from side of fuel pump and turn over engine crankshaft in direction of its normal rotation until timing lines on the pump can be seen through timing hole. Align timing lines.

d. Check that piston of the cylinder to which injection pump is timed is at proper position before top center. This can be detemined as follows:

1. Remove injection nozzle from cylinder to which pump is timed. Place finger over nozzle opening and feel for air being forced out during compression stroke as engine is cranked.

2. Check timing mark on flywheel in relation to timing mark on fuel pump. With fuel injection pump timing marks exactly aligned, exact pump timing is indicated by flywheel degree mark which is aligned with timing pointer. Record this information for reference when reinstalling the fuel injection pump. (This information is also shown on the engine nameplate.)

e. Disconnect and remove fuel line (23, figure 3-11). Disconnect leakoff manifold line (33). Disconnect fuel return line from pump to fuel tank.

f. Disconnect throttle and stop controls,

g. Tag and disconnect fuel injection lines (28). After removing each fuel line, reinstall its passage bolts to keep dirt from entering pump.

h. Remove bolts (19, figure 3-23), and lockwashers (20) that secure thrust plate (17) to gear housing cover. Remove thrust plate (17) and gasket (18).

i. Remove spring (55, figure 3-11) bumper (56), nut (48) and washer (47).

j. Remove screws (49), and washers (52).

k. Disengage pump from gear housing approximately 1/4 inch. Using a soft mallet, tap fuel pump drive shaft or use a gear puller to remove pump from drive gear.

CAUTION

When a pump is removed from an engine for repair, secure the throttle in the wide open position after removal. This will prevent the governor weights from dislodging inside the pump housing while the pump is in transit or storage.

1. Remove fittings (18, 38, and 39) from fuel injection pump and install plugs to keep dirt from entering.

3-42. Cleaning and Inspection.

a. Discard and replace all gaskets and seals.

WARNING

solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

b. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

c. Blow clean, dry compressed air through the fuel lines to make sure they are clear and unobstructed.

d. Inspect fuel lines for cracks, dents, kinks, and other damage. Replace damaged fuel lines. Check for missing eyelets (21, figure 3-11) in the ends of the plastic fuel lines.

e. Check the fittings for damaged threads and to make sure fuel passages are clear.

f. Always remove the pump to a clean place for repair.

3-43. Installation and Timing.

a. Rotate crankshaft to align engine flywheel at proper (before top dead center) degree mark of timed cylinder on its compression stroke.

CAUTION

Do not rotate the pump shaft backwards to align the internal timing marks. Always rotate it in the same diretion as the engine crankshaft, when viewed from the front or timing gear end of the engine.

b. Remove timing hole cover plate from injection pump. Turn rotor in direction of engine rotation so that timing lines of the pump coincide. This times pump so that it can be positioned on engine which has crankshaft aligned to proper timing position.

NOTE

If the fuel pump drive shaft has been removed, note that the shaft has a tang with an off-center drilled hole that aligns with a matching drilled hole in the distributor rotor. Check the alignment of these holes to assure correct installation.

c. Insert drive shaft into taper of drive gear (46, figure 3-11) and onto mounting studs.

d. Install screws (49) and washers (52). Tighten only finger tight.

e. Install washer (47), and nut (48) on fuel pump drive shaft. Rotate tapered shaft until timing marks are aligned, and tighten nut to 65 foot-pounds.

f. Install thrust plate gasket (18, figure 3-23), thrust plate (17), washer (20), and bolts (19). Tighten bolts securely.

g. Install pump timing cover plate on the fuel pump.

h. Remove fuel passage bolts from ports of fuel injection pump and connect fuel lines to their respective ports. Refer to figure 3-12 for proper installation positions. Use new gaskets when installing fuel lines. Tighten fuel passage bolts to 35 foot-pounds.

i. Connect throttle and stop control linkages to pump. Make sure linkages are adjusted so that they provide full movement of the associated levers when controls are operated.

j. Connect the fuel return line and fittings on top of the pump.

k. Connect the leakoff manifold line (33, figure 3-11) to the pump.

l. Connect the fuel line (23) to the pipe tee (18) and the fuel filter. Make sure the eyelets (21) are in place in the line before installation.

m. Open fuel supply to engine from tank. Start the engine and check for fuel leaks.

3-44. FUEL INJECTION NOZZLES AND LINES.

3-45. Removal and Disassembly.

a. Loosen fuel injection line nuts and disconnect fuel lines from the injection nozzles. Do not remove nuts or ferrules from the fuel lines.

b. Disconnect fuel leakoff lines (30, figure 3-11) from each of nozzles. Tag leakoff lines to assure that they'll be assembled to their original nozzles.

c. Remove each fuel injection nozzle and holder assembly from the cylinder head by removing two bolts (27). Tag each nozzle and holder assembly to identify its position in cylinder head.

NOTE

The fuel nozzle and holder assemblies must be handled with care at all times. The nozzle and

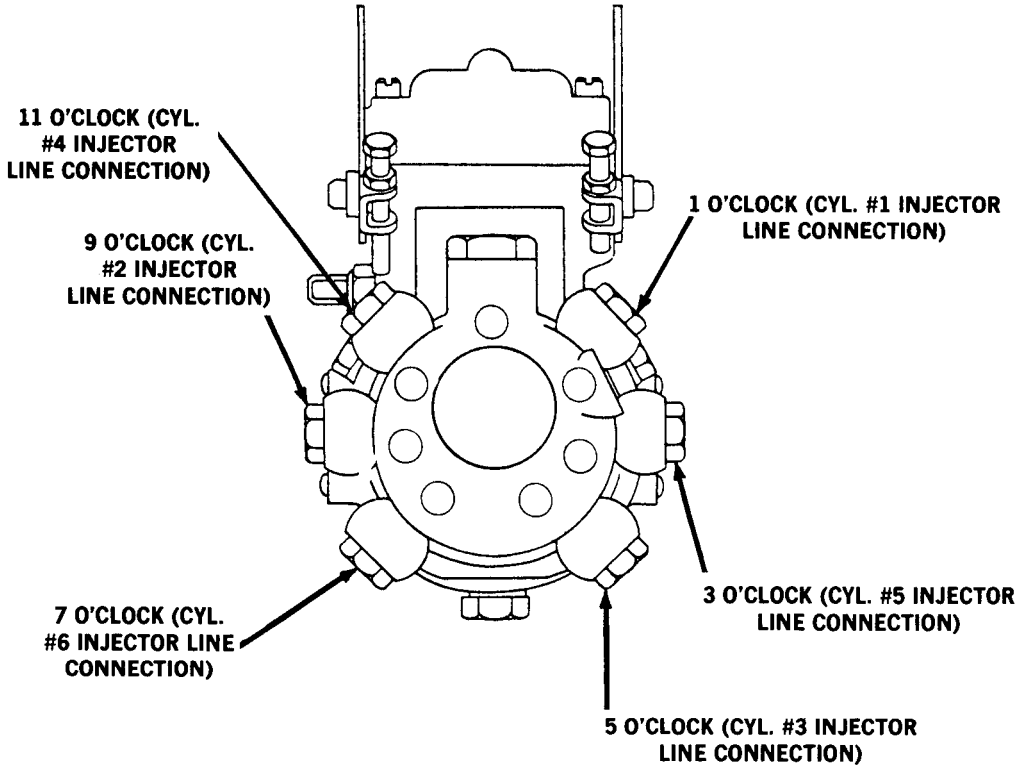


Figure 3-12. Fuel Line Installation

holder assemblies should only be disassembled, cleaned, and adjusted by a competent fuel system technician, using proper fuel nozzle testing equipment.

d. Fuel nozzle and holder assembly (24) can be disassembled by using a twelve point, 3\4-inch box wrench to remove fuel nozzle retaining nut. Carefully remove fuel nozzle (26) from nozzle holder (25).

3-46. Cleaning and Inspection.

a. Discard all gaskets and seals.

b. Clean fuel injection nozzles (26, figure 3-11) in clean diesel fuel. Dry thoroughly with filtered, dry compressed air. Blow air through fuel lines to assure that they are clear and unobstructed.

c. Inspect fuel lines for cracks, dents, kinks, loose or damaged ferrules, and nuts with damaged threads. Replace damaged lines.

d. Visually inspect fuel nozzle and holder assemblies (24) for damaged threads, cracks, or other visible signs of damage. Replace a damaged fuel nozzle and holder assembly.

3-47. Installation.

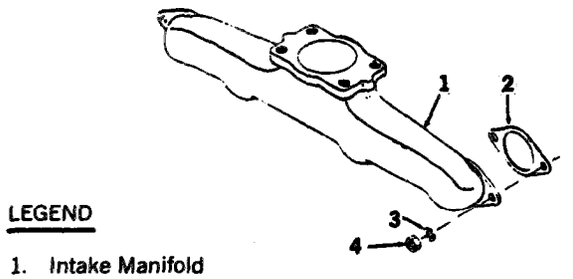
a. Insert assembled fuel nozzle and holder (24, figure 3-11) into the cylinder head bore from which it was removed.

b. Install two securing bolts (27) for each nozzle and holder assembly. Tighten bolts evenly to assure proper alignment of the fuel nozzle and holder assembly. Uneven tightening of the securing bolts may distort nozzle holder or nozzle tip. This will cause engine misfiring or possible destruction of the complete assembly. Use a torque wrench to progressively tighten bolts from 25 to 30 foot-pounds to ensure equal tension on both sides of nozzle and holder assembly.

c. Install and connect fuel lines (28). Tighten the fuel line nuts securely but not excessively. If new fuel lines are installed, install new ferrules and nuts on lines during installation.

d. Install and connect the leakoff manifold lines (30 and 33) between proper nozzles.

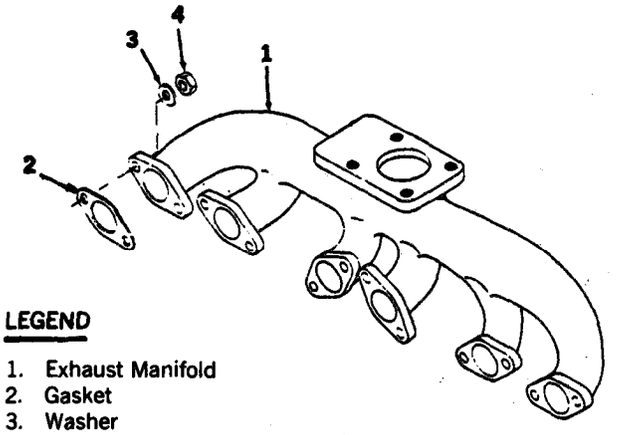
e. If removed, connect fuel lines and leakoff lines to proper fittings on fuel injection pump. When installing fuel lines, use new gaskets.



LEGEND

1. Intake Manifold
2. Gasket
3. Lockwasher
4. Nut

Figure 3-13. Intake Manifold



LEGEND

1. Exhaust Manifold
2. Gasket
3. Washer
4. Nut

Figure 3-14. Exhaust Manifold

f. Open fuel supply to engine; start engine and check for leaks in fuel system. Correct leaking by tightening fittings. If necessary remove, inspect, and reclean leaking components.

3-48. INTAKE MANIFOLD.

3-49. Removal.

a. Remove air inlet flange at manifold.

b. Remove manifold attaching nuts (4, figure 3-13) and lockwashers (3).

c. Remove intake manifold (1) and gaskets (2).

3-50. Cleaning and Inspection.

a. Discard gaskets (2, figure 3-13).

WARNING

solvent fumes are toxic, Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

b. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

c. Inspect intake manifold (1) for cracks, distortion, damaged threads, and other damage. Replace a damaged manifold.

3-51. Installation.

a. Install intake manifold (1, figure 3-13) with new gaskets (2).

b. Install nuts (4) and lockwashers (3). Start at center of manifold and torque each nut in progressive steps from 30 to 40 foot-pounds.

c. Connect air inlet flange.

3-52. EXHAUST MANIFOLD.

3-53. Removal.

a. Remove exhaust outlet flange at exhaust manifold.

b. Remove nuts (4, figure 3-14), washers (3), and exhaust manifold (1) with gaskets (2).

3-54. Cleaning and Inspection.

a. Discard all gaskets (2, figure 13-14).

b. Clean exhaust manifold (1) and related parts with a wire brush.

c. Inspect exhaust manifold (1) for cracks, distortion, severe rust, and damaged threads.

d. Inspect remaining parts for cracks, distortion, corrosion, damaged threads, and other damage. Replace damaged parts.

3-55. Installation.

a. Install exhaust manifold (1, figure 3-14) with new gaskets (2).

b. Install nuts (4) and washers (3). Start at center of manifold and torque each nut in progressive steps from 30 to 40 foot-pounds.

c. Connect exhaust outlet flange.

LEGEND

1. Head Assembly
2. Cylinder Head
3. Valve Guide
4. Fuel Nozzle Holder Sleeve
5. Washer
6. Stud
7. Stud
8. Pipe Plug
9. Pipe Plug
10. Pipe Plug
11. Intake Valve
12. Exhaust Valve
13. Spring
14. Valve Spring Seat
15. Seat Lock
16. Intake Valve Stem Seal
17. Gasket
18. Washer
19. Washer
20. Nut
21. Nut
22. Cylinder Head Cover
23. Gasket
24. Nut
25. Washer
26. Breather Cap
27. Rocker Arm Assembly
28. Rocker Arm
29. Adjusting Screw
30. Rocker Arm Shaft
31. Shaft Plug
32. Spring
33. Shaft Support
34. Spacer
35. Spacer
36. Retaining Ring
37. Tappet
38. Pushrod
39. Nut
40. Washer
41. Thermostat Housing
42. Plug
43. Thermostat
44. Gasket
45. Bolt
46. Lockwasher
47. Water Outlet Cover
48. Bolt
49. Lockwasher
50. Pipe Plug
51. Washer

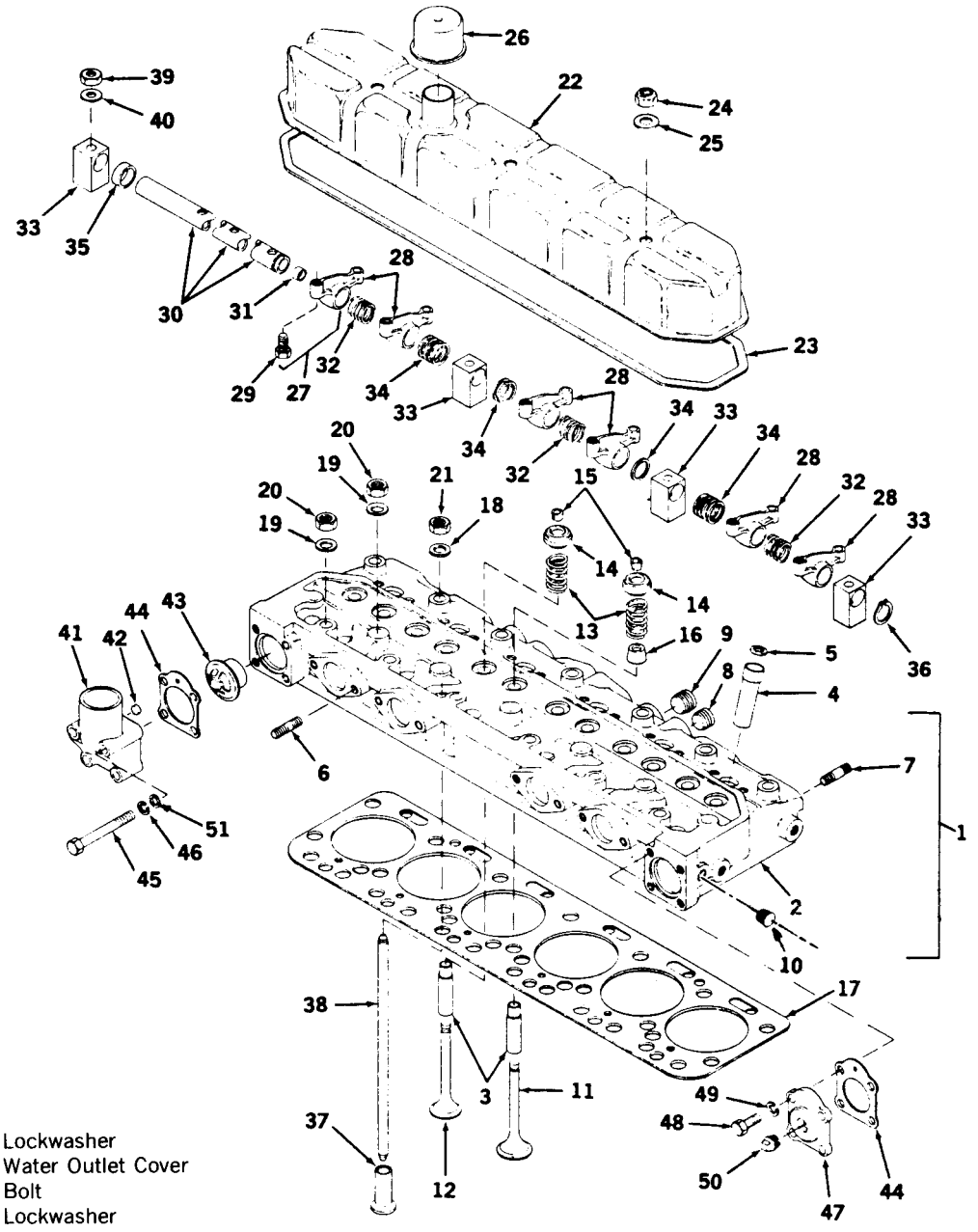


Figure 3-15. Rocker Arm, Cylinder Head, and Valve Assemblies

3-56. THERMOSTAT.

3-57. Removal.

a. Open radiator drain cock and drain radiator enough so that coolant will not flow from thermostat opening.

b. Loosen hose clamp and disconnect water return hose from thermostat housing.

c. Remove the thermostat housing (41, figure 3-15) and gasket (44) from cylinder head by removing four bolts (45) lockwashers (46) and plain washers (51).

d. Remove thermostat (43).

3-58. Cleaning and Inspection.

a. Discard gasket (44, figure 3-15).

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

b. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

c. Inspect thermostat housing (41) for cracks, distortion, loose plug (42), and other damage; replace a damaged housing.

d. Inspect thermostat (43) for cracks, excessive scale, and other damage. Immerse thermostat and a thermometer in a pan of water so that both are raised from bottom of container. Heat water. Check that thermostat starts to open at about 180°F, and is fully open at 200°F ±5°. Replace a damaged or defective thermostat.

3-59. Installation.

a. Install thermostat (43, figure 3-15) in cylinder head so that cone-shaped end points out.

b. Install thermostat housing (41) and gasket (44) on cylinder head; secure with four bolts (45) lockwashers (46) and plain washers (51).

c. Connect water return hose and secure with a hose clamp.

d. Fill radiator with required coolant. Make sure drain cock on radiator is closed.

3-60. ROCKER ARM ASSEMBLY.

3-61. Removal and Disassembly.

a. Remove cylinder head cover (22, figure 3-15) and gasket (23) by removing nuts (24) and washers (25).

b. Remove nuts (39) and washers (40).

NOTE

Before removing rocker arm assembly from cylinder head, use a length of wire between No. 1 and No. 12 rear rocker arms to hold the two shaft assemblies together to prevent accidental disassembly of the rocker arms. Carefully lift the complete assembly from the cylinder head.

c. Disassemble rocker arm assembly by removing retaining rings (36) from shaft ends. Remove shaft supports (33), rocker arms (28), spacing springs (32), and spacers (34 and 35).

3-62. Cleaning and Inspection.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Blow out rocker arm lubricating passages with compressed air.

c. Check rocker arms (28, figure 3-15) for cracks and surface imperfections by magnetic inspection,

d. Check springs' (32) for damaged ends and mis-aligned coils. A 10-pound load on spring should compress it to 1 inch. Replace a damaged or weak spring.

e. Check ball end of rocker arm adjusting screw (29) and rocker arm (28). Replace screw if flat on bottom or if there is evidence of scratching or wearing. If rocker arm contact surfaces are worn or damaged, replace with new rocker arm.

f. Check for damaged threads on all adjusting screws and rocker arms, Adjusting screws are self-locking and must take a minimum of 3 foot-pounds torque to turn into rocker arms. Replace any loose-fitting adjusting screws.

g. Check rocker arms (28) for worn shaft bore diameter. Maximum allowable diameter is 0.8665 inch. Discard worn rocker arms if damaged or worn beyond this limit.

h. Check rocker arm shaft (30) for wear or scoring, if shaft has shoulders or ridges due to rocker arm action on shaft, replace with new shaft. Rocker arm shaft diameter should not be worn to less than 0.8560 inch.

i. Inspect cylinder head cover (22) for cracks, dents, and distorted sealing area. Discard and replace if damaged. Make sure breather screen" is clean and in good condition and that breather cap (26) fits securely on cylinder head cover.

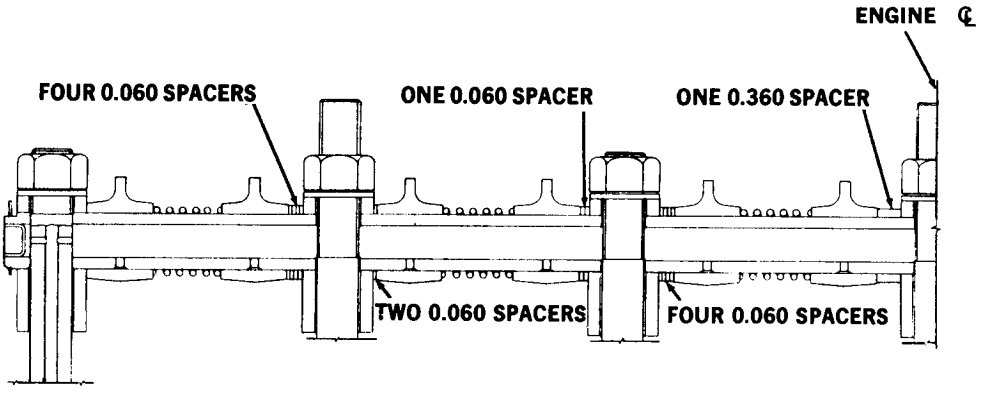


Figure 3-16. Rocker Arm Shaft Showing Spacer Position

3-63. Assembly and Installation.

a. Coat rocker arm shaft (30, figure 3-15) lightly with clean lubricating oil. Slide shaft supports (33), rocker arms (28), spacing springs (32), and spacers (34 and 35) onto rocker arm shaft. Install spacers (34) on shaft as indicated in figure 3-16.

b. Install retaining rings (36, figure 3-15) on each end of shaft (30).

c. Check that rocker arms are properly installed and that they move freely on shaft. It will aid installation of rocker arm assembly if a wire is used to hold shaft together as in removal.

d. Install rocker arm assembly over cylinder head stud extensions and seat it firmly on cylinder head. Make certain rocker arm adjusting screws (29), are positioned over pushrods (38). Secure rocker arm assembly to cylinder head with nuts (39) and washers (40).

e. Adjust valve clearance.

f. Start engine and warm up to operating temperatures. With engine idling slowly, readjust the valve clearance.

g. Install cylinder head cover (22) and new gasket (23) and secure to cylinder head with nuts (24) and washers (25).

h. Install breather cap (26).

3-64. CYLINDER HEAD.

3-65. Removal and Disassembly.

a. Drain radiator and remove thermostat housing, hoses, and bypass hose. Disconnect coolant temperature gauge thermocouple from cylinder head.

b. Remove exhaust manifold.

c. Remove the intake manifold.

d. Remove the fuel nozzle and holder assemblies.

e. Remove cylinder head cover and rocker arm assembly.

f. Lift out pushrods (38, figure 3-15).

g. Remove cylinder head nuts (20 and 21) and washers (18 and 19). Lift cylinder head (2) and gasket (17) from engine. It maybe necessary to tap head lightly with a soft mallet to loosen it. Do not pry on contact surfaces.

h. Remove water outlet cover (47) and gasket (44) by removing four bolts (48) and lockwashers (49).

i. Disassemble cylinder head by removing the valve assemblies.

j. Do not remove plugs (8, 9, and 10), studs (6 and 7), or fuel nozzle holder sleeves (4) unless they are damaged and require replacement.

3-66. Cleaning and Inspection.

a. Inspect cylinder head gasket (17, figure 3-15) and cylinder head (2) for indications of gasket failure and leaking. If cylinder head gasket failure is apparent, make a thorough check of contributing factors.

b. Remove all carbon from combustion areas using a scraper and wire brush.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

c. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

d. Make sure that gasket contact surfaces on head and block are clean, smooth, and flat. Rework contact surfaces to assure that they are free of erosion, pits, burrs, scratches, or blemishes.

e. Checkout-of-flatness with straight edge and feeler gauge. Maximum allowable tolerance is 0.005 inch on width or length. Out-of-flatness should vary gradually and uniformly from end to end and side to side. Resurface cylinder head as necessary by light sanding with an orbital sander.

f. Check for free water flow through cylinder head. If restriction is evident, remove plugs and injector sleeves. Clean water jackets of salt, lime, or sludge by submerging cylinder head into a tank of heated cleaning solution. Circulate cleaning solution. When clean, remove cylinder head from tank and dry with compressed air.

g. Inspect for loose or damaged fuel nozzle holder sleeves. If necessary, pull out sleeves and press in new ones. To pull sleeves, it may be necessary to thread inner diameter to provide a pulling surface.

h. Water-test cylinder head for cracks and leaks. Check for cracks in valve and injector port areas using magnetic detection.

i. Inspect other parts for cracks, distortion, damaged threads, and other damage. Replace any damaged parts.

3-67. Assembly and Installation.

a. Before reassembling cylinder head, regrind or service valves as necessary.

b. Make sure Cylinder block contact surface is clean of carbon deposits. Install a new cylinder head gasket (17, figure 3-15) on cylinder head (2). Gasket must be asembled with bead (rolled edge around combustion chamber) down. For sealing, use cylinder head gasket cement.

NOTE: TORQUE VALUES ARE GIVEN DIRECTLY OVER STUD LOCATIONS

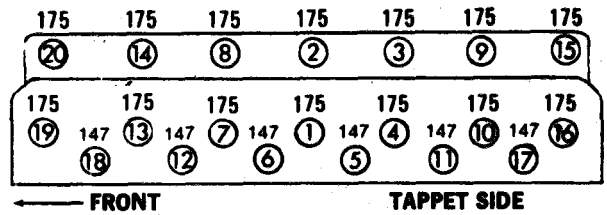


Figure 3-17. Cylinder Head Nut Tightening Sequence, and Torque Values

c. Install water outlet cover (47) and gasket (44) on cylinder head and secure with bolts (48) and lock-washers (49).

d. Install valve assemblies into cylinder head.

e. Place cylinder head assembly (1) on block. Be careful not to damage contact surfaces or cylinder head studs.

f. Install cylinder head nuts (20 and 21) and washers (18 and 19). Tighten evenly, working from center of head outward. Refer to figure 3-17 for tightening sequence, torque, and procedure for tightening cylinder head to cylinder block. Tighten all nuts first to 75 foot-pounds torque in sequence indicated, then 125 foot-pounds torque and then to final torque value shown in figure 3-17.

CAUTION

The cylinder head nuts must be retightened and the valve clearance reset after 1 hour of service.

g. Install valve pushrods (38).

h. Install rocker arm assembly.

i. Install fuel nozzle and holder assemblies.

j. Install intake manifold.

k. Install exhaust manifold.

L. Install coolant temperature gauge thermocouple in cylinder head.

m. Install thermostat and housing and radiator hoses. Fill cooling system with clean water and anti-freeze.

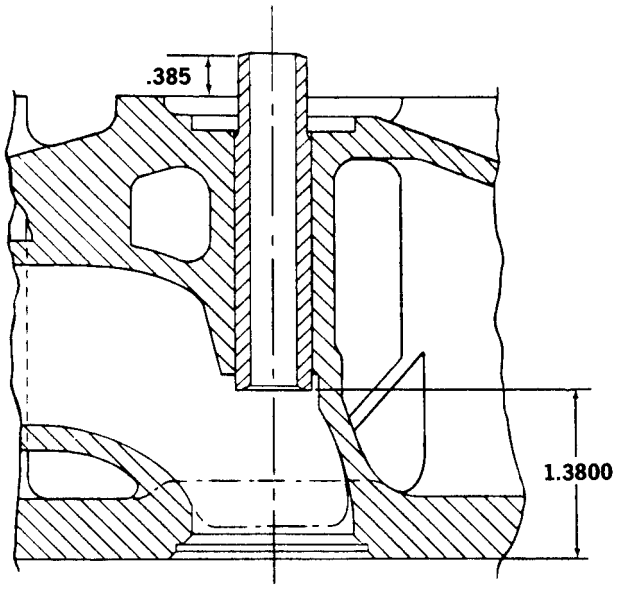


Figure 3-18. Valve Guide Installation

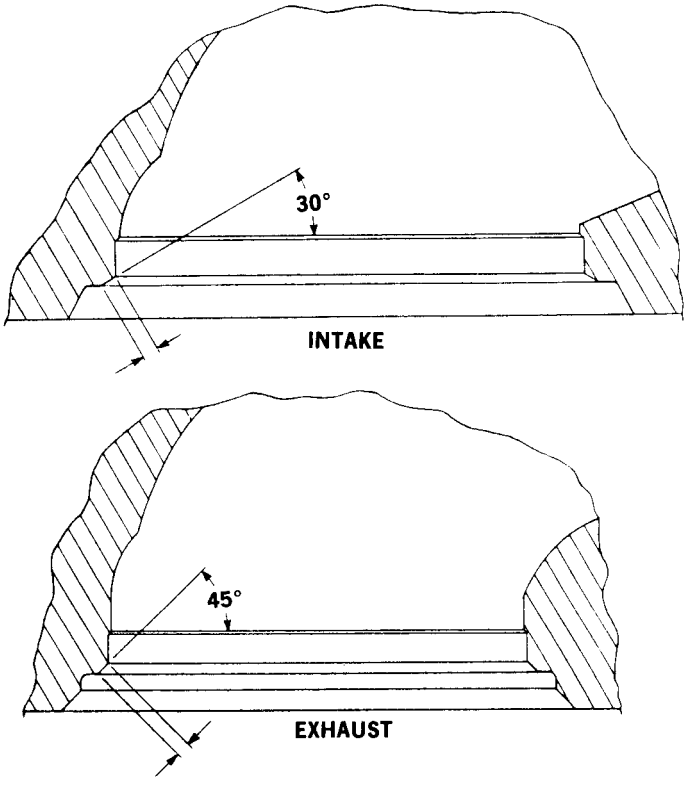


Figure 3-19. Valve Reseating Dimensions

3-68. VALVES.

3-69. Removal.

a. Remove cylinder head.

b. With a clamp-type valve spring compressor, compress valve springs (13, figure 3-15) and remove valve spring seat locks (15).

c. Remove valve springs (13) and seats (14). Lift out valves (11 and 12). Place valves in order in a rack, with holes numbered for both intake and exhaust valves so that valves can be installed in their respective places at assembly.

d. Remove intake valve stem seals (16).

3-70. Cleaning and Inspection.

a. Discard all seals and gaskets.

b. Clean all carbon from the cylinder head, piston heads, valve seats, and valves, using suitable scraping or buffing tools.

c. Clean valve guides (3, figure 3-15). Remove lacquer or other deposits by running a valve cleaner or wire brush through guides. Inspect valve guides for excessive wear. Maximum allowable bore diameter of intake valve guides is 0.3780 inch. Maximum allowable bore diameter of exhaust valve guide is 0.3790 inch.

d. Inspect valve seats. If they are pitted or if new valve guides (3) will be installed, seats must be refinished.

e. Inspect valves (11 and 12) carefully. If stems are bent or badly worn or if valves are deeply pitted, valves must be replaced. Valves that are only slightly pitted can be used by refacing them on a valve grinder. Exhaust valves must have an accurately finished 45-degree face angle and intake valves a 30-degree face angle.

3-71. Repair.

a. If valve guides (3, figure 3-15) are excessively worn and require replacing, it must be done before any refinishing is done on valve seats. This will insure that seat being finished is square with respect to new guide. To drive out guides, use drift with 5/8-inch diameter and 3/8-inch diameter pilot. Drive in new guides so that dimension from lower edge of valve guide to gasket face of cylinder head is 1.3800 inches. See figure 3-18. After new guides are driven in, ream inside diameter to correct any squeezing-in or any distortion. Ream exhaust valve guides to 0.3750 to 0.3760 inch. Ream intake valve guide to 0.3740 to 0.3750 inch.

b. If valve seats are pitted or if new valve guides (3) have been installed, seats must be refinished. Intake valve seats are finished on a 30-degree angle and exhaust valve seats are finished on a 45-degree angle. Use a vibrating angle grinder-type reseating tool with a 3/8-inch diameter pilot. Lightly lubricate and install pilot into valve guide bore. Lower grinder head over pilot shank until stone just clears valve seat. Turn on power and

gently allow stone to contact valve seat. Very little pressure other than weight of stone should be used. Grind seat sufficiently to remove shoulders and pits, and to provide an even, smooth surface. Do not grind any deeper than necessary. The finished valve seat should contact the approximate center of valve face. Refer to figure 3-19.

3-72. Seating Valves. If valves and seats are not deeply pitted or shouldered or have been refaced, grind or lap each valve to its seat as follows:

a. Lubricate valve stem and apply a thin coating of good quality, medium coarse grinding compound on valve face.

b. Take light coil spring with enough tension to just hold valve off seat and insert it over valve stem. Insert valve in valve guide.

c. Use reciprocating grinding tool and rotate valve a few times, pressing firmly on grinding tool. Do not use a grinding tool with a continuous circular motion that will cut grooves in the valves or seat. Release pressure on tool and allow spring to lift valve from its seat. Rotate valve 15 or 20 degrees and repeat grinding process. Periodically wipe off valve and seat and inspect seating progress. Reapply another thin coating of compound and continue grinding until inspection shows surfaces are in contact.

d. Wipe off all heavy compound, apply thin coating of fine compound, and continue grinding.

e. When surfaces show a bright, silver-like band of uniform width on both valve and seat, clean off all traces of compound.

f. Test each valve for a tight fit as follows. Make 10 or 12 pencil marks, equally spaced, across valve seat. Firmly rotate valve in seat for part of a turn and again lift out valve. Observe if all pencil marks are rubbed out on contact surface. If not, regrind until this test shows a gas-tight mating of valve and seat.

NOTE

It is imperative that valves be assembled in the same seats to which they were ground.

3-73. Assembly and Installation.

NOTE

Make certain that the valves (11 and 12, figure 3-15) are reinstalled in the same position from which they were removed.

a. Thoroughly clean all traces of grinding compound from valves (11 and 12), stems, and guides (3). Lubricate valve stems with a few drops of engine oil and insert valves (11 and 12) in same holes from which they were removed.

b. Insert intake valve stem seals (16) over ends on intake valves (11) and secure firmly on exposed ends of valve guides (3).

c. Install valve springs (13) and spring seats (14), on valve stems. Using valve spring compressor, compress valve springs and install valve locks (15).

d. Turn head (2) on exhaust manifold side and pour solvent in intake openings. If solvent seeps out around any valve, remove that valve and regrind it. Repeat test, pouring solvent in exhaust opening. If any exhaust valve leaks, regrind it.

e. When assured of gas-tight valve seating, install assembled cylinder head (1) on engine.

f. Install the rocker arm assembly.

g. Adjust the valve clearance per paragraph 3-74.

h. Fill cooling system with water and antifreeze. Start the engine and warm to operating temperatures.

i. With engine idling slowly, readjust valve clearance to the correct operating clearance.

j. Install cylinder head cover (22) and new gasket (23). Secure to cylinder head cover with nuts (24) and washers (25).

3-74. Adjusting Valve Clearance. Adjust valve stem-to-rocker arm clearance whenever the cylinder head has been removed from the cylinder block. Proceed as follows to adjust valve clearance:

a. Rotate crankshaft by hand or with starting motor until both intake and exhaust valves of No. 1 cylinder are fully closed. Valves will be fully closed when No. 1 cylinder is at top dead center. For a cold engine, use a 0.016- or 0.017-inch feeler gauge inserted between rocker arm and valve stem and adjust adjusting screw until it just touches pushrod. There should be a slight pull when removing feeler gauge.

b. Adjust remaining valve clearances in similar manner. Rotate crankshaft in direction of normal rotation and adjust valves in cylinder firing order (1-5-3-6-2-4).

c. After all valves have been adjusted, install cylinder head cover (22, figure 3-15) and gasket (23). Start engine and allow it to warm up to operating temperature. When warm, readjust valve clearance to 0.015 inch with engine running at low idle.

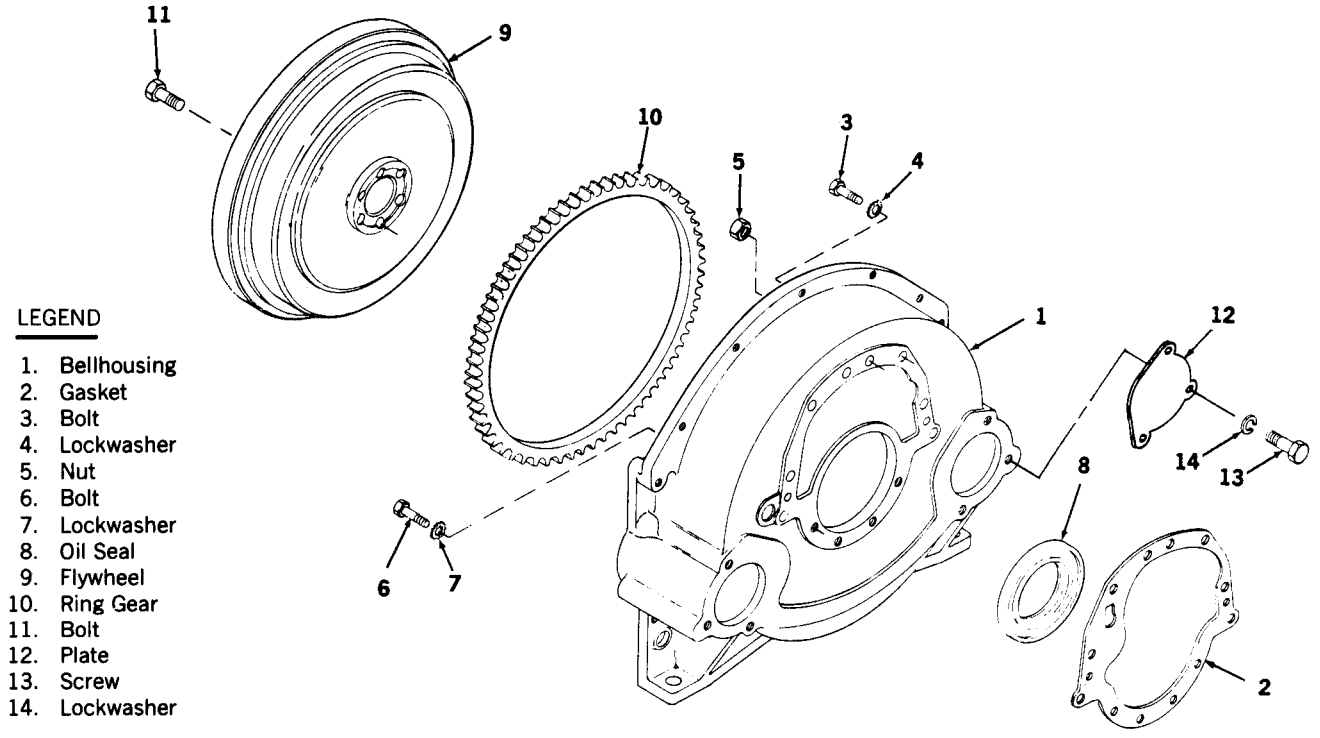


Figure 3-20. Flywheel and Bellhousing Assembly

3-75. FLYWHEEL.

3-76. Removal.

a. Remove engine and disconnect transmission/ torque converter.

b. Remove the starting motor.

c. Remove the six flywheel bolts (11, figure 3-20).

d. Using a pry bar, pull flywheel (9) from crankshaft.

e. Do not attempt to remove ring gear (10) from flywheel unless it is damaged and must be replaced.

3-77. Cleaning and Inspection.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Inspect ring gear (10, figure 3-20) for broken or cracked teeth. If damage is evident and replacement is necessary, drive gear from flywheel with a blunt chisel.

c. Inspect flywheel (9) for distortion, cracks, or other damage or wear. Replace damaged flywheel.

d. To install new ring gear (10), heat it in an oven or with a heating torch to approximately 600°F (315.6°C). Do not overheat. Place heated ring gear on flywheel and quickly drive onto flywheel until gear is firmly seated.

3-78. Installation.

a. Turn crankshaft so that timing cylinder is in top dead center position.

b. Turn flywheel (9, figure 3-20) so that dead center timing mark is in line with timing hole in bellhousing. Install flywheel on crankshaft. Note that one of six bolts (11) is off center so that flywheel can only be installed in one position. Add sealant on bolts (11) on installation. Draw flywheel onto crankshaft by tightening six bolts alternately and evenly. Torque bolts to 80 foot-pounds.

c. Attach indicator, as shown in figure 3-21, to check concentricity of pilot bore. This should not exceed 0.005 inch total indicator reading.

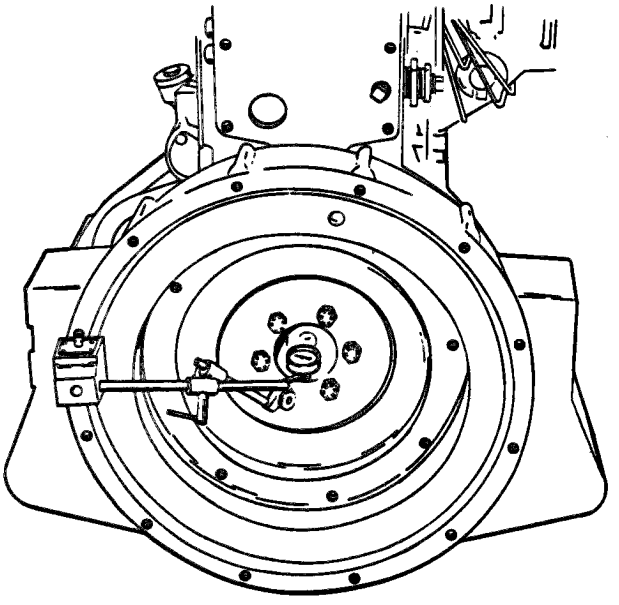


Figure 3-21. Indicating Flywheel Pilot Bore

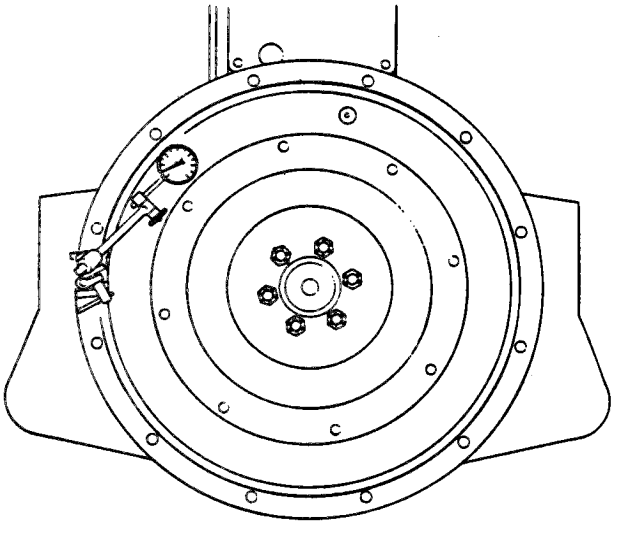


Figure 3-22. Indicating Flywheel Face

d. Attach indicator as shown in figure 3-22, to check face of flywheel. Runout should not exceed 0.008 inch total indicator reading. If runout is excessive, remove flywheel and check for dirt or foreign matter between flywheel and mounting seat on crankshaft. Reinstall and recheck.

e. Install lock wires.

f. Install transmission and torque converter. Install engine.

3-79. BELLHOUSING.

3-80. Removal.

a. Drain the crankcase oil.

b. Remove engine from crane. Disconnect transmission and torque converter.

c. Remove the flywheel.

d. Disconnect the oil lines and remove oil filter.

e. Remove starting motor.

f. Remove rear oil pan adapter (3, figure 3-5) by first removing two nuts (4) and lockwashers (5), securing adapter to cylinder block and then removing four screws (13) and lockwashers (14) securing adapter to bell-housing.

g. Remove bellhousing attaching bolts (3 and 6, figure 3-20), stud nuts (5), and lockwashers (4 and 7).

h. Pull bellhousing (1) away from engine. It may be necessary to tap housing with a soft mallet to loosen it from dowels or from gasket (2) sticking to block.

i. Remove rear oil seal (8).

3-81. Cleaning and Inspection.

a. Discard gasket (2, figure 3-20) and seal (8).

WARNING

Solvent fumes are toxic, Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

b. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

c. Inspect bellhousing for cracks, distortion, and other damage. Replace a damaged bellhousing.

d. Check that bellhousing dowel pins in block are tight and in good condition.

3-82. Installation.

a. Install new oil seal (8, figure 3-20) in bellhousing, using a small amount of sealing compound in bore before pressing in seal. If new seal is pre-coated, sealing compound is not required. Cement new gasket (2) to bell housing, allowing cement to dry sufficiently to prevent gasket from slipping at installation.

b. Clean and polish oil seal surface of crankshaft to remove nicks or scratches. Use crocus cloth or very fine polishing cloth.

c. Apply thin coat of oil soap to seal (8) and seal surface of crankshaft. If seal is already oil treated, additional lubricant is not required. Install seal (8). Keep seal surface clean during assembly. Carefully place bell-housing on cylinder block so that seal is not damaged as it engages crankshaft. Align so that dowels properly enter their respective holes. Seat bellhousing (1) to engine and install bolts (3 and 6), nuts (5), and lockwashers (4 and 7), but do not tighten. Coat bolts (6) with sealant prior to installation.

d. Install rear oil pan adapter (3, figure 3-5), securing it to cylinder block with two nuts (4) and lockwashers (5). Secure adapter to bell housing with four screws (13) and lockwashers (14). Tighten down bellhousing bolts and nuts evenly and securely.

e. Install starting motor.

f. Install oil filter and connect the oil lines.

g. Install the flywheel.

h. Check concentricity of bellhousing in relation to flywheel (figures 3-21 and 3-22).

i. Install transmission and torque converter. Install engine.

3-83. GEAR HOUSING AND COVER.

3-84. Removal.

a. Remove radiator and tag and disconnect hoses.

b. Remove fan and belt(s) for easier access to the gear cover and gears.

c. Remove vibration dampener (32, figure 3-23) from drive pulley by removing bolts (33).

d. Remove pulley (28) by removing screw (31), spacers (30) and washer (34).

e. Remove bolts (8, 14, and 15) lockwashers, and nuts (4) that secure cover (10) to gear housing. Remove cover by pulling it away from engine.

f. Remove thrust plate (17) and gasket (18) from gear cover by removing four bolts (19) and lockwashers (20). Press oil seal (12) from gear cover.

g. Remove fuel pump.

h. If necessary, remove idler gear and bearing (23) from idler shaft. Idler gear is retained by a bolt (26) and washer (27). Do not remove idler shaft (2) unless it is damaged.

i. If it is necessary to remove gear housing (1) from crankcase, proceed as follows:

1. Drain crankcase and remove oil pan.

2. Remove front oil pan adapter (2, figure 3-5) by removing two nuts (4) and lockwashers (5) four screws (13) and lockwashers (14).

3. Remove camshaft nut (50, figure 3-25). To keep shaft from turning, insert brass bar between crank-shaft gear and camshaft gear. Using standard foot-type puller inserted in holes in gear, pull camshaft gear (48) from the camshaft (45).

4. Remove bolts (6, figure 3-23) and lockwashers (7 and 9). Pull gear housing (1) away from cylinder block. It may be necessary to tap housing with a soft mallet to loosen it from dowels or from gasket (3) sticking to block.

3-85. Cleaning and Inspection.

a. Discard all gaskets and seals.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

b. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

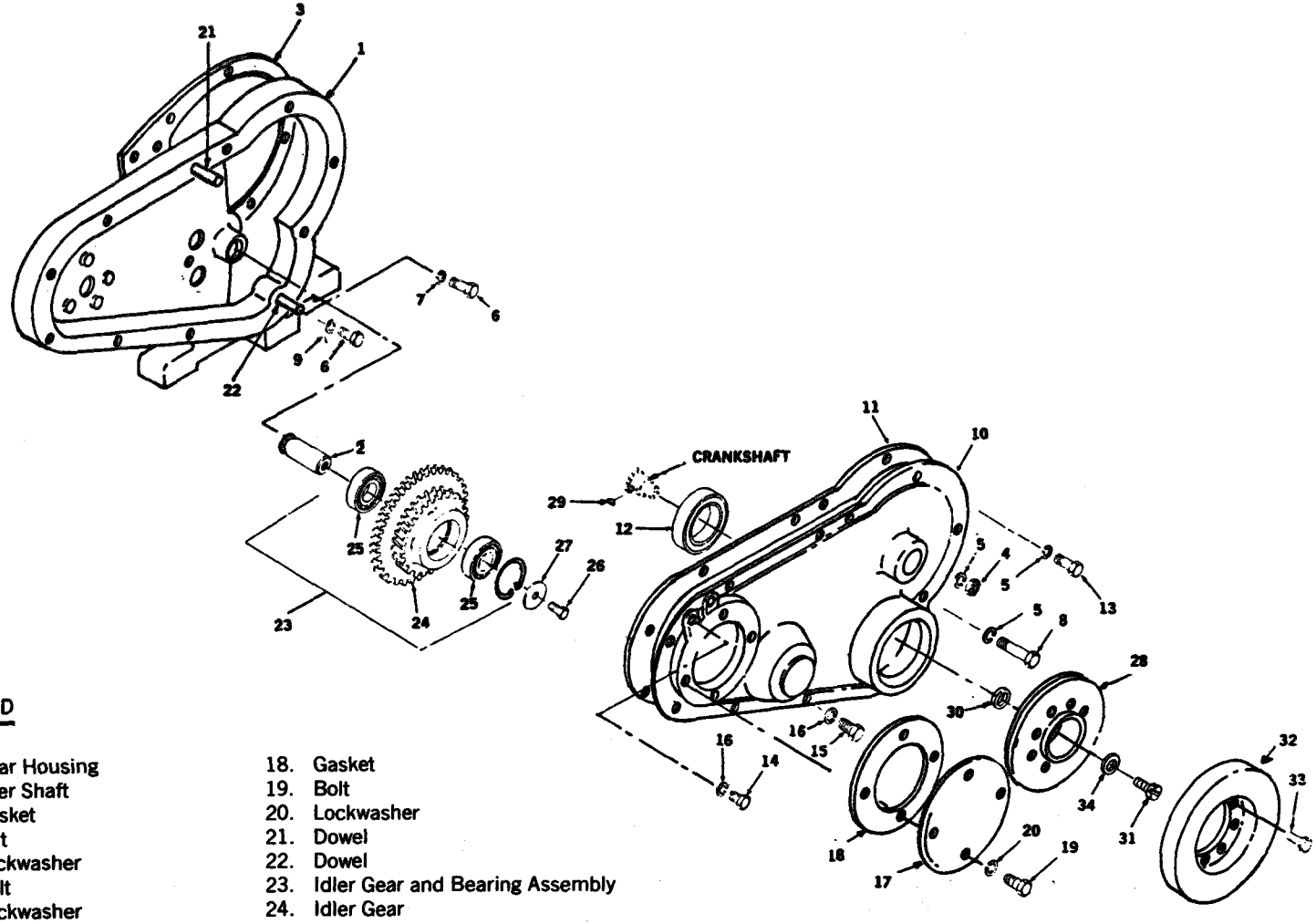
c. Inspect gear cover (10, figure 3-23) and gear housing (1) for cracks, distortion, and other damage. Replace either if damaged.

d. Check that gear housing dowel pins and studs in cylinder block are tight and that stud threads are in good condition. Replace any damaged parts.

e. Inspect all gears for chipped, cracked, or broken teeth. Replace damaged gears.

f. Check the idler gear bearing (25) for wear or rough operation. There should be very little play in the bearing. Replace a worn bearing.

g. Check that idler gear shaft (2) is tightly fitted in gear housing. It must withstand a direct pull of 32 pounds. Replace a loose-fitting idler gear shaft.



LEGEND

1. Gear Housing
2. Idler Shaft
3. Gasket
4. Nut
5. Lockwasher
6. Bolt
7. Lockwasher
8. Bolt
9. Lockwasher
10. Gear Cover
11. Gasket
12. Oil Seal
13. Bolt
14. Bolt
15. Bolt
16. Lockwasher
17. Thrust Plate
18. Gasket
19. Bolt
20. Lockwasher
21. Dowel
22. Dowel
23. Idler Gear and Bearing Assembly
24. Idler Gear
25. Bearing
26. Bolt
27. Retaining Washer
28. Drive Pulley
29. Key
30. Spacer
31. Screw
32. Vibration Dampener
33. Bolt
34. Washer

Figure 3-23. Gear Housing and Gears

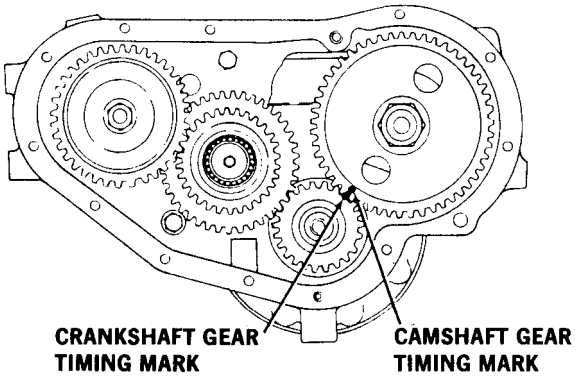


Figure 3-24. Aligning Drive Gear Timing Marks

3-86. Installation.

a. If the gear housing (1, figure 3-23) was removed, install as follows:

1. Cement a new gasket (3), to the gear housing, allowing cement to dry sufficiently to prevent gasket from slipping at installation.

2. Place gear housing (1) on cylinder block. Install attaching bolts (6) and lockwashers (7 and 9) but do not tighten completely.

3. Install front oil pan adapter (2, figure 3-5) with nuts (4) and lockwashers (5). Secure adapter to gear housing with screws (13) and lockwashers (14). Tighten gear housing bolts and nuts evenly and securely.

4. Install oil pan.

5. Install alternator bracket screws and lockwashers.

6. Install fuel injection pump and connect the fuel lines.

7. Install camshaft gear (48, figure 3-25) aligning timing mark with timing mark on crankshaft gear (see figure 3-24). Insert brass bar between camshaft and crankshaft gears. Pull down and secure gear with the camshaft nut (50, figure 3-25). Tighten the nut to 125 to 135 foot-pounds torque.

8. Apply Loctite to bolt (26, figure 3-23) and bearing (23) and secure with bolt (26) and washer (27). Torque bolt (26) at 25 foot-pounds.

b. Turn crankshaft so that flywheel timing marks indicate the required fuel pump timing position for timing cylinder.

c. Install new oil seal (12), using small amount of sealing compound in bore before pressing. If new seal is pre-coated, sealing compound is not required. Cement new gasket (3) to the gear housing cover (1).

d. Clean and polish oil seal surfaces of crankshaft to remove any nicks or scratches which could damage seal. Use an oil stone or very fine emery cloth and polish with crocus cloth. If shafts have a keyway which might damage seal during installation, cover this keyway with a thin feeler gauge to protect seal.

e. Apply thin coat of oil soap to seal (12) and seal surface of crankshaft. If seal is already oil treated, additional lubricant is not required. Keep seal surface clean during assembly. Carefully place oil seal over crankshaft to install cover (10). Install bolts (8, 14, and 15) and lockwashers (5 and 16).

f. Install pulley (28), spacer (30), washer (34), and screw (31).

g. Install vibration dampener (32) and bolts (33).

h. Install thrust plate (17) and gasket (18) on gear cover and secure with bolts (19) and lockwashers (20).

i. Install fan and belt.

j. Install radiator. Remove tags and connect hoses.

k. Fill crankcase to proper lever with oil MIL-L-2104 SAE 30 (+32°F to +100°F) or SAE 10 (0°F to +32°F).

1. Start the engine and check for oil, water, and fuel leaks.

3-87. CAMSHAFT.

3-88. Removal.

a. Drain radiator. Tag and disconnect hoses and remove radiator.

b. Drain lubricating oil from crankcase and remove oil pan.

c. Remove oil pump.

d. Remove fan and belt(s) for easier access to gear cover and gears.

e. Remove gear cover.

f. Remove cylinder head cover and rocker arm assembly.

g. Remove pushrods (38, figure 3-15).

LEGEND

1. Cylinder Block Assembly
2. Cylinder Block
3. Main Bearing Assembly
4. Upper Main Bearing
5. Lower Main Bearing
6. Center Main Bearing
7. Main Bearing Cap
8. Main Bearing Cap
9. Center Main Bearing Cap
10. Main Bearing Cap
11. Bolt
12. Bolt
13. Stud
14. Cylinder Head Oil Passage Stud
15. Cylinder Head Stud
16. Cylinder Head Stud
17. Cylinder Head Stud
18. Cylinder Head Stud
19. Cylinder Head Stud
20. Stud
21. Stud
22. Pin
23. Pin
24. Front and Rear Camshaft Bearing
25. Center Camshaft Bearing
26. Cup Plug
27. Pipe Plug
28. Pipe Plug
29. Pipe Plug
30. Pipe Plug
31. Pipe Plug
32. Pipe Plug
33. Pipe Plug
34. Pipe Plug
35. Setscrew
36. Pipe Plug
37. Pipe Plug
38. Bayonet Gauge Tube
39. Instruction Plate
40. Drive Screw
41. Crankshaft Assembly
42. Crankshaft
43. Crankshaft Gear
44. Key
45. Camshaft
46. Camshaft Thrust Plate
47. Bolt and Washer Assembly
48. Camshaft Gear
49. Key
50. Nut
51. Oil Level Bayonet Gauge
52. Bolt
53. Cover
54. Gasket

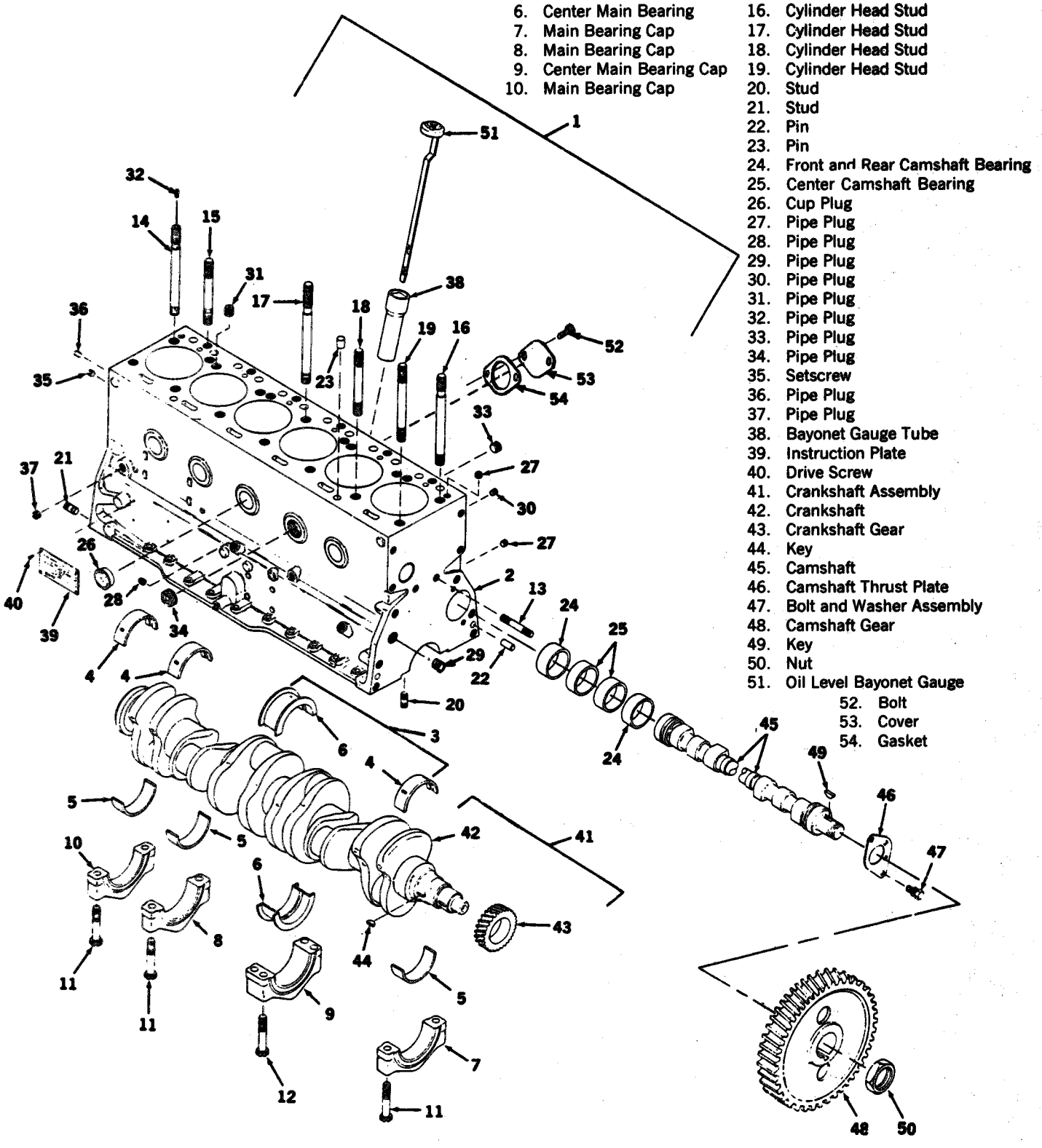


Figure 3-25. Cylinder Block

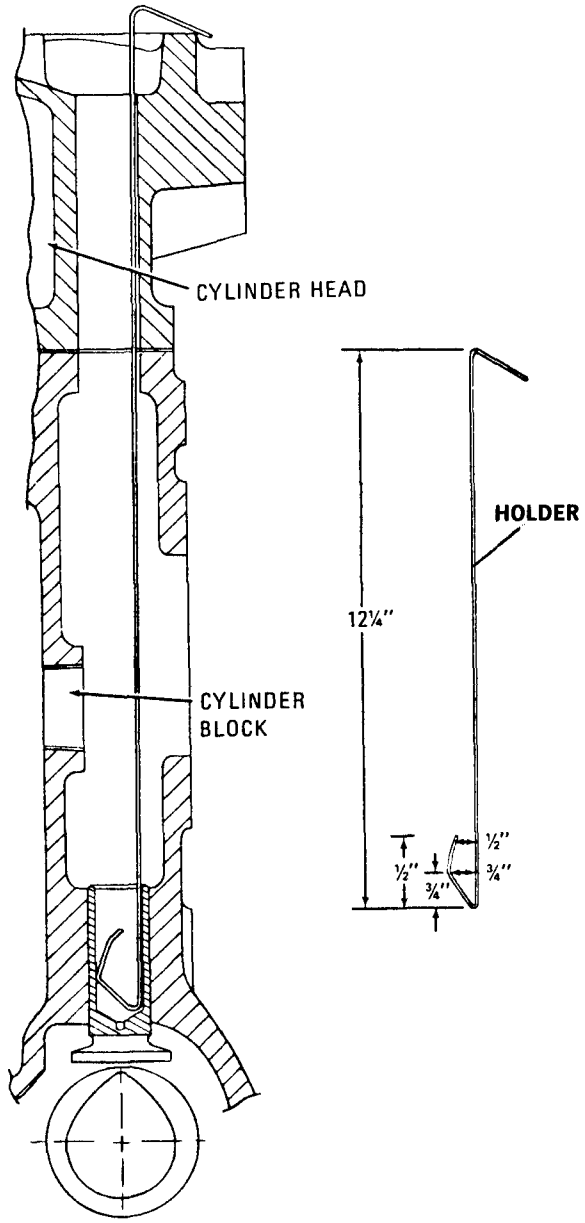


Figure 3-26. Valve Tappet Positioned for Camshaft Removal

h. Valve tappets (37) must be held in raised position in order to remove camshaft. Make holder, as illustrated in figure 3-26, by bending wire to form a spring-acting hook on one end. This holder may then be inserted into hollow part of tappet and tappet lifted away from camshaft. Bend holder over edge of pushrod hole in cylinder head so that tappet will remain in this position. Repeat this procedure for each of remaining tappets. With engine out of crane, it is necessary only to set engine on bellhousing or upside down (support engine with suitable blocks so that cylinder head studs will clear), push tappets to raised position, and remove camshaft.

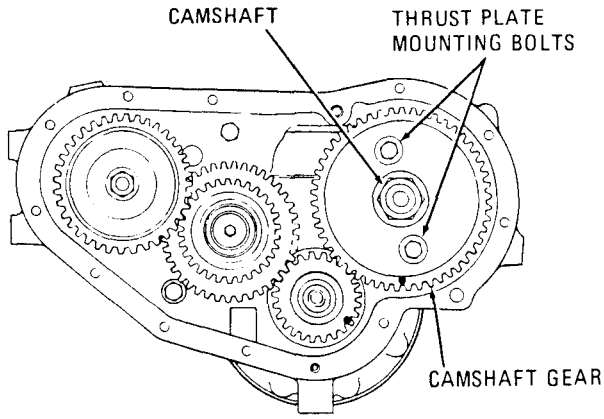


Figure 3-27. Thrust Plate Mounting Bolt Removal

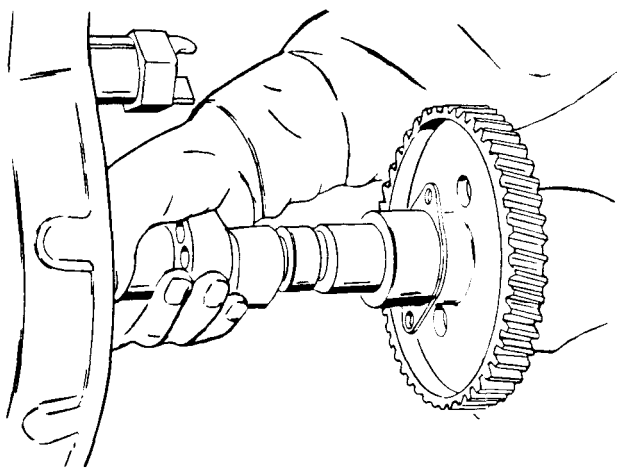


Figure 3-28. Camshaft and Thrust Plate Removal

i. With tappets in raised position, rotate engine crankshaft until two holes in camshaft gear expose thrust plate mounting bolts. See figure 3-27.

j. Remove thrust plate mounting bolt and washer assembly (47, figure 3-25) and pull camshaft assembly (45) forward out of cylinder block as shown in figure 3-28.

k. Remove camshaft bearings (24 and 25, figure 3-25). If bearings cannot be withdrawn by hand, drive out camshaft bearings with brass drift. If difficulties are encountered removing rear camshaft bearing, it may be necessary to remove bellhousing.

1. If it is necessary to remove camshaft gear (48, figure 3-25) from camshaft, remove nut (50). Place shaft (45) in an arbor press and, with suitable supports under gear,

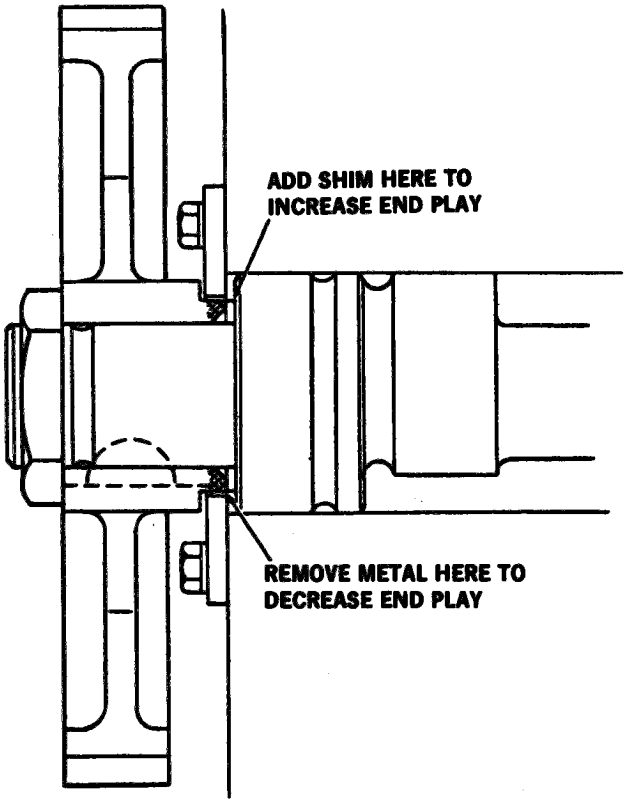


Figure 3-29. Adjusting Camshaft End Play

mess shaft out of gear. Remove woodruff key from camshaft and remove camshaft thrust plate (46).

m. Remove valve tappets (37, figure 3-15).

3-89. Cleaning and Inspection.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Inspect camshaft (45, figure 3-25) for scored or worn cams and bring surfaces, damaged oil pump gear, threads or keway, or worn thrust surfaces. Replace camshaft if it has scuffed, scored, or cracked valve cams. Replace camshaft it any bearing journal diameter is worn to- less than 2.051 inches.

c. Inspect bearings (24 and 25) for scored or worn bores, cracks, or scored faces. Replace worn or damaged bearings. Maximum allowable clearance between camshaft journal and bearing bore is 0.006 inch.

d. Inspect thrust plate (46) for worn or scored thrust surfaces and distortion.

e. inspect camshaft gear (48) for worn, cracked, or broken teeth, and worn keyway. Replace damaged gear.

f. Check valve tappets (37, figure 3-15) for wear and replace any that exceed 0.005-inch clearance in cylinder block bore.

3-90. Installation.

a. Insert valve tappets (37. figure 3-15) into their respective holes in cylinder block. Use holding wires to keep tappets in raised position during camshaft installation, as shown in figure 3-26.

b. Install camshaft bearings (24 and 25, figure 3-25). Replacement camshaft bearings are precision cut and no line reaming is required. When installing, make sure oil holes in bearings are aligned with oil holes in drilled passageways in cylinder block. Tap bearings into place with bearing driver.

c. If camshaft gear (48) was removed place thrust plate (46) on camshaft (45) and press gear onto camshaft with woodruff key (49) in place. Secure with nut (50). Make certain all tappets are in raised position. Carefully insert assembled camshaft (45) into cylinder block, aligning timing marks on camshaft gear with timing marks on crankshaft gear. This ensures correct timing of valves.

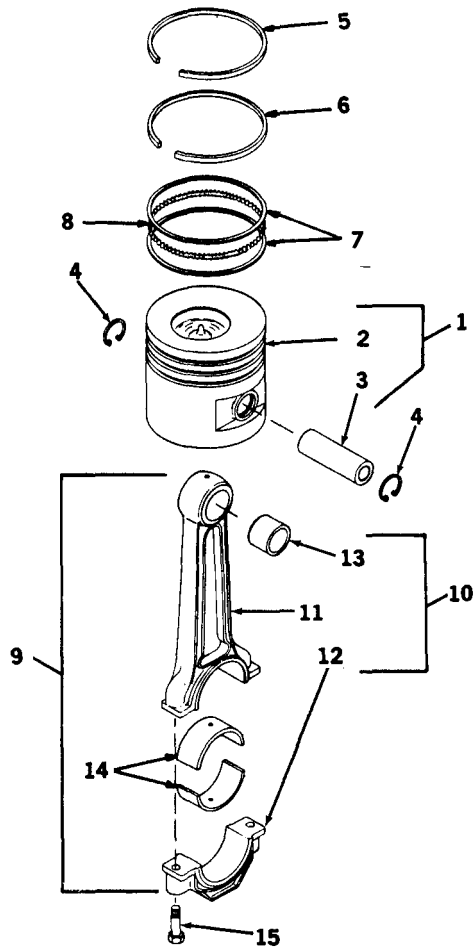
d. Secure thrust plate (46) to the cylinder block with two bolt and washer assemblies (47). Check camshaft end play. Normal end play is 0.005 to 0.008 inch and shall not exceed 0.012 inch. To decrease end play, use a draw file to remove a small amount of metal from camshaft gear hub on which thrust plate rides. See figure 3-29. To increase end play, add a shim between camshaft gear hub and camshaft bearing, or, using apiece of very fine emery cloth on a surface plate, polish thrust plate to desired thickness. Check backlash of camshaft gear to crankshaft gear. Backlash must be 0.0015 to 0.0025 inch,

e. Remove wire holders, allowing valve tappets to fall into position on camshaft.

f. Place pushrods (38, figure 3-15) into their proper places in cylinder head.

g. Install rocker arm assembly and cylinder head cover.

h. Install the gear cover.



LEGEND

1. Piston & Pin Assembly
2. Piston
3. Piston Pin
4. Retaining Ring
5. Piston Ring
6. Piston Ring
7. Piston Ring
8. Spacer
9. Rod and Bearing Assembly
10. Rod Assembly
11. Connecting Rod
12. Connecting Rod Cap
13. Piston Pin Bushing
14. Bearing
15. Cap Bolt

Figure 3-30. Piston and Connecting Rod Assembly

i. Install the fan and belt(s).

j. Install the oil pump.

k. Install radiator. Remove tags and install hoses.

1. Install oil pan. Fill crankcase with oil MIL-L-2104 SAE 30 (+32°F to +100°F) or SAE 10 (0°F to +32°F).

m. Adjust the valve clearance.

3-91. PISTON AND CONNECTING ROD ASSEMBLIES.

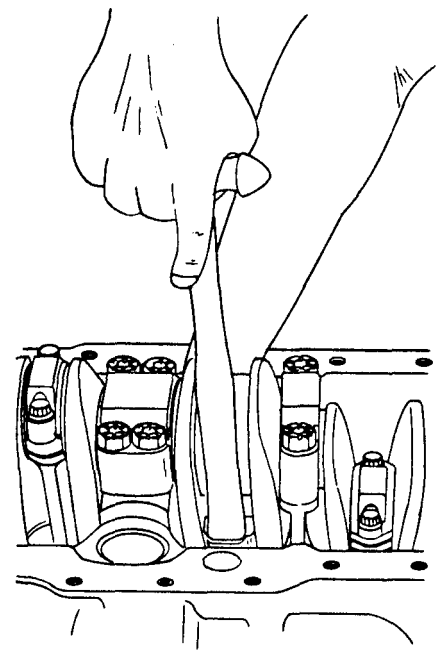


Figure 3-31. Piston and Connecting Rod Removal

3-92. Removal and Disassembly.

a. Drain radiator. Tag and disconnect hoses.

b. Remove thermostat housing and thermostat. Remove water pump bypass hose from water pump. Disconnect water temperature gauge thermocouple.

c. Disconnect exhaust flange from exhaust manifold.

d. Disconnect fuel lines to fuel nozzle and holder assemblies.

e. Remove cylinder head cover, rocker arm assembly, and pushrods.

f. Remove cylinder head assembly (manifolds maybe removed with the head).

g. Remove oil pan and oil pump.

h. Carefully scrape carbon deposits from top of each cylinder bore so that pistons (1, figure 3-30) can be removed without damage to rings (5 thru 8). On cylinder bores with excessive wear, it may be necessary to use a ridge reamer.

i. Crank engine so that No. 1 piston connecting rod caps (12) can be removed. Remove cap bolts (15), connecting rod cap (12), and lower bearing (14). Be sure to keep connecting rod, cap, and bearings for each piston together. Do not mix parts. With a block of wood or hammer handle, carefully push piston and rod assembly out

through top of cylinder block. See figure 3-31. After connecting rod (11, figure 3-30) and piston (1) are removed, reassemble connecting rod cap (12) and lower bearing (14) to connecting rod (11).

j. Remove remaining pistons and connecting rod assemblies in a similar manner. Rotate crankshaft as necessary to provide easy access to each connecting rod cap.

k. Secure connecting rod in vise equipped with soft jaws and remove piston rings (5 thru 8) with piston ring expander took

1. Remove piston pin retaining rings (4) and push pin (3) out of piston and piston pin bushing (2).

3-93. Cleaning and Inspection.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes, If solvent is splashed on bare skin, rinse skin with fresh water immediately,

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Clean compression ring grooves of piston (2, figure 3-30). This can be done with a broken compression ring that has been ground to a bevel edge.

c. Using standard aligning fixture, check connecting rod (11) for distortion and misalignment. Check connecting rods (11), caps (12), and bolts (15) for cracks with magnetic particle test. Discard and replace parts if cracks are detected.

d. Inspect connecting rod bearings (14) for scoring, chipping, flaking, pits, cracks, and signs of overheating. Bright spots on back of bearings indicate shifting and are cause for replacement.

e. Check pistion pin bushing (13) for scoring or wear. Replace bushing if bore is scored or if worn to more than 1.2523 inches. Press worn bushing from connecting rod and press in new one.

f. Inspect piston pin (3) for wear or scoring. Replace pin if worn to less than 1.2478-inch diameter. Maximum allowable pin clearance in piston is 0.0005 inch and in connecting rod is 0.0012 inch.

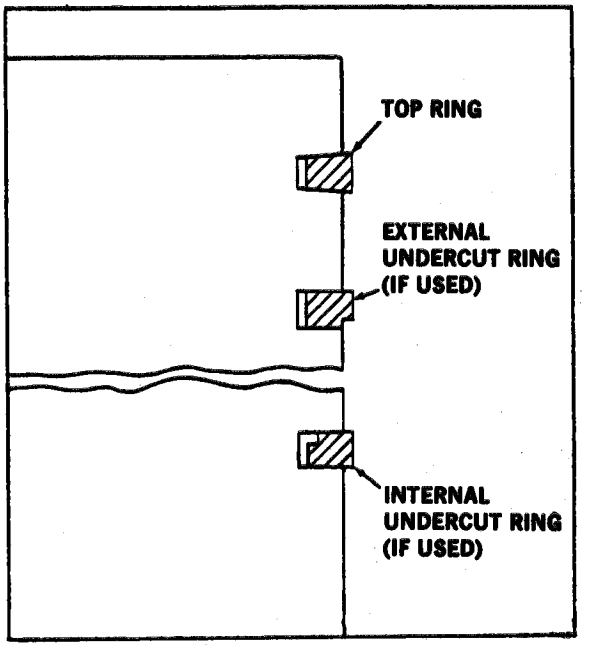


Figure 3-32. Piston Ring Installation

g. Inspect the pistons (2) for damaged ring grooves, scoring, or cracks. Remove light scoring with fine emery cloth. Replace piston if damaged beyond repair.

3-94. Assembly and Installation.

NOTE

All parts should be at room temperature to insure proper dimensional tolerances during piston and ring fitting.

a. Using a micrometer or cylinder bore indicator, measure size of cylinder bores. Piston size will be identified by letter stamped on top of piston. Check fit of piston without rings in cylinder bore. If any binding occurs, remove piston and examine piston and cylinder wall for burrs. Remove burrs with a fine hone (a flat one is preferable) before proceeding with installation. If a new standard piston is to be installed, specify size by letter A, B, C, D, or E stamped on top of piston.

b. All new piston rings (5 thru 8, figure 3-30) must be installed whenever a piston (2) is removed, regardless of whether a new or used piston is installed.

c. Insert one ring at a time inside of cylinder bore, far enough down to be within normal area of ring travel. Use a piston (2) to push down ring to be sure it is parallel with top' of the cylinder bore. Measure ring gap with a feeler gauge. All ring gaps shall be 0,010 to 0.020 inch.

d. Check ring clearance in piston ring grooves.

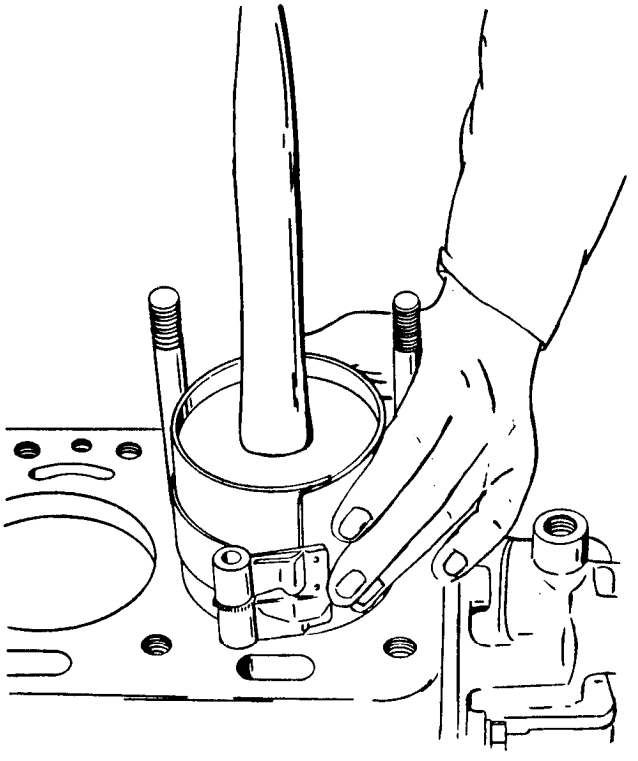


Figure 3-33. Piston Installation

e. Assemble each piston and connecting rod assembly by placing upper end of connecting rod (11) between piston pin bosses and in line with piston pin holes. Slide the piston pin (3) in place. To facilitate assembly, heat piston (2) in boiling water for a few minutes, but do not heat piston pin (3). Install the pin retaining rings (4).

f. Install piston rings (5 thru 8) on piston as follows:

1. Install rings on piston with an expander tool. To avoid breaking or overstressing rings, do not spread them any more than necessary to slip them over piston.

2. When installing piston rings, stagger positions of ring gaps around piston to minimize compression loss. No two ring gaps may be in line.

3. On all piston rings that have groove on outside diameter of ring, place undercut or groove towards bottom of piston. See figure 3-32.

4. On all piston rings that have groove cut on inside diameter of ring, place undercut or groove towards top of piston. See figure 3-32.

g. Inspect crankshaft for any rough or scored marks that might damage connecting rod bearing. If any rough marks are found, polish shaft with an oil stone, very tine emery cloth, or crocus cloth. Clean shart thoroughly after polishing.

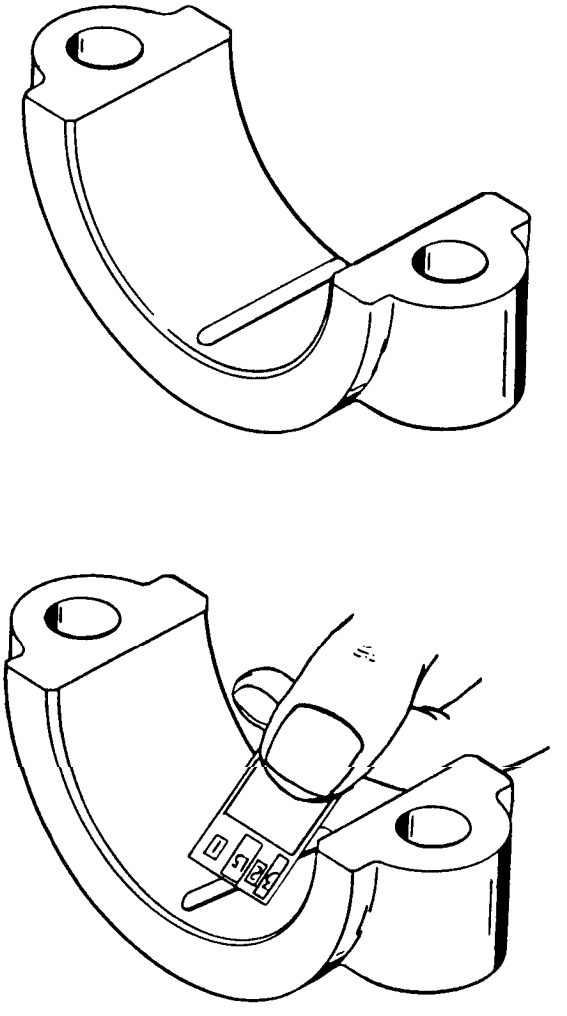


Figure 3-34. Checking Bearing Clearance

NOTE

The cylinder number is stamped on the connecting rods and caps on the camshaft side and to the front of the engine.

h. Select proper piston and connecting rod assembly for first cylinder bore and turn crankshaft so that connecting rod journal for that cylinder is in lowered position. Apply a coat of lubricating oil to cylinder bores, pistons, rings, piston pin, and crankshaft journal.

i. Use a ring compressor to compress piston rings to facilitate installation of piston and rod assemblies. With connecting rod bearing cap and bearings removed from connecting rod, insert piston (2) from top of the cylinder block. Use a hammer handle or block of wood against top

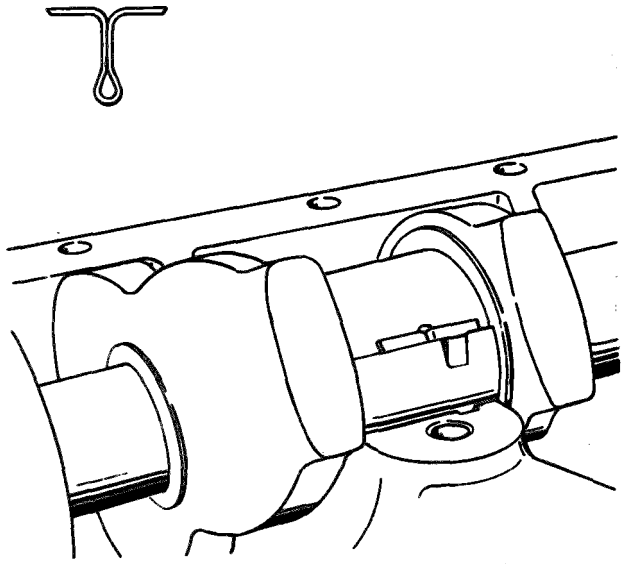


Figure 3-35. Upper Main Bearing Removal and Installation

of piston (2) to push piston into cylinder bore. See figure 3-33. Take care that connecting rod (11) is in line with crankshaft journal and will not score it.

j. With piston (2) entirely in cylinder bore, insert upper bearing (14) in connecting rod. Pull piston and rod assembly down until upper bearing seats firmly on crankshaft journal.

k. To check crankshaft journal-to-bearing shell clearance, place a piece of plastic gauge material full width of lower bearing (14) about 1/4 inch off center. See figure 3-34. Rotate crankshaft about 30° from bottom dead center and install connecting rod cap (12). Tighten connecting rod cap bolts (15) to 70 foot-pounds torque.

1. Remove connecting rod cap (12). Flattened plastic gauge material will be found adhering to either lower bearing or crankshaft. Compare width of flattened plastic gauge material at its widest point with graduations on package, as shown in figure 3-34. Required clearance for new parts is 0.001 to 0.003 inch. With used par&s, maximum allowable clearance is 0.005 inch.

m. If clearance is within required limits, remove gauge material and reinstall the connecting rod bearings and cap (12). Tighten the bolts (15) to 68 to 72 foot-pounds torque. Check connecting rod side clearance; it should be 0.005 to 0.012 inch with a maximum clearance of 0.020 inch.

n. Install remaining piston and connecting rod assemblies in a similar–manner.

o. Install oil pump.

p. Inspect top of cylinder block and pistons. Make sure no foreign matter is present; install cylinder head gasket.

q. Install cylinder head.

r. Insert valve push rods and install the rocker arm assembly,

s. Install cylinder head cover, using a new gasket. Install nuts and washers.

t. Install thermostat, thermostat housing, and water pump bypass hose. Connect water temperature gauge thermocouple.

u. Connect fuel lines.

v. Connect exhaust outlet flange at exhaust manifold,

w. Remove tags and connect radiator hoses and fill radiator with clean water or antifreeze.

x. Install oil pan, using new gaskets and fill crankcase with oil MIL-L-2104 SAE 30 (+32°F to +100°F) or SAE 10 (0°F to +32°F).

y. Adjust the valve clearance.

3-95. CRANKSHAFT AND MAIN BEARINGS.

3-96. Removal.

a. Remove engine from crane. Remove transmission and torque converter. Mount engine on maintenance stand.

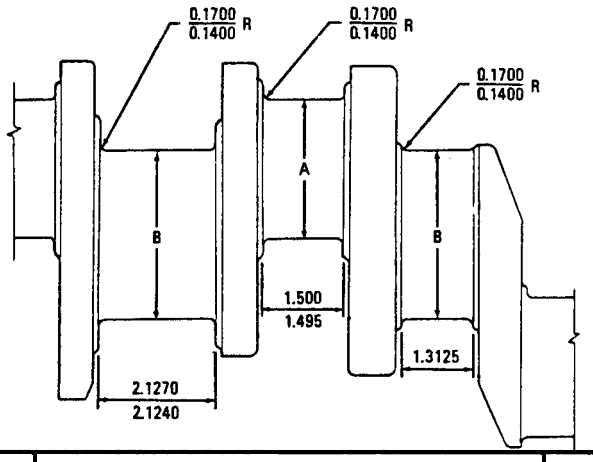
b. Remove fan and fan belts. Remove fan pulley and gear housing cover.

c. Remove Iuboil pump and tachometer drive.

d. Remove front and rear oil pan adapters.

e. Remove main bearing caps (7, 8, 9, and 10, figure 3-25) by removing bolts (12). Remove main bearing caps and lower main bearings (5 and 6), one cylinder at a time. Keep each bearing matched with its bearing cap. It may be necessary to use a small pry bar to remove main bearing caps from cylinder block. Be careful not to score or mar crankshaft journals.

f. To remove upper main bearings (4 and 6), without removing crankshaft, insert a small tee-shaped pin in crankshaft oil hole. Rotate crankshaft (42) so that pin will push upper main bearing (4 and 6) out, as shown in figure 3-35. If crankshaft is to be removed, remove upper bearings after removing crankshaft.



Bearing Sizes (Inches)	Connecting Rod Journal Dia "A" (Inches)	Main Bearing Journal Dia "B" (Inches)
Standard	2.3730/2.3740	2.8734/2.8744
0.010 Undersize	2.3630/2.3640	2.8634/2.8644
0.020 Undersize	2.3530/2.3540	2.8534/2.8544
0.030 Undersize	2.3430/2.3440	2.8434/2.8444
0.040 Undersize	2.3330/2.3340	2.8334/2.8344
0.060 Undersize	2.3130/2.3140	2.8134/2.8144

Figure 3-36. Crankshaft Journal and Crankpin Dimensions

g. Remove connecting rod bearing caps and bearings.

h. With engine inverted on an overhaul stand, use rope sling and hoist to remove crankshaft (42, figure 3-25). Take care to prevent scoring of crankshaft journals.

i. Remove the upper main bearings (4 and 6).

3-97. Cleaning and Inspection.

a. Discard used gaskets and seals.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

b. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

c. Clean oil passages in crankshaft (42, figure 3-25) with a small tube brush.

d. Inspect crankshaft gear (43) for cracked or worn gear teeth. If gear removal is necessary, properly support crankshaft and gear in an arbor press and remove gear from the crankshaft. Remove woodruff key (44). If gear must be replaced and an arbor press is not available, use a 1/4-inch drill centered midway between edge of keyway and base of gear teeth. Drill through gear parallel with keyway. Spread gear with a' chisel and pull from shaft. Be careful not to drill into crankshaft.

e. Inspect bearing caps (7 thru 10) for cracks and distortion. Replace if damaged.

f. Inspect main bearings (5 and 6) for scoring, chipping, flaking, pits, and signs of overheating. Bright spots on back of bearings indicate shifting and are cause for replacement. Replace all main bearings if one or more is damaged and requires replacement.

g. Inspect crankshaft (42) for cracks, scored journals, and misalignment. Replace if damaged beyond repair. Perform detailed inspection of crankshaft as follows:

1. Check surfaces of crankshaft (42) for cracks. There are several methods of determining the presence of minute cracks not visible to the eye. These inspection methods include magnetic particle, fluorescent magnetic particle, and fluorescent penetrant. Check for

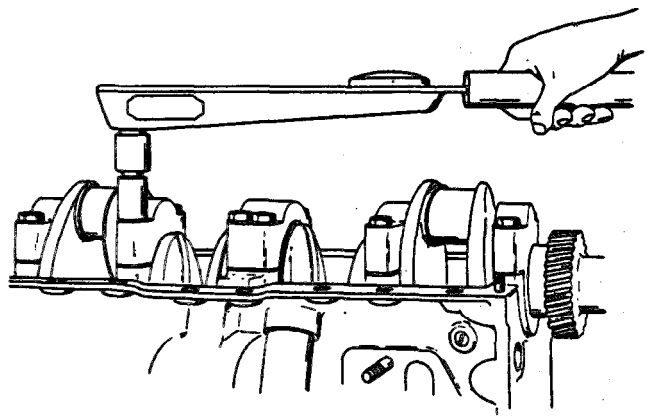


Figure 3-37. Tightening Main Bearing Cap Bolts

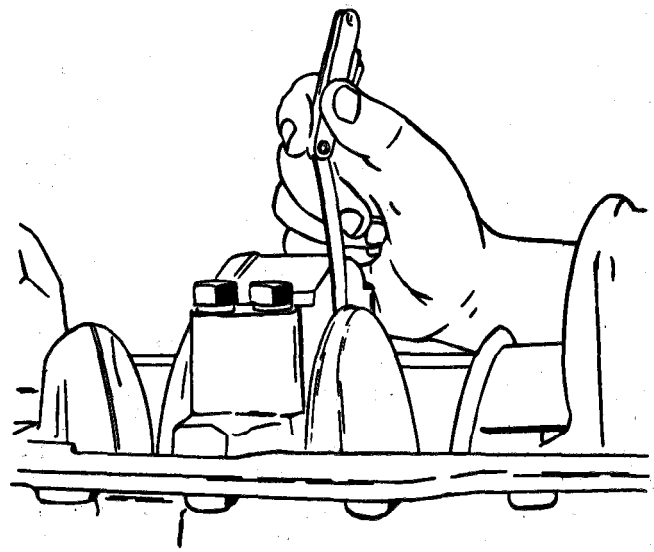


Figure 3-38. Checking Crankshaft End Thrust

circumferential fillet cracks at critical areas, and 45° cracks (45° with axis of shaft) starting from either critical fillet locations or crankshaft holes. Cracks of this nature require replacement of shaft.

2. Inspect keyways for cracks or wear. Replace shaft if necessary.

3-98. Repair.

a. If crankshaft (42) is worn so that maximum journal-to-bearing clearance (with new bearings) exceeds 0.007 inch, or maximum taper is 0.0015 inch, or out-of-round is 0.002 inch, crankshaft must be reground to 0.010, 0.020, 0.030, 0.040, or 0.060 inch undersize.

1. Prior to grinding a crankshaft, check carefully for cracks which start at an oil hole and follow journal surface at an angle of 45° to axis. Any crankshafts with such cracks must be rejected, as these cracks indicate torsional fatigue. Grinding of shaft will increase stress at cracks causing eventual failure.

2. Measure crankshaft journals, and compare these measurements to diameters required for various undersize bearings shown in figure 3-36. These measurements will determine size to which crankshaft journals must be reground.

3. If one or more main or connecting rod journals required grinding, then all main or all connecting rod journals must be ground to same required size.

4. When regrinding crankshafts, all journal fillets must have a 0.140- to 0.170-inch radius between crank cheek and crank journal, and must not have any sharp grind marks. Fillet must blend smoothly into journal and cheek, and must be free of scratches.

5. After all regrinding operations have been completed, perform another magnetic particle inspection of crankshaft to determine whether grinding cracks have originated due either to insufficient cooling or crowding of grinding wheel. Finally, demagnetize crankshaft.

6. Wash and clean crankshaft with diesel fuel and blow dry with air. Blow out oil passages to make sure they are clear.

3-99. Assembly and Installation.

a. Install crankshaft gear (43, figure 3-25) onto crankshaft (42). Use an arbor press to press gear on shaft. Make sure woodruff key (44) is in place.

b. Install upper main bearings (4 and 6) in cylinder Mock. Upper bearings are bearings with two holes and an oil groove. Bearings must be installed in same position from which they were removed.

NOTE

The upper main bearing (4 and 6) can be installed with crankshaft in place. Install a small tee-shaped pin into the crankshaft oil hole. After starting the bearing into place, rotate the crankshaft to seat it on the cylinder block, as shown in figure 3-35.

c. Apply clean engine oil to all of crankshaft journals and bearings and, using a sling and hoist, carefully set crankshaft in place so that timing marks on crankshaft gear and camshaft gear align as shown in figure 3-24.

d. With lower main bearings (4 and 6, figure 3-25) installed in bearing cap (7 thru 10) from which they were removed, install caps (7 thru 10) in their original positions on cylinder block. Caps are marked with cylinder number in which they are used. Center main bearing cap (9) is secured with four 1/2-inch diameter bolts. Remaining bearing caps are secured with two 9/16-inch diameter bolts each. Draw bolts up snug, then rap caps sharply with a soft mallet to seat them properly. Check original center main bearing cap for a T stamped on side opposite cylinder number to determine required torque value. If bearing cap is stamped with a T, torque center main bearing cap bolts to 130 foot-pounds and other main bearing cap bolts to 100 foot-pounds. If bearing caps are not stamped with a T, torque all bolts to 80 foot-pounds. Refer to figure 3-37. Start with center cap (9, figure 3-25) and work alternately toward both ends of block. If bearings have been installed properly, crankshaft will turn freely with all main bearing caps drawn down to specified torque.

e. After installing crankshaft with new bearings and center thrust bearing, check crankshaft end thrust. Insert different dimension feeler gauges until one just fits between center thrust bearing and crankshaft as shown in figure 3-38. This dimension must be between 0.005 and 0.010 inch for new bearings, and maximum allowable clearance of 0.015 inch. Insufficient clearance can be result of a misaligned main bearing, or a burr or dirt on inner face of thrust bearing flange. Disassemble, clean, and assemble as necessary. If clearance is still insufficient, polish thrust bearing flanges on a flat surface with crocus cloth to obtain proper clearance.

f. Position connecting rods so that they engage the journals of crankshaft. Apply a coat of engine oil to bearing shells to assure proper lubrication. Install connecting rod bearings and bearing caps.

g. Install front and rear oil pan adapters.

h. Install oil pump and tachometer drive.

i. Place new seal (12, figure 3-23) in gear housing cover (10) and install cover. Install fan drive pulley.

j. Install fan and belt(s).

k. Install transmission and torque converter. Install engine in crane.

3-100. CYLINDER BLOCK.

3-101. Removal and Disassembly.

a. Remove engine from crane. Remove transmission and torque converter.

b. Mount engine on maintenance stand.

Table 3-1. Cylinder Bore Dimensions

CYLINDER BORE DIAMETER	MANUFACTURING DIAMETER	
	MINIMUM	MAXIMUM
4 inch bore	3.9987	4.0011
.020 over-size	4.0187	4.0211
.040 over-size	4.0387	4.0411

c. Remove intake and exhaust manifolds.

d. Remove fuel filter and strainer, transfer pump, injection pump, fuel nozzles, and fuel lines.

e. Remove water pump and fan assembly, cylinder head, flywheel, oil filter, and oil lines.

f. Remove oil pan, bellhousing, gear housing, luboil pump, and camshaft.

g. Remove pistons with connecting rods and crankshaft.

h. Remove bayonet gauge tube (38, figure 3-25).

i. Remove oil passage pipe plugs. Do not remove expansion plugs (26) unless they show signs of leakage.

j. Remove studs (14 thru 19) only if they are damaged.

3-102. Cleaning and Inspection.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

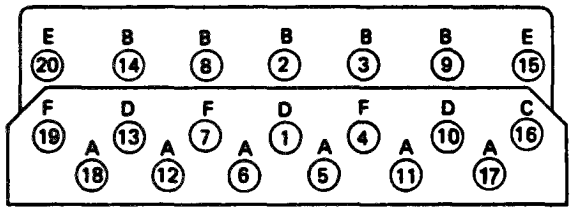
Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean block (2, figure 3-25) by submerging in tank of heated cleaning solvent. Circulate solvent to increase cleaning effectiveness.

NOTE

If additional machining is to be performed, clean oil passage and reinstall plugs after all machining is completed.

b. Clean oil passages by running a wire brush through them.



(TAPPET SIDE)

Studs	6 Cylinder	
	A-Diameter	B-Height
A	.562	4.620
B	.625	4.680
C-Oil Supply	.625	6.620
D-Cover	.625	7.430
E-Lift	.625	5.810
F	.625	6.620

Figure 3-39. Cylinder Stud Installation

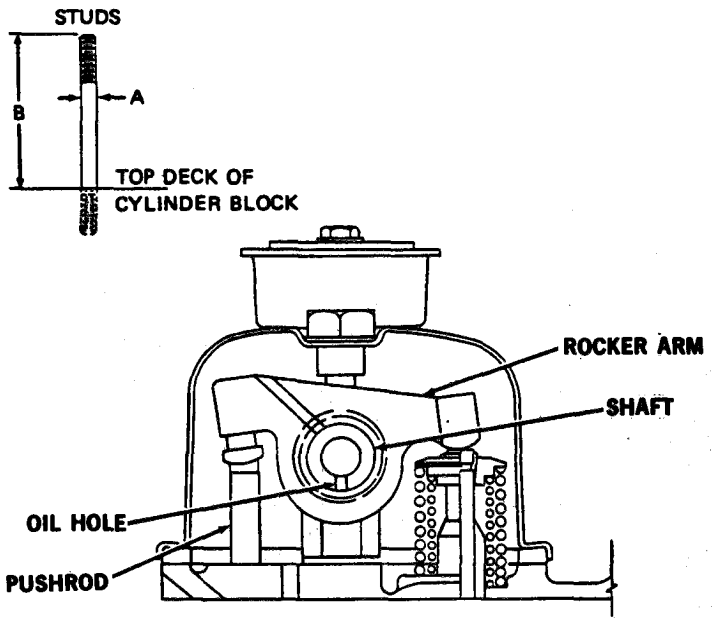


Figure 3-40. Rocker Arm Shaft

c. Check cylinder block for cracks by using dye penetrants according to manufacturer's instructions. Replace a damaged block.

d. Check for excessive cylinder bore wear by determining diameter of wear area and comparing this with original cylinder bore diameter. Gauge at intervals of approximately 45 degrees. Refer to table 3-1 for standard bore dimensions. Maximum allowable wear is 0.005 inch.

NOTE

If wear appears to be unusually excessive, check for original bore diameter by gauging the diameter of the cylinder below the piston ring wear area. The cylinder may already have been rebored for over-sized pistons.

e. Out-of-round must not exceed 0.003 inch or taper must not be more than 0.002 inch in each bore. Irregularities in cylinder bore (out-of-round and taper) may result in galling and seizing of new pistons.

f. If cylinder bores are worn excessively, they can be rebored for 0.020 and 0.040 oversize pistons and piston rings. Use a good commercial boring unit and follow manufacturer's instructions. After boring, check bore finish to be sure it is smooth.

g. Hone cylinders and ridge ream, if necessary. After honing cylinders, visually check honed surface of each cylinder bore. There must not be any low spot with an area larger than a half dollar (1.25 inches diameter). Recheck cylinder tolerance as described above.

h. Check top of block for flatness with an accurate straightedge and a feeler gauge. Top surface must not vary more than 0.005 inch on width or length. Out-of-flatness should vary gradually and uniformly from end to end and side to side. If it is necessary to machine top surface of block to correct for above conditions, do not remove more than 0.005 inch of metal. Dimension from centerline of crankshaft to top of block must not be less than 13.12 inches.

i. Remove and replace any damaged or broken cylinder head studs (14 thru 19, figure 3-25). With studs removed, inspect tapped stud holes in block and, if threads are damaged, use a tap (same size as hole) to clean up threads or retap larger and install a helical thread insert. Add locktite in hole and install new studs in cylinder block to dimension indicated in figure 3-39. Install end oil passage studs so that oil holes are within a 40-degree angle with center line of rocker arm shaft, as shown in figure 3-40.

j. Check main bearing bores as follows:

1. Install main bearing caps (7 thru 10, figure 3-25) in their original positions. Draw bolts up snugly, and rap bearing cap sharply with a soft mallet to assure proper seating. Tighten bolts to proper torque.

NOTE

It is imperative that the main bearing caps are reinstalled in their original positions to maintain the main bearing bore alignment. The caps are marked with the number of the cylinder in which they are used.

2. Measure main bearing bores. Bearing bores must be 3.0665 to 3.0670 inches. If bores do not fall within these limits, discard cylinder block.

3. Check main bearing bores for alignment. Misalignment may be caused by a broken crankshaft, excessive heat, or other severe damage. Check bearing bore alignment. If a crankshaft having standard size journals, new standard size main bearing shells installed and lubricated, and bearing caps properly tightened, can be rotated freely by hand, bores are properly aligned. If a main bearing bore is out of alignment, block must be line-bored or scraped. After boring, all bores must be within the 3.0665- to 3.0670-inch limits.

k. Check camshaft bearing bores. Internal diameter of bearing bores must be 2.1870 to 2.1889 inches. If bores do not fall within these limits, replace cylinder block.

1. Check plugs in vertical oil passages in corners of block to be sure they are flush with or below the top surface of block.

m. Check all machined accessory mounting pads for flatness, nicks, and burrs. Remove nicks and burrs with a fine file.

n. Check studs (14 thru 19) and dowel pins in block for damaged threads, distortion, cracks, or other damage. Replace any damaged parts.

o. Check all threaded holes in cylinder block. Make sure they are clean and threads are in good condition. Clean up damaged threads in tapped holes with a same size tap or retap larger and install helical thread inserts, if necessary.

p. Inspect bayonet gauge tube (38) for cracks, dents, distortion, and other damage.

3-103. Assembly and Installation.

a. Install studs (14 thru 19, figure 3-25), dowel pins, or expansion plugs (26) that were replaced. Install pipe plugs in open oil passages. Ensure that lower camshaft thrust flange mounting hole is plugged.

b. Install oil level bayonet gauge tube (38).

c. Install crankshaft with main bearings, pistons with connecting rods, camshaft, and oil pump.

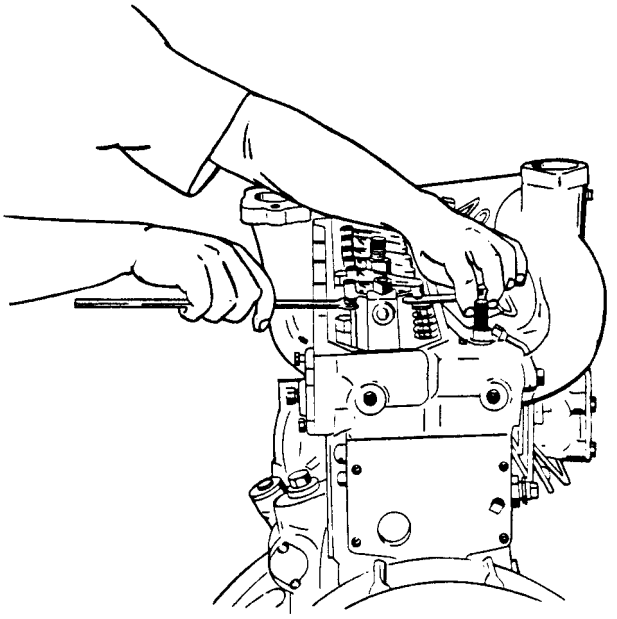


Figure 3-41. Valve Clearance Adjustment

d. Install gear housing, bellhousing, oil pan, oil filters, and oil lines.

e. Install flywheel, cylinder head, rocker arm assembly, thermostat with housing, and water pump and fan assembly.

f. Install fuel nozzles, fuel lines, injection pump, transfer pump, fuel filter, and fuel strainer.

g. Install intake and exhaust manifolds.

h. Install transmission and torque converter. Install engine in crane.

i. Adjust valve clearance.

j. Time fuel injection pump.

k. Adjust engine idler speed.

1. Adjust maximum governed speed.

3-104. ENGINE ADJUSTMENTS.

3-105. Valve Clearance Adjustment.

a. Start engine and allow it to warm to operating temperature.

b. Remove cylinder head cover and gasket.

c. With engine running at slow idle, check for 0.015 inch clearance between rocker arm and end of the valve stem, using a feeler gauge as shown in figure 3-41.

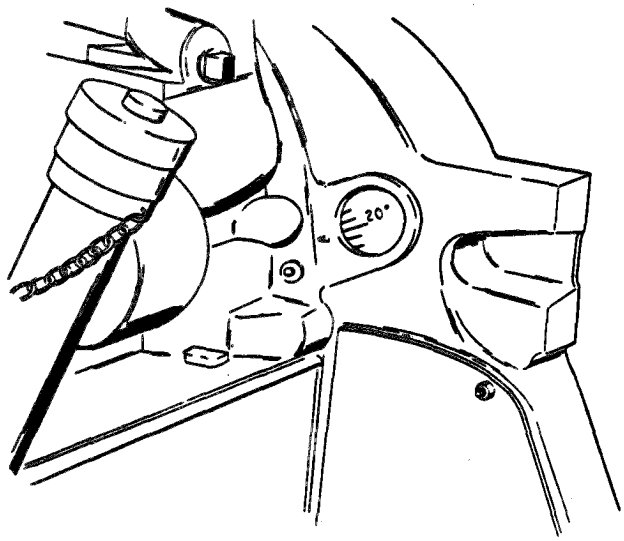


Figure 3-42. Flywheel Timing Marks

d. If valve clearance is incorrect, adjust setting of the adjusting screw to provide required clearance. Refer to figure 3-41. When properly adjusted, there will be a slight drag on feeler gauge with valve in unoperated position.

NOTE

After valve grinding or rocker arm or cylinder head removal, it is necessary to do a preliminary valve clearance adjustment with the engine shut down and using cold settings.

e. Adjusting screw is self-locking therefore lock nuts are not required.

f. Repeat procedure to adjust remaining intake and exhaust valves. Adjust all valves to same clearance.

g. Reinstall cylinder head cover and gasket. Use new gasket if old one shows any signs of cracking or deterioration.

3-106. Fuel Injection Pump Timing Adjustment.

a. Rotate engine until required timing mark on flywheel aligns with mark on flywheel housing as shown in figure 3-42.

b. Remove timing hole cover plate on fuel injection pump. Timing marks on pump should be aligned as shown in figure 3-43. If the marks are not aligned, fine adjustment may be made by loosening fuel injection pump mounting bolts and rotating pump slightly. When marks on pump are aligned, check that timing marks on the flywheel are still aligned, then tighten fuel injection pump mounting bolts. For a large adjustment, loosen drive and reposition. (Excessive movement of lines will cause overstress.)

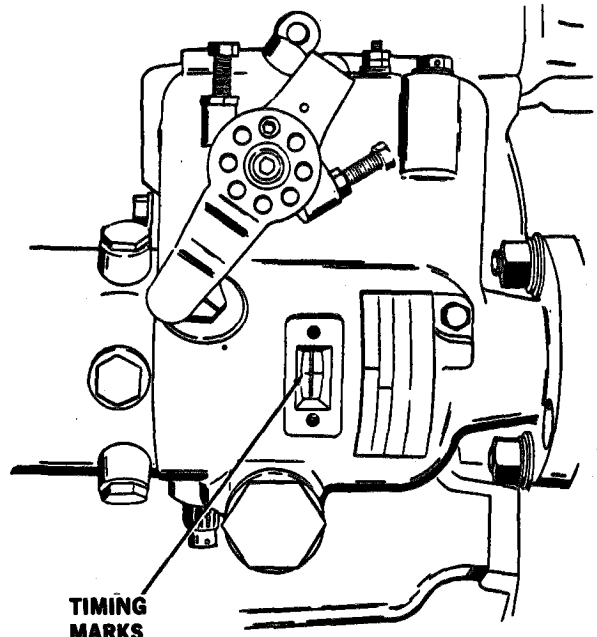


Figure 3-43. Fuel Injection Pump Timing Marks

3-107. Idle Speed Adjustment.

a. Adjust idle speed (650-700 RPM) by loosening adjusting screw locknut and turning adjusting screw in or out as necessary. Refer to figure 3-44.

3-108. Maximum Engine Speed Adjustment. With no load on engine, operate throttle control to full open position. Check full throttle speed. If maximum speed has altered slightly from recommended speed of 2640 RPM, adjust it by loosening adjusting screw locknut and turning high speed adjusting screw in or out as necessary. Refer to figure 3-44. Do not exceed 2640 RPM.

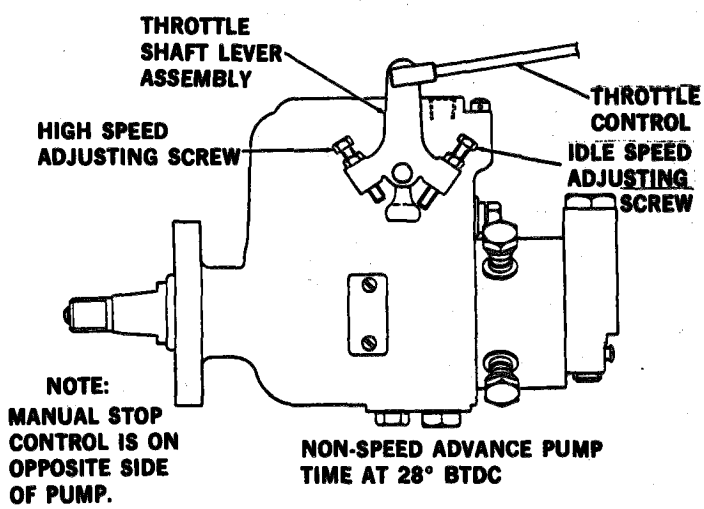


Figure 3-44. Fuel Injection Pump Speed Adjustments

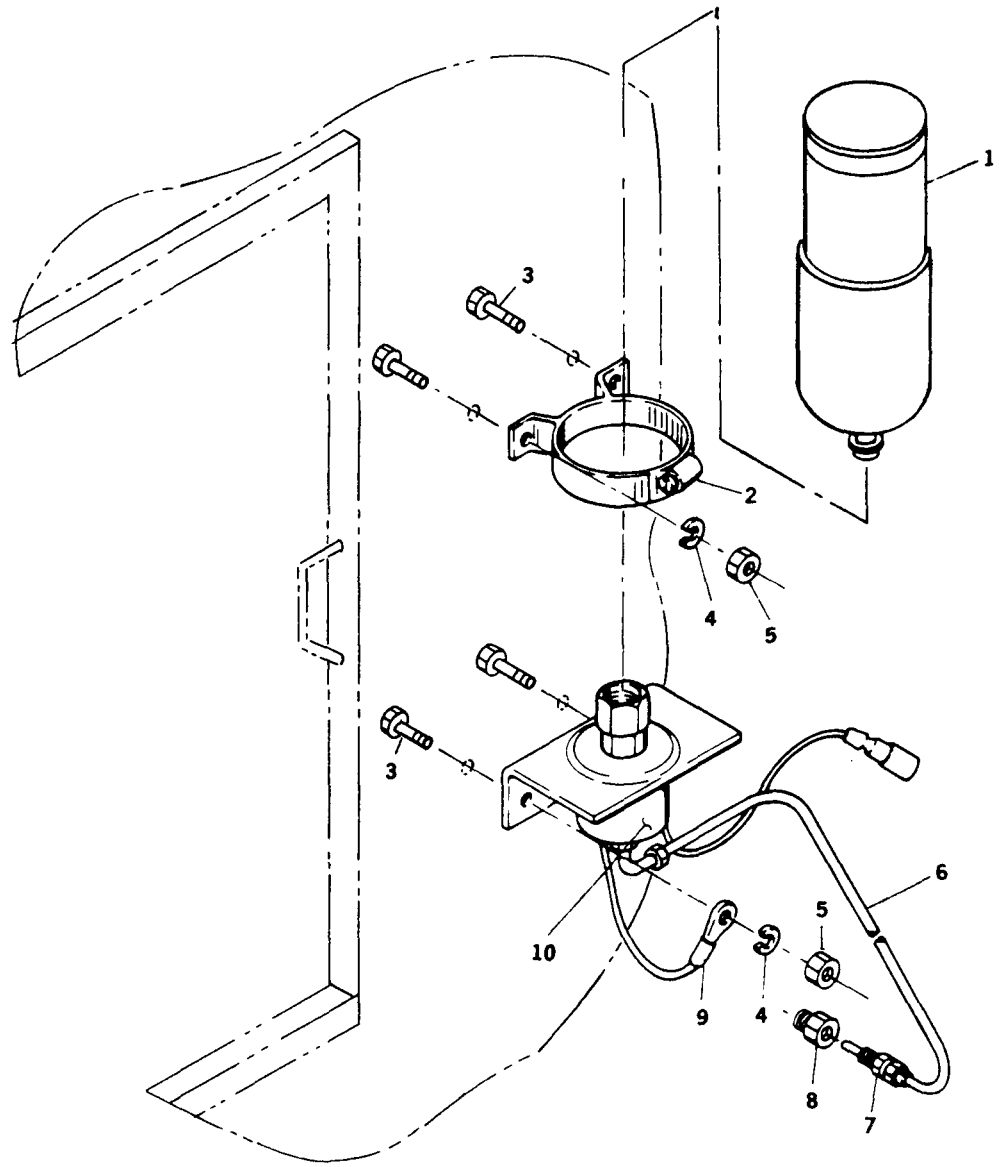


Figure 3-45. Cold Starting Aid

3-109. COLD STARTING AID.

3-110. DISASSEMBLY.

a. Remove tube (6) and reducer (8, figure 3-45) at air intake manifold on engine. Remove atomizer (7).

b. Disconnect terminals at valve (10). Remove nuts (5), lockwashers (4), capscrews (3), terminal (9), and valve (10) with cylinder (1).

c. Loosen clamps (2) and remove cylinder (1).

3-111. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with a clean cloth dipped in cleaning solvent P-D-680.

b. Wipe residue with clean cloth.

LEGEND

1. Capscrew
2. Lockwasher
3. Washer
4. Muffler Guard
5. Tail Pipe
6. Coupling
7. Clip
8. Clamp
9. Mounting Band
10. Nut
11. Lockwasher
12. Mounting Plate
13. Capscrew
14. Muffler
15. Capscrew
16. Mounting Bracket
17. Mount
18. Washer
19. Lockwasher
20. Nut
21. Capscrew
22. Elbow
23. Adapter
24. Clamp
25. Exhaust Tube
26. Capscrew
27. Lockwasher

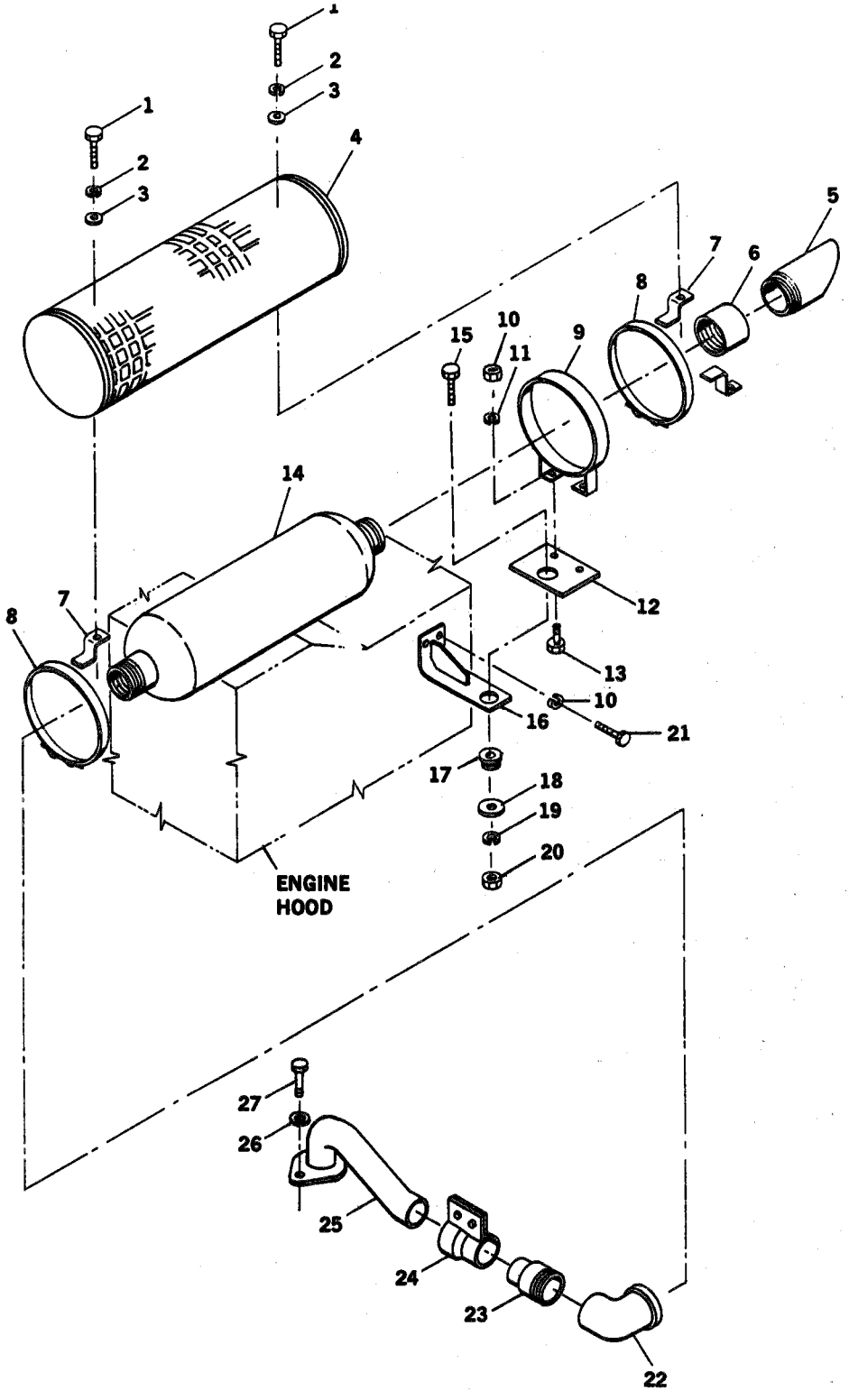


Figure 3-46. Exhaust System

c. Dry thoroughly.

d. Inspect all parts for damage and wear.

3-112. ASSEMBLY.

a. Assemble valve (10, figure 3-45), cylinder (1), and clamps (2).

b. Install valve (10) with cylinder to engine hood (inside) with capscrews (3), lockwashers (4), and nuts (5).

c. Install atomizer (7) and reducer (8) at air intake manifold on engine.

d. Connect lead at valve (10).

3-113. EXHAUST SYSTEM.

3-114. REMOVAL AND DISASSEMBLY.

a. Loosen clamp (24, figure 3-46). Remove adapter (23).

b. Remove nut (20), lockwasher (19), washer (18), mount (17), capscrew (15) and muffler (14) with muffler guard (4).

c. : Remove elbow (22), tail pipe (5) and coupling (6).

d. Remove capscrews (1), lockwashers (2), and washers (3), and muffler guard (4).

e. Remove capscrews (13), nuts (10), lockwashers (11), mounting plate (12), and mounting band (9).

f. Remove clamps (8) and clips (7).

3-115. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with a clean cloth dipped in cleaning solvent P-D-680.

b. Wipe residue with clean cloth.

c. Dry thoroughly.

d. Inspect all parts for corrosion damage.

e. Inspect all threaded parts for damage.

3-116. ASSEMBLY AND INSTALLATION,

a. Assembly elbow (22, figure 3-46), muffler (14), coupling (6), and tail pipe (5).

b. Install clamps(8), mounting band (9) and clips (7),

c. Install muffler guard (4) with capscrews (1), lockwashers (2), and washers (3).

d. Install nuts (10), lockwashers (11), mounting plate (12), and capscrews (13).

e. Install adapter (23).

f. Install muffler (14) with muffler guard (4) with capscrew (15), mount (17), washer, lockwasher(19), nut (20), and clamp (24). Install new clamp (24) if required.

SECTION 4

DRIVE TRAIN MAINTENANCE INSTRUCTIONS

4-1. TROUBLESHOOTING.

NOTE

Always make all troubleshooting checks with the converter outlet temperature at least 180 to 200 degrees F (82.3 to 93.3 degrees C).

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Low clutch pressure.	a. Low oil level.	a. Fill to proper level.
	b. Clutch pressure regulating valve spool stuck open.	b. Clean valve spool and housing (para. 4-14).
	c. Faulty charging pump.	c. Replace pump (para. 4-9).
	d. Broken or worn clutch shaft or piston sealing rings.	d. Replace sealing rings (para. 4-9).
	e. Clutch piston bleed valve stuck open.	e. Clean bleed valves thoroughly.
2. Low converter charging pump output.	a. Low oil level.	a. Fill to proper level.
	b. Suction screen plugged.	b. Clean suction screen. (para. 4-17).
	c. Air leaks at pump intake hose and connections or collapsed hose.	c. Tighten all connections or replace hose if necessary.
	d. Defective oil pump.	d. Replace pump (para. 4-9).
3. Overheating.	a. Worn oil sealing rings.	a. Remove, disassemble, and rebuild converter assembly (para. 4-9).
	b. Worn oil pump.	b. Replace (para. 4-9).
	c. Low oil level.	c. Fill to proper level.
	d. Pump suction line taking air.	d. Check oil line connections and tighten securely.
4. Noisy converter.	a. Worn coupling gears.	a. Replace (para. 4-9).
	b. Worn oil pumps.	b. Replace (para. 4-9).
	c. Worn or damaged bearings.	c. A complete disassembly will be necessary to determine what bearing is faulty (para. 4-9).
5. Lack of power.	a. Low engine rpm at converter stall.	a. Tune-up engine and check governor (para. 3-104).
	b. Overheating. See Symptom 3.	b. See Solution 3.

4-2. DRIVE LINES.

4-3. REMOVAL AND DISASSEMBLY.

a. Remove front and rear drive shafts (figure 4-1) from transmission and front and rear axles.

b. Disassemble front and rear drive shafts by removing capscrews (1) and cross and bearing assembly (2) from slip yoke (3).

c. Remove capscrews (5) and cross and bearing assembly (6) from yoke (7).

d. Loosen dust cap (4) and separate slip yoke (3) and yoke (7).

4-4. CLEANING.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

4-5. ASSEMBLY AND INSTALLATION.

a. Assemble front and rear drive shafts by assembling yoke (7) and slip yoke (3) by tightening dust cap (4).

b. Attach cross and bearing assembly (6) to yoke (7) and install capscrews (5).

c. Attach cross and bearing assembly (2) to slip yoke (3) and install capscrews (1).

d. Install front and rear drive shafts to transmission and axles.

4-6. TRANSMISSION.

4-7. REMOVAL AND DISASSEMBLY.

4-8. Engine and Transmission Removal. Remove the engine and transmission as follows:

a. Disconnect and remove batteries.

b. Disconnect exhaust outlet flange at exhaust manifold and air inlet flange at intake manifold.

c. Remove oil pan plug (1, figure 4-2) and drain engine oil into five gallon container. Remove transmission drain plug (2) and drain transmission oil into a five gallon container.

d. Remove radiator cap, open draincock, and drain coolant into 10 gallon container.

e. Tag and disconnect coolant and heater hoses. Remove radiator grill and remove radiator.

f. Remove engine hood assembly.

g. Tag and disconnect hydraulic lines to pump mounted on rear of torque converter. Remove bolts and pump.

h. Tag and disconnect fuel supply and return lines. Disconnect cold weather start system.

i. Tag and disconnect leads to starter, alternator, and temperature and pressure sending units.

j. Remove accelerator control cable at fuel injection pump. Remove nuts, u-bolts, cotter pins, and clevis pin securing shift linkage at transmission control valve. Disconnect axle disconnect linkage.

k. Disconnect front and rear drive shafts.

l. Attach hoist to engine and transmission assembly. Remove capscrews (3), washers (4), lockwashers (6), and nuts (5), securing engine and transmission to frame. Remove engine and transmission. Secure engine to maintenance stand.

m. Remove cover on flywheel housing (opposite starter). Manually rotate crankshaft until capscrew (7) is visible. Remove capscrew (7).

n. Rotate crankshaft and remove next capscrew (7). Repeat step until total of eight capscrews (7) have been removed.

o. Support transmission with overhead hoist and remove twelve capscrews (8) and lockwashers (9). Transport transmission to work area.

4-9. Transmission Disassembly. Disassemble the transmission as follows:

a. Remove filter element (9, figure 4-3), screws (5 and 6), lockwashers (4 and 7) and stud nuts (8), Remove charging pump (3) with gasket (1) and O-ring (2).

b. Remove screws and lockwashers (73), backing ring (72), and drive plates (70).

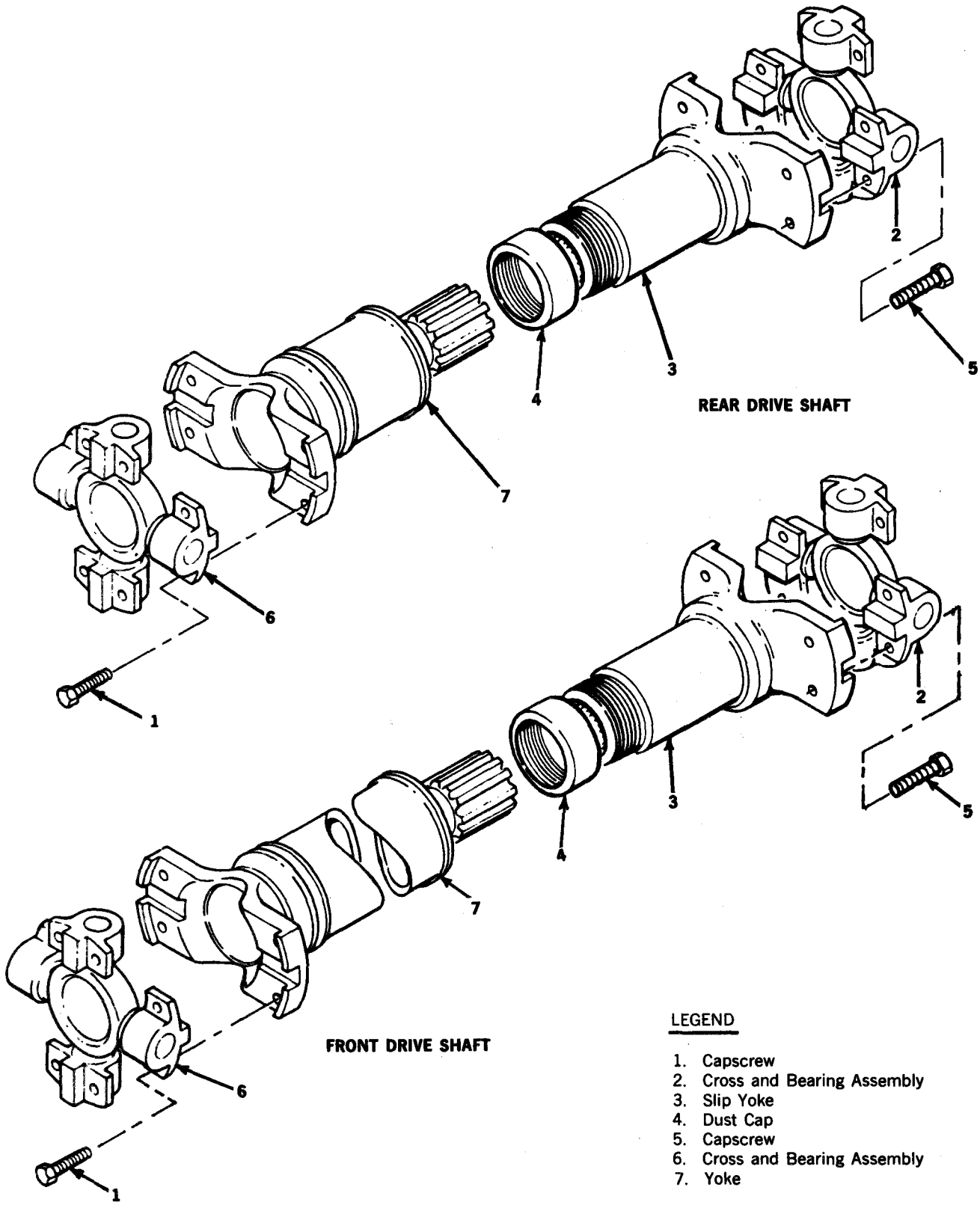


Figure 4-1. Front and Rear Drive Shafts

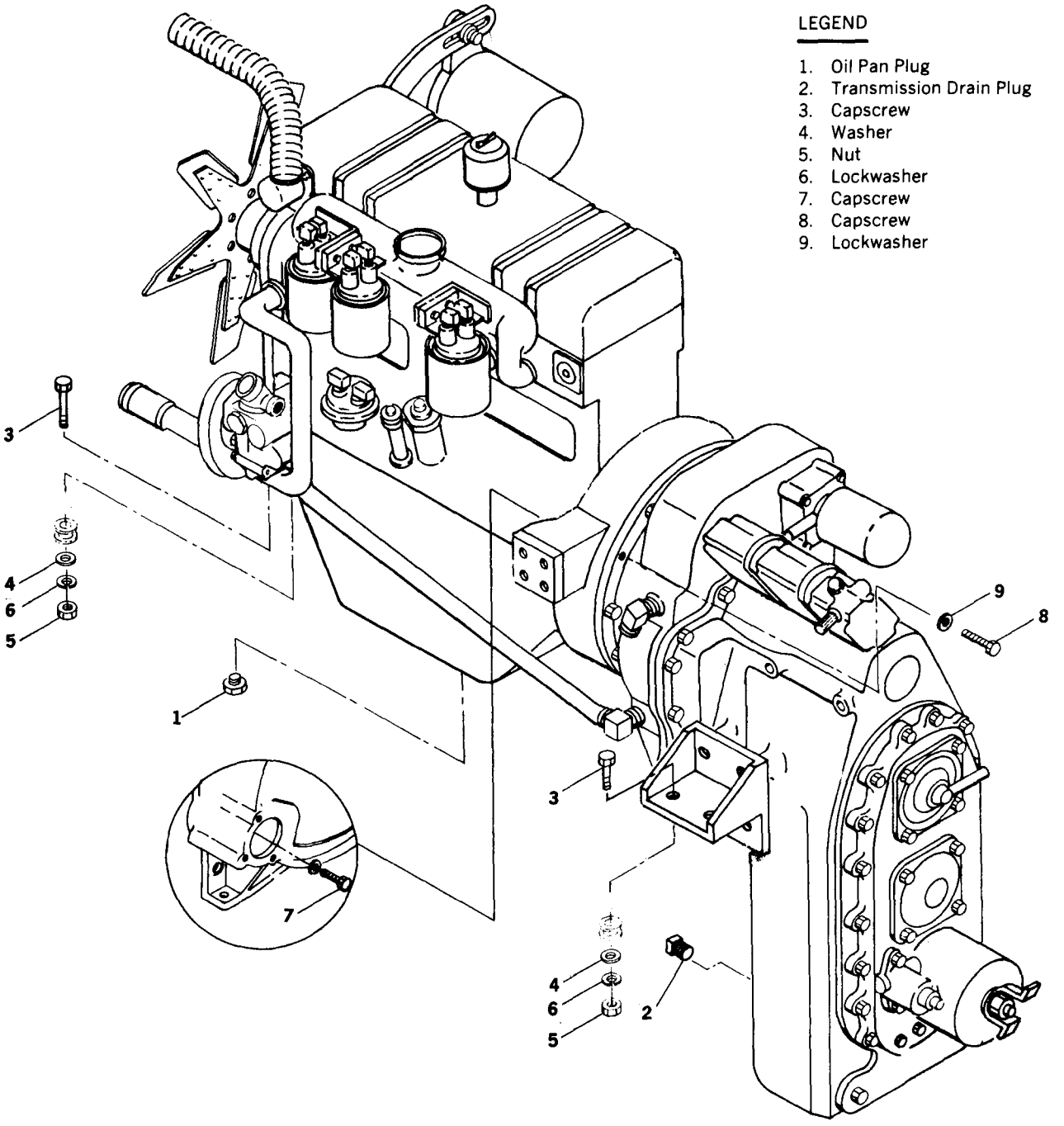


Figure 4-2. Transmission Removal

c. Remove retaining ring (69), plug (68), 0-ring (67), and retaining ring (66).

d. Remove screws and lockwashers (58), impeller cover (65) with Q-ring (64), and bearing (62) with washer (63) and locating ring (61).

e. Remove turbine (60) and retaining ring (59).

f. Remove retainer ring (57), reaction member (56), spacer (55), and impeller (52). Remove screws (54), tabs (53), gear (50), and 0-ring (51) if needed.

g. Remove oil baffle with puller tool fabricated as shown in figure 4-4.

h. Remove retaining ring (18), gear (19), and bearing (20).

i. Remove screw and washer (10), tap gear (16) and support (12) from housing with soft mallet. Remove locating ring (11), support (12), retainer ring (13), bearing (14), and locating ring (15) if needed. (Repeat this procedure to remove second pump drive gear and housing, not shown.)

j. Remove screen (18, figure 4-5) and gasket (17).

k. Remove screws (1), lockwashers (2), and control valve (3) with gasket (4). Do not lose balls (5) and springs (6). Disassemble control valve if necessary (para 4-15).

1. Support converter housing (9) with chain hoist and remove screws (14) and lockwashers (13). Separate the converter housing (9, figure 4-5) from the transmission case (28). Remove the housing to case gasket (19).

m. Open snap ring (3, figure 4-6) and remove reverse and second clutch assembly (14).

n. Remove nuts (74), lockwashers (73), and cap (72) with 0-ring (70).

o. Remove nuts (77), lockwashers (78), and cap (79) with 0-ring (81).

p. Remove flange nut (88), washer (89), 0-ring (90), and flange (91).

q. Remove nuts (113), lockwashers (114), and support (115) with 0-ring (108). Do not lose detent ball.

r. Remove nuts (4, figure 4-9), lockwashers (5), and axle disconnect (7). Disassemble axle disconnect if necessary (para 4-16).

1. Remove rear bearing locating rings (not shown) from bearings, (66, 84, and 95, figure 4-6).

s. Remove screws (34, figure 4-5) and lockwashers (35). Pry cover (33) with gasket (31) off. Tap low clutch, idler, and output shafts with soft mallet to prevent binding.

t. Remove retainer ring (68, figure 4-6), washer (67), and bearing (66).

u. Remove idler shaft and gear (42). Remove shaft fork (101).

v. Remove nut (122), washer (121), 0-ring (120), and flange (119).

w. Tap output shaft (126) trom housing. Remove oil seal (94), bearing (95), thrust washer (96), and hub (102).

x. Remove oil seal (118), bearing (117), thrust washer (107), and gear (106). Remove bearing (103), spacer (104), and bearing (105).

y. Remove hub and retaining ring (20).

z. Compress ears on locating ring (55). Remove ring from ring groove.

aa. Tap low clutch (41) from housing with soft mallet.

bb. Contract locating ring (47). From front of transmission, tap 3rd clutch (54) with soft bar and mallet. Remove bearing carrier (48) with bearing (45) and hub (49).

cc. Remove 3rd clutch (54).

dd. Remove plug (21), retainer ring (22), gear (23) and tap forward clutch (24) from bearing (65) with soft mallet. Remove forward clutch (24).

ee. Remove retaining ring (62), sleeve (63), and bearing (65) if needed.

4-10 Low Clutch. Disassemble and assemble the low clutch (41, figure 4-6) as follows:

a. Remove bearing (29), spacer (30), bearing (31), and gear (34). Remove locating ring (32) and spacer (33), retaining ring (37), bearing (36), and locating ring (35).

b. Remove snap ring (1, figure 4-7) and plate (2). Turn over low clutch and remove inner and outer clutch discs (3 and 4).

c. Retain piston spring (40, figure 4-6) with pipe sleeve. Remove snap ring (38), retainer (39), and spring (40) by releasing pressure on spring.

d. Remove piston (5, figure 4-7). Remove 0-rings (6 and 7).

e. Install new 0-ring (6). Size 0-ring until it is flush with outer diameter of piston (5). Install new 0-ring (7). Install piston (5) being careful not to damage 0-rings (6 and 7).

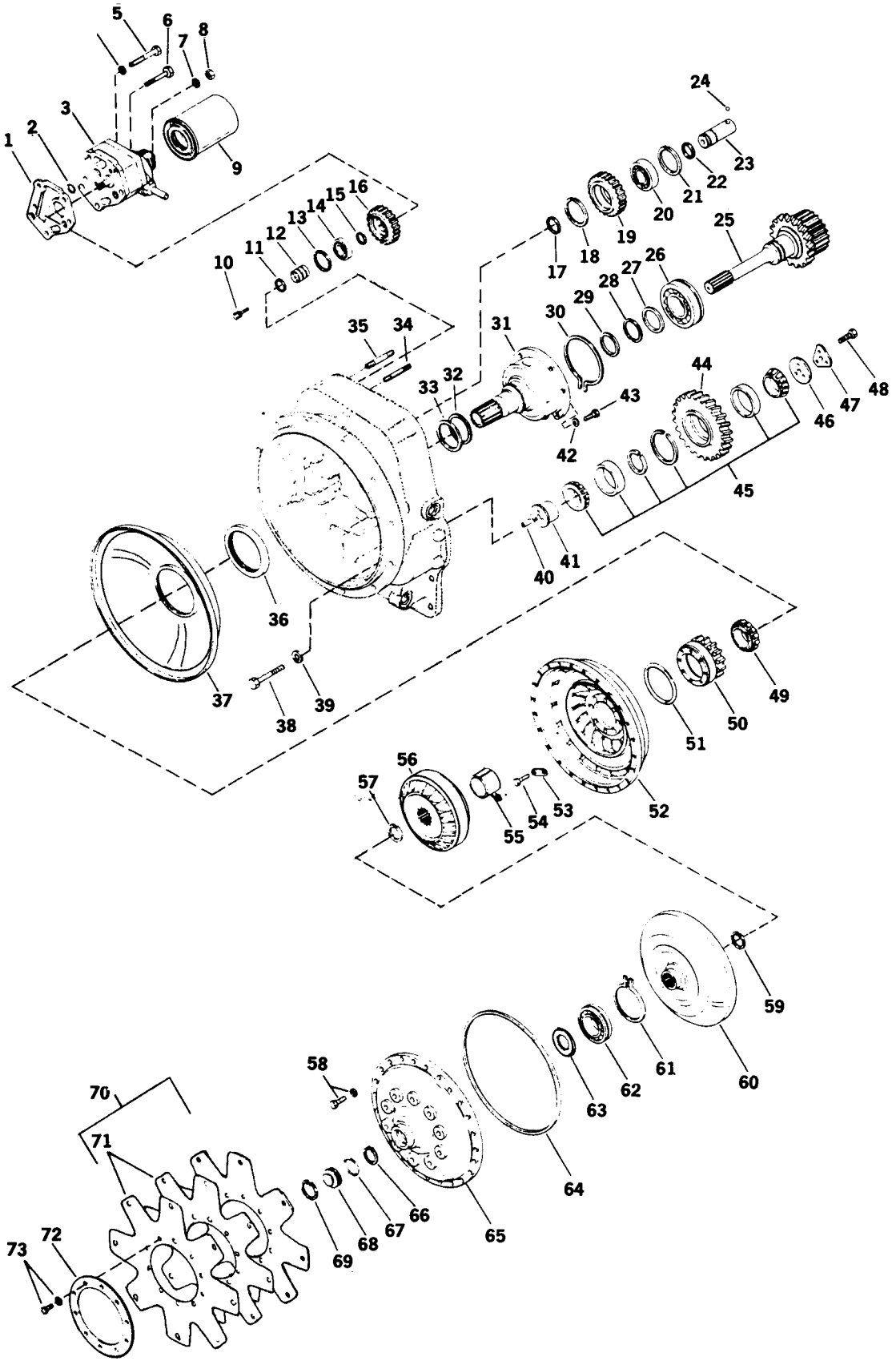


Figure 4-3. Converter Group

LEGEND FOR FIGURE 4-3

1. Pump to Housing Gasket
2. O-Ring
3. Charging Pump Assembly
4. Lockwasher
5. Screw
6. Screw
7. Lockwasher
8. Nut
9. Filter
10. Screw & Lockwasher
11. Locating Ring
12. Pump Drive Bearing Support
13. Retaining Ring
14. Gear Bearing
15. Locating Ring
16. Pump Drive Gear
17. Locating Ring
18. Retaining Ring
19. Idler Gear
20. Shaft Bearing
21. Retaining Ring
22. Locating Ring
23. Stub Shaft
24. Stub Shaft Lockball
25. Turbine Shaft & Retaining Ring
26. Shaft Bearing
27. Locating Washer
28. Retaining Ring
29. Piston Ring
30. Snap Ring
31. Stator Support
32. Expander Spring
33. Piston Ring
34. Stud
35. Stud
36. Oil Seal
37. Oil Baffle Assembly
38. Shaft Screw
39. Screw Lockwasher
40. Shaft Pin
41. Idler Shaft
42. Screw Lockwasher
43. Screw
44. Idler Gear
45. Idler Gear Bearing
46. Retaining Plate
47. Lockplate
48. Screw
49. Gear Bearing
50. Hub Gear
51. O-Ring
52. Impeller
53. Lock Tab
54. Screw
55. Bearing Spacer
56. Reaction Member
57. Retaining Ring
58. Screw & Lockwasher
59. Retaining Ring
60. Turbine
61. Locating Ring
62. Hub Bearing
63. Retaining Washer
64. O-Ring
65. Impeller Cover
66. Retaining Ring
67. O-Ring
68. Bore Plug
69. Retaining Ring
70. Drive Plate Assembly
71. Drive Plate
72. Backing Ring
73. Screw & Lockwasher

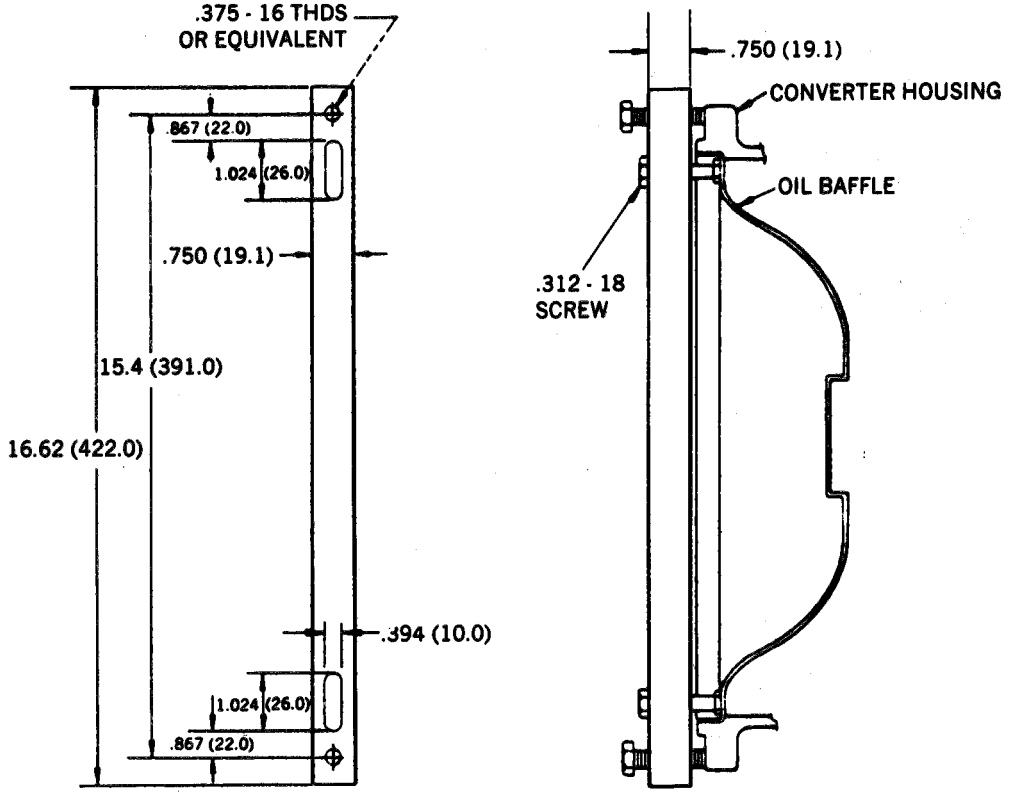


Figure 4-4. Oil Baffle Puller Tool

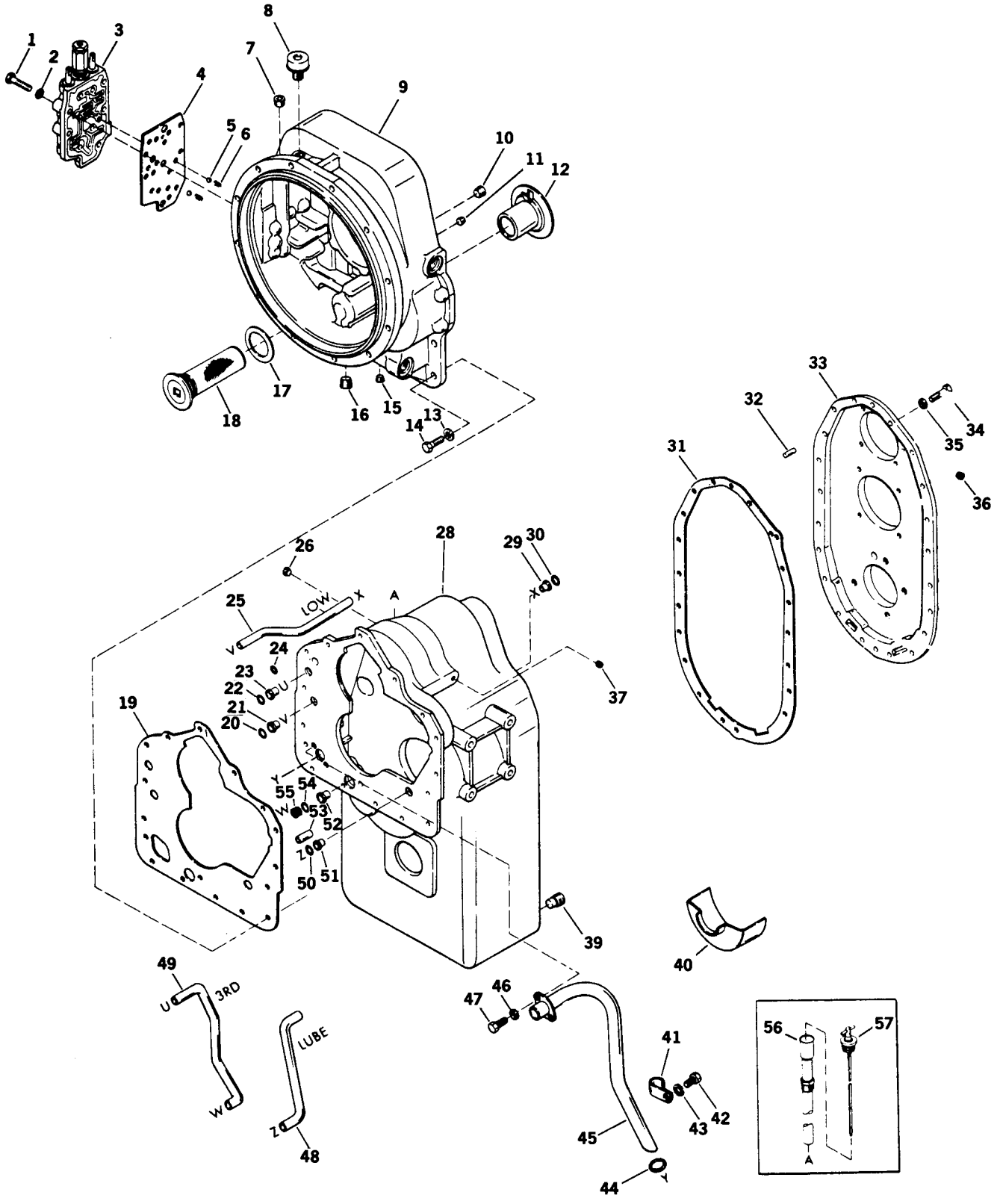


Figure 4-5 Converter and Transmission Case Group

LEGEND FOR FIGURE 4-5

1. Screw
2. Lockwasher
3. Control Valve Assembly
4. Control Valve Gasket
5. Detent Ball
6. Detent Spring
7. Pipe Plug
8. Air Breather
9. Converter Housing
10. Pipe Plug
11. Pipe Plug
12. Converter Housing Sleeve
13. Lockwasher
14. Screw
15. Pipe Plug
16. Pipe Plug
17. Screen Assembly Gasket
18. Screen Assembly
19. Housing to Case Gasket
20. O-Ring
21. Tube Sleeve
22. O-Ring
23. Tube Sleeve
24. O-Ring
25. Pressure Tube
26. Pipe Plug
28. Transmission Case Assembly
29. Tube Sleeve
30. O-Ring
31. Gasket
32. Dowel Pin
33. Rear Cover & Plug Assembly
34. Screw
35. Lockwasher
36. Pipe Plug
37. Pipe Plug
39. Magnetic Drain Plug
40. Oil Baffle
41. Suction Tube Clip
42. Retaining Screw
43. Lockwasher
44. O-Ring
45. Suction Tube Assembly
46. Lockwasher
47. Screw
48. Lube Tube
49. 3rd Speed Tube
50. O-Ring
51. Tube Sleeve
52. Tube Sleeve
53. Dowel Pin
54. O-Ring
55. Plug
56. Dipstick Tube
57. Dipstick

f. Install spring (40, figure 4-6), retainer (39) and snap ring (38) with pipe sleeve.

g. Install locating ring (37), disc (4, figure 4-7), and disc (3). Alternate discs (4 and 3) until eight of each have 'been installed.

h. Install plate (2) and snap ring (1).

i. Install locating ring (35, figure 4-6), bearing (36), spacer (33), gear (34), locating ring (32), bearing (31), spacer (30), and bearing (29).

4-11. Reverse and 2nd Clutch. Disassemble and assemble reverse and 2nd clutch as follows:

a. Remove rings (1, figure 4-6), retaining ring (2), bearing (4), and gear (8). Use gear puller.

b. Remove spacer (7), retaining rings (6 and 9), and bearings (5 and 10).

c. Remove snap ring (25, figure 4-7), plate (26), and clutch discs (27 and 28). With pipe sleeve, remove snap ring (11, figure 4-6), spring washers (12), and spacer (13).

d. Remove piston (29, figure 4-7). Remove 0-rings (30 and 31).

e. Remove snap ring (33), plate (34), and clutch discs (35 and 36). With pipe sleve, remove snap ring (17, figure 4-6), retainer (16), and spring (15) by releasing pressure on pipe sleeve.

f. Remove piston (37, figure 4-7). Remove 0-rings (38 and 39).

g. Install new 0-rings (30 and 38). Size 0-rings until flush with outer diameter of pistons (29 and 37). Install new 0-rings (31 and 39).

h. Install piston (37) being careful not to damage 0-rings.

i. Install spring (15, figure 4-6), retainer (16) and snap ring (17) using pipe sleeve.

j. Install disc (36, figure 4-7) and disc (35). Alternate discs (36 and 35) until six of each have been installed.

k. Install plate (34) and snap ring (33).

I. Install piston (29) being careful not to damage 0-rings.

m. Install spacer (13, figure 4-6), spring washers (12), and snap ring (11) with pipe sleeve.

n. Install disc (28, figure 4-7). Install disc (27). Alternate installing discs (28 and 27) until eight of each have been installed,

o. Install plate (26) and snap ring (25).

p. Install bearings (5 and 10, figure 4-6), retaining rings (6 and 9), and spacer (7).

q. install gear (8), bearing (4), retaining ring (2), and rings (1).

4-12. Forward Clutch. Disassemble and assemble forward clutch (24, figure 4-6) as follows:

a. Remove rings (61).

b. Remove snap ring (9, figure 4-7), plate (10), and discs (11 and 12).

c. Remove bearing (28, figure 4-6), snap ring (27), spring washers (26), and spacer (25) using pipe sleeve.

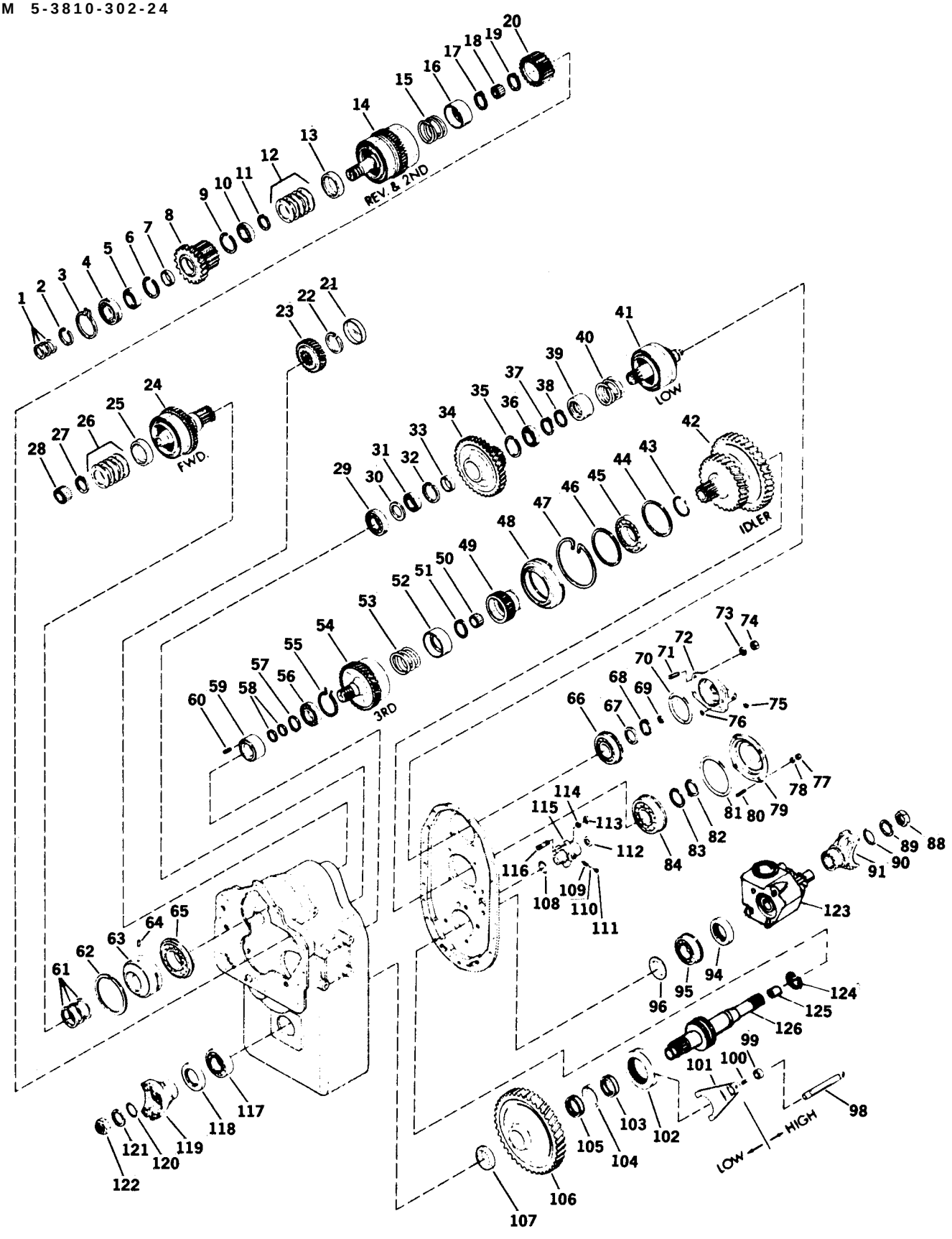


Figure 4-6. Clutch and Gear Group

LEGEND FOR FIGURE 4-6

1. Piston Ring
2. Retaining Ring
3. Snap Ring
4. Front Bearing
5. Gear Bearing
6. Retaining Ring
7. Bearing Spacer
8. Gear & Hub Assembly
9. Retaining Ring
10. Gear Bearing
11. Snap Ring
12. Spring Washers
13. Spring Spacer
14. Reverse & 2nd Clutch
15. Return Spring
16. Spring Retainer
17. Snap Ring
18. Rear Bearing
19. Snap Ring
20. Hub & Retaining Ring Assembly
21. Bore Plug
22. Snap Ring
23. Shaft Gear
24. Forward Clutch
25. Spring Spacer
26. Spring Washers
27. Snap Ring
28. Pilot Bearing
29. Front Bearing
30. Bearing Spacer
31. Gear Bearing
32. Locating Ring
33. Gear Spacer
34. Gear & Hub Assembly
35. Locating Ring
36. Gear Bearing
37. Retaining Ring
38. Snap Ring
39. Spring Retainer
40. Return Spring
41. Low Clutch
42. Idler Shaft & Gear
43. Retaining Ring
44. Locating Ring
45. Disc Hub Bearing
46. Locating Ring
47. Locating Ring
48. Bearing Carrier
49. Hub & Retaining Ring Assembly
50. Pilot Bearing
51. Snap Ring
52. Spring Retainer
53. Return Spring
54. 3rd Clutch
55. Locating Ring
56. Front Bearing
57. Retaining Ring
58. Piston Ring
59. Outer Race
60. Roll Pin
61. Piston Ring
62. Retainer Ring
63. Ring Sleeve
64. Roll Pin
65. Rear Bearing
66. Rear Bearing
67. Support Washer
68. Retaining Ring
69. Piston Ring
70. O-Ring
71. Stud
72. Bearing Cap
73. Lockwasher
74. Nut
75. Plug
76. O-Ring
77. Nut
78. Lockwasher
79. Bearing Cap
80. Stud
81. O-Ring
82. Retaining Ring
83. Washer
84. Rear Bearing
88. Nut
89. Washer
90. O-Ring
91. Output Flange
94. Oil Seal
95. Rear Bearing
96. Thrust Washer
98. Shift Rail
99. Spacer
100. Lockscrew
101. Shift Fork
102. Shift Hub
103. Gear Bearing
104. Bearing Spacer
105. Gear Bearing
106. Range Gear
107. Thrust Washer
108. O-Ring
109. Lock Spring
110. Lock Ball
111. Detent Plug
112. Oil Seal
113. Nut
114. Lockwasher
115. Rail Support
116. Stud
117. Front Bearing
118. Oil Seal
119. Output Flange
120. O-Ring
121. Washer
122. Nut
123. Axle Disconnect
124. Retaining Ring
125. Shaft Bushing
126. Shaft & Bushing Assembly

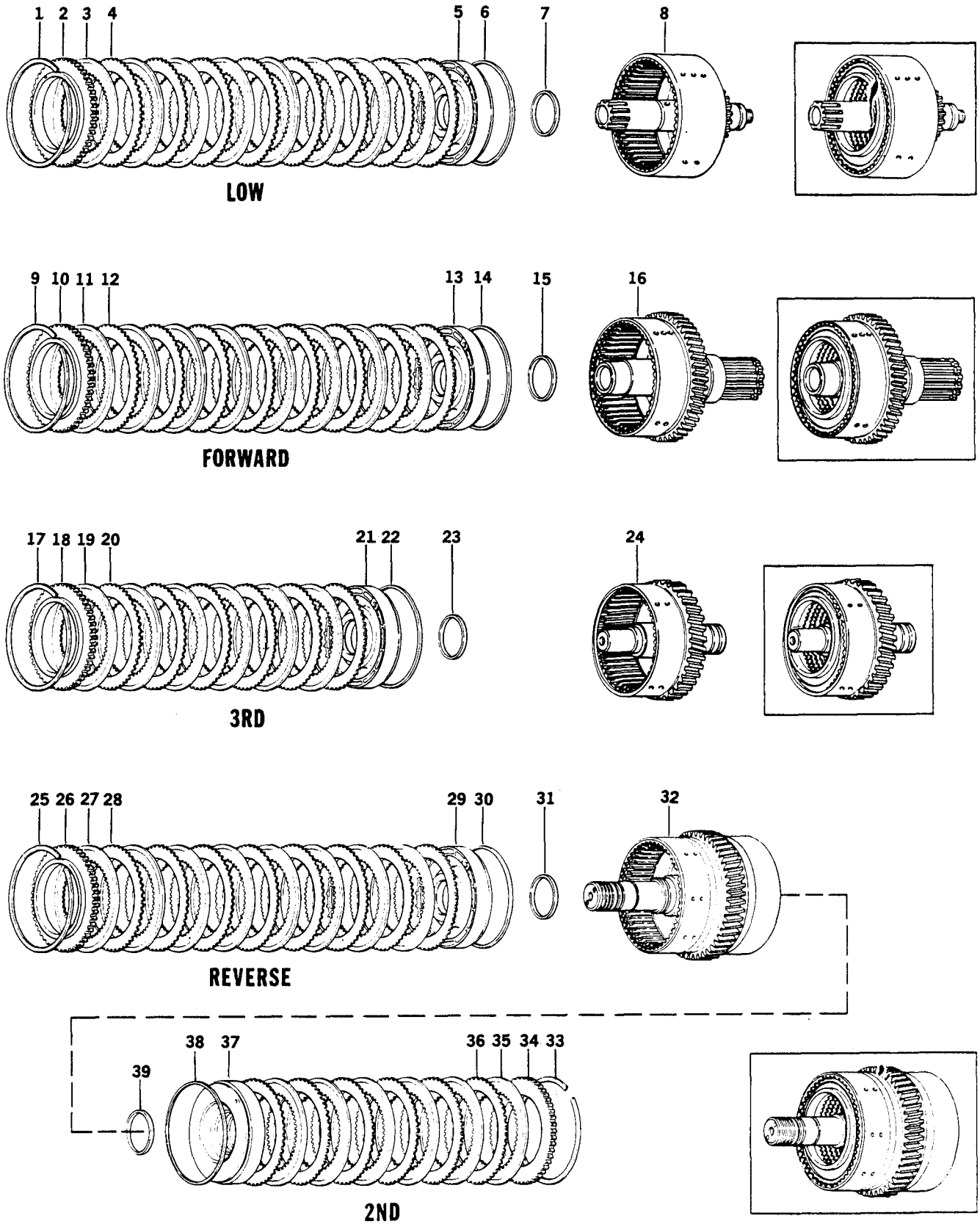


Figure 4-7. Clutch Group Assembly

LEGEND FOR FIGURE 4-7

1. Snap Ring
2. Backing Plate
3. Clutch Inner Disc
4. Clutch Outer Disc
5. Clutch Piston
6. Outer Clutch Piston Ring
7. Inner Clutch Piston Seal
8. Low Clutch Shaft Drum & Bleed Valve Assembly
9. Snap Ring
10. Backing Plate
11. Clutch Inner Disc
12. Clutch Outer Disc
13. Clutch Piston
14. Outer Clutch Piston Ring
15. Inner Clutch Piston Seal
16. FWD Shaft, Drum & Plug Assembly
17. Snap Ring
18. Backing Plate
19. Clutch Inner Disc
20. Clutch Outer Disc
21. Clutch Piston Assembly
22. Outer Clutch Piston Seal
23. Inner Clutch Piston Seal
24. 3rd Clutch Shaft, Drum & Plug Assembly
25. Snap Ring
26. Backing Plate
27. Clutch Inner Disc
28. Clutch Outer Disc
29. Clutch Piston
30. Outer Clutch Piston Seal
31. Inner Clutch Piston Seal
32. Drum & Plug Assembly
33. Snap Ring
34. Backing Plate
35. Clutch Inner Disc
36. Clutch Outer Disc
37. Clutch Piston
38. Outer Clutch Piston Seal
39. Inner Clutch Piston Seal

d. Remove piston (13, figure 4-7). Remove O-rings (14 and 15).

e. Install new O-ring (14). Size O-ring until flush with outer diameter of piston (13). Install O-ring (15).

f. Install piston (13) being careful not to damage O-rings.

g. Install spacer (25, figure 4-6), spring washers (26), and snap ring (27) with pipe sleeve. Install bearing (28).

h. Install disc (12, figure 4-7). Install disc (11). Alternate installing discs (12 and 11) until eight have been installed.

i. Install plate (10) and snap ring (9). install rings (61, figure 4-6).

4-13. 3rd Clutch. Disassemble and assemble 3rd clutch (54, figure 4-6) as follows:

a. Remove outer race (59), rings (58), retaining ring (57), and bearing (56).

b. Remove snap ring (17, figure 4-7), plate (18), and discs (19 and 20).

c. Remove bearing (50, figure 4-6), snap ring (51), retainer (52), and spring (53) with pipe sleeve.

d. Remove piston (21, figure 4-7). Remove O-rings (22 and 23).

e. Install new O-ring (22). Size O-ring until flush with outer diameter of piston (21). Install O-ring (23).

f. Install piston (21) being careful not to damage O-rings.

g. Install spring (53, figure 4-6), retainer (52), and snap ring (51) with pipe sleeve. Install bearing (50).

h. Install disc (20, figure 4-7). Install disc (19). Alternate installing discs (20 and 19) until six of each have been installed, Install plate (18) and snap ring (17).

i. Install bearing (56, figure 4-6), retaining ring (57), rings (58), and outer race (59).

4-14. Converter l-lousing. Disassemble the converter housing (figure 4-3) as follows:

a. Remove screws (48), lockplate (47), plate (46), screws (38), lockwashers (39), and gear (45). Disassemble gear (45) if needed.

b. Spread ears on snap ring (30) and tap shaft (25) from housing.

c. Remove piston ring (29), retaining ring (28), washer (27), and bearing (26).

d. Remove screws (43), lockwashers (42), and support (31). Remove bearing (49), seal (36), spring (32), and ring (33).

4-15. Transmission Shift Control Valve. Repair the transmission shift control valve (figure 4-8) as follows:

a. Remove spool stops (6) and remove spools (1 and 11).

b. Remove oil seals (3 and 10) and discard.

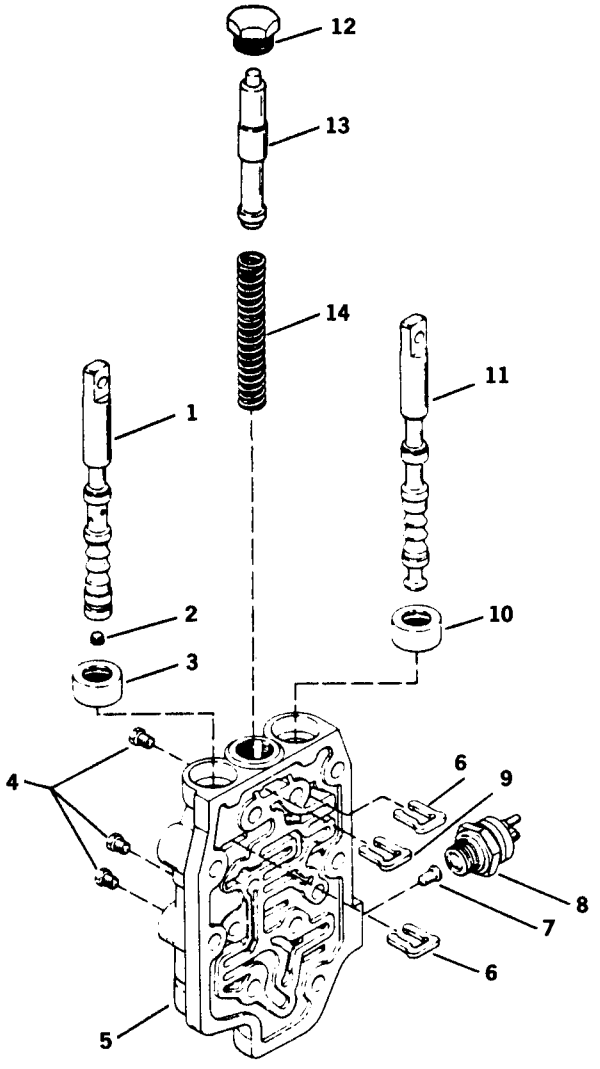
c. Install new oil seals (3 and 10).

d. Install spools (1 and 11) being careful not to damage oil seals (3 and 10).

e. Install spool stops (6).

4-16. Axle Disconnect. Repair the axle disconnect (figure 4-9) as follows:

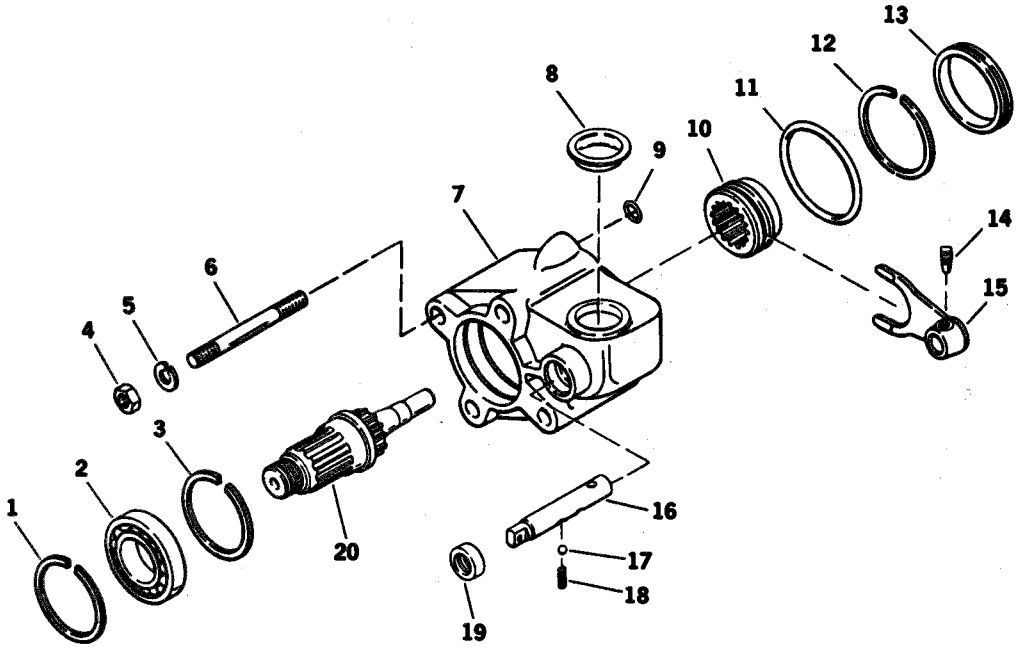
a. Remove cap (8) and lockscrew (14).



LEGEND

1. Spool & Plug Assembly
2. Plug
3. Oil Seal
4. Pipe Plug
5. Control Valve Housing
6. Valve Spool Stop
7. Actuating Pin
8. Neutral Switch
9. Valve Spool Stop
10. Oil Seal
11. Forward & Reverse Valve
12. Plug
13. Valve Spool
14. Control Valve Spring

Figure 4-8. Transmission Control Valve Assembly



LEGEND

1. Retainer Ring
2. Bearing
3. Retainer Ring
4. Nut
5. Lockwasher
6. Stud
7. Disconnect Housing
8. Housing Plug
9. O-Ring
10. Shift Hub
11. O-Ring
12. Retainer Ring
13. Pilot Ring
14. Lockscrew
15. Shift Fork
16. Shift Rail
17. Detent Ball
18. Detent Spring
19. Oil Seal
20. Disconnect Shaft

Figure 4-9. Axle Disconnect Assembly

b. Remove retaining rings (1, 3, and 12). Remove shaft (20), bearing (2), hub (10), ring (13), and fork (15).

c. Assemble shaft (20), retaining rings (1,3, and 12), and bearing (2).

d. Install shaft (2), hub (10), fork (15), and ring (13).

e. Install lockscrew (14) and plug (8).

4-17. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Wear goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all parts in solvent P-D-680.

b. Wipe all parts with clean cloth.

c. Dry with low-pressure compressed air. Do not spin bearings.

d. Clean housings and bearing caps in hot solution tank with mild alkali solution. Rinse with fresh water. Dry thoroughly.

e. Inspect rollers, cages, and cups for wear, chips. and nicks. Replace cones and cups as matched sets. Oil bearing in light machine oil.

f. Replace all oil seals, O-rings, sealing rings, gaskets, and snap rings.

g. Inspect all gears for wear, pits, chipping, cracks, and scoring.

h. Inspect shafts for sprung, bent, or twisted condition.

i. Inspect all other parts for cleanliness, wear, and damage.

4-18. REPAIR. Repair shall be limited to the replacement of all worn or damaged parts.

4-19. ASSEMBLY AND INSTALLATION.

NOTE

Replace all O-rings, seals, and snap rings prior to assembly. Lubricate O-rings and seals in oil MIL-L-2104 SAE 10.

4-20. Converter Housing. Assemble the converter housing as follows:

a. Install new ring (33, figure 4-3), spring (32), and bearing (49). Expander spring gap to be 180 degrees from sealing ring hook joint. Bearing (49) must be installed with part number up.

b. Install support (31) and tap into position. Secure with screws (43) and lockwashers (42). Torque screws (43) from 23 to 25 ft lbs.

c. Install bearing (26), washer (27), retaining ring (28), and piston ring (29) on shaft (25).

d. Spread ears on snap ring (30) and tap shaft (25) into housing.

e. Install new seal (36).

f. Assemble gear (45) if previously disassembled. Position gear (45) in housing with long hub of gear out.

g. Secure gear (45) with lockwashers (39) and screws (38). Torque screws (38) from 58 to 64 ft lbs. Install plate (46), lockplate (47) and screws (48). Torque screws (48) from 58 to 64 ft lbs. Bend lock tabs over screws (48).

4-21. Transmission Housing. Assemble the transmission as follows:

a. Tap bearing (65, figure 4-6) into bore with snap ring toward front of housing.

b. Tap sleeve (63) into position with roll pin in sleeve aligned. Secure with retaining ring (62).

c. Position forward clutch (24) in housing bore. Do not damage rings (61). Tap clutch into position.

d. Position gear (23) on shaft and install snap ring (22) and plug (21).

e. Press bearing (45) into carrier (48) against locating ring (46). Secure bearing with locating ring (44).

f. Press hub (49) into carrier (48) and secure with retaining ring (43).

g. Position carrier (48) on 3rd clutch (54). Align splines of hub (49) with internal teeth of discs in clutch. Do not force.

h. Install locating ring (55) and race (59).

i. Using contracting-type snap ring pliers, lock pliers to hold locating ring (47) contracted. Tap 3rd clutch (54) into housing bore until locating ring (47) is aligned with groove in housing. Remove snap ring pliers.

j. Install oil baffle (40, figure 4-5).

k. Install hub (102, figure 4-6), bearings (103 and 105) and spacer (104) on shaft (126). Position gear (106) on bearings (103 and 105) and install thrust washers (96 and 107). Long hub of gear (106) should be up.

l. Press bearings (95 and 117) on shaft (126). Install shaft (126) in housing bore. Tap assembly into place.

m. Install retaining ring (55) at front of housing.

n. From rear, position clutch (41) in bearing bore. Tap clutch into place.

o. Install hub (20) at front with snap ring (19).

p. Install oil seal (118), flange (119), new O-ring (120), washer (121), and nut (122). Torque nut (122) from 200 to 250 ft lbs.

q. Install pilot bearing (50) in hub (49).

r. Install fork (101).

s. Install baring (84), and washer (83) on gear and shaft (42).

t. Install gear (42) by aligning splines on shaft with splines on hub (49).

u. Install bearing (66), washer (67), and retaining ring (68).

v. Position new gasket (31, figure 4-5) on housing, install new O-ring (30) if needed, and install cover (33). Tap cover into place aligning shaft bearings and bearing bores. Install screws (34) and lockwashers (35). Torque screws (34) from 37 to 41 ft lbs.

w. Position spring (109, figure 4-6) and ball (110) in support (115).

x. Install support (115) with new O-ring (108). Secure support with nuts (113) and lockwashers (114). Torque nuts (113) from 26 to 29 ft lbs.

y. Tap shaft (126) from front and install bushing (125) retaining ring (124). Install retaining ring (82) on gear (42) and retaining ring (68) on clutch (41).

z. Apply light coat of Permatex No. 2 to outer diameter of seal (94). Install seal (94), and disconnect (7, figure 4-9) with new O-ring (11). Install nuts (4) and lockwashers (5). Torque nuts (4) from 64 to 70 ft lbs.

aa. Install flange (91, figure 4-6), new O-ring (90), washer (89), and nut (88). Torque nut (88) from 200 to 250 ft lb.

bb. Position new O-ring (81) in cap (79). Install cap (79) and secure with lockwashers (78) and nut (77). Torque nuts (77) from 41 to 45 ft lbs.

cc. Position new O-ring (70) in cap (72). Install cap (72) and secure with lockwashers (73) and nuts (74). Torque nuts (74) from 41 to 45 ft lbs.

dd. Install bearing (18). Position reverse and 2nd clutch on hub (20) aligning splines on hub with internal teeth of clutch discs. Do not force.

4-22. Converter Housings to Transmission Assembly.

a. Install new O-rings (20, 22,50, and 54, figure 4-5) as needed.

b. Install bearing (28, figure 4-6) on forward clutch (24). Spread ears on snap ring (3). Lock pliers open to hold snap ring open.

c. Install new gasket (19, figure 4-5). Position converter housing (9) on transmission case. Do not disturb O-rings and gasket.

d. Tap converter housing into place and install one screw (14) and lockwasher (13) in front and one in back to secure converter.

e. Use hook-type hammer puller to pull reverse and second clutch (14, figure 4-6) toward front of converter housing until snap ring (13) groove in bearing with groove in housing. Remove pliers.

f. Install remaining screws (14, figure 4-5) and lockwashers (13). Torque screws (14) from 37 to 41 ft lbs.

g. Install screen (18) with new gasket (17). Torque screen (18) from 10 to 15 ft lbs.

h. Assemble locating ring (11, figure 4-3) support (12), retaining ring (13), bearing (14), and locating ring (15) into gear (16). Install gear (16) and secure with screws (10). Torque screws (10) from 23 to 25 ft. tbs. Repeat procedure for installing second pump drive gear assembly.

i. Assemble retaining ring (18), gear (19), bearing (20), retaining ring (21), and locating ring (22). Install gear (19) and secure with locating ring (17).

j. Apply light coat of #92 Loctite to O.D. of baffle (37). Remove excess sealant immediately.

k. Install baffle (37) with new oil seal (36). Position puller screw holes 15 to 30 degrees either side of vertical centerline. Tap baffle (37) in until it shoulders in converter housing.

l. Install impeller (52) with new O-ring (51), gear (50), bearing (49), screws (54), and lock tabs (53). Use caution not to cut, break, or unhook oil seals.

m. Install spacer (55), reaction member (56), and retaining ring (57).

n. Install bearing (62), washer (63), and locating ring (61) as follows:

1. Heat impeller cover (65) from 200 to 250°F.

2. Position locating ring (61) in groove.

3. Place washer (63) in impeller cover (65)

4. Spread ears on locating ring (61) and press bearing (62) on hot impeller cover (65).

5. Align grooves and release locating ring (61). Install turbine (60) with retaining ring (59).

o. Install impeller cover (65) with new O-ring (64). Install screws (58) and retaining ring (66). Torque screws (58) from 23 to 25 ft lbs.

p. Install new O-ring (67), plug (68), and retaining ring (69).

q. Install backing ring (72), drive plates (70), and screws (73). Note two dimples on backing ring (72) must be out. Torque screws (73) from 23 to 25 ft lbs.

r. Install charge pump (3) with new gasket (1) and O-ring (2). Install screws (5 and 6), lockwashers (4 and 7), and nuts (8). Torque screws (5 and 6) from 37 to 41 ft lbs. Torque nuts (8) from 41 to 45 ft lbs.

s. Install new filter (9). Torque from 20 to 25 ft lbs.

t. Install control valve (3, figure 4-5) with new gasket (4), balls (5), and springs (6). install screws (1) and lock-washers (2). Torque screws (1) from 23 to 25 ft lbs.

4-23. Engine and Transmission Installation. Install the engine and transmission as follows:

a. Install one capscrew (7, figure 4-2) through access hole in flywheel housing mating engine flywheel with transmission drive plates.

b. Install capscrews (8) and lockwashers (9). Torque capscrews (8) is 30 ft lbs.

c. Torque capscrew (7) to 35 ft tbs. Manually rotate crankshaft until next tapped hole in flywheel is visible through access hole. Install capscrew (7). Repeat step until a total of eight capscrews (7) have been installed.

d. Install cover on flywheel housing.

e. Hoist engine and transmission assembly and position on frame mounting brackets.

f. Install capscrews (3), washers (4), lockwashers (6), and nuts (5).

e. Connect front and rear drive shafts, axle disconnect linkage, and transmission shift linkage.

h. Install accelerator control cable at fuel injection pump.

i. Remove tags and install leads to starter, alternator, and temperature and pressure sending units.

j. Remove tags and install fuel supply and return lines.

k. Install hydraulic pump. Remove tags and install hydraulic lines to pump. Connect cold weather start system.

l. Install engine hood assembly.

m. Install radiator and radiator grill. Remove tags and install coolant and heater hoses.

n. Close draincock and fill radiator with a solution of one part fresh water and one part anti-freeze MIL-C-11755.

o. Install drain plug (2) and fill transmission sump with oil MIL-L-2104 SAE 10.

p. Install oil pan plug (1) and fill engine with oil MIL-L-2104 SAE 30 (+32° to 100°F) or SAE 10 (0° to +32°F).

q. Connect exhaust outlet flange and air intake flange.

r. Install batteries and connect.

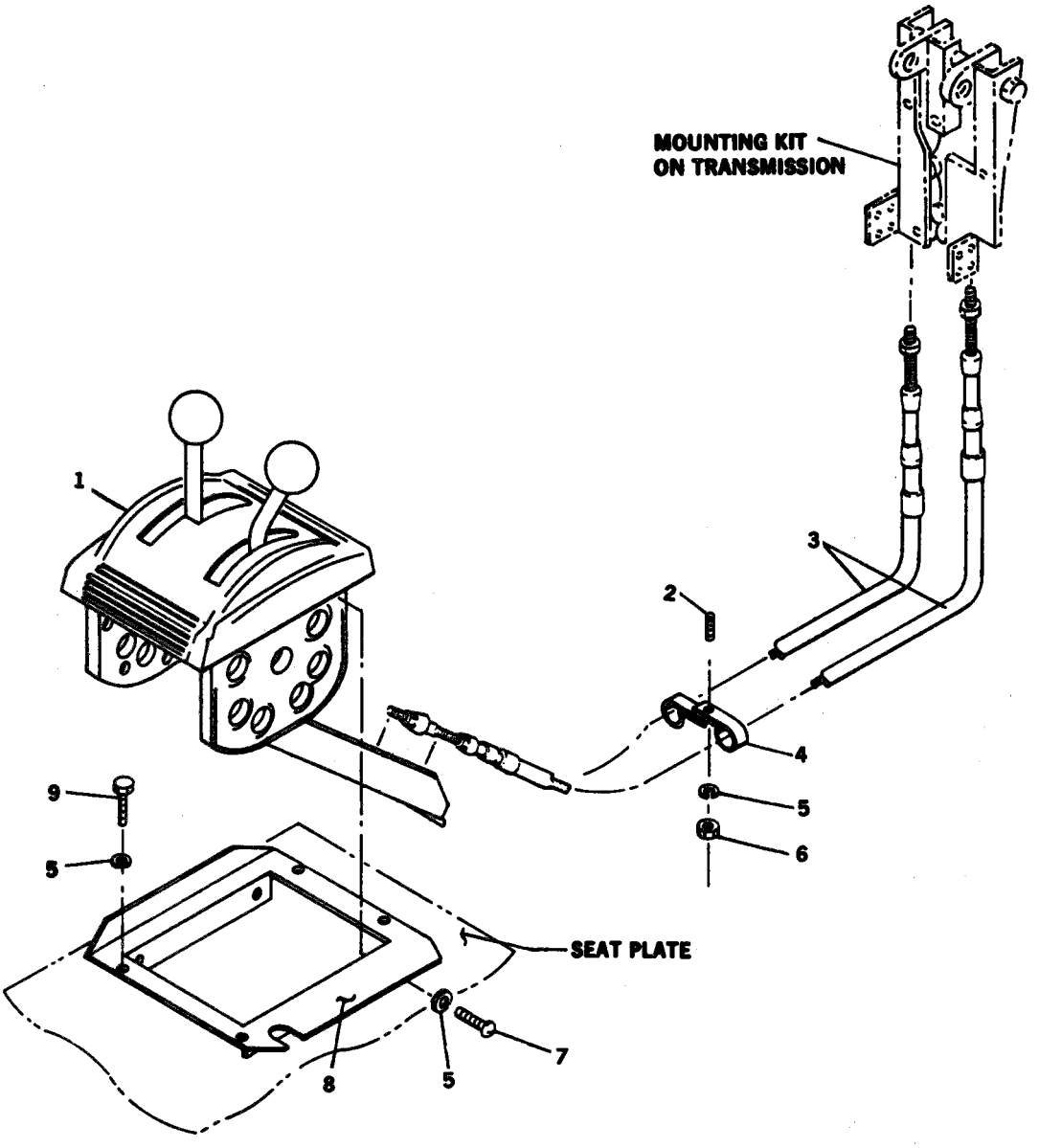
4-24. TRANSMISSION SHIFTER INSTALLATION.

4-25. REMOVAL AND DISASSEMBLY,

a. Disconnect cables (3, figure 4-10) at transmission mounting kit on transmission (left side).

b. Remove nuts (6), lockwashers (5), and clamps (4).

c. Remove capscrews (9) and lockwashers (5). Remove control assembly (1) with mount (8)



LEGEND

1. Control Assembly
2. Stud
3. Cable
4. Clamp
5. Lockwasher
6. Nut
7. Screw
8. Mount
9. Capscrew

Figure 4-10. Transmission Shifter Installation

d. Remove screws (7), lockwashers (5), cables (3), and mount (8).

e. Remove screws (31, figure 4-11), clamps (32), cotter pins (29), clevis pins (30), and cables (3, figure 4-10). Remove terminals (28, figure 4-11) from cable ends.

f. Remove screws (37) and hangers (34 and 36).

g. Remove knobs (1), screws (9), lockwashers (10), and spacers (11).

h. Remove screws (7), lockwashers (8), and housing (5) with plate (6).

i. Remove spacers (15) and retaining rings (27). Remove shaft (26) and spacer (22).

j. Remove rivets (23), plates (16), screws (21), roll pins (14 and 25), and levers (12 and 24).

k. Separate actuators (17) and remove slug (18), spring (19), and ball (20).

4-26. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Wear goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with a clean cloth dipped in cleaning solvent P-D-680.

b. Wipe residue with clean cloth.

c. Dry thoroughly.

d. Inspect all parts for corrosion damage and wear.

4-27. REPAIR.

a. Repair shall be limited to the replacement of all damaged parts.

4-28. ASSEMBLY AND INSTALLATION.

a. Assemble actuators (17, figure 4-11) with slug (18), spring (19), ball (20), and screws (21).

b. Install levers (12 and 24) with roll pins (14 and 25).

c. Install plates (16) with rivets (23).

d. Assemble spacer (15), shaft (26), actuator (17), spacer (22), actuator (17), and spacer (15). Secure with retaining ring (27).

e. Install housings (5), plate (6), screws (7), and lockwashers (8).

f. Install spacers (11) lockwashers (10), and screws (9). Install knobs (1).

g. Install hangers (34 and 36) with screws (37).

h. Install terminals (28) to control cables.

i. Install terminals (28) to plates (16) using clevis pins (30) and cotter pins (29).

j. Install clamps (32) with screws (31) and nuts (35).

k. Install mount (8, figure 4-10) to control assembly (1) with screws (7) and lockwashers (5).

l. Install control assembly (1) with mount (8) and cables (3).

m. Install capscrews (9) and lockwashers (5).

n. Install clamps (4) with lockwashers (5) and nuts (6).

o. Connect cables (3) at transmission mounting kit.

p. Shift levers several times to ensure smooth shifting of transmission control valve.

4-29. AXLE SHIFT INSTALLATION.

4-30. REMOVAL AND DISASSEMBLY.

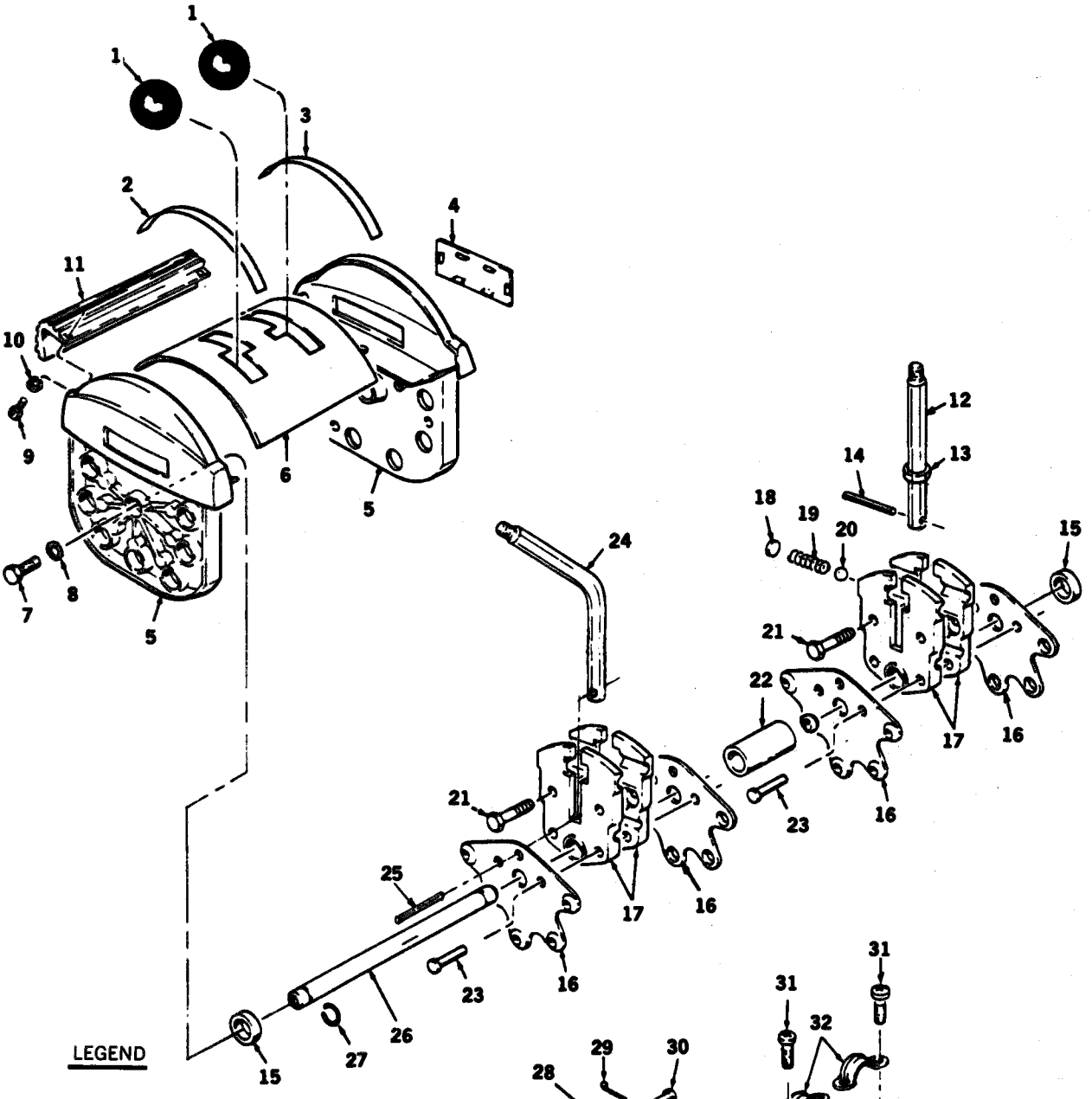
a. Disconnect control cables (9 and 10, figure 4-12) at transmission by removing cotter pins (7), clevis pins (6), and rod ends (8).

b. Remove nuts (17), lockwashers (14), and clamps (18).

c. Remove capscrews (15), lockwashers (14), and control assembly (11) with mount (12).

d. If necessary, remove cotter pins (7), clevis pins (5), capscrews (19), brackets (1 and 2), and levers (3 and 4).

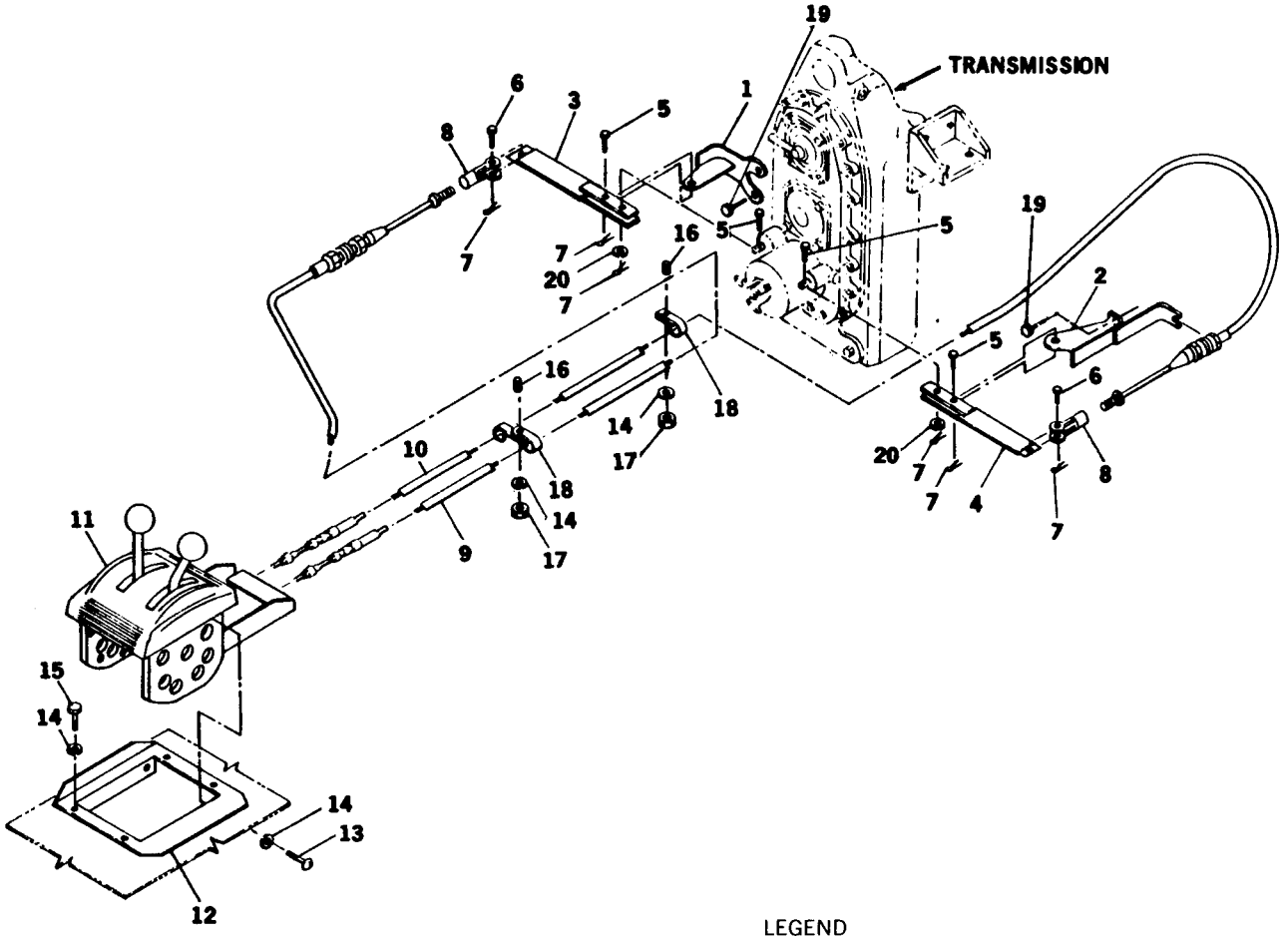
e. Remove screws (13), lockwashers (14), and mount (12).



LEGEND

1. Knob
2. Position Strip
3. Position Strip
4. Cap
5. Housing
6. Plate
7. Screw
8. Lockwasher
9. Screw
10. Lockwasher
11. Spacer
12. Lever
13. Detent
14. Pin
15. Spacer
16. Plate
17. Actuator
18. Slug
19. Spring
20. Ball
21. Screw
22. Spacer
23. Rivet
24. Lever
25. Roll Pin
26. Shaft
27. Retaining Ring
28. Terminal
29. Cotter Pin
30. Clevis Pin
31. Screw
32. Clamp
33. Shim
34. Hanger
35. Nut
36. Hanger
37. Screw

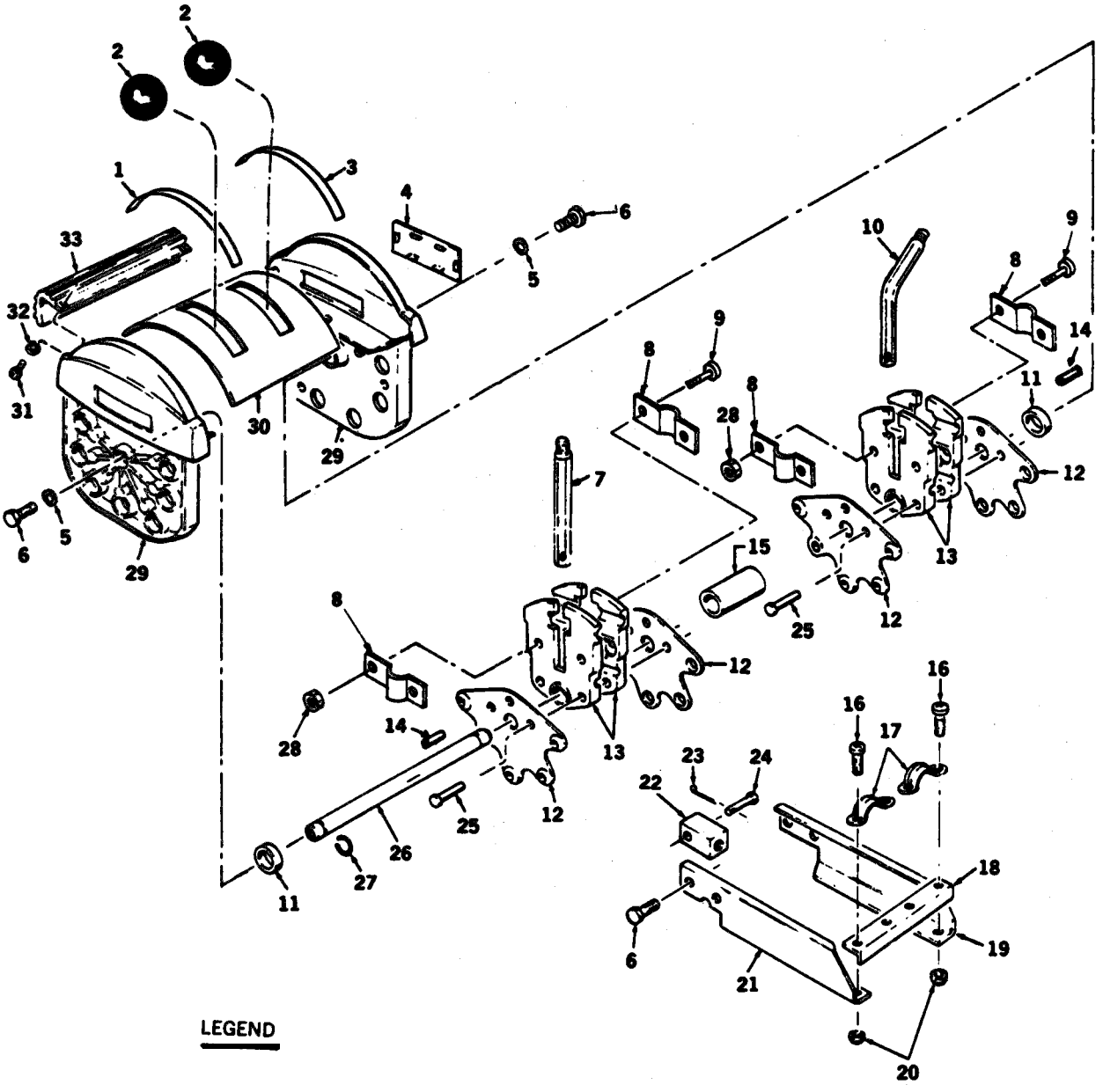
Figure 4-11. Transmission Shifter



LEGEND

1. Bracket
2. Bracket
3. Lever
4. Lever
5. Clevis Pin
6. Clevis Pin
7. Cotter Pin
8. Rod End
9. Control Cable
10. Control Cable
11. Control Assembly
12. Mount
13. Screw
14. Lockwasher
15. Capscrew
16. Stud
17. Nut
18. Clamp
19. Capscrew
20. Washer

Figure 4-12. Axle Shift Installation



LEGEND

1. Position Strip
2. Knob
3. Position Strip
4. Cap
5. Lockwasher
6. Screw
7. Lever
8. Strap
9. Screw
10. Lever
11. Spacer
12. Plate
13. Actuator
14. Roll Pin
15. Spacer
16. Screw
17. Clamp
18. Shim
19. Hanger
20. Nut
21. Hanger
22. Terminal
23. Cotter Pin
24. Clevis Pin
25. Rivet
26. Shaft
27. Retaining Ring
28. Nut
29. Housing
30. Plate
31. Screw
32. Lockwasher
33. Spacer

Figure 4-13. Axle Shifter

f. Remove cotter pins (23, figure 4-13), clevis pins (24), screws (16), and clamps (17). Remove control cables (9 and 10, figure 4-12).

g. Remove terminals (22, figure 4-13) from control cables.

h. Remove screws (6) and hangars (19 and 21).

i. Remove knobs (2), screws (31), lockwashers (32), and spacers (33).

i. Remove screws (6), lockwashers (5), and housings (29) with plate (30).

k. Remove spacers (11) and retaining rings (27). Remove shaft (26) and spacer (15).

l. Remove rivets (25), plate (12), screws (9), straps (8), nuts (28), roll pins (14), actuators (13), and levers (7 and 10).

4-31. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Wear goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680.

b. Wipe residue with clean cloth.

c. Dry thoroughly.

d. Inspect all parts for corrosion damage or wear.

4-32. REPAIR.

a. Repair shall be limited to the replacement of all damaged parts.

4-33. ASSEMBLY AND INSTALLATION.

a. Assemble actuators (13, figure 4-13) with levers (7 and 10), roll pins (14), nuts (28), straps (8), and screws (9).

b. Install plates (12) with rivets (25).

c. Install spacer (11), actuator (13), spacer (15), actuator (13), and spacer (11) on shaft (26). Secure with retaining rings (27).

d. Assemble housings (29), plate (30), and shaft (26). Install lockwashers (5) and screws (6).

e. Install spacers (33), lockwashers (32), and screws (31).

f. Install hangars (21 and 19) with screws (6).

g. Install one terminal (22) on each control cable (9 and 10, figure 4-12).

h. Attach terminals (22, figure 4-13) to plates (12) with clevis pins (24) and cotter pins (23). Install clamps (17) with screws (16) and nuts (20).

i. Install mount (12, figure 4-12) with screws (13) and lockwashers (14).

j. Install control assembly (11) and secure with capscrews (15) and lockwashers (14).

k. If removed, install levers (3 and 4), brackets (1 and 2) with capscrews (19), clevis pins (5), and cotter pins (7).

l. Install control cables (9 and 10) with rod ends (8), clevis pins (6), and cotter pins (7).

m. Install clamps (18), lockwashers (14), and nuts (17).

n. Shift levers several times to ensure that axle shifter operation is smooth.

SECTION 5

AXLES MAINTENANCE INSTRUCTIONS

5-1. TIRE AND WHEEL ASSEMBLY.

5-2. REMOVAL AND DISASSEMBLY.

WARNING

Do not attempt to remove and disassemble a tire and wheel assembly without proper training. The high pressures involved can cause the tire and rim parts and tools to fly apart with explosive force. Proper procedures must be utilized to avoid severe injury or death.

a. Use outriggers to raise affected wheel(s) off ground. Place jack stands under outrigger weldments.

b. Remove valve stem core and completely deflate tire.

c. Remove lug nuts and rim locks. Remove tire and wheel assembly and place on floor with rim ring up.

d. Drive goose-neck end of two tools TO-399 between rim ring (1, figure 5-1) and side wall of tire five inches apart.

e. Pry down and out on tools. Leave one tool in position and place second tool five inches beyond, progressively prying around tire until bead is separated from rim ring.

f. Insert tapered end of tool TO-399 into notch on rim ring (1) and pry ring from its groove in rim base (5).

g. Turn tire and wheel assembly over. Using goose-neck end of tool TO-399, separate tire bead from rim base.

h. Remove rim base (5) from tire (2).

5-3. CLEANING AND INSPECTION.

a. Remove surface rust and dirt with a wire brush.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

b. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

c. Inspect rim base (5, figure 5-1) and rim ring (1) for cracks and damage. Replace cracked, badly worn, damaged, and severely rusted components.

d. Remove corrosion and paint rim base (5) and rim ring (1).

e. Inspect tire (2) and tube (3) for wear and deterioration. Inspect tube valve stem for cracks.

5-4. REPAIR.

a. Repair shall be limited to the replacement of all damaged parts.

5-5. ASSEMBLY AND INSTALLATION.

WARNING

Do not mix one type of rim base (5, figure 5-1) with a different type of rim ring (1). Improper seating of these parts can cause rim ring and rim base to fly apart with explosive force.

Always use a rubber, lead, plastic, or brass faced mallet if it is necessary to tap components together.

a. Insert lubricated tube (3) into tire (2).

b. Position rim base (5) flat on floor with valve slot up.

c. Align valve stem with slot in rim base (5) and work tire onto rim base.

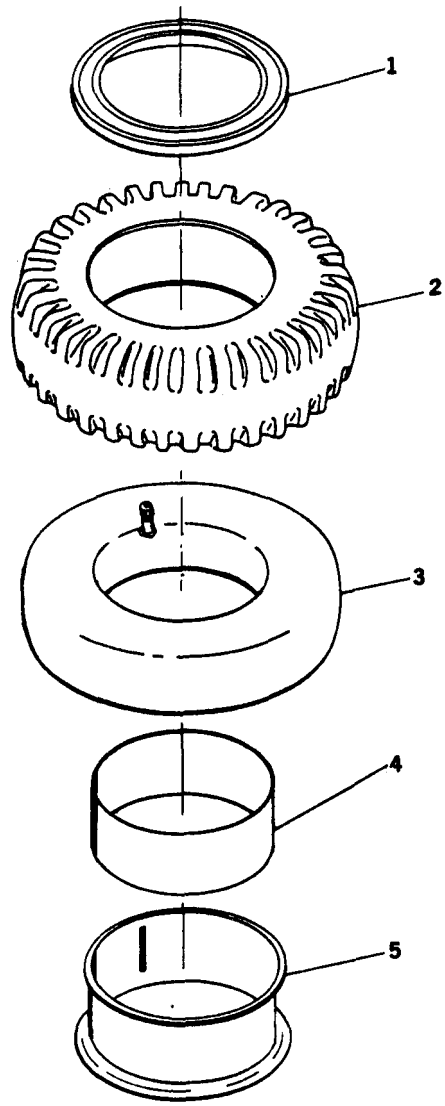
d. Place rim ring (1) on rim base (5) and snap leading end of ring into place.

e. Start rim ring (1) and walk it into place. Ensure that rim ring (1) is locked in place. Refer to figure 5-2 for illustration of proper fit, Insert valve stem core.

WARNING

Always use a safety cage to inflate tire and wheel assembly to avoid serious injury or death from exploding rim parts.

f. Place tire and wheel assembly into safety cage.



LEGEND

1. Rim Ring
2. Tire
3. Tube
4. Flap
5. Rim Base

Figure 5-1. Tire & Wheel Assembly

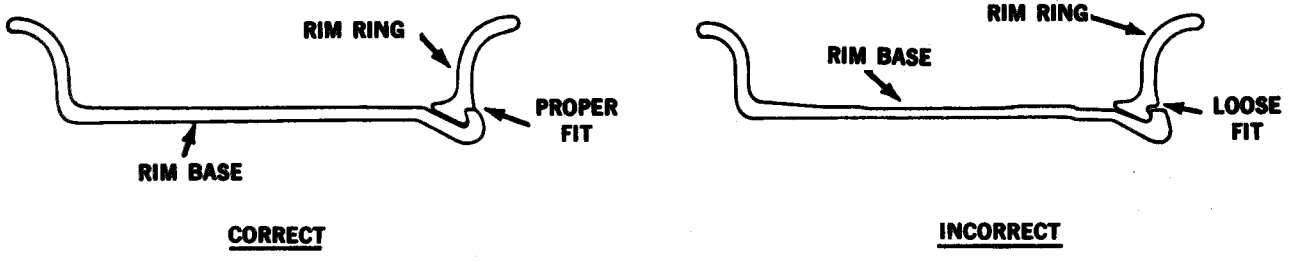


Figure 5-2. Rim Base to Rim Ring Fit

g. Inflate tire to 10 psi and check rim base (5) and rim ring (1) for proper fit.

h. Completely deflate tire to prevent localized over-stretching of tube (3).

i. Reinflate tire to 75 psi (65 psi if crane is to be towed).

NOTE

Do not lubricate lug nuts.

j. Install tire and wheel assembly on axle. Install rim and lug nuts.

k. Remove jack stands and raise outriggers.

5-6. FRONT AND REAR AXLE.

5-7. REMOVAL AND DISASSEMBLY.

NOTE

Axles do not have to be removed to perform maintenance on the axle. Steps g, h, and i apply only if axle(s) is to be replaced.

a. Lower outriggers to raise wheels off ground. Place jack stands under outrigger weldments and frame.

b. Remove applicable drive line. Disconnect brake line to axle at tee coupling.

c. Remove cotter pin, clevis pin, washers, and clamp securing parking brake cable to front axle.

d. Disconnect, cap, and tag hydraulic lines to steer cylinder.

e. Remove cotter pin (6, figure 5-3) and nut (10). Disconnect socket (7) and steer cylinder (11).

f. Remove plug (57, figure 5-5) and drain oil into container.

NOTE

To facilitate disassembly, do not remove tires and wheels at this time.

WARNING

Each axle (12, figure 5-3) weighs approximately 900 pounds. Use caution when removing the axle.

g. Position jacks under axle for support.

h. For front axle, remove nuts (1), washers (2), and u-bolts (13). Lower axle onto wheeled dolly and transport to clean work area.

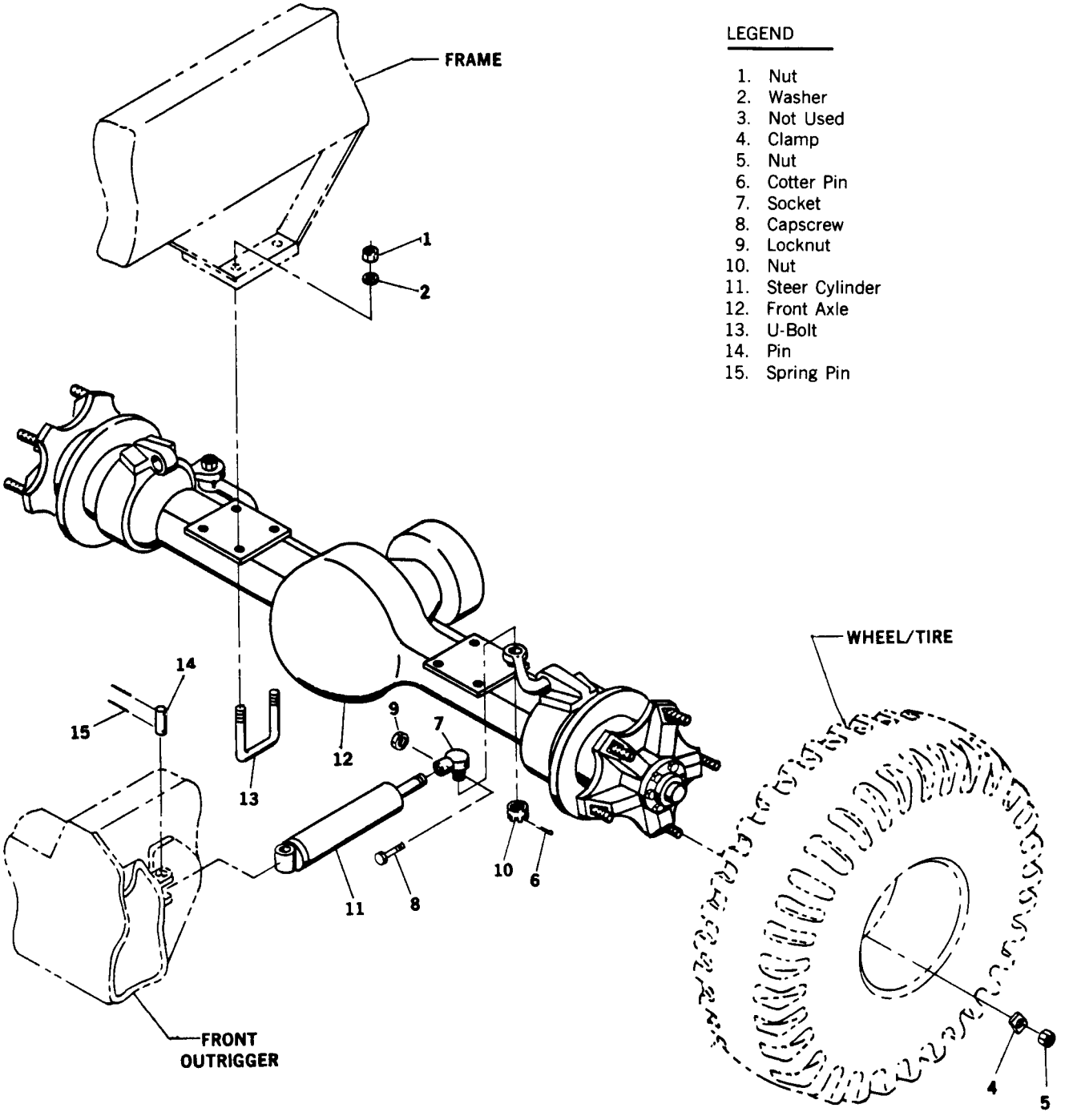
i. For rear axle, remove nuts (6, figure 5-4), washers (7), plate (8), plate (17), and u-bolt (15). Lower axle onto wheeled dolly and transport to clean work area.

j. Disconnect brake hoses at brake calipers.

k. Remove key (30, figure 5-5) capscrews (18), lockwashers (17), retainers (16), and brake caliper (29). Repair brakes per section 7, Brake System.

l. Remove capscrews (1), washers (2), cap (3), and gasket (4). Tap cap (3) with rubber mallet if needed.

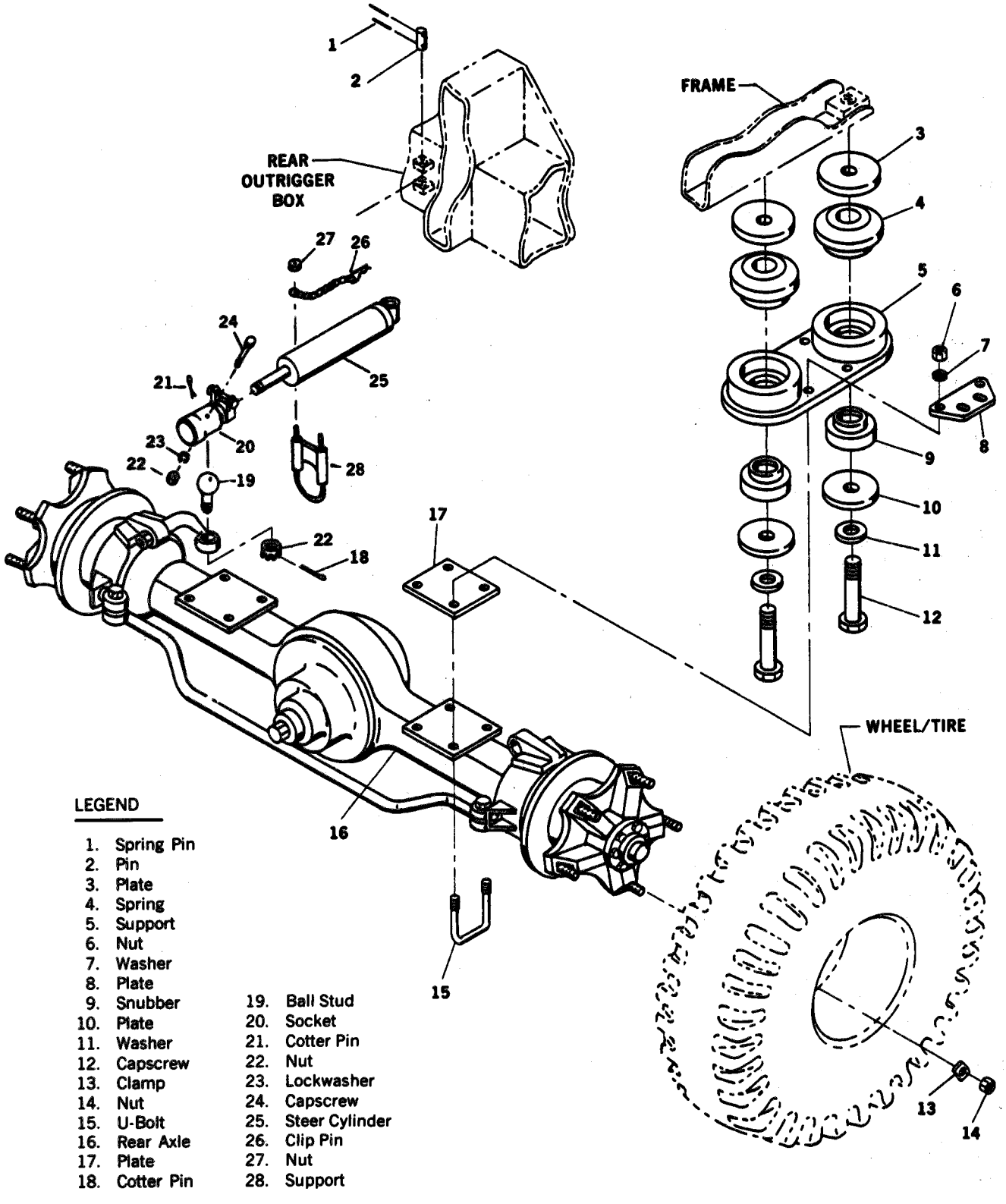
m. Remove capscrews (25), washers (26), and flange (5).



LEGEND

1. Nut
2. Washer
3. Not Used
4. Clamp
5. Nut
6. Cotter Pin
7. Socket
8. Capscrew
9. Locknut
10. Nut
11. Steer Cylinder
12. Front Axle
13. U-Bolt
14. Pin
15. Spring Pin

Figure 5-3. Front Axle Installation



LEGEND

1. Spring Pin
2. Pin
3. Plate
4. Spring
5. Support
6. Nut
7. Washer
8. Plate
9. Snubber
10. Plate
11. Washer
12. Capscrew
13. Clamp
14. Nut
15. U-Bolt
16. Rear Axle
17. Plate
18. Cotter Pin
19. Ball Stud
20. Socket
21. Cotter Pin
22. Nut
23. Lockwasher
24. Capscrew
25. Steer Cylinder
26. Clip Pin
27. Nut
28. Support

Figure 5-4. Rear Axle Installation

n. Remove nut (6), washer (7), and nut (8).

o. Slide wheel hub (10) off spindle (19).

p. Remove nuts (5, figure 5-3), clamps (4), and tire and wheel.

q. Remove bolts (18, figure 5-5), washers (17) retainers (16), slide keys (30) and brake caliper assemblies (29).

r. Remove bolts (25), washers (26) and flange (5). Bolts (1), washers (2), cap (3) and gasket (4) need not be removed.

s. Remove nuts (6) and (8) and lockwasher (7) and pull off wheel hub assembly (10), including bearings (9) and (13), bearing cups (11 and 12), and oil seal (14).

t. Separate disc (10A) from wheel (10E) if required by removal of eight bolts (10C), and washers (10B).

NOTE

Disc (10A) and wheel (10E) are a balanced assembly and should be match marked prior to disassembly.

u. Remove and discard oil seal (14) with long screwdriver.

v. Remove bearing cones (9 and 13) and cups (11 and 12) using a bearing puller.

w. Remove capscrews (27), washers (28), and spindle (19) with plate (15).

x. If needed, remove wiper (22), retainer, and felt (20).

y. Pull universal joint (24) straight out from knuckle (37) and housing (48). Remove oil seal (23) if necessary.

z. Remove oil seal (51) and thrust washer (52) if necessary. If required to remove bushings (53) split and collapse inward and replace on reassembly. Adapter (54) should not be removed from axle housing (48).

aa. Loosen locknut (55) and stopscrew (56). Remove cotter pin (62) and remove nut on rod end (65). Remove tie rod assembly (63).

bb. Remove capscrews (42 and 43), washers (44), and adapter (34). Remove grease seals (36) and shims (35). Note size and number of shims.

cc. Remove capscrews (27), washers (28), cap (40), pin (39), and thrust washer (38).

dd. Remove steering knuckle (37).

ee. If necessary, remove bushing (49) and plug (50).

ff. Repeat steps k thru ee for opposite side of axle.

gg. Remove all capscrews (58, 60, and 61) and washers (59) except two top capscrews.

hh. Break differential carrier (not shown) loose from axle housing with rawhide mallet.

ii. Remove two top capscrews and washers and work differential carrier free. Place roller jack under differential carrier and transport to work area. Repair differential carrier per para 5-12.

5-8. CLEANING AND INSPECTION.

a. Clean all parts having ground or polished surfaces such as knuckle pins, shafts, bearings, and spindles with diesel fuel. Wipe all parts with clean, lint-free cloth.

b. Rough parts such as housings can be cleaned in hot solution tanks with mild alkali solutions. These parts should be thoroughly cleaned and heated. Rinse parts thoroughly and dry with clean, lint-free cloth.

c. Coat clean parts with light oil to prevent corrosion.

d. Inspect all parts for wear, stress cracking, and corrosion.

e. Inspect rod end (65, figure 5-5) for damage. Ensure that seal is securely seated. Replace rod end if seal is damaged. Check torque value between rod end stud and ball cavity. If torque value is less than five inch pounds, replace rod end.

f. Inspect all bearings, cups, and cones for wear and pitting. Inspect bearings for:

1. Large ends of rollers worn flush to recess or radii worn sharp.

2. Visible step wear, particularly at small end of ‘oiler track.

3. Deep indentations, cracks, or breaks in bearing cup and/or cone surfaces.

4. Bright rubbing marks on dark phosphate surfaces of bearing cage.

5. Etching or pitting on functioning surfaces.

6. Spalling or flaking on bearing cap and\or cone surfaces.

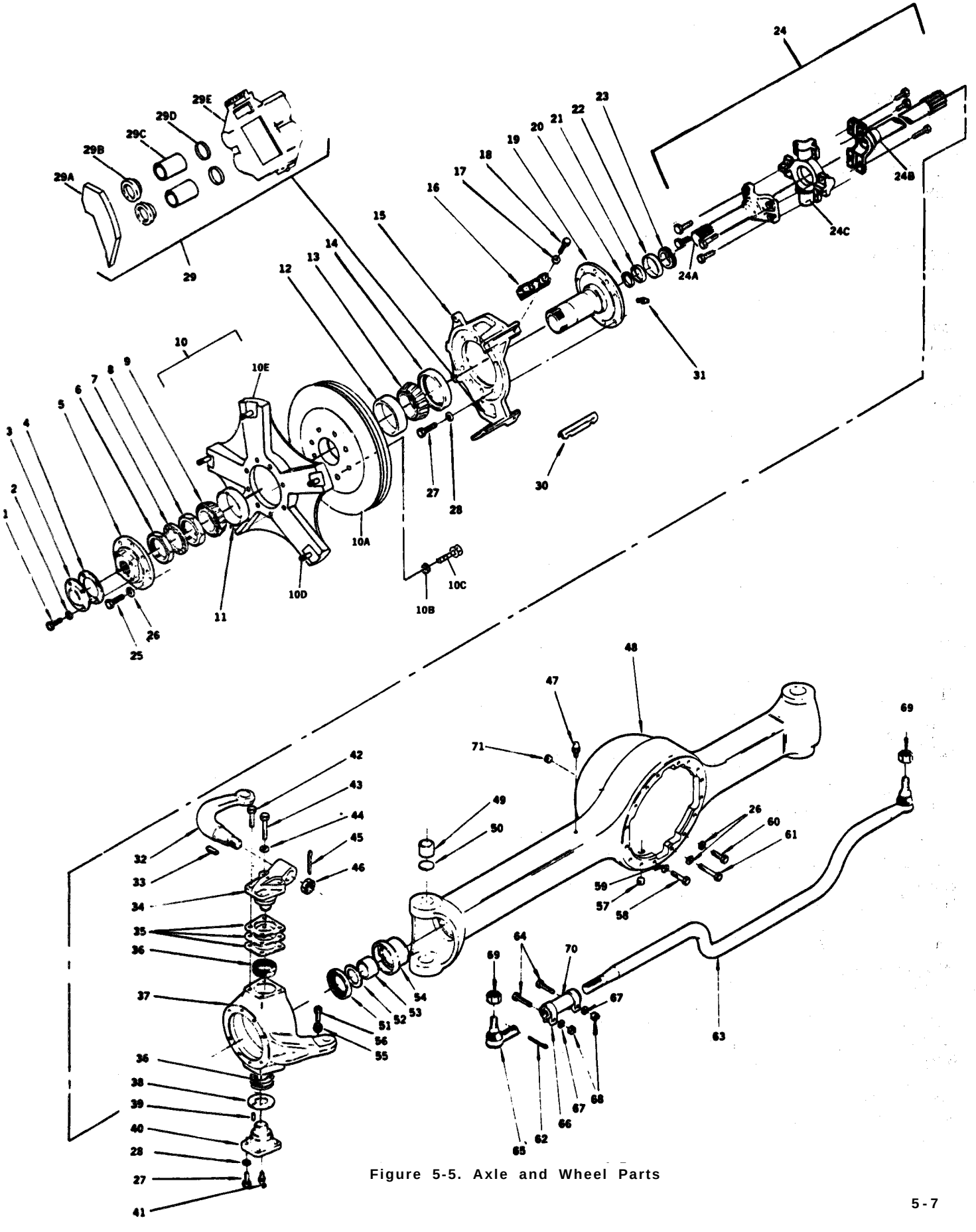


Figure 5-5. Axle and Wheel Parts

g. Inspect housing (48) for cracks, loose studs, nicks and burrs on machined surfaces. Remove nicks and burrs with stone or file.

5-9. REPAIR.

a. Repair shall be limited to replacement of all damaged parts.

b. Replace all lockwashers, oil seals, and gaskets.

c. Replace disc brake linings (29A) if required.

5-10. ASSEMBLY AND INSTALLATION.

a. Install assembled differential carrier as follows:

WARNING

Minor concentrations of acetic acid vapor may be produced during the application of silicone RTV gasket material. Provide adequate ventilation when working in a confined area.

LEGENDFOR FIGURE 5-5

1. Capscrew
2. Washer
3. Cap
4. Gasket
5. Flange
6. Nut
7. Washer
8. Nut
9. Bearing Cone
10. Wheel Hub Assembly
10A. Disc
10B. Lockwasher
10C. Capscrew
10D. Stud
10E. Wheel
11. Bearing Cup
12. Bearing Cup
13. Bearing Cone
14. Oil Seal
15. Plate
16. Retainer
17. Lockwasher
18. Capscrew
19. Spindle
20. Felt
21. Retainer
22. Wiper
23. Oil Seal
24. Universal Joint
24A. Short Shaft
24B. Long Shaft
24C. Center Parts Group
25. Capscrew
26. Washer
27. Capscrew
28. Washer
29. Brake Caliper
29A. Lining
29B. Boot
29C. Piston
29D. Seal
29E. Caliper
30. Key
31. Lubrication Fitting
32. Steering Arm
33. Key
34. Adapter
35. Shim
36. Grease Seal
37. Steering Knuckle
38. Thrust Washer
39. Pin
40. Cap
41. Lubrication Fitting
42. Capscrew
43. Capscrew
44. Washer
45. Cotter Pin
46. Nut
47. Oil Breather
48. Axle Housing
49. Bushing
50. Plug
51. Oil seal
52. Thrust Washer
53. Bushing
54. Adapter
55. Locknut
56. Stopscrew
57. Plug
58. Capscrew
59. Washer
60. Short Capscrew
61. Long Capscrew
62. Cotter Pin
63. Tie Rod Assembly
64. Bolt
65. Rod End
66. Clamp
67. Lockwasher
68. Nut
69. Nut
70. Sleeve
71. Plug

WARNING

Eye contact with silicone RTV gasket material can cause irritation. flush eyes immediately with fresh water for 15 minutes. Obtain medical attention immediately.

1. Apply silicone RTV gasket material in a 1/8-inch bead completely around mating surface of axle housing (48, figure 5-5).

CAUTION

Driving the differential carrier into the housing with a steel hammer will damage the carrier flange.

2. Roll carrier into position on roller jack. Start carrier into axle housing with four washer and nuts equally spaced and tighten alternately to draw carrier squarely into axle housing.

3. Remove nuts and washers and install washers (59) and capscrews (58, 60, and 61). Torque capscrews (58 and 61) from 50 to 75 foot pounds. Torque capscrews (60) from 75 to 115 foot pounds.

CAUTION

Do not use excessive pressure to install oil seal (51, figure 5-5) or tap seal after it has bottomed. This will crush the seal retainer resulting in seal damage.

b. Replace bushing (53), (if removed during disassembly), thrust washer (52), and oil seal (51).

c. If plugs (509 were removed, apply coat of silicone (RTV) gasket material to mating surface of plug only. Install plug (50) immediately so that concave side of plug is facing outward. Wipe top of plug and bearing bore to remove excess gasket material.

d. Install bushings (49).

e. Assemble thrust washer (38), pin (39), and cap (40).

f. Position steering knuckle (37) on axle housing (48) and install cap (40), washers (28), and capscrews (27). Torque capscrews (27) from 180-230 foot pounds.

g. Assemble new grease seals (36), shims (35), and adapter (34). Use same number and size shims (35) removed during disassembly. Install steering arm, ‘nut (46), and cotter pin (45) if previously removed. Torque nut (46) from 390 to 525 foot pounds. Advance nut (46) to install cotter pin (45) (do not back off). Check final torque value. Value not to exceed 725 foot pounds.

h. Install assembled adapter (34). Install capscrews (42 and 43) with washers (44). Torque capscrews (42 and 43) from 310-400 foot pounds.

i. Check steering knuckle bearing preload as follows:

1. Wrap soft wire or cord through rod end boss of steering knuckle (37) and attach pound scale to wire or cord.

2. Rotate knuckle with pound scale. Note rotating torque on pound scale (not starting torque).

3. If scale indicates between 10 and 19 pounds, bearing preload is correct.

4. To increase bearing preload, remove shims (35).

5. To decrease bearing preload, add shims (35).

j. Grease universal joint (24). Ensure that grease purges from all seals.

CAUTION

Do not use excessive pressure to install oil seal (23) or tap seal after it has bottomed. This will crush the seal retainer resulting in seal damage.

k. Install new oil seal (23).

l. Carefully install universal joint (24). Align splined end of inner shaft with differential gear splines and install.

m. Assemble spindle (19), felt (20), retainer (21), and wiper (22). Install spindle (19) with keyway pointed upward.

n. Install torque plate (15), capscrews (27), and washers (28). Torque capscrews (27) from 180 to 230 foot pounds.

o. Pack bearing cones (9 and 13) with grease. Grease wheel hub (10) bearing bores.

p. Install bearing cup (12) and bearing cone (13) in wheel hug (10). Install bearing cup (11).

CAUTION

Do not use excessive pressure to install oil seal (14) or tap seal after it has bottomed. This will crush the seal retainer resulting in seal damage.

q. Install new oil seal (14).

r. Reassemble disc (10A) and wheel (10E), if previously separated, with 10 each capscrews (10C), and washers (10B). Use match marks when assembling disc (10A) and wheel (10E) to retain balance of wheel hub assembly (10). Install wheel hub (10) on spindle (19) being careful not to damage oil seal (14). Install bearing cone (9). Ensure that bearing cone (13) is seated flush on spindle.

s. Install nut (8) and torque to 50 foot pounds. Oscillate bearings to be sure oil bearing surfaces are in contact. Retorque nut to 50 foot pounds.

t. Back off nut (8) 1/6 to 1/4 turn.

u. Install washer (7) and nut (6). Torque nut (6) from 200 to 300 foot pounds. The resulting end play must be within limits of .001 to .010 inch loose.

v. Apply silicone (RTV) gasket material in one continuous 1/8-inch wide bead to inside mating surface of flange (5). Apply small amount of grease to internal splines of flange.

w. Install flange (5), capscrews (25) and washers (26). Torque capscrews (25) from 60 to 75 foot pounds. Wipe off excess gasket material.

x. Apply silicone (RTV) gasket material in one continuous 1/8-inch wide bead to inside mating surface of cap (3). Install capscrews (1) and washers (2). Torque capscrews (1) from 40 to 55 foot pounds, Wipe off excess gasket material.

y. Repeat steps b thru x for opposite side of axle.

z. Install rod ends (65) at steering knuckle. Torque nut on rod end (65) from 90 to 120 foot pounds. Advance nut to install cotter pin (62) (do not back off). Check final torque value. Value not to exceed 170 foot pounds.

aa. Tighten stopscrew (56) and locknut (55). Torque locknut (55) from 75 to 100 foot pounds.

bb. Install brake caliper (29) with retainers (16), lockwashers (17), capscrews (18), and key (30).

cc. Connect brake hoses at brake calipers (29).

dd. If removed, install rear axle as follows:

1. Postion axle under frame using wheeled dolly.

WARNING

Axle weighs approximately 900 pounds.

2. Use floor jacks to raise axle into position.

3. Install u-bolts (15, figure 5-4), plates (17), plates (8), washers (7), and nuts (6). Torque nuts (6) to 185 foot pounds.

ee. If removed, install front axle as follows:

1. Position axle under frame using wheeled dolly.

WARNING

Axle weighs approximately 900 pounds.

2. Use floor jacks to raise axle into position.

3. Install u-bolts (13, figure 5-3), washers (2), and nuts (1). Torque nuts (1) to 185 foot pounds.

NOTE

Do not lubricate nuts (5).

ff. Install tires and wheels and secure with clamps (4) and nuts (5).

gg. Install plug (57, figure 5-5) and fill axle with lubricant. Refer to lubrication chart.

hh. Install steer cylinder (11, figure 5-3). Secure with nut (10) and cotter pin (6), Torque nut (10) to 200 foot pounds.

ii. Remove caps and tags and install hydraulic lines to steer cylinder (11).

jj. Install parking brake cable to front axle with clamp, washers, clevis pin, and cotter pin.

kk. Connect brake line at tee coupling on axle housing.

ll. Install applicable drive line.

mm. Bleed brake lines. Refer to section 7.

nn. Adjust axle toe-in per para 5-11.

5-11. AXLE TOE-IN ADJUSTMENT.

a. Lower outriggers to raise wheels off ground. Place jack stands under outrigger weldments and frame.

b. Scribe a line at center of each tire around its entire circumference with white chalk.

c. Remove jack stands and raise outriggers.

d. Drive crane forward and backward approximately six feet.

e. Set sliding scale end of trammel baron zero and lock in place.

f. Position trammel bar at rear of tires and adjust pointers to line up with scribe lines and lock in place.

g. Position trammel bar at front of tires. Adjust scale end so that pointers line up with scribe marks.

h. Read toe-in (or toe-out) from scale. Toe-in should be 0 inches.

i. If adjustment is required, loosen nuts (68, figure 5-5) and adjust clamp (66). Torque nuts (68) from 35-50 foot pounds.

j. Recheck axle toe-in.

5-12. DIFFERENTIAL CARRIER.

NOTE

The following procedures except where noted, apply to both the front differential carrier (figure 5-6) and the rear differential carrier (figure 5-7).

a. Remove differential carrier per para 5-7.

b. Place differential carrier in suitable. holding fixture.

NOTE

If initial inspection indicates that bevel gear (8, figure 5-6) and pinion (11) are not going to be replaced, the established backlash between these two gears should be measured and noted for reference during assembly.

c. Center punch one cap (22, figure 5-6) and carrier and cap leg (19) to identify in assembly.

d. Remove bolts (20), washers (21), and cotter pin (18).

e. Remove cap (22) and adjusting ring (l).

f. Repeat steps d and e for opposite side.

g. Lift out bevel gear (8) with differential case (4).

h. Punch mark differential case (4) and plain half case (5).

i. Remove bolts (7) and washers (6) and separate halves.

j. Remove spider (15), gears (14), gears (16), and thrust washers (13 and 17).

k. If required to replace bevel gear (8) remove bolts (30), washers (31), and nuts (32).

1. Using puller, remove bearing cups (2) and bearing cones (3).

m. Hold yoke/flange (42) with suitable tool and remove nut (12) and washer (43).

n. Remove yoke/flange (42) using suitable puller. Remove yoke washer (28).

If required, remove bolts (50), washers (51), and brake drum (41) (front axle only).

Remove return springs (40), brake shoes (47), brake lever (39) and roller (46) (front axle only).

q. Remove bolts (38), washers (37), and backing plate (36) (front axle only).

r. Remove capscrews (44) and washers (45).

s. Remove cover (34) and gasket (33) (front axle only.

t. Remove cage (26) with pinion (11).

u. Remove shims (23). Use same number and size shims for assembly.

v. Tap pinion (11) out of cage (26) with soft mallet.

w. Remove bearing cones (24) and bearing cups (27).

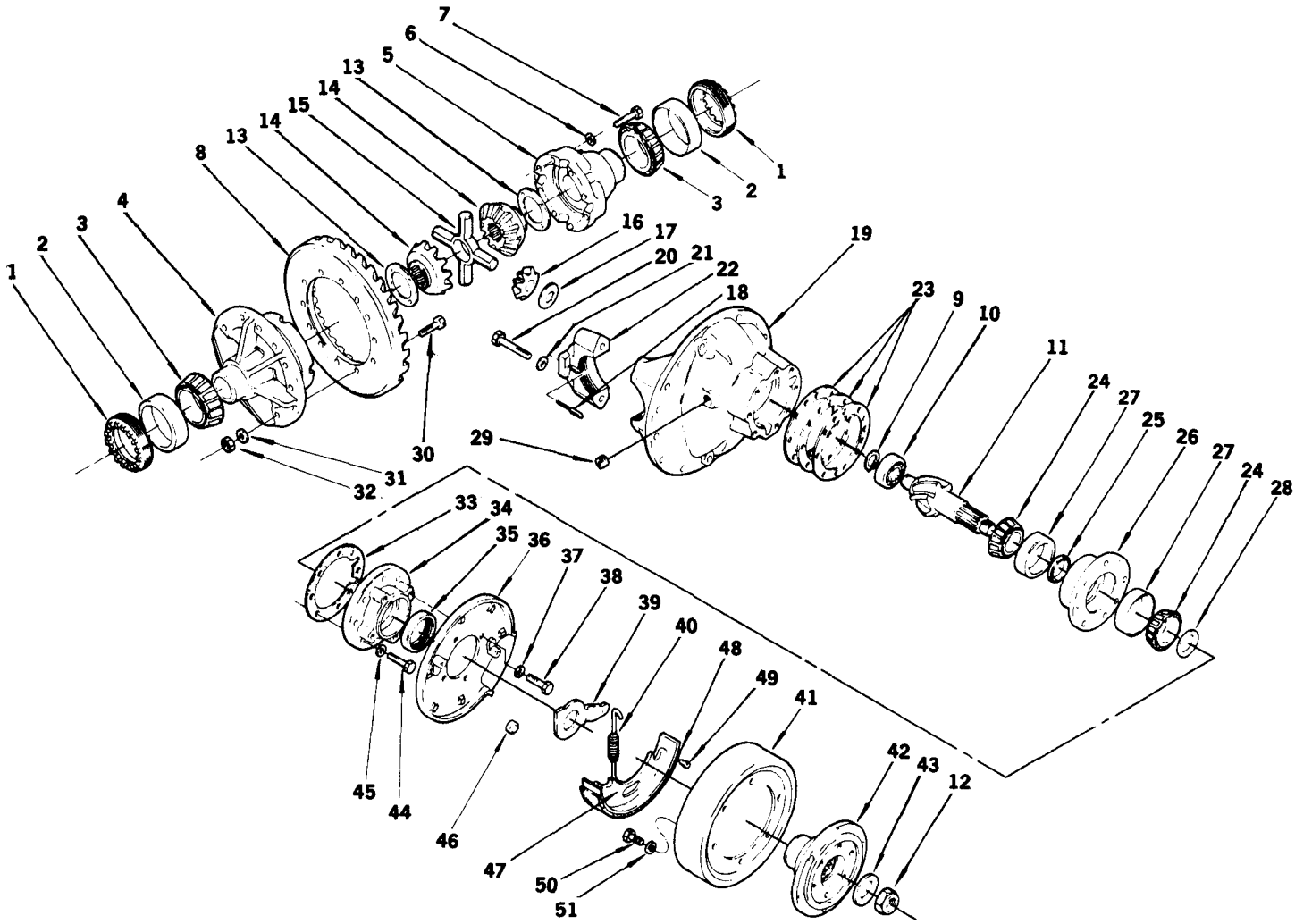
x. Remove spacer (25), retainer (9), and bearing (10) with suitable puller.

y. Remove oil seal (35).

5-14. CLEANING AND INSPECTION.

a. Clean all parts having ground or polished surfaces such as gears, shafts, and bearings with diesel fuel. Wipe all parts with clean, lint-free cloth.

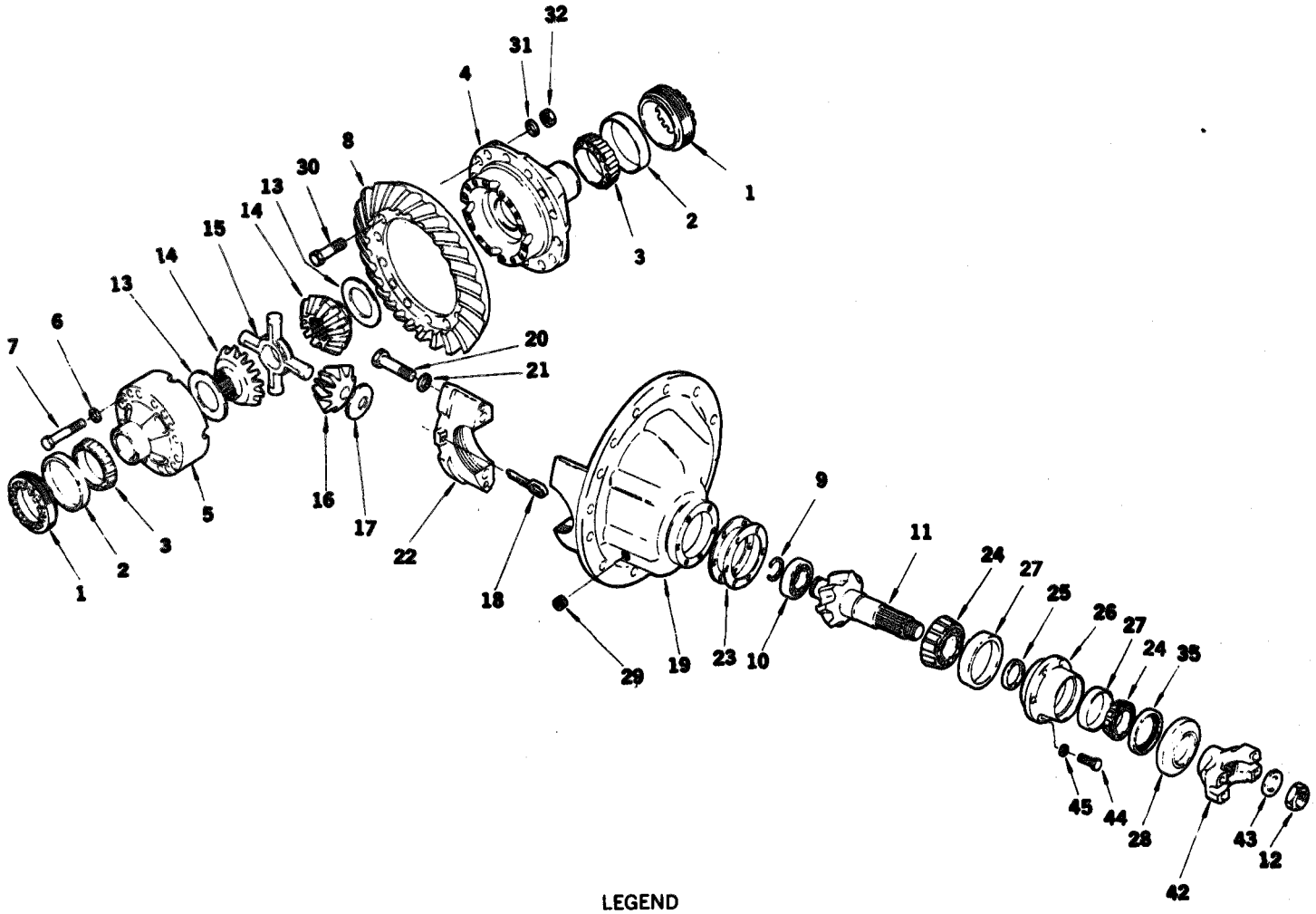
b. Rough parts such as housings can be cleaned in hot solution tanks with mild alkali solutions. These parts should be thoroughly cleaned and heated. Rinse parts thoroughly and dry with clean, lint-free cloth.



LEGEND

1. Adjusting Ring
2. Bearing Cup
3. Bearing Cone
4. Differential Case
5. Plain Half Case
6. Washer
7. Bolt
8. Bevel Gear
9. Retainer
10. Bearing
11. Pinion
12. Nut
13. Thrust Washer
14. Gear
15. Spider
16. Gear
17. Thrust Washer
18. Cotter Pin
19. Carrier and Cap
20. Bolt
21. Washer
22. Cap
23. Shim
24. Bearing Cone
25. Spacer
26. Cage
27. Bearing Cup
28. Yoke Washer
29. Plug
30. Bolt
31. Washer
32. Nut
33. Gasket
34. Cover
35. Oil Seal
36. Backing Plate
37. Washer
38. Bolt
39. Brake Lever
40. Return Spring
41. Brake Drum
42. Yoke/Flange
43. Washer
44. Capscrew
45. Washer
46. Roller
47. Brake Shoe
48. Brake Shoe Lining
49. Rivet
50. Bolt
51. Washer

Figure 5-6. Front Axle Differential Carrier



LEGEND

1.	Adjusting Ring	20.	Bolt
2.	Bearing Cup	21.	Washer
3.	Bearing Cone	22.	Cap
4.	Differential Case	23.	Shim
5.	Plain Half Case	24.	Bearing Cone
6.	Washer	25.	Spacer
7.	Bolt	26.	Cage
8.	Bevel Gear	27.	Bearing Cup
9.	Retainer	28.	Yoke Washer
10.	Bearing	29.	Plug
11.	Pinion	30.	Bolt
12.	Nut	31.	Washer
13.	Thrust Washer	32.	Nut
14.	Gear		
15.	Spider	35.	Oil Seal
16.	Gear	42.	Yoke/Flange
17.	Thrust Washer	43.	Washer
18.	Cotter Pin	44.	Capscrew
19.	Carrier and Cap	45.	Washer

Figure 5-7. Rear Axle Differential Carrier

c. Coat clean parts with light oil to prevent corrosion.

d. Inspect all parts for wear, stress cracking, and corrosion.

e. Inspect all bearings, cups, and cones for wear, pitting, or damage.

f. Inspect gears for wear and damage. Replace gears that are ridged, pitted, scored, or worn. Replace bevel gear (8, figure 5-6) and pinion (11) as a matched set. Replace spider (15), gears (14), gears (16), and thrust washers (13 and 17) as a set.

g. Inspect carrier and cap (19) for cracks, nicks, and burrs on machined surfaces. Remove nicks and burrs with stone or file.

h. Inspect brake shoes (47) for wear. Replace both brake linings if either is worn to 1/32-inch (front axle only).

5-15. REPAIR.

a. Repair shall be limited to the replacement of all worn or damaged parts.

b. Replace all oil seals and lockwashers.

5-16. ASSEMBLY.

a. Lubricate bearings (10 and 24, figure 5-6) with light machine oil.

b. Press bearings (10 and 24) into pinion (11) with suitable sleeve that will bear only the bearing inner race. Install bearing cup (27).

c. Install retainer (9) into pinion groove (11).

d. Insert pinion (11) into cage (26). Install spacer (25).

e. Install bearing cone (24) and bearing cup (27).

f. Rotate cage (26) several times to ensure normal bearing contact.

g. Check pinion bearing preload as follows:

1. Install yoke flange (42), nut (12) and torque from 300 to 400 foot pounds.

2. Check bearing preload with torque wrench. Use rotating torque not starting torque.

3. If rotating torque is greater than 5 to 25 inch-pounds for new bearings or 5 to 15 inch-pounds for used bearings, use thicker spacer (25) to decrease preload. If less, use thinner spacer to increase preload.

h. Recheck pinion bearing preload.

i. Remove nut (12) and yoke flange (42).

j. Lubricate oil seal (35) and cover outer edge of seal body with non-hardening sealing compound. Use seal driver to press oil seal against cover (34) (front axle only).

k. Install cover (34) with new gasket (33) (front axle only).

l. Lubricate oil seal (35) and cover outer edge of seal body with non-hardening sealing compound. Use seal driver to press oil seal into cage (26) (rear axle only).

m. Install backing plate (36). Secure with bolts (38) and washers (37). Torque bolts (38) from 60 to 75 foot pounds (front axle only).

n. Install roller (46), brake lever (39), brake shoes (47), and return spring (40). Assemble brake drum (41) and yoke/flange (42) with bolts (50) and washers (51). Torque bolts (50) from 35 to 50 foot pounds (front axle only).

o. Install yoke washer (28) and press yoke/flange (42) onto pinion (11).

p. Install washer (43) and nut (12). Torque nut (12) from 300 to 400 foot pounds.

q. Install same number and size shims (23).

r. Position cage (26) with pinion (11) over carrier and cap (19). Secure with capscrews (44) and washers (45). Torque capscrews (44) from 60 to 75 foot pounds.

s. Heat bevel gear (8) in hot water (160 to 180 degrees F).

t. Install heated bevel gear (8) onto differential case (4). Secure with bolts (30), washers (31), and nuts (32). Torque nuts (32) from 85 to 115 foot pounds.

u. Lubricate inner walls of differential case (4) with axle lubricant.

v. Position thrust washer (13) and gear (14) in bevel gear (8).

w. Assemble spider (15), gears (16), and thrust washers (17). Install spider (15).

x. Install second gear (14) and thrust washer (13).

NOTE

Do not apply Locktite if new bolts (7) are to be installed.

y. If bolts (7) are to be reused, apply liquid Locktite No. 277 to threaded holes of differential case (4). Allow four or five drops to run down side of each hole. Visually-check to ensure that Locktite has contacted threads.

z. Align punched marks on differential case (4) and plain half case (5). Draw assembly together with three equally spaced bolts (7) and washers (6).

aa. Install remaining bolts (7) and washers (6). Torque bolts (7) from 90 to 120 foot pounds.

bb. Press bearing cones (3) squarely and firmly on case halves with suitable sleeve.

cc. Check rolling resistance of differential as follows:

NOTE

Use soft metal covers over vice jaws to protect bevel gear (8).

1. Place differential and bevel gear assembly in vice.

2. Insert checking tool into differential nest. Allow splines of tool to engage spline of one sidegear only.

NOTE

Checking tool can be made by cutting an axle shaft and welding a nut on the end to accept a wrench socket.

3. Using suitable socket and torque wrench, rotate differential nest and observe torque wrench. Correct roiling resistance of differential assembly is 50 foot pounds torque maximum applied to one sidegear.

dd. Install bearing cups (2) and caps (22) with bolts (20) and washers (21). Torque bolts (20) from 185 to 235 foot pounds.

ea. Bearing cups (2) must be hand push fit into bores of caps (22). If they do not, bores must be reworked with scraper or emery cloth until hand push is obtained. Use blued bearing cup as gauge and check fit as work progresses. When bearing cups fit properly, remove caps (22).

ff. Lubricate bearing cones (3) and bearing cups (2) with axle lubricant. See lubrication chart.

gg. Place bearing cups (2) over cones and place assembly into carrier and cap (19).

hh. Install adjusting rings (1) and turn handtight against bearing cups (2).

ii. Install caps (22) in correct location as marked and tap lightly into position.

jj. Install bolts (20) and washers (21). Torque bolts (20) from 185 to 235 foot pounds.

kk. Adjust bearing preload as follows:

1. Using dial indicator at backface of bevel gear (8), loosen adjusting ring (1) on side opposite gear only sufficient to notice end play on indicator.

2. Tighten same side adjusting ring (1) only enough to obain 0.000 end play.

3. Check bevel gear (8) for runout. If runout exceeds 0.0008 inch, remove differential and check for cause.

4. Tighten adjusting rings (1) one notch each from 0.000 end play to preload differential bearings.

ll. Check bevel gear (8) backlash as follows:

NOTE

If bevel gear (8) was not replaced, use backlash established before disassembly. For new gears, initial backlash should be 0.010 inch. Adjust backlash by backing off one adjusting ring (1) and advancing opposite ring same amount. After satisfactory gear contacts have been established, backlash can be altered within 0.0005 to 0.015 inch to obtain better contact pattern.

1. Apply oiled red lead lightly to bevel gear teath (8), Coating twelve teeth is sufficient.

2. Using wrench, rotate pinion (11) while applying slight resistance to bevel gear (8) with flat steel bar.

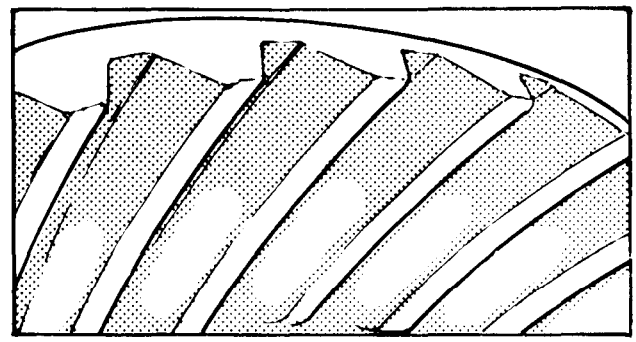
3. Compare contact pattern obtained with examples shown in figure 5-8. Take corrective actions as indicated.

mm. Install cotter pin (18).

nn. Install assembled differential carrier per para 5-10a.

GEAR AND PINION TOOTH CONTACT PATTERNS

The gear tooth contact patterns illustrated are approximate shapes. Actual contact may vary, however the same general shape should be obtained. When adjusting gear sets that have been in service, tooth contact may vary because of wear. To obtain best results, strive to obtain a pattern coinciding with original patterns.



PATTERN "A" - CORRECT TOOTH CONTACT

Correct adjustment is obtained when pattern of tooth bearing (both lengthwise and profile) appear as shown.

PATTERN "B" - CONCENTRATED BEARING AT TOE

Not enough backlash. . . move gear away from pinion to increase lengthwise bearing. This may change the profile bearing to some extent and an adjustment of the pinion may be required.

PATTERN "C" - CONCENTRATED BEARING AT HEEL

Too much backlash move gear toward pinion to obtain correct lengthwise bearing. This may change the profile bearing to some extent and an adjustment of the pinion may be required.

PATTERN "D" - PROFILE BEARING HIGH

Pinion is out too far . . remove shims to move pinion toward gear. Then move gear away from pinion to obtain correct lengthwise bearing.

PATTERN "E" - PROFILE BEARING LOW

Pinion is in too far. . add shims to move pinion away from gear. Then move gear toward pinion to obtain correct lengthwise bearing.

Figure 5-8. Correct and Incorrect Tooth Contact

5-17. PARKING BRAKE.

5-18. REMOVAL AND DISASSEMBLY.

a. Park crane on level ground and chock all four wheels.

b. Remove cotter pin, clevis pin, washers, and clamp securing parking brake cable to front axle.

c. Disconnect drive line at front axle.

d. Remove nut (12, figure 5-6), washer (43), and yoke/flange (42).

e. Remove return springs (40), brake shoes (47), roller (46), and brake lever (39).

5-19. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If soslvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Inspect brake linings (48, figure 5-6) for wear. Replace both linings if either is worn to 1/32-inch.

5-20. REPAIR.

a. Repair shall be limited to the replacement of all worn or damaged parts.

5-21. ASSEMBLY.

a. Install brake lever (39, figure 5-6) and roller (46).

b. Install brake shoes (47) and return springs (40).

c. Install yoke/flange (42) with brake drum (41). Secure with washer (43) and nut (12). Torque nut (12) from 300 to 400 foot pounds.

d. Connect drive line at front axle.

e. Install clamp, washers, clevis pin, and cotter pin securing parking brake cable at brake lever.

f. Set brake with hand lever (in cab) to test parking brake.

5-22. PARKING BRAKE LINKAGE.

5-23. REMOVAL AND DISASSEMBLY.

a. Chock wheels.

b. Remove cotter pin (9, figure 5-9), washers (7), and clevis pin (8).

c. Remove nuts (5), lockwashers (6), capscrews (11), and clamp (10).

d. Remove capscrews (12), lockwashers (2), nuts (1), and brake lever (13).

e. Remove brake cable (3) and grommet (4).

5-24. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Inspect all parts for wear.

5-25. REPAIR.

a. Repair shall be limited to the replacement of all worn parts.

5-26. ASSEMBLY AND INSTALLATION.

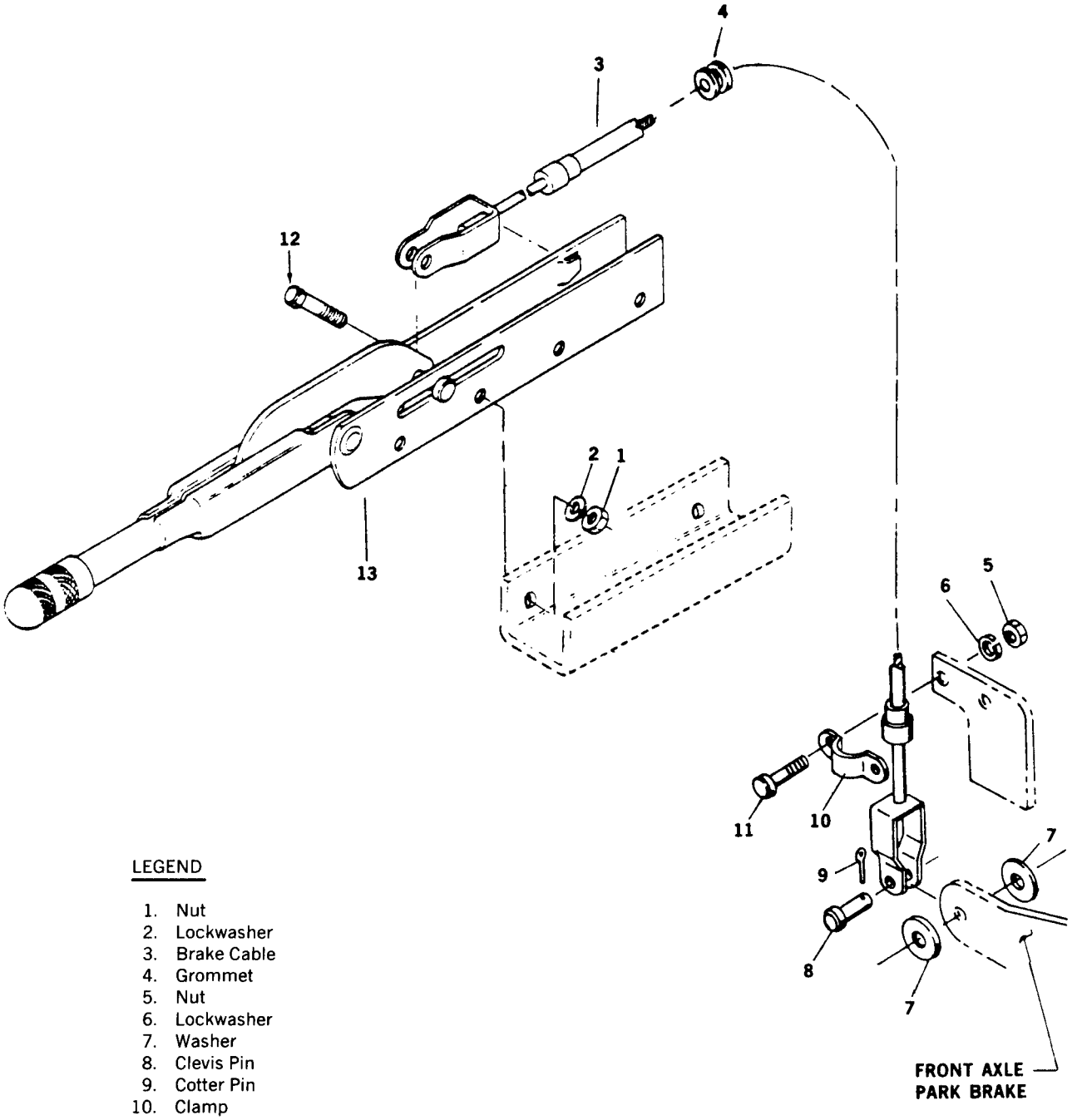
a. Install brake cable (3, figure 5-9) with grommet (4).

b. Install brake lever (13) with nuts (1), lockwashers (2), and capscrews (12).

c. Install clamp (10) with capscrews (11), lockwashers (6), and nuts (5).

d. Install clevis pin (8) with washers (7), and cotter pin (9)

e. Remove chocks.



LEGEND

1. Nut
2. Lockwasher
3. Brake Cable
4. Grommet
5. Nut
6. Lockwasher
7. Washer
8. Clevis Pin
9. Cotter Pin
10. Clamp
11. Capscrew
12. Capscrew
13. Brake Lever

Figure 5-9. Parking Brake Installation

SECTION 6

STEERING MAINTENANCE INSTRUCTIONS

6-1. TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Hard to steer left and right.	a. Hydraulic oil low.	a. Fill hydraulic reservoir.
	b. Clogged or loose hydraulic lines or fittings.	b. Clean or tighten lines or fittings.
	c. Insufficient lubricant on steer cylinders.	c. Lubricate steer cylinders.
	d. Defective pressure relief valve.	d. Repair or replace valve (para. 6-12).
	e. Defective steering control valve.	e. Repair or replace valve (para. 6-2).
	f. Defective steering pump.	f. Repair or replace pump (para. 6-12).
2. Hard to steer either left or right.	a. Clogged or loose hydraulic lines or fittings.	a. Clean or tighten lines or fittings.
	b. Insufficient lubricant on steer cylinder.	b. Lubricate cylinder.
	c. Defective steer cylinder.	c. Repair or replace cylinder (para. 6-7).
3. Steering is erratic left or right.	a. Hydraulic oil low.	a. Fill hydraulic reservoir.
	b. Clogged or loose hydraulic lines or fittings.	b. Clean or tighten lines or fittings.
	c. Defective pressure relief valve.	c. Repair or replace valve (para. 6-12).
	d. Defective steering control valve.	d. Repair or replace valve (para. 6-2).
	e. Defective steering pump.	e. Repair or replace pump (para. 6-12).
4. Noisy steering pump caused by cavitation.	a. Hydraulic oil low.	a. Fill hydraulic reservoir.
	b. Oil too heavy.	b. Change to proper viscosity.
	c. Oil filter plugged.	c. Clean filters (para. 8-8).
	d. Suction line plugged or too small.	d. Clean line and check for size
5. Oil overheating.	a. Oil supply low.	a. Fill hydraulic reservoir.
	b. Oil in system too light.	b. Drain reservoir and refill with proper viscosity oil.
	c. Contaminated oil.	c. Drain reservoir and refill with clean oil.

SYMPTOM	PROBABLE CAUSE	SOLUTION
5. Oil Overheating (cont'd)	d. Setting of relief valve too high or too low.	d. Set to correct pressure (para. 8-31).
6. Steering pump shaft seal leakage.	a. Worn shaft seal.	a. Replace shaft seal (para. 6-12). **NOTE** If replacing the shaft seal does not stop leakage, the pump should be disassembled and inspected thoroughly.
	b. Bearings out of position.	b. Replace or reposition bearings (para. 6-12).
	c. Excessive internal wear.	c. Replace pump (para. 6-12).
7. Foaming oil.	a. Low oil level.	a. Fill hydraulic reservoir.
	b. Air leaking into suction line.	b. Tighten fittings.
	c. Wrong kind of oil.	c. Drain and fill reservoir with non-foaming oil.
8. Rear steering inoperative.	a. Hydraulic oil low.	a. Fill hydraulic reservoir.
	b. Clogged, broken, or loose hydraulic lines or fittings.	b. Clean, tighten, or replace lines or fittings.
	c. Steer cylinder locked.	c. Repair or replace cylinder (para. 6-7).
	d. Defective control valve.	d. Repair or replace valve (para. 8-13).

6-2. STEERING CONTROL INSTALLATION.

6-3. REMOVAL AND DISASSEMBLY – FRONT STEER.

a. Remove front cover.

b. Clean steering control valve and surrounding area thoroughly.

c. Tag and disconnect hydraulic hoses at steering control valve. Cap four hoses and ports in steering control valve.

d. Tag and disconnect leads to horn button and turn signal switch. Loosen clamps and remove horn button and turn signal switch.

e. Remove plug button (1, figure 6-1), nut (6), and steering wheel (2).

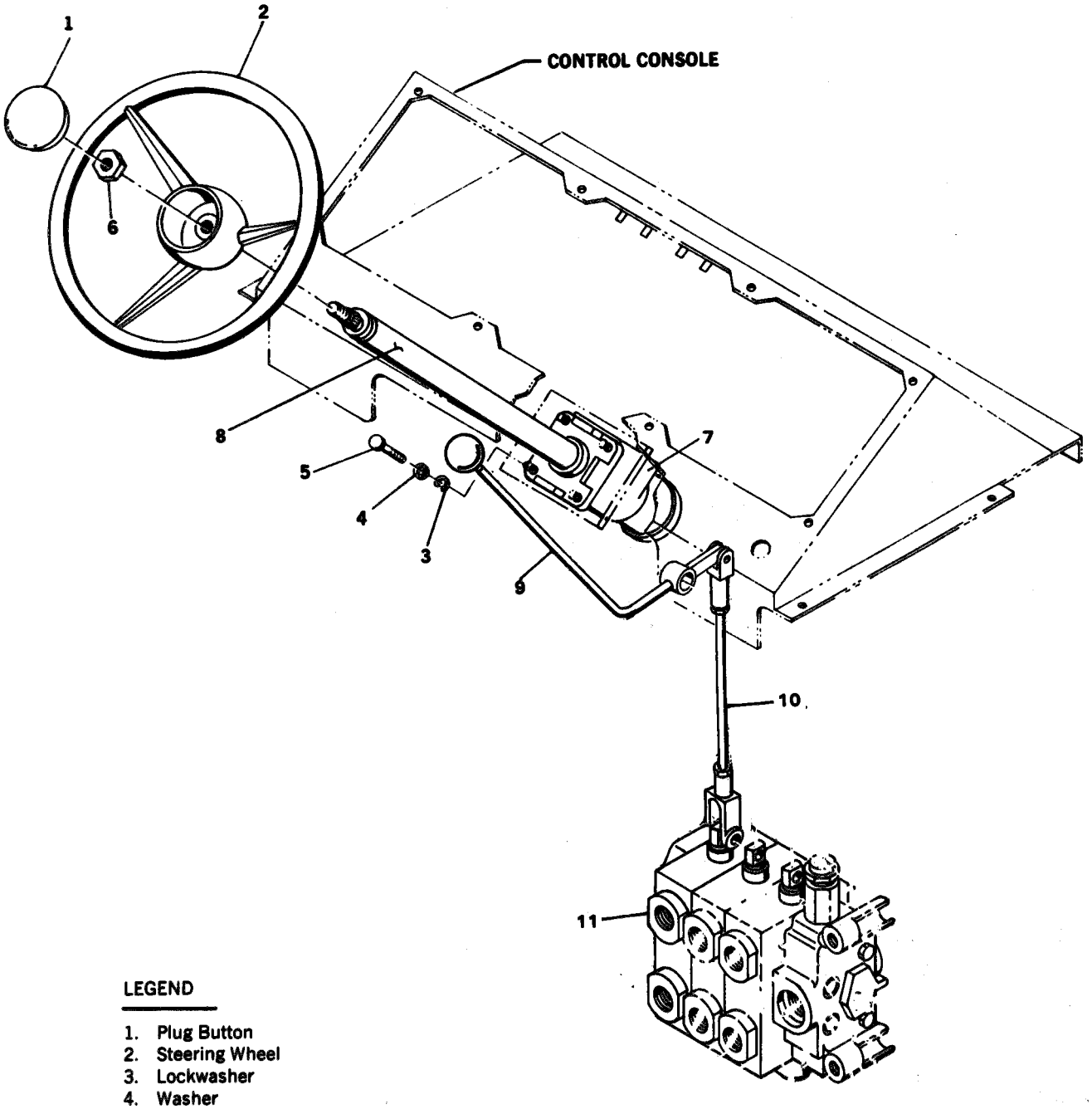
f. Remove four capscrews (5), washers (4), and lockwashers (3), securing steering control valve (7), to steering column (8), and bracket. Remove steering control valve.

g. Check shaft end of steering control valve. If wet, the shaft seal may have been leaking.

NOTE

A functional problem or leakage at the control end of the steering control valve requires disassembly of the control end only.

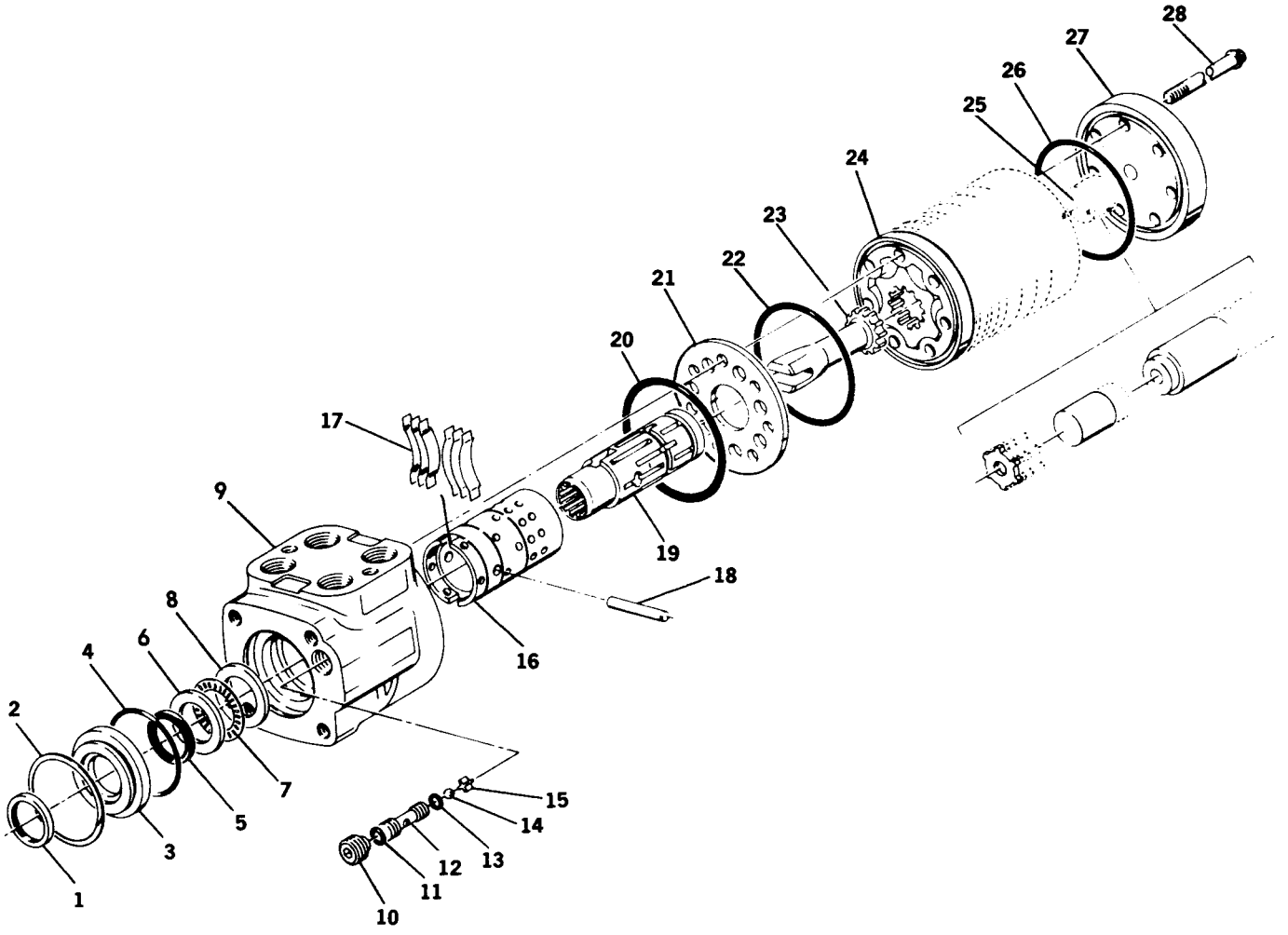
h. If complete disassembly is required, clean all paint and surface contamination from steering control valve. Use wire brush to clean unit around geroter end, ringing and blowing away all surface contamination.



LEGEND

1. Plug Button
2. Steering Wheel
3. Lockwasher
4. Washer
5. Capscrew
6. Nut
7. Steering Control Valve
8. Steering Column
9. Rear Steer Control
10. Rear Steer Linkage
11. Rear Steer Control Valve

Figure 6-1. Steering Control Installation



LEGEND

1. Dust Seal
2. Retaining Ring
3. Seal Gland Bushing
4. Seal, 2-1/8 Inch OD
5. Quad Ring Seal
6. Bearing Race
7. Needle Thrust Bearing
8. Bearing Race
9. Housing
10. Setscrew
11. Seal, 5/8 Inch OD
12. Check Ball Seat
13. Seal, 7/16 Inch OD
14. Check Ball
15. Check Ball Retainer
16. Control Sleeve
17. Centering Springs
18. Centering Pin
19. Control Spool
20. Seal, 3 Inch OD
21. Spacer Plate
22. Seal, 3 Inch OD
23. Drive
24. Geroter
25. Spacer(s)
26. Seal, 3 Inch OD
27. End Cap
28. Capscrew

Figure 6-2. Steering Control Valve

CAUTION

Disassemble the steering control valve on a clean bench. Use clean, lint-free cloth, cleaning solvent, and low-pressure air to clean parts.

i. Clamp steering control valve in vise, geroter end up. Use protective material on vise jaws and clamp lightly on edges of mounting area. Do not overtighten.

j. Remove capscrews (28, figure 6-2), end cap (27), and seal (26). Remove geroter (24). Do not drop star. Remove seal (22).

k. Remove spacer (21), drive (23), and seal (20). Loosen vise and remove housing (9). Place housing on clean lint-free cloth.

l. Pry retaining ring (2) from housing (9) with thin-bladed screwdriver.

m. Rotate control spool (19) and control sleeve (16) until centering pin (18) is horizontal. Push control spool (19) forward until seal gland bushing (3) is clear of housing. Remove seal gland bushing.

n. Install dry quad ring seal (5) in seal gland bushing

o. Remove bearing race (6), needle thrust bearing (7), and bearing race (8).

CAUTION

Do not bind the spool and sleeve in the housing. Rotate the spool and sleeve assembly slowly when removing it from the housing.

p. Remove control spool (19) and control sleeve (16) from fourteen hole end of housing (9). Remove centering pin (18).

q. Push control spool (19) partially from control end of control sleeve (16). Carefully remove centering springs (17).

r. Rotate control spool (19) slowly and push through and out of control sleeve (16).

s. Remove seal (4).

t. Remove setscrew (10). Screw 1/8-24 machine screw into check ball seat (12). Use pliers to remove check ball seat.

u. Remove seals (11 and 13), check ball (14), and check ball retainer (15).

6-4. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well. ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Inspect all mating surfaces for scratches or burrs.

c. Inspect needle thrust bearing (7, figure 6-2) for wear.

6-5. REPAIR.

a. Repair shall be limited to the replacement of all worn parts.

b. Replace needle thrust bearing (7, figure 6-2) and bearing races (6 and 8) as a matched set.

c. Replace all seals.

6-6. ASSEMBLY AND INSTALLATION.

a. Lubricate seals (4, 11, 13, 20, 22, and 26, figure 6-2) with petroleum jelly prior to assembly.

b. Use needle nose pliers to install check ball retainer (15). Ensure retainer lays flat.

c. Install check ball (14). Install seals (11 and 13) on check ball seat (12). Do not twist or damage seals.

d. Lubricate and install check ball seat (12) with care to avoid damage to seals. Push seat to bottom of hole.

e. Install setscrew (10). Torque setscrew to 100 inch-pounds (115 kgcm). Setscrew must be slightly below housing mounting surface.

f. Assemble control spool (19) and control sleeve (16) with spring slots aligned at same end. Rotate spool while sliding parts together. Test for free rotation. Spool should rotate freely with fingertip force applied at splined end.

g. Align spring slots of control spool (19) and control sleeve (16) and stand both parts on end. Insert spring installation tool 600057 through both parts as shown in figure 6-3. Position three pairs of centering springs (17, figure 6-2) in two sets of three each so that extended edge is down and arched section is together. Enter one end of spring set into spring installation tool.

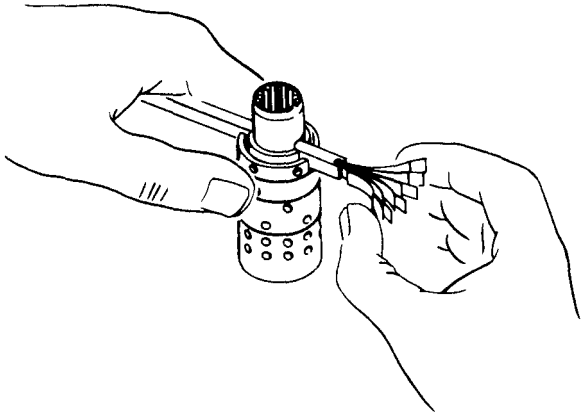


Figure 6-3. Centering Spring installation

h. Compress extended end of centering spring set and push into spool sleeve assembly. Center spring set so they push down evenly and are flush with upper surface of spool and sleeve.

i. Install centering pin (18) until pin is flush on both sides of control sleeve (16).

CAUTION

Be careful that parts do not tilt out of position while installing the control spool and sleeve.

j. Install control spool and sleeve so that splined end of spool (19) enters housing (9) on fourteen hole end first. Push parts in gently with slight rotating action. Keep centering pin (18) nearly horizontal. Push control spool and sleeve until parts are flush with fourteen hole end of housing. Ensure that centering pin (18) has not dropped into discharge groove of housing.

k. Turn control spool (19) to check for free rotation with light fingertip pressure at splined end.

l. Place housing (9) on clean, lint-free cloth and install new seal (4), two bearing races (6 and 8), and needle thrust bearing (7).

m. Install dust seal (1) in seal gland bushing (3) with smooth or flat side of seal facing bushing.

n. Remove quad ring seal (4) from seal gland bushing. Pry dust seal (1) loose using thin-bladed screwdriver into pocket of bushing.

o. Install seal gland bushing (3) over spool end with twisting motions. Tap bushing in place with rubber mallet. Ensure bushing is flush against bearing race.

p. Install retaining ring (2). Tap ring end around entire circumference to ensure ring is seated properly in its groove.

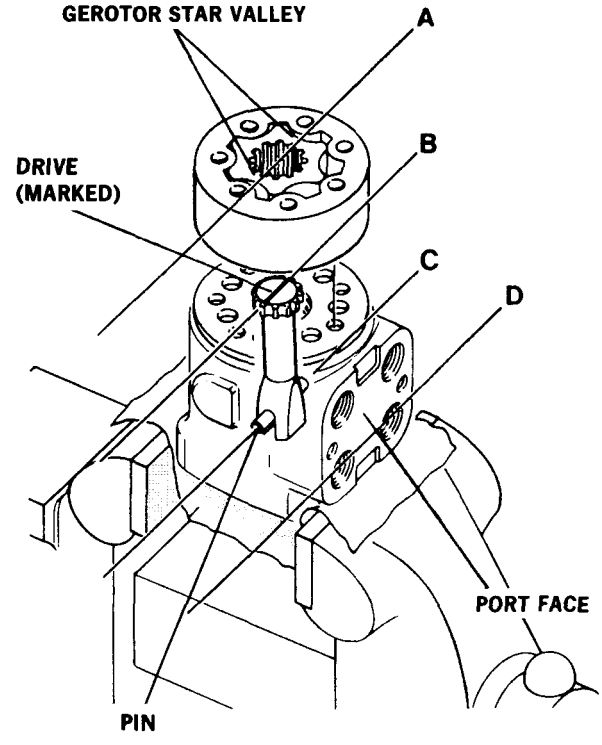


Figure 6-4. Drive and Geroter Installation

q. Clamp housing (9) in vise, fourteen hole end up. Use protective material on vise jaws and clamp lightly on mounting area. Do not overtighten.

r. Wipe upper surface of housing with palm of hand. Do not use cloth or paper, Ensure that control spool (19) and sleeve (16) are flush with housing end.

s. Install seal (20) and spacer plate (21). Align bolt holes in spacer plate with tapped holes in housing.

t. Rotate control spool (19) until centering pin (18) is parallel with port face of housing (9). Install drive (23) engaging centering pin (18). To ensure proper alignment, mark drive (23) as shown in figure 6-4, reference B. Note relationship between slotted end of drive to splined end of drive when marking.

u. Install seal (22, figure 6-2).

v. With seal side of geroter (24) towards spacer (21), align star valleys (figure 6-4, reference A) on drive (reference B). Note parallel relationship of reference lines A, B, C, and D. Align bolt holes in geroter (24, figure 6-2) without disengaging geroter and drive.

w. Install same number and size spacers removed during disassembly.

x. Install seal (26) in end cap (27). Install end cap (27) and align bolt holes.

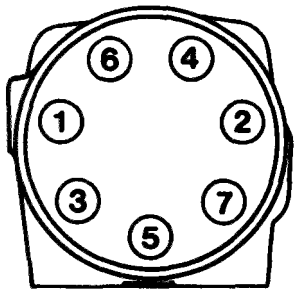


Figure 6-5. Capscrew Torque Sequence

y. Install dry capscrews (28). Pretighten capscrews to 150 inch-pounds (172.8 kgcm). Torque capscrews to 275 inch-pounds (316.8 kgcm) in sequence shown in figure 6-5.

z. Install steering control valve (7, figure 6-1) to steering column (8) and mounting bracket with capscrews (5), washers (3), and flat washers (4).

aa. Remove tags and port plugs and connect four hydraulic hoses.

m . Install front cover.

cc. Install steering wheel (2), nut (6), and plug button (1).

6-7. STEERING CYLINDER - FRONT AND REAR.

6-8. REMOVAL AND DISASSEMBLY.

a. Tag and disconnect hydraulic lines to steering cylinder.

b. Remove cotter pin and slotted nut on rod end of steering cylinder.

c. Remove cotter pins and rod on tube end of steering cylinder. Remove steering cylinder and transport to clean work area.

d. Locate spanner wrench in drilled holes in head (11, figure 6-6). Rotate spanner wrench counterclockwise one full turn.

e. Insert screwdriver under retaining ring (12) to start ring out of cylinder. Remove retaining ring.

f. Pull rod (7) and remove head (11) and piston (5).

g. Remove nut (3), piston (5), and uniring (4).

h. Remove O-ring (6), head (11), O-ring (14), back-up ring (13), O-ring (10), back-up ring (9), and wiper (8).

6-9. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Inspect rod (7, figure 6-6) and tube bore (2) for nicks, burrs, or corrosion. Remove slight defects with fine sandpaper (400 grit). Clean thoroughly.

6-10. REPAIR.

a. Repair shall be limited to replacement of all worn components.

b. Replace all seals prior to assembly. Use repair kit 11389.

6-11. ASSEMBLY AND INSTALLATION.

a. Lubricate all parts with clean oil MIL-L-2104 SAE 10.

CAUTION

Do not stretch seals.

b. Install wiper (8, figure 6-6), back-up ring (9), and O-ring (10).

c. Install head (11) with back-up ring (13) and O-ring (14) on rod (7).

d. Install O-ring (6), piston (5) with uniring (4). Install nut (3). Torque nut (3) to 115 foot-pounds.

e. Push rod (7) with piston into tube (2) until shoulder of head (11) butts up to tube end.

f. Locate drilled hole in head (11) through milled slot in tube and insert retaining ring (12).

g. Locate spanner wrench in drilled holes in head (11) and rotate spanner wrench one full turn.

h. Position steering cylinder on axle and install pin with new cotter pin on tube end.

i. Locate rod end of steering cylinder and steering arm of axle and install slotted nut and new cotter pin.

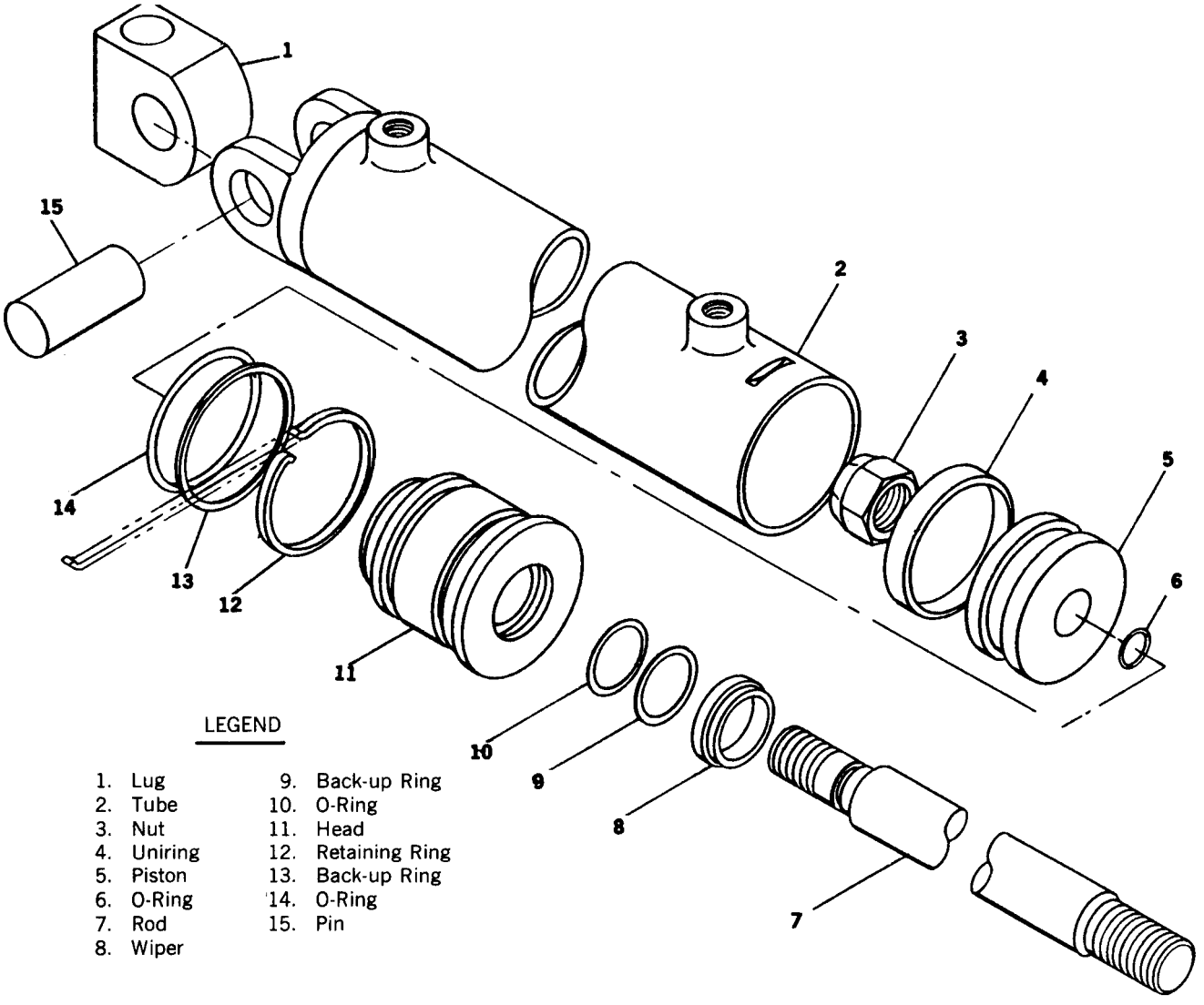


Figure 6-6. Steering Cylinder

j. Remove tags and install hydraulic lines to steering cylinder.

6-12. STEERING PUMP.

6-13. REMOVAL AND DISASSEMBLY.

a. Loosen capscrews on steering pump mounting bracket and remove drive belt.

b. Tag and disconnect hydraulic lines to steering pump.

c. Remove capscrews and steering pump. Transport steering pump to clean work bench.

d. Remove bolt (1, figure 6-7), lockwasher (2), and washer (3). Using puller, remove pulley (4).

e. Remove bolt (14), adapter (15), and gasket (16).

f. Remove bolts (9 and 13) and separate body (11) and cover (25) by lifting cover vertically to prevent internal parts from falling out.

g. Remove and discard o-rings (24 and 27).

h. Scribe line on carrier (21) and cam (19) to aid in assembly. Do not scratch surfaces.

i. Remove rollers (22), carrier (21), and drive pin (23).

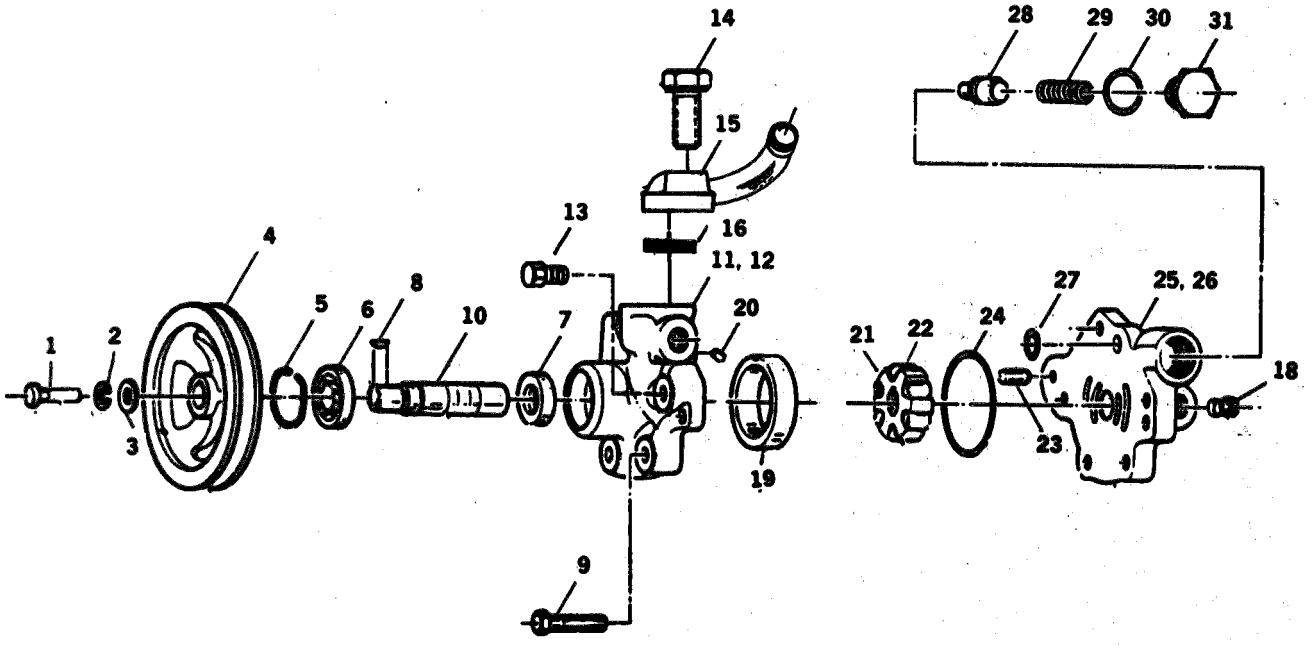


Figure 6-7. Steering Pump

LEGEND

1. Bolt
2. Lockwasher
3. Washer
4. Pulley
5. Snap Ring
6. Bearing
7. Seal
8. Key
9. Bolt
10. Shaft
11. Body
12. Bushing
13. Bolt
14. Bolt
15. Adapter
16. Gasket
17. Not Used
18. Orifice
19. Cam
20. Pin
21. Carrier
22. Roller
23. Drive Pin
24. O-Ring
25. Cover
26. Bushing
27. O-Ring
28. Valve
29. Spring
30. O-Ring
31. Cap

j. Remove cam (19) and pin (20).

k. Remove snap ring (5) and shaft (10). Press bearing (6) from shaft.

1. Remove and discard seal (7) using puller.

m. Remove cap (31), o-ring (30), and spring (29).

Tap cover (25) on wooden block to remove valve (28).

6-14. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. inspect bushings (12 and 26, figure 6-7). If bushings are worn, replace body (11) or cover (25) as needed.

c. Inspect pulley (4) tor worn sheave and cracks.

d. Inspect all parts for wear and damage.

6-15. REPAIR.

a. Repair shall be limited to the replacement of all damaged parts.

b. Replace all seals and o-rings.

6-16. ASSEMBLY AND INSTALLATION.

a. Coat all parts with light oil.

b. install valve (28, figure 6-7). Ensure that ball end of valve enters first.

c. Install new o-ring (30), spring (29), and cap (31).

d. Torque cap (31) from 30 to 35 foot pounds.

e. Install new seal (7) in body (11) with lip of seal toward carrier (21).

f. Press bearing (6) on shaft. (10) until bearing seats against shoulder.

g. Install shaft (10) and snap ring (5). Ensure that snap ring is seated.

h. Install pin (20) and cam (19). Ensure that notch in cam indexes pin (20) and that cam is firmly seated.

i. Install drive pin (23), and carrier (21). Ensure that line on carrier indexes with line on cam (19).

j. Install rollers (22) and check end play as follows:

1. Place straight edge across edge of carrier (21).

2. Measure end play between straight edge with feeler gage.

3. Replace cam (19), carrier, and rollers (22) if end play exceeds .002 inch.

k. Install new o-rings (24 and 27).

1. Position cover (25) on body (11) and install bolts (9 and 13). Torque bolts from 25 to 35 foot pounds.

m. Rotate pump shaft and check for free rotation

n. Install new gasket (16) and adapter (15) with bolt (14).

o. Install pulley (4), washer (3), lockwasher (2), and bolt (1). Torque bolt (1) from 20 to 27 foot pounds.

p. Align steering pump with its mounting brackets and install capscrews and lockwashers.

q. Install belt and adjust tension until belt deflects one-half inch at midspan.

6-17. REAR STEER INSTALLATION.

6-18. For removal and installation of rear steer controls refer to valve usage table 8-2 and paragraphs 8-13 thru 8-17.

6-19. REAR STEER INDICATOR ADJUSTMENT.

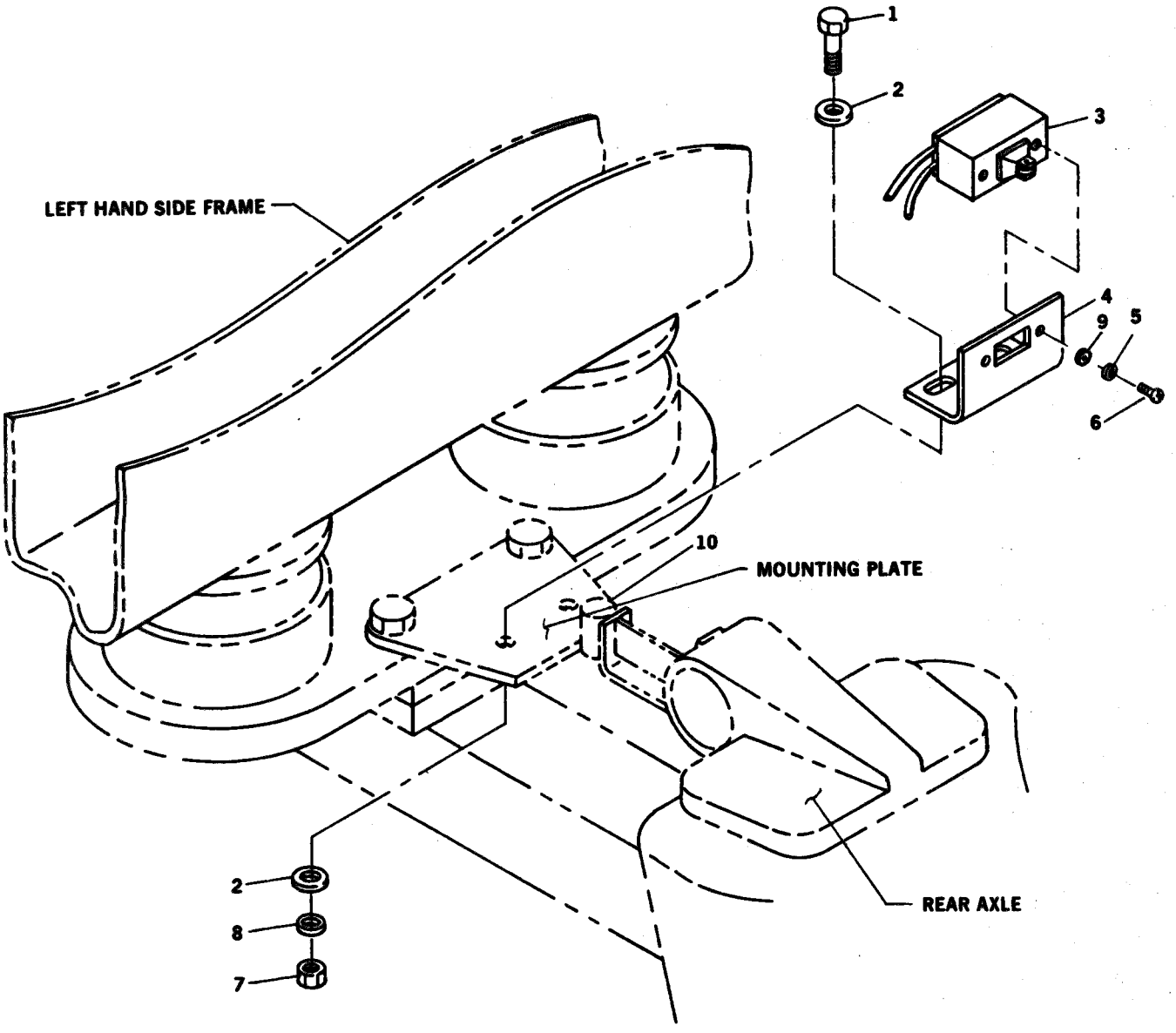
6-20. Adjust rear steer indicator as follows:

a. Make sure rear wheels are centered.

b. Loosen nuts (7, figure 6-8) allowing movement of switch and mounting bracket.

c. Position switch so that roller is centered on cam (10) and depressed sufficiently to put out light on dash.

d. Tighten nuts (7).



LEGEND

1. Screw
2. Washer
3. Switch
4. Bracket
5. Lockwasher
6. Screw
7. Nut
8. Lockwasher
9. Washer
10. Cam

Figure 6-8. Rear Steer Indicator Installation

SECTION 7

BRAKE SYSTEM MAINTENANCE INSTRUCTION

7-1. TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Brakes are poor.	a. Brakes are out of adjustment.	a. Adjust brakes.
	b. Brake pedal linkage binding.	b. Free linkage.
	c. Restriction or leaks in lines.	c. Check all lines for leaks and restrictions.
	d. Low brake fluid level.	d. Add the proper brake fluid to the master cylinder.
	e. Air in brake lines.	e. Bleed the brakes (para. 7-12).
	f. Brake linings are grease soaked.	f. Replace linings (para. 7-2).
	g. Engine not running.	g. Start engine. Due to the operation of the power boost head - the engine must be running to provide full brake power.
	h. Priority valve not providing priority flow to power boost unit.	h. Check the flow from the priority valve. The priority valve provides 3.5 gpm (13.25 lpm) at idle.
	i. Power boost head relief valve stuck open.	i. Replace the relief valve (para. 7-7).
2. Hard brake pedal with engine running.	a. Pedal travel being interfered with.	a. Check all pedal linkage and ensure it's free and adjusted properly.
	b. Internal problem with the power head.	b. Repair or replace the power head (para. 7-7).
3. Brakes lock up.	a. Priority valve, providing too much flow.	a. Check the flow from the priority valve. Too much flow will cause the brakes to be applied by the oil trapped in the power boost chamber.
	b. Brake pedal push rod improperly adjusted causing brakes to be always applied.	b. Adjust the push rod linkage so the brake pedal and push rod fully return.
	c. Return spring in the power head stuck.	c. Disassemble and repair power head (para. 7-7).

SYMPTOM	PROBABLE CAUSE	SOLUTION
4. Uneven braking or lining wear.	a. Corroded or frozen calipers.	a. Remove, clean, and free-up the calipers (para. 7-2).
	b. Brakes are out of adjustment.	b. Adjust the brakes.
	c. Grease on the linings.	c. Replace the linings (para. 7-7).

7-2. BRAKE ASSEMBLY.

7-3. REMOVAL AND DISASSEMBLY.

a. Remove approximately two thirds of the brake fluid from master cylinder. Do not drain reservoir completely.

b. Use outriggers to raise wheels off ground. Place jack stands under outrigger weldments. Remove tire and wheel assemblies.

NOTE

Always replace brake linings as a complete axle set. Never, service one wheel side only.

c. Disconnect brake hose at frame, then at fitting on caliper (7, figure 7-1) and cap end of hose to prevent dirt from entering.

d. Remove capscrews (11), washers (12), key (9), and retainer (10).

e. With caliper butted against support rail opposite key end, rotate retainer end up and away from torque plate (13) and off wheel hub (2).

f. Remove brake lining (1) farthest from pistons (5) by aligning pad in removal slot provided in caliper abutment rails. Remove brake lining (3). Drain brake fluid from caliper.

NOTE

Check for signs of fluid leakage around pistons and boots. Thoroughly clean caliper exterior surfaces with clean isopropyl alcohol or brake fluid. Ensure surface surrounding piston bores is free of loose dirt particles.

CAUTI

Never use mineral base cleaning solvents such as gasoline, kerosene, acetone, or paint thinner to clean caliper. These solutions will damage rubber parts.

WARNING

Use only enough air pressure to ease piston out of bore. Do not place hand in front of piston when applying air pressure. This could result in serious personal injury.

g. Place wood block (2 inches thick) under pistons (5). Pad caliper exterior with clean cloth. Direct compressed air into caliper fluid opening forcing pistons from bores.

h. Remove boots (4).

CAUTION

Do not use a metal tool to remove seal (6). This could damage caliper bore.

i. Remove seal (6) from groove in caliper bore with a pointed piece of wood or plastic. Discard seals.

7-4. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in well-ventilated area. Wear goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

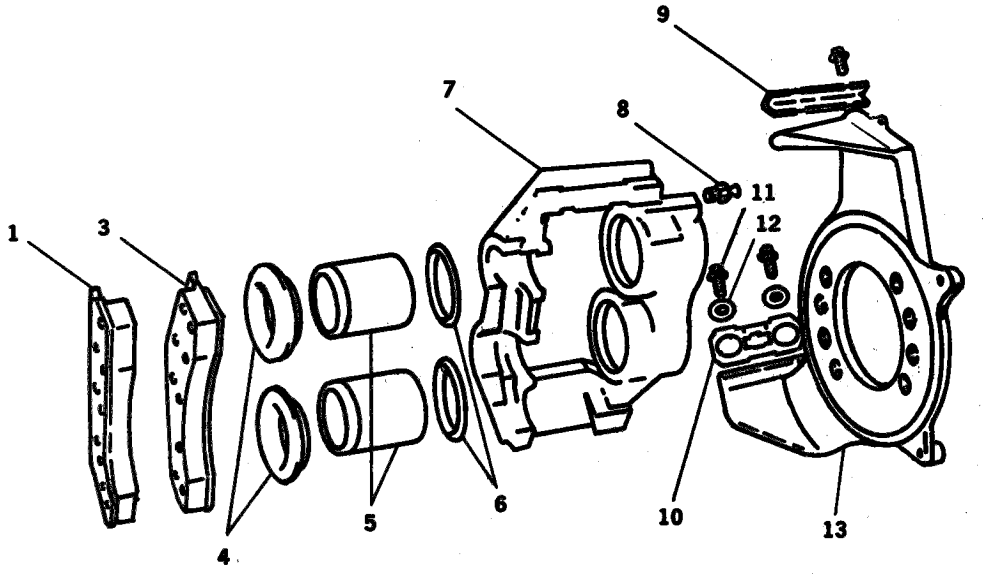
a. Clean all metal parts except caliper (7, figure 7-1) with a clean cloth dipped in cleaning solvent P-D-680.

b. Wipe residue with clean cloth.

c. Dry thoroughly.

CAUTION

Never use mineral base cleaning solvents such as gasoline, kerosene, acetone or paint thinner to clean caliper. These solutions will damage rubber parts.



LEGEND

1 Brake Lining
2 Wheel Hub (Not Shown)
3 Brake Lining
4 Boot
5 Piston
6 Seal
7 Caliper
8 Bleeder Screw
9 Key
10 Retainer
11 Capscrew
12 Washer
13 Torque Plate

figure 7-1. Disc Brake Assembly

d. Examine outside diameter of piston (5) for scoring, nicks, corrosion, and worn or damaged plating.

NOTE

The outside diameter of piston must not be refinished by any means, nor abrasives used for any reason.

e. Inspect boots (4) for cuts, cracks, or other damage. If boot damage is noted or evidence of leakage is observed, caliper (7) should be overhauled. Never reuse boots (4).

f. Clean support rails on torque plate (13) and mating surfaces on caliper (7). Remove any rust buildup by sanding surfaces lightly with emery cloth.

7-5. REPAIR.

a. Repair shall be limited to the replacement of all worn or damaged parts.

7-6. ASSEMBLY AND INSTALLATION.

a. Dip new seal (6, figure 7-1) in clear heavy duty brake fluid, and install in cylinder groove of caliper (7). Gently work seal around cylinder bore with finger until properly seated into inboard seal groove. Ensure seal is not twisted nor rolled in groove.

b. Install new dust boot (4) in cylinder outboard groove. Gently work boot around until properly seated.

c. Coat outside diameter of piston (5) with clean heavy brake fluid. Use small flat plastic or wood tool to gradually work dust boot around piston.

d. Press piston straight into caliper bore until it bottoms. Boot internal diameter should slide up piston as piston is pushed into caliper bore and comes to rest in boot groove in piston.

e. Install new brake linings (1 and 3) in caliper (7) by inserting through slots in caliper abutment rails. Install inboard brake lining (3) first with metal side against pistons (5). Install outboard brake lining (1) with lining side facing inboard lining.

f. Lightly lubricate brake rails on caliper with grease. Place caliper (7) over wheel hub (2) while spreading brake linings (1 & 3) apart. Rest caliper on rail opposite key end and rotate in place positioning caliper and support rails.

g. Install key (9) and retainer (10) with capscrews (11) and washers (12). Torque capscrews (11) from 12 to 20 foot pounds.

h. Remove cap from hose and connect hydraulic hose fitting at caliper (7).

i. Add clean brake fluid MIL-B-46176 into master cylinder reservoir to bring fluid to operating level.

j. Bleed brake system per paragraph 7-12.

k. Install wheel and tire assembly. Remove jack stands and retract outriggers. Road test crane.

7-7. HYDRAULIC BRAKE BOOSTER AND MASTER CYLINDER ASSEMBLY.

7-8. REMOVAL AND DISASSEMBLY.

a. Remove clevis pin securing push rod to front brake pedal and loosen jam nut securing push rod to brake booster and master cylinder. Unscrew push rod from brake booster unit. Disconnect stoplight switch.

b. Tag and disconnect hydraulic hoses to hydraulic brake booster unit. Cap hose ends and ports on hydraulic brake booster unit.

c. Tag and disconnect flare nuts (21 and 22, figure 7-2), and tubes (10 and 20). Cap brake lines and ports on master cylinder. Tag and disconnect leads to electric pump.

d. Unscrew caps (24) and pull plugs (25) from reservoir fill ports. Wrap plugs with clean rags and cover reservoir ports to prevent the entry of dirt. Unsnap the tee (31) from clip (30) and remove the brake pressure bleed system.

e. Further disassemble the brake pressure bleed system, if required, by removing the hose assemblies (28) and unscrewing the elbows (27) from the plugs (25) remove O-rings (26) and tee plug (32).

WARNING

The hydraulic brake booster and master cylinder unit weighs approximately 25 pounds. Use caution when removing the unit.

f. Remove four bolts (13), lockwashers (14), and nuts (15). Remove the hydraulic brake booster unit and master cylinder.

g. Remove nuts (46, figure 7-4). Separate master cylinder (figure 7-3) and hydraulic brake booster unit (figure 7-4).

h. Remove mounting bolts (22, figure 7-3) and reservoir (3).

i. Remove valve seals (28), valve poppets (27), and valve springs (26). Remove piston stop seal (24).

WARNING

The spring load on the primary piston assemble is approximately 60 to 70 pounds force (27.22 to 31.75 kg force). Use special spring compression tool

j. Compress primary piston assembly (5) and remove piston stop (23). Keep assembly compressed,

k. Remove lock ring (12) and slowly relieve pressure and remove primary piston assembly.

l. Remove primary return spring (4).

CAUTION

If it is necessary to use air pressure to remove the secondary piston assembly (13), ensure the pressure is controlled and no more than 20 psi (1.41 kg/cm^2). Place the bore approximately one-inch (2.45 cm) from a padded workbench or other surface to catch the piston assembly (13) when it comes out of the bore.

WARNING

Never point the open end of the bore at anyone when applying air pressure. Serious injury may occur if the piston comes out of the bore.

m. Remove secondary piston assembly (13).

NOTE

If air pressure is used, it may be necessary to plug the front outlet port and to apply air pressure to the front compensating valve port.

n. Remove secondary return spring (20).

o. Use press to compress primary piston assembly (5) until retaining ring (8) is exposed. Remove retaining ring (8), primary actuator (6), and primary actuator spring (7).

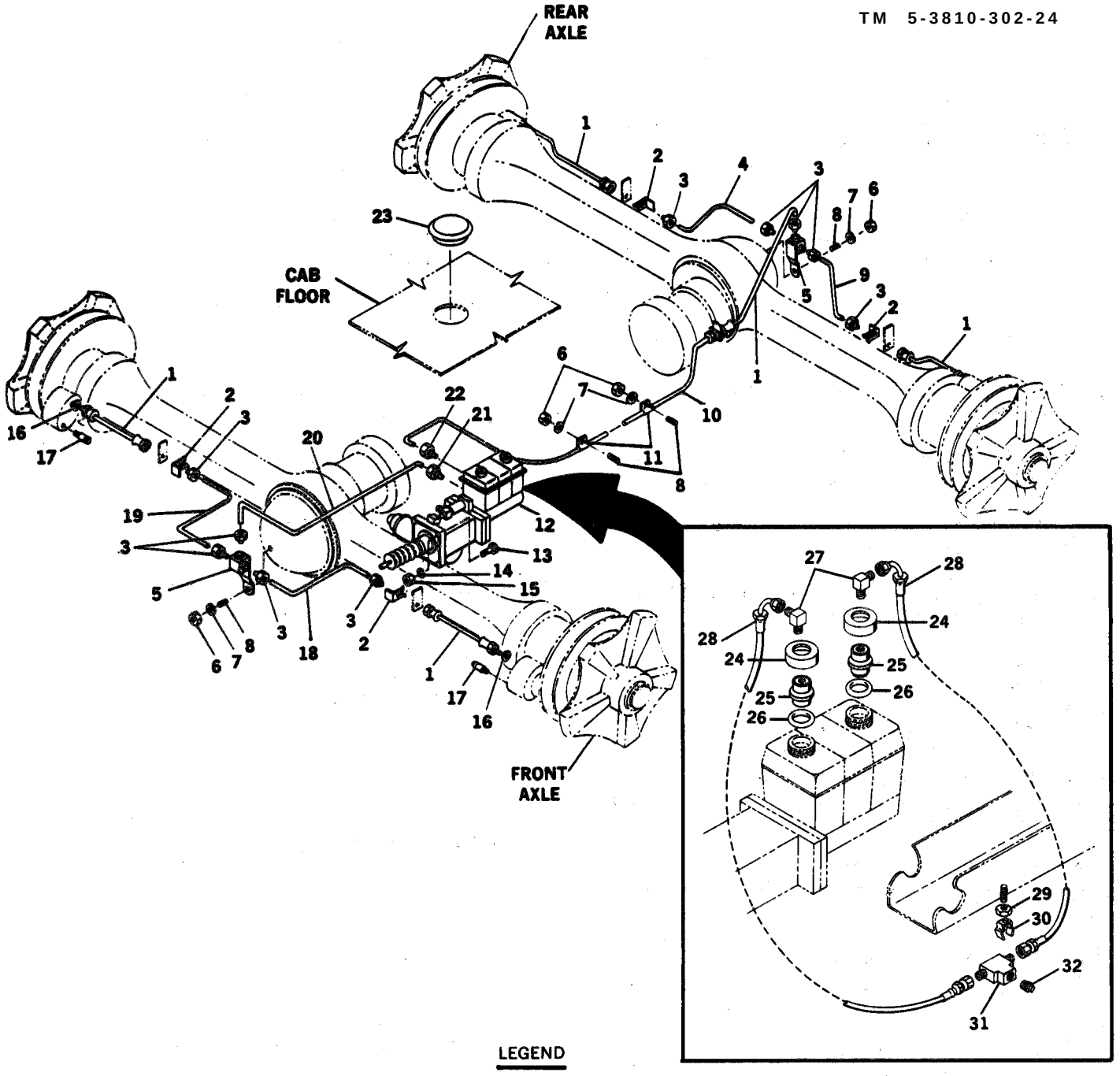
p. Remove and discard primary pressure seal (10) and back-up ring (11).

q, Remove caging bolt (19), secondary actuator (18), and secondary actuator spring. (17)

r. Remove and discard secondary pressure seals (14) and back-up rings (15).

NOTE

When electric pump (34, figure 7-4) is re-, moved, about three cups of oil will run out.



LEGEND

1. Brake Hose
2. Spring Clip
3. Nut
4. Tubing
5. Strap Fitting
6. Nut
7. Lockwasher
8. Stud
9. Tubing
10. Tubing
11. Clamp
12. Hydraulic Brake Booster and Master Cylinder
13. Bolt
14. Lockwasher
15. Nut
16. Copper Gasket
17. Bleeder Valve
18. Tubing
19. Tubing
20. Tubing
21. Flare Nut
22. Flare Nut
23. Plug
24. Cap
25. Plug
26. O-ring
27. Elbow
28. Hose Assembly
29. Nut
30. Clip
31. Tee
32. Plug

Figure 7-2. Power Boost and Brake Lines Installation

s. Secure housing in machinist vise with wood between vise jaws and housing. Loosen bolts (35) and drain oil into suitable container.

t. Remove bolts (35), electric pump (34), and face seals (36).

u. Remove boot (45).

CAUTION

When removing piston assembly (1), pull piston straight out without scraping bore of housing (33).

v. Push on push rod (43) to force piston assembly (1) out of housing (33). Rotate end cap (8) for easier removal.

w. Clamp push rod (43) in vise, push against end cap (8), and remove snap ring (2).

x. Remove filter and end cap assembly (4), O-ring (3), and return spring (10).

y. Loosen and remove input plug (28). Remove O-ring (27), actuator seal (26), actuator seal retainer (25), actuator pin (24), retaining ring (22), valve rod retainer (21), relief valve spring (20), and reaction piston (19).

z. Remove valve rod (18), poppet valve (16), valve return spring (15), retaining ring (14), and piston seal (11). Remove input seals (32).

aa. Remove flow switch (42) and O-ring (41). Use small magnet to remove flow switch piston (40) and flow switch spring (39).

7-9. CLEANING AND INSPECTION.

CAUTION

Do not use brake fluid or any other solvent to clean the brake boost unit.

a. Clean all master cylinder components (figure 7-3) with clean brake fluid MIL-B-46176.

b. Clean all hydraulic brake booster components (figure 7-4) except flow switch (42) in denatured alcohol or hydraulic oil MIL-L-2104 SAE 10.

c. Clean flow switch (42) by wiping with clean cloth dipped in denatured alcohol.

d. Inspect all parts for cracks, distortion, and excessive wear.

e. Inspect bore of master cylinder body (21, figure 7-3) for wear or corrosion. Inspect primary piston (9) and secondary piston (16) for scoring, nicks, burrs, and corrosion.

f. Inspect power piston (12, figure 7-4), valve rod (18), reaction piston (19), and bore of housing (33) for scoring, nicks, burrs, and corrosion.

g. Inspect filter (6) for contamination.

7-10. REPAIR.

a. Repair shall be limited to the replacement of all worn or damaged parts.

b. Replace all O-rings and seals prior to assembly.

7-11. ASSEMBLY AND INSTALLATION.

a. Install flow switch return spring (39, figure 7-4) and flow switch piston (40). Install new O-ring (41) on flow switch (42). Install flow switch (42). Torque switch from 20 to 40 foot pounds.

b. Secure housing (33) in machinist vise with wood placed between vise jaws and housing (33).

c. Install new input seals (32). Install new piston seal (11).

d. Assemble retaining ring (14), valve return spring (15), poppet valve (16), valve rod (18), reaction piston (19), relief valve spring (20), valve rod retainer (21), and retaining ring (22).

e. Install new O-ring (27). Install actuator pin (24), actuator seal retainer (25), new actuator seal (26), and input plug (28).

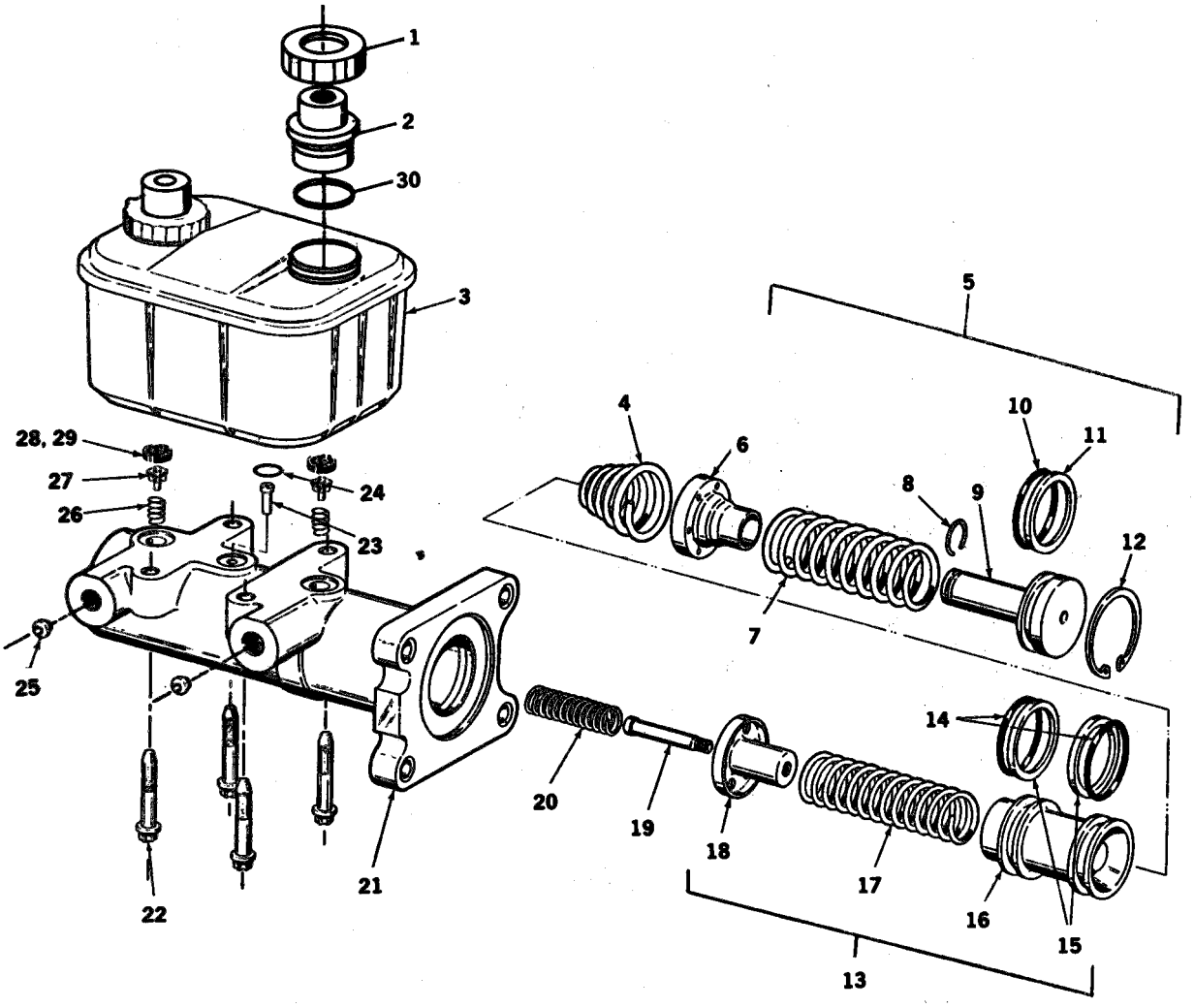
f. Lubricate input seals (32) and special tool with clean oil MIL-L-2104SAE 10. Install piston assembly (1) in housing (33).

g. Assemble new seal (5), filter (6), insert (7), and end cap (8). Install new O-rings (3 and 9).

h. Install return spring (10) into housing (33) small end first.

i. Lubricate O-rings (3 and 9), seal (5), piston assembly (1), and housing (33) with clean oil MIL-L-2104 SAE 10.

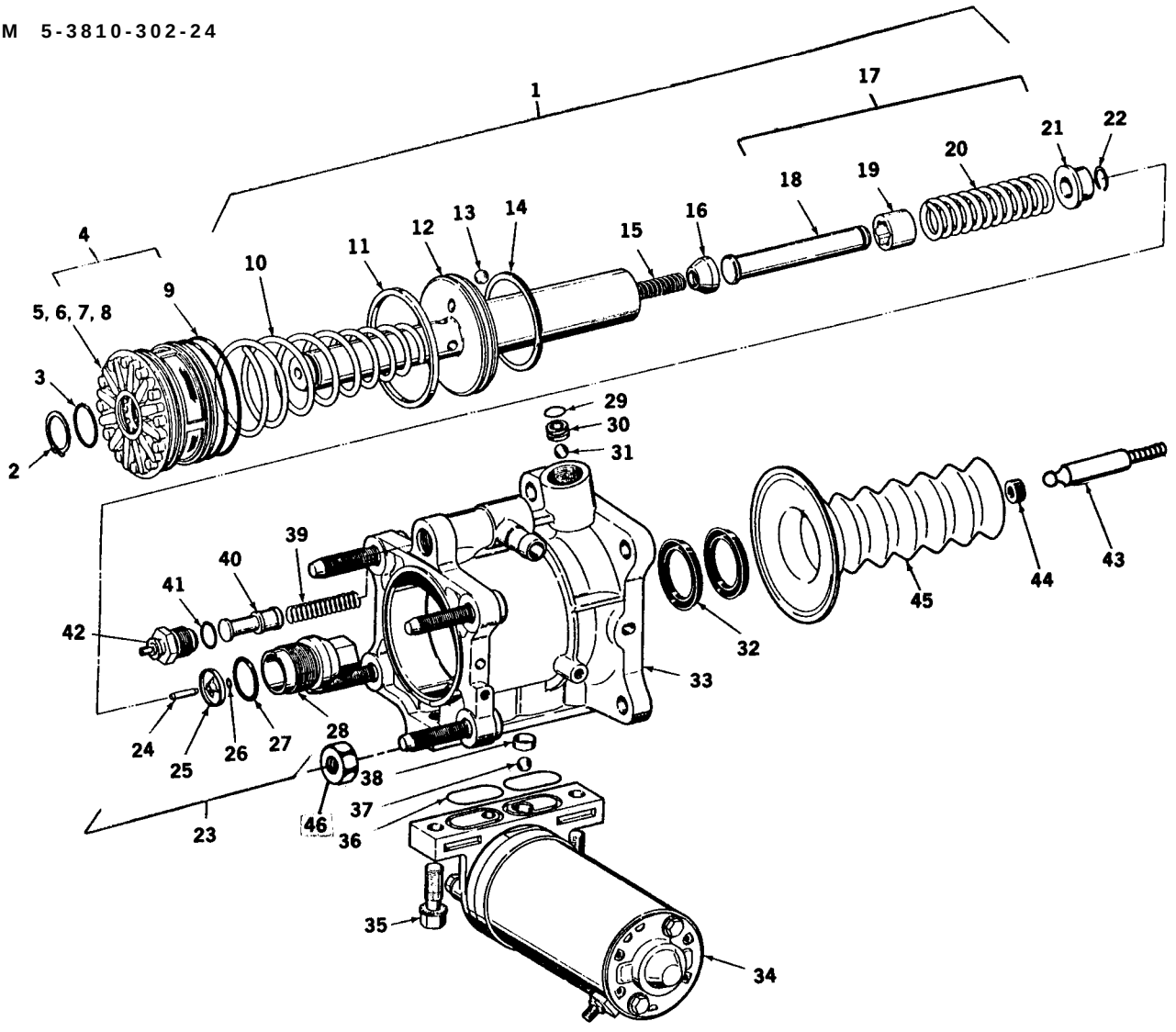
j. Depress filter and end cap (4) on power piston (12) and install snap ring (2). Remove special tool.



LEGEND

1. Cap
2. Plug
3. Reservoir
4. Primary Return Spring
5. Primary Piston Assembly
6. Primary Actuator
7. Primary Actuator Spring
8. Retainer Ring
9. Primary Piston
10. Primary Pressure Seal
11. Back-up Ring
12. Lock Ring
13. Secondary Piston Assembly
14. Secondary Pressure Seal
15. Back-up Ring
16. Secondary Piston
17. Secondary Actuator Spring
18. Secondary Actuator
19. Caging Bolt
20. Secondary Return Spring
21. Body
22. Mounting Bolts
23. Piston Stop
24. Piston Stop Seal
25. Tube Seat Inserts
26. Valve Spring
27. Valve Seat Poppet
28. Valve Seal
29. Valve Seal Insert
30. O-Ring

Figure 7-3. Master Cylinder Assembly



LEGEND

1. Piston Assembly
2. Snap Ring
3. O-ring
4. Filter and End Cap Assembly
5. Seal
6. Filter
7. Insert
8. End Cap
9. O-ring
10. Return Spring
11. Piston Seal
12. Power Piston
13. Check Ball
14. Retaining Ring
15. Valve Return Spring
16. Poppet Valve
17. Piston and Rod Assembly
18. Valve Rod
19. Reaction Piston
20. Relief Valve Spring
21. Valve Rod Retainer
22. Retaining Ring
23. Plug and Seal Assembly
24. Actuator Pin
25. Actuator Seal Retainer
26. Actuator Seal
27. O-ring
28. Input Plug
29. O-ring
30. Inlet Check Valve
31. Check Ball
32. Input Seals
33. Housing
34. Electric Pump
35. Bolts
36. Face Seals
37. Check Ball
38. Check Ball Retainer
39. Flow Switch Spring
40. Flow Switch Piston
41. O-ring
42. Flow Switch
43. Push Rod
44. Grommet
45. Boot
46. Nut

Figure 7-4. Hydraulic Brake Boost Unit

k. Lubricate new face seals (36) in clean oil. install electric pump (34). Use care to avoid damage to mating surfaces. Install mounting bolts (35).

l. Install boot (45) and push rod (43).

m. Lubricate diaphragms (2, figure 7-3), seals (10, 14, and 24), and back-up rings (11 and 15) with clean brake fluid MIL-B-46176.

n. Install new secondary pressure seals (14) and back-up rings (15).

o. Assemble secondary piston (16), secondary actuator spring (17) and secondary actuator (18). Install caging bolt (19).

p. Install secondary return spring (20) in recess of secondary actuator (18).

q. Install new primary pressure seal (10) and back-up ring (11).

r. Assemble primary piston (9), primary actuator spring (7), and primary actuator (6). With tool, depress primary actuator (6) and install retaining ring (8).

s. Install secondary piston assembly (13), primary return spring (4) small end first, and primary piston assembly (5) in body (21). Press primary piston (9) and install lock ring (12).

t. Press primary piston (9) and install piston stop (23). Install piston stop seal (24).

u. Install valve springs (26), valve seat poppets (27), and valve seals (28).

v. With primary piston (9) depressed, install reservoir (3) and secure with mounting bolts (22). Torque bolts from 170 to 210 inch pounds.

w. Install plugs (2) with new O-rings (30), and caps (1).

x. Mate hydraulic brake boost unit (figure 7-4) and master cylinder assembly (figure 7-3). Install nuts (46, figure 7-4).

WARNING

The hydraulic brake booster and master cylinder weighs approximately 25 pounds. Use caution when installing the unit.

y. Position hydraulic brake booster and master cylinder (12, figure 7-2) on frame mounting bracket and install bolts (13), lockwashers (14), and nuts (15). Torque bolts (13) to 31 foot pounds.

z. Remove tags and connect leads to electric motor.

aa. Remove tags and caps and install flare nuts (21 and 22) and brake lines (10 and 20).

bb. Remove tags and caps and install hydraulic hoses to hydraulic brake boost unit.

cc. Install clevis pin securing push rod on hydraulic brake booster and master cylinder and foot brake pedal. Connect stop-light switch.

dd. Connect battery at negative battery terminal.

ee. Fill master cylinder with new brake fluid MIL-B-. 46176.

ff. Complete the brake pressure bleed system installation by replacing the elbows (27, figure 7-2). Hose assemblies (28), tee (31) and plug (32).

gg. Bleed brake system per para. 7.12.

7-12. PRESSURE BLEEDING BRAKE SYSTEM.

NOTE

Ensure that master cylinder is filled to proper level with brake fluid MIL-B-46176.

a. Remove plug (32, figure 7-2) and install bleeding adapter in tee (31).

b. Using clean bleed tank, fill bleed tank at least 1/2 full with brake fluid MIL-B-46176.

c. Position tank so it will not have to be moved again until bleeding is finished.

d. Connect 35 psi (2.5 kg/cm^2) air source to bleeder tank.

e. Open bleeder tank valve and bleed all air out of hose to be connected to adapter.

f. Connect bleeder hose to adapter and open bleeder valve.

NOTE

Always bleed the wheel units beginning with the wheel having the longest line.

NOTE

Repeat steps (g) and (h) at each bleeder valve location.

g. Connect end of bleeder hose to bleeder valve on wheel cylinder. Submerge other end in glass jar partially filled with clean brake fluid.

h. Open bleeder valve and allow fluid to flow into jar until it is a solid stream, free of air bubbles. Close bleeder valve.

i. Bleed valve at each wheel cylinder.

j. Remove air supply from bleeder tank.

k. Close bleeder tank valve and disconnect hose from bleeder adapter on master cylinder.

l. Remove bleeder tank and hose.

m. Remove bleeder adapter from tee (31) and replace plug (32).

n. Start engine and pump brake pedal several times until approximately full pedal is obtained.

o. Release brake pedal.

7-13. MANUALLY BLEEDING BRAKE SYSTEM.

a. Connect end of bleeder hose to bleed valve on wheel cylinder. Submerge other end in jar partially filled with clean brake fluid.

b. Open bleed valve on wheel cylinder and allow fluid to flow into jar while pumping brake pedal, until a solid stream, free of bubbles, is acquired. Close bleeder valve.

c. Repeat a. and b. at each wheel.

d. Remove master cylinder reservoir caps and check fluid level. Add brake fluid as required.

e. Approximately full pedal should be obtained, otherwise repeat the above procedure.

SECTION 8

HYDRAULIC SYSTEM MAINTENANCE INSTRUCTIONS

8-1. TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. No oil flows in hydraulic system.	a. Low oil level.	a. Fill reservoir with MIL-L-2104, SAE 10.
	b. Pump coupling or shaft sheared or disengaged.	b. Properly engage the pump drive. If drive or coupling is damaged or sheared, remove and repair or replace as necessary.
	c. Reservoir-to-pump supply line broken or restricted. Air entering at suction lines. Pump not priming.	c. Clean, repair, or replace line as necessary. Check all lines for security, suction lines for cracks, and proper attachment. Tighten, repair, or replace components as necessary.
	d. Internal contamination.	d. Repair or replace pump. Drain, flush, and refill system with recommended oil (para. 8-32).
2. Excessive pressure buildup.	a. System relief valve set too high.	a. Use adequate pressure gauge and adjust system relief valve as necessary (para. 8-32).
	b. Restricted pump-to-control valve supply line.	b. Clean, repair, or replace line as necessary.
3. Pump noise. Accompanied by oil foaming in reservoir.	a. Air entering at suction lines. Low oil level.	a. Check all lines for security and proper attachment. Tighten repair, or replace components as necessary. Ensure that oil level in reservoir is adequate. Fill to HIGH mark on sight gage.
	b. Excessive engine rpm.	b. Regulate engine speed.
4. Sticking control valve Spool.	a. Excessively high oil temperature.	a. Eliminate any restriction in pipe line or filtering system.
	b. Dirt in oil.	b. Change oil and flush system (para. 8-4).
	c. Pipe fittings too tight.	c. Check torque. Retorque as necessary.
	d. Valve warped from mounting.	d. Loosen valve and check.
	e. Excessively high pressure in valve. (Relief valve not working properly).	e. Check pressure at inlet and at working ports (para. 8-13).

SYMPTOM	PROBABLE CAUSE	SOLUTION
	f. Handle or linkage binding.	f. Free linkage.
	g. Spring or valve cap binding.	g. Loosen cap and retighten (para. 8-13).
5. Leaking control valve seals.	a. Paint or dirt on or under seal.	a. Remove and clean, as necessary.
	b. Excessive back pressure.	b. Open line to reservoir.
	c. Scored spool.	c. Replace valve (para. 8-13).
	d. Cut or scored seal.	d. Replace faulty parts (para. 8-13).
6. Unable to move control valve Spool in or out.	a. Dirt in valve.	a. Clean and flush out valve assembly (para. 8-13).
	b. Spool cap full of oil.	b. Replace seals (para. 8-13).
	c. Bind in linkage.	c. Free linkage.
7. Poor hydraulic system performance or failure.	a. Damaged pump.	a. Repair or replace pump (para. 8-32).
	b. Dirt in relief valve.	b. Disassemble and clean relief valve (para. 8-32).
	c. Relief valve damaged.	c. Replace relief valve (para. 8-32).
	d. Worn cylinder(s) or motor(s).	d. Repair or replace damaged components.
	e. Load too heavy.	e. Reduce load. (Refer to load chart for rated capacities).
	f. Internal valve crack.	f. Replace valve (para. 8-13).
	g. Spool not at full stroke.	g. Check movement and linkage (para. 8-13).
	h. Oil low in reservoir.	h. Add oil, Fill to FULL mark on sight gage.
	i. System filter clogged.	i. Clean or replace filter element (para. 8-8).
	j. Line restricted.	j. Check lines. Clean or repair as necessary.

8-2. HYDRAULIC SCHEMATIC.

8-3. The complete hydraulic system schematic of the SCAMP is shown in figure 8-1. A U.S.A.S.I. Graphical Symbols chart is provided for interpretation of the schematic.

8-4. DRAINING AND FLUSHING.

8-5. If a component has been changed because of a failure that might allow metal or abrasive particles to enter the system, all systems must be thoroughly checked, drained, and flushed.

a. Remove reservoir drain plug. Allow approximately three minutes, after oil stops flowing from drain port, for side walls to drain.

b. Clean and install reservoir plug and fill reservoir with a 50-50 mixture of fuel oil and clean oil MIL-L-2104 SAE 10.

c. Cycle crane through all functions several times then return crane to its stowed position and turn front and rear wheels to extreme left. Shut down engine.

d. Remove reservoir drain plug and drain reservoir. Clean and install drain plug and fill reservoir with clean oil MIL-L-2104 SAE 10.

CAUTION

Oil supply lines must be connected to the cylinders when flushing the system.

NOTE

Draining the various components will be facilitated by connecting a drain line in place of the disconnected return line.

e. Disconnect return line from lift cylinder and raise boom to maximum elevation.

f. Connect cylinder return line and lower boom to its stowed position. Replenish reservoir oil level as required.

g. Disconnect return line from an outrigger cylinder and fully extend outrigger.

h. Connect outrigger return line and retract outrigger. Replenish reservoir oil level as necessary.

i. Repeat steps g and h for three remaining outriggers.

j. Disconnect return line from telescope cylinder and fully extend boom.

k. Connect return line and retract boom. Replenish reservoir oil level as necessary.

L Disconnect return line from front steer cylinder and turn front wheels to extreme right.

m. Connect return line and turn front wheels to extreme left and then back to center. Replenish reservoir oil level as necessary.

n. Disconnect return line from rear steer cylinder and turn rear wheels to extreme right.

o. Connect return line and turn rear wheels to extreme left and then back to center. Replenish reservoir oil level as necessary.

8-4. FILLING HYDRAULIC RESERVOIR.

8-5. After filling hydraulic reservor with oil MIL-L-2104 SAE 10, operate system for a brief period and recheck oil level. Reservoir capacity is 40 gallons (151 liters). The crane must be in the travel mode with all cylinders retracted when fresh oil is added to reservoir. Fill reservoir to FULL mark on sight gage. After reservoir is filled, operate all circuits and recheck sight gage.

8-6. REMOVING AIR FROM HYDRAULIC SYSTEM.

8-7. Air entering the hydraulic oil will normally be removed automatically by passage of the oil over the baffles in the hydraulic reservoir. However, if a component has been replaced, the reservoir level is too low, or a leak develops in the suction lines to the pumps, air can enter the system. Noisy operation of the swing motor and hoist motor can indicate trapped air in the hydraulic oil. First, check the hydraulic oil level in reservoir. Second, trapped air in the cylinders can be removed by cycling the cylinder several times. Then, inspect the suction lines for leaks. Check for leaks as follows

a. Seal all normal openings in hydraulic system and reservoir.

b. Pressurize hydraulic system from 2 to 4 psi using pressure regulator.

c. Apply soap solution to fittings and joints and check for minute leaks.

d. Relieve hydraulic system pressure.

WARNING

Do not loosen fittings in pressurized lines or while hydraulic pumps are in operation.

Use extreme care when removing plugs or restrictions in hydraulic lines suspected of having trapped air that might be pressurized.

e. Replace defective component(s).

f. Open all normal openings (vents, etc.).

LINES AND LINE FUNCTIONS	
LINE, WORKING	
LINE, PILOT	
LINE, DRAIN	
CONNECTOR	
LINE, FLEXIBLE	
LINES JOINING	
LINES PASSING	
DIRECTION OF FLOW	
LINE TO RESERVOIR ABOVE FLUID LEVEL	
BELOW FLUID LEVEL	
LINE TO VENTED MANIFOLD	
PLUG OR PLUGGED CONNECTION	
RESTRICTION, FIXED	
RESTRICTION, VARIABLE	
PUMPS	
SINGLE, FIXED DISPLACEMENT	
SINGLE, VARIABLE DISPLACEMENT	
ACTUATORS	
MOTOR, FIXED DISPLACEMENT REVERSIBLE	
MOTOR, FIXED DISPLACEMENT NON-REVERSIBLE	
MOTOR, VARIABLE DISPLACEMENT, REVERSIBLE	

CYLINDER - SINGLE ACTING	
CYLINDER - DOUBLE ACTING DIFFERENTIAL	
NON-DIFFERENTIAL	
VALVES	
CHECK	
ON-OFF (MANUAL SHUT-OFF)	
PRESSURE RELIEF	
PRESSURE REDUCING	
FLOW CONTROL, ADJUSTABLE - NON-COMPENSATED	
FLOW CONTROL ADJUSTABLE (TEMPERATURE AND PRESSURE COMPENSATED)	
TWO POSITION TWO CONNECTION	
TWO POSITION THREE CONNECTION	
TWO POSITION FOUR CONNECTION	
THREE POSITION FOUR CONNECTION	
TWO POSITION IN TRANSITION	
VALVES CAPABLE OF INFINITE POSITIONING (HORIZONTAL BARS INDICATE INFINITE POSITIONING ABILITY)	

METHODS OF OPERATION	
SPRING	
MANUAL	
PUSH BUTTON	
PUSH-PULL LEVER	
PEDAL OR TREADLE	
MECHANICAL	
DETENT	
PRESSURE COMPENSATED	
SOLENOID,SINGLE WINDING	
REVERSING MOTOR	
PILOT PRESSURE REMOTE SUPPLY	
INTERNAL SUPPLY	

MISCELLANEOUS	
ROTATING SHAFT	
ENCLOSURE	
RESERVOIR VENTED	
PRESSURIZED	
PRESSURE GAUGE	
ELECTRIC MOTOR	
ACCUMULATOR, SPRING LOADED	
ACCUMULATOR, GAS CHARGED	
HEATER	
COOLER	
TEMPERATURE CONTROLLER	
FILTER, STRAINER	

Table 8-1. U.S.A.S.I. Graphical Symbols

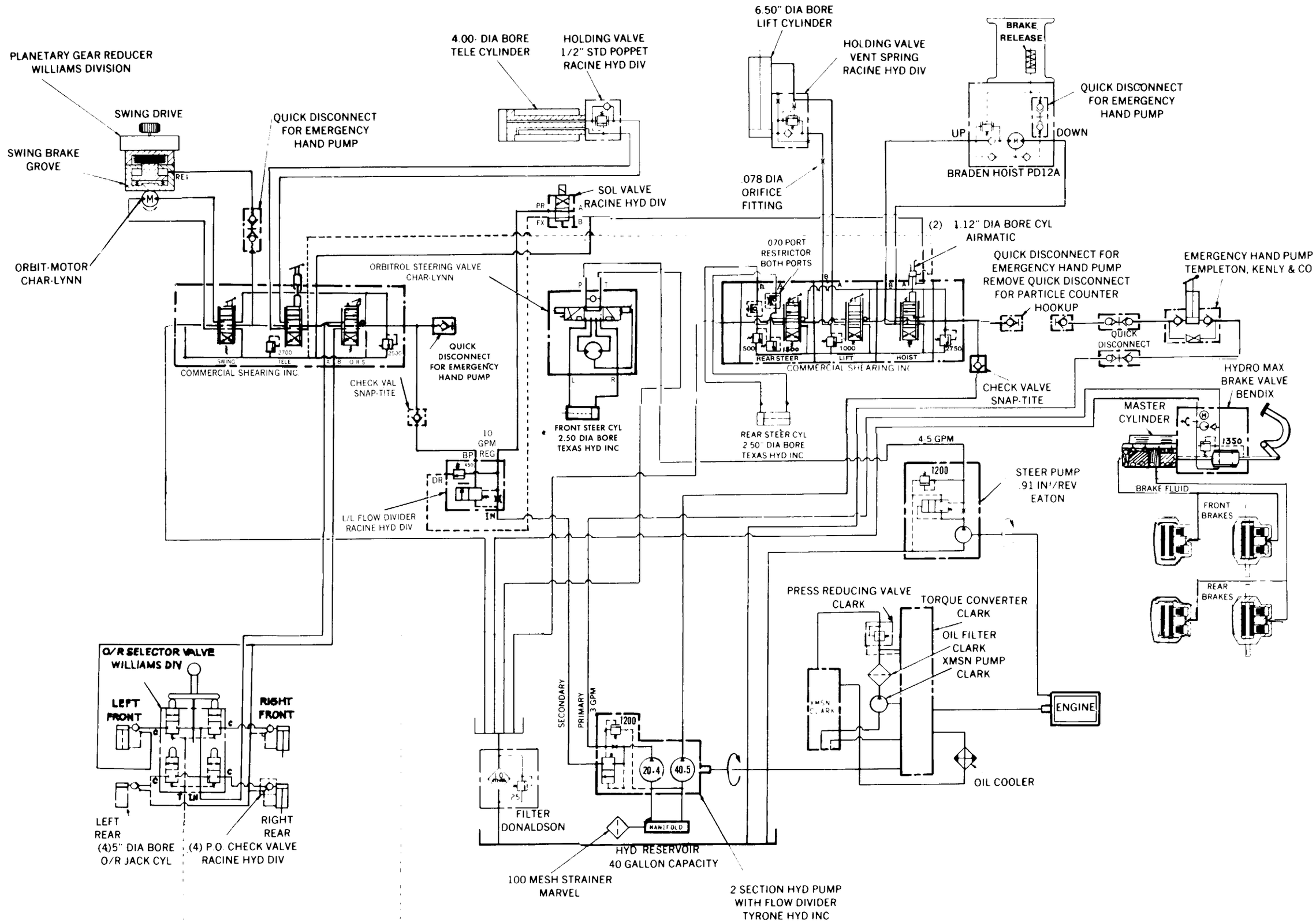


Figure 8-1. Hydraulic System Schematic

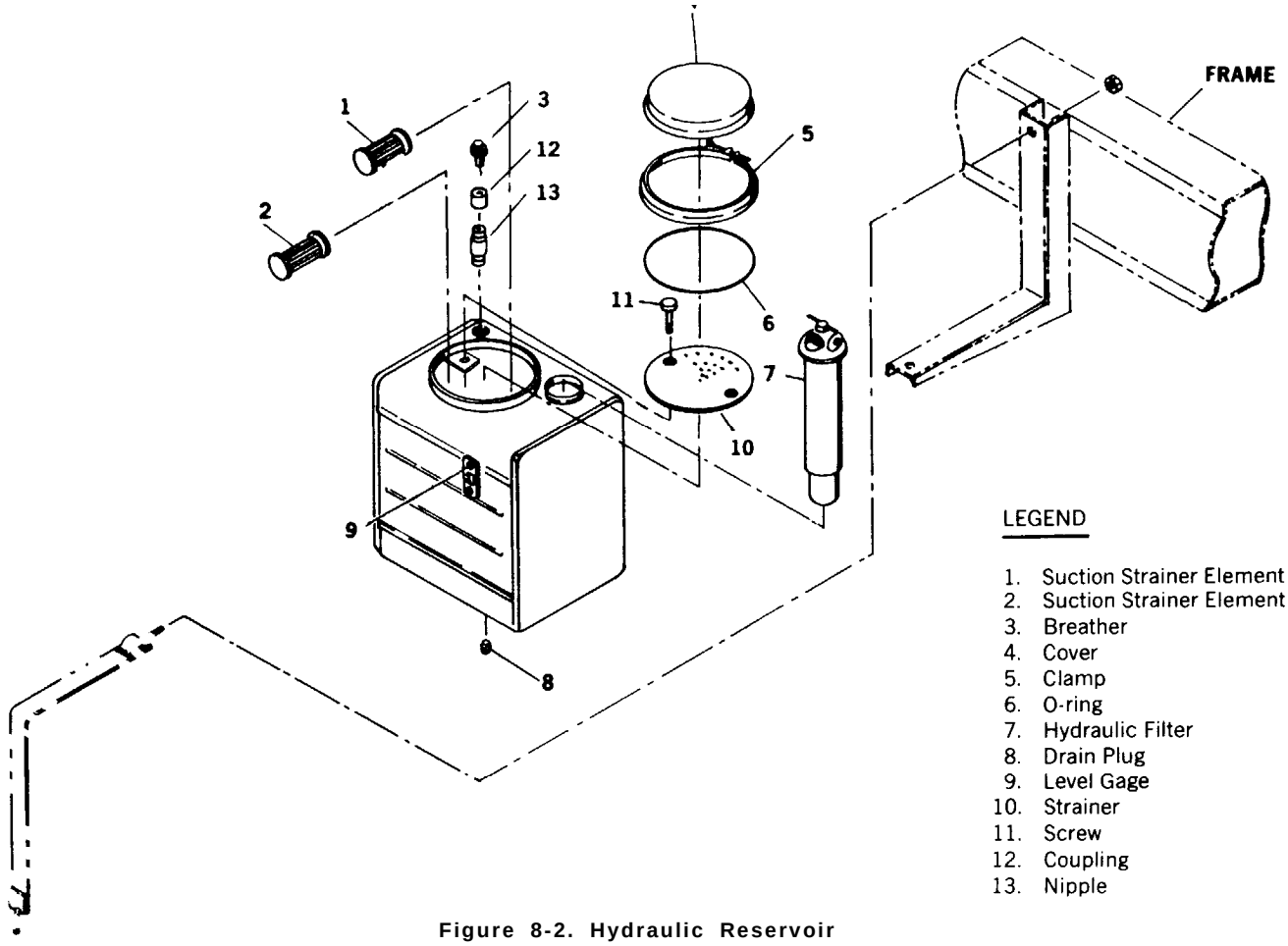


Figure 8-2. Hydraulic Reservoir

g. Fill hydraulic reservoir with clean oil MIL-L-2104 SAE 10.

h. Operate all hydraulic circuits several times in both directions.

8-8. HYDRAULIC FILTER AND STRAINERS.

8-9. REMOVAL AND DISASSEMBLY.

WARNING

Ensure that all hydraulic systems are shut-down and pressure is relieved.

a. Shut down engine.

b. Wipe dirt around cover (4, figure 8-2). Loosen clamp (5) and remove cover (4) and strainer (10).

c. Remove strainer elements (1 and 2) by hand.

d. Wipe dirt off filter housing (7).

e. Open bleed valve (7, figure 8-3).

f. Remove nut (3) and head (2).

g. Remove bypass valve (9) and baffle (11).

h. Remove element (13).

8-10 CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

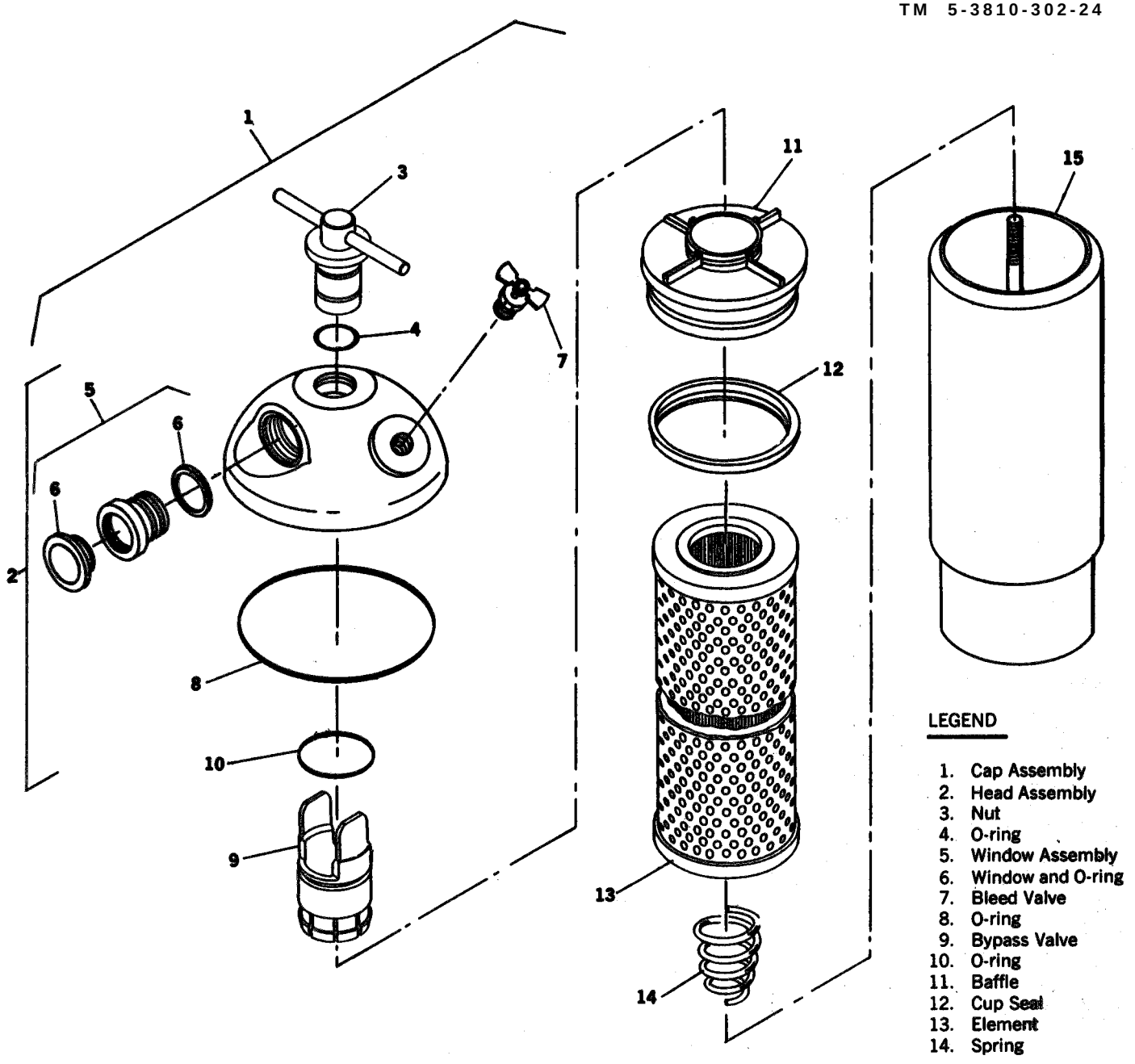


Figure 8-3. Hydraulic Filter Assembly

b. Soak strainers (1 and 2, figure 8-2) in solvent P-D-680 for 30 minutes. Brush with soft bristle (not steel) brush. Rinse strainers in clean solvent and drip dry on rack. Air dry from inside out with low pressure air. Inspect strainers for damage.

c. Discard element (13, figure 8-3) and all O-rings.

d. Inspect window assembly (5) for damage.

e. Inspect cup seal (12) for damage.

8-11. REPAIR.

a. Repair shall be limited to the replacement of all defective parts.

8-12. ASSEMBLY AND INSTALLATION.

a. Install element (13, figure 8-3), baffle (11) with cup seal (12), bypass valve (9), and O-ring (10).

b. Install head (2) with O-ring (8). Make sure that indicator ears on bypass valve (9) appear in window assembly (5).

Table 8-2. Valve Usage Table

Valve	Circuit	Physical Location
A20 Valve Bank	Outrigger Telescope Swing	Valve Compartment. (under Dash)
A36 Valve Bank	Hoist Boom Lift Rear Steer	Valve Compartment. (Under Dash)
Outrigger Selector Valve	Outrigger	Right of Seat in Cab.
Holding Valves	Outrigger Boom Lift Telescope Hoist	Lift Cylinder, Port Block Telescope Cylinder, Port Block Hoist Motor

c. Install nut (3) and tighten fingertight.

d. Close bleed valve (7).

e. Install clean strainer elements (1 and 2, figure 8-2) and strainer (10).

f. Install hydraulic reservoir cover (4) with O-ring (6). Tighten clamp (5).

g. Start engine and check hydraulic filter for leaks.

8-13. CONTROL VALVES A20 AND A36.

8-14. REMOVAL AND DISASSEMBLY.

a. Remove front panel.

b. Remove cotter pins, washers, and clevis pins that attach mechanical linkage to valve bank. Refer to table 8-2 for valve usage.

c. Tag and disconnect hydraulic hoses to valve bank. Cap all hoses and plug ports in valve bank.

d. Match mark valve sections to aid in assembly. Remove capscrews and lockwashers that secure valve bank. Remove valve bank.

CAUTION

Use care when handling valve bank to avoid damage to faces and O-ring grooves.

e. Remove nuts (21, figure 8-4) and separate valve sections. Remove and discard O-rings (11, 12, 17, and 19).

f. Remove relief valves (7, 20) only if necessary.

g. Remove capscrews (1), cap (2), and spool (15).

h. If necessary, remove stripper bolt (3), spring guides (4), spring (5), retaining plate (6), back-up ring (8), and ring seal (9 and 16).

8-15. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Inspect mating surfaces of valve sections for nicks and burrs.

8-16. REPAIR.

a. Repair shall be limited to the replacement of all worn components. Replace O-rings and seals with applicable seal kit.

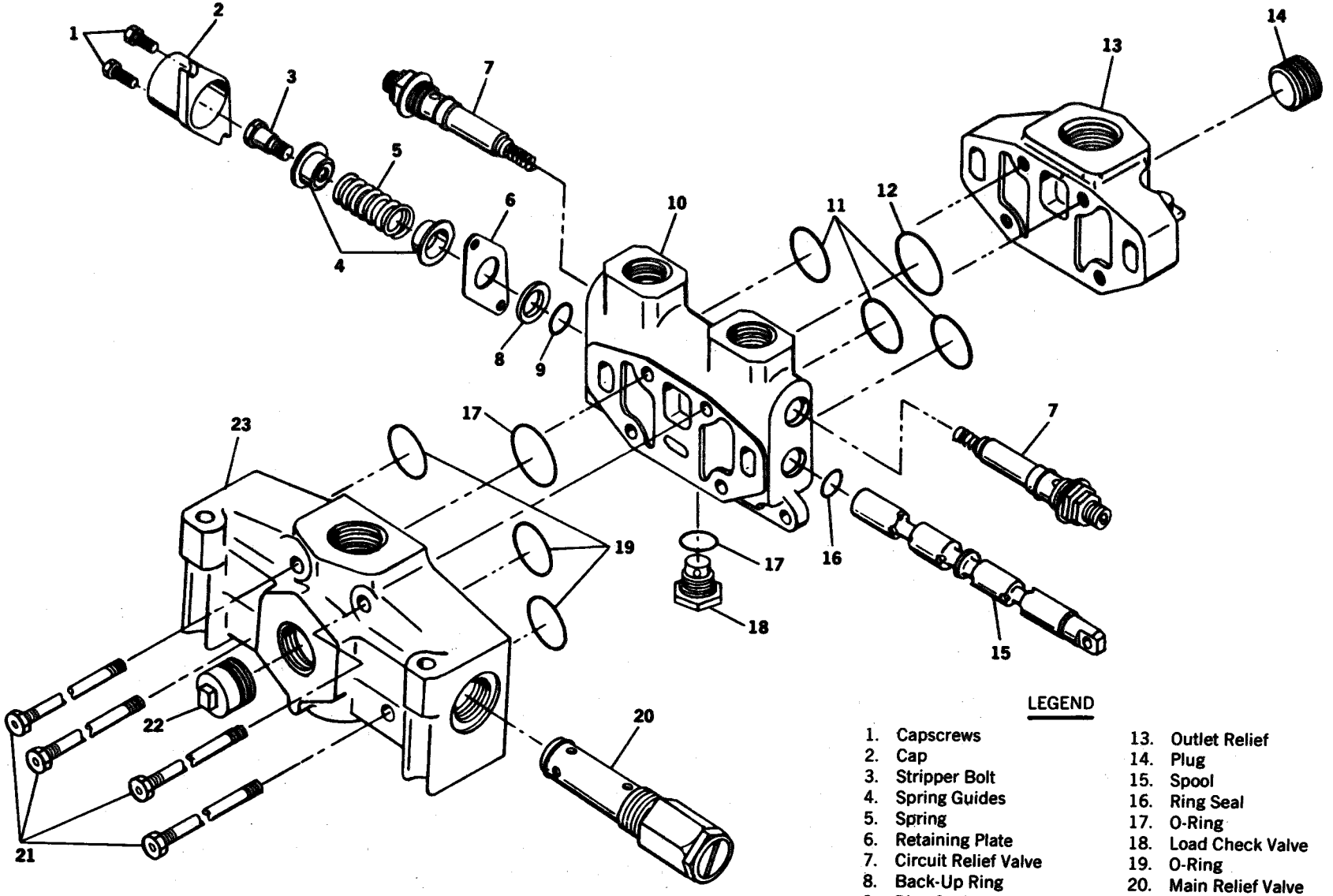
8-17. ASSEMBLY AND INSTALLATION.

a. Position spring guides (4, figure 8-4) on spring (5) and place spring on spool (15). Install stripper bolt (3).

b. Position back-up ring (8) and retaining ring (6) against spring (5).

c. Install ring seals (9 and 16) in spool bore of housing (10).

d. Install assembled spool (15), position cap (2), and install capscrews (1).



LEGEND

1. Capscrews
2. Cap
3. Stripper Bolt
4. Spring Guides
5. Spring
6. Retaining Plate
7. Circuit Relief Valve
8. Back-Up Ring
9. Ring Seal
10. Housing
11. O-Ring
12. O-Ring
13. Outlet Relief
14. Plug
15. Spool
16. Ring Seal
17. O-Ring
18. Load Check Valve
19. O-Ring
20. Main Relief Valve
21. Nuts and Studs
22. Plug
23. Inlet Section

Figure 8-4. Hydraulic Control Valve

e. Coat new O-rings (11, 12, 17, and 19) with light coat grease to hold O-rings in place.

CAUTION

A pinched O-ring will cause leakage between sections and spool binding.

f. Install O-rings (11, 12, 17, and 19) in grooves of inlet, outlet, and intermediate valve sections.

g. Carefully stack valve sections together aligning match marks.

h. Install nuts (21). Do not torque nuts.

i. Install assembled main relief valve (20) if removed.

j. Install relief valves (7) if removed.

k. Torque nuts (21) to 350 inch-pounds (403.2kgcm) for A20 valve bank or 400 inch-pounds (460.8 kgcm) for A-36 valve bank.

l. Actuate spool (15) to ensure free movement.

m. Position valve bank on mounting plate and install capscrews and lockwashers.

n. Remove plugs in valve bank ports and caps on hydraulic hoses. Remove tags and install hydraulic hoses to valve bank.

o. install clevis pins and cotter pins to connect mechanical linkage.

p. Start engine and operate affected circuit(s). Check for smooth operation of cylinders and motors. Inspect valve bank and fittings for leaks.

8-18. OUTRIGGER SELECTOR VALVES.

8-19. REMOVAL AND DISASSEMBLY.

a. Tag and disconnect hydraulic hoses at outrigger selector valve. Cap hydraulic lines and plug ports on valve.

b. Remove nuts, (1, figure 8-5) lockwashers (2), and capscrews (3) that secure outrigger selector valve to seat plate. Remove valve.

c. Thoroughly clean outrigger selector valve and move to clean work area.

d. Clamp outrigger selector valve in vise with selector rod (4) up.

e. Remove knob (5) and capscrews (6).

WARNING

Mounting plate (10) compresses spring loaded spools (14) under 30 pounds (13 kg) force).

f. While applying steady pressure on mounting plate (10), release spring pressure by slowly and evenly loosening capscrews (11). Remove capscrews (11). Remove locknut (24) from rod (4) and remove cap (9). Remove boot (8), mounting plate (10) and rod (4).

g. Remove swivel ball (13) and spools (14). Remove and discard O-rings (15).

h. Remove selector control valve from vise and lay it on its side.

i. Remove spacers (16) and springs (17).

j. Remove capscrews (18), lockwashers (19), and bottom plate (20).

8-20. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Inspect springs (17, figure 8-5) for damage.

c. Inspect spools (14) for scratches and burrs.

8-21. REPAIR.

a. Repair shall be limited to the replacement of all seals and damaged components.

8-22. ASSEMBLY AND INSTALLATION.

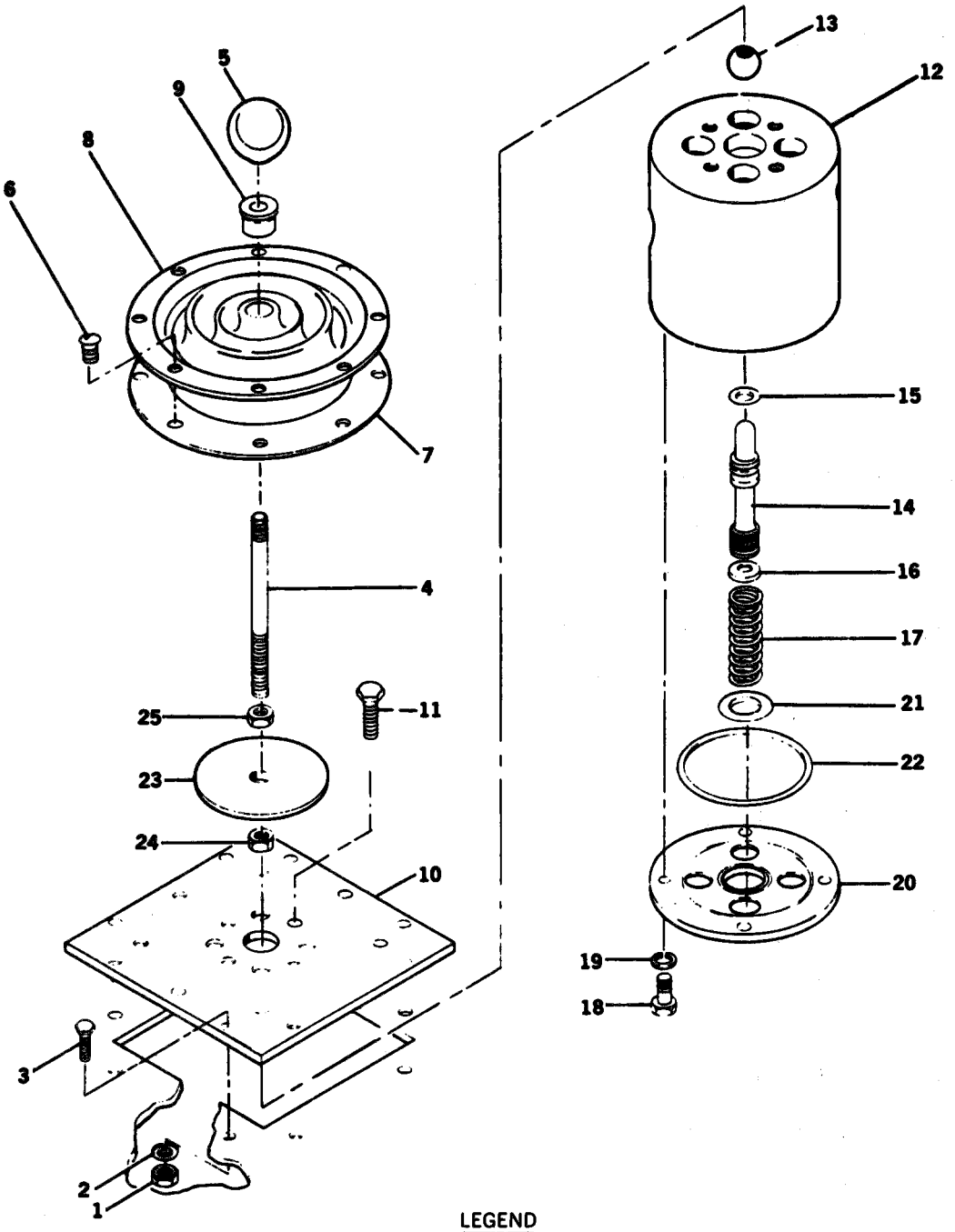
a. Lubricate O-rings with clean oil MIL-L-2104 SAE 10.

b. Install O-rings (21 and 22, figure 8-5), on bottom plate (20).

c. With outrigger selector control lying on its side, install bottom plate (20) to housing (12) with capscrews (18) and lockwashers (19).

d. Mount assembly in a vise with bottom plate down.

e. Insert springs (17) and spring spacers (16) in spool housings.



LEGEND

1. Nut
2. Lockwasher
3. Capscrew
4. Selector Rod
5. Knob
6. Capscrew
7. Seal Ring
8. Boot
9. Cap
10. Mounting Plate
11. Capscrews
12. Housing
13. Swivel Ball
14. Spool
15. O-Ring
16. Spacer
17. Spring
18. Capscrews
19. Lockwasher
20. Bottom Plate
21. O-Ring
22. O-Ring
23. Actuator
24. Locknut
25. Locknut

Figure 8-5. Outrigger Selector Valve

Table 8-3. Circuit Relief Settings

Valve Bank	Circuit	Circuit Relief Psi (kPa/bar)	Main Relief Psi (kPa/bar)
A20	Swing	——	2500 (17,238/172.38)
	Outrigger	——	2500 (17,238/172.38)
	Telescope	2700 (18,617/186.17)	2500 (17,238/172.38)
A36	Rear Steer	1500 (10,342/103.42)	2750 (18,962/189.62)
	Boom Lift	1000 (6895/68.95)	2750 (18,962/189.62)
	Hoist	——	2750 (18,962/189.62)
——	Front Steering	1500 (10,342/103.42)	——

f. Install O-rings (15) on spools (14) and insert four spools (14) into position.

g. If necessary, assemble actuator (23) by attaching upper locknut (25) first. Position actuator (23) flush with upper locknut (25) and then attach lower locknut (24). Bottom of actuator (23) should just barely touch top of four spools (14).

h. Insert selector rod (4) through mounting plate (10) and attach swivel ball (13) to selector rod.

i. Install mounting plate (10) with spool (14) ends protruding through corresponding mounting plate (10) holes.

j. Using firm downward pressure on mounting plate (10), install capscrews (11).

NOTE

Ensure the actuator (23) is just touching the tops of the spools (14).

k. Slide rubber boot (8) over selector rod (4).

l. Install boot seal ring (7) and capscrews (6).

m. Attach selector rod knob (5) to selector rod (4).

n. Install selector control valve to seat support plate with capscrews (3), lockwashers (2), and nuts (1).

o. Remove tags, caps, and plugs and install hoses and fittings to selector valve as tagged prior to removal.

p. Start engine and check outrigger selector valve for proper operation and leakage.

8-23. RELIEF VALVES.

8-24. GENERAL.

The following tests ensure correct main and circuit relief valve settings. Adjustment is required if any pressure setting is not within ±100 psi (±689.5 kPa/6.8 bar) of the setting listed in table 8-3, Circuit Relief Settings.

a. Start engine and warm up until hydraulic oil reaches minimum of 70 degrees F (21.1C).

b. Turn adjustment screw in to increase or out to decrease relief valve setting.

CAUTION

Do not hold the relief valve open for more than one minute at a time.

c. Release control lever after each reading and while making adjustments.

CAUTION

Do not overtighten the adjustment screw or locknut.

d. Tighten locknut after attaining proper pressure setting.

e. Recheck relief valve setting.

NOTE

An accurate O to 5000 psi (O to 34,475 kPa/344.75 bar) pressure gage should be used when adjusting relief valves. Quick disconnect pressure test ports are located in the inlet line at each valve bank.

8-25. MAIN AND CIRCUIT RELIEF VALVE PRESSURE SETTINGS.

8-26. A20 Valve Bank Main Relief Valve Setting.

a. Install pressure gage in quick disconnect fitting at inlet to valve bank.

b. Set throttle to 2400 rpm.

c. Fully extend outriggers lifting crane off ground and hold momentarily. Note maximum reading on pressure gage.

d. Adjust main relief valve (on inlet section) if maximum reading is not 2500 psi (17,238 kPa/172.38 bar) ±100 psi (±689.5 kPai/6.8 bar).

e. Retract outriggers and remove pressure gage.

8-27. A36 Valve Bank Main Relief Valve Setting.

a. Install pressure gage in quick disconnect fitting at inlet to valve bank.

b. Set throttle to 2400 rpm.

c. Lower boom until lift cylinder bottoms and hold momentarily. Note maximum reading on pressure gage.

d. Adjust main relief valve (on inlet section) if maximum reading is not 2750 psi (18,962 kPai/189.62 bar) +100 psi (+689.5 kPa/6.8 bar).

e. Shut down engine. Remove pressure gage and install pipe plug.

8-28. Telescope - Retract.

NOTE

Telescope extend mode uses the valve bank main relief valve.

a. Tag and disconnect the telescope cylinder retract line at port block.

b. Install tee in the line. Install pressure gage in tee.

c. Connect Port-O-Power to tee. Port-O-Power should be capable of delivering 10 gpm and 3000 psi (20,686 kPa/206.86 bar).

d. Activate Port-O-Power and note maximum reading on pressure gage.

e. Adjust relief valve if maximum reading is not 2700 psi (18,617 kPa/186.17 bar) +100 psi (+689 kPa/6.89 bar).

f. Disconnect Port-O-Power and pressure gage. Remove tee and connect retract line to port block.

8-29. Rear Steer Circuit Relief Valve Setting.

a. Install pressure gage in quick disconnect fitting at inlet to A36 valve bank.

b. Lower outriggers until wheels are off ground.

c. Set throttle to 1000 rpm.

d. Steer rear wheels fully left. Note maximum reading on pressure gage.

e. Adjust relief valve if maximum reading is not 1500 psi (10,342 kPa/103.42 bar) ±100 psi (±689 kPa/6.89 bar).

f. Raise outriggers.

g. Shutdown crane. Remove pressure gage.

8-30. Boom Lift - Retract Circuit Relief Valve Setting.

NOTE

Lift raise uses the valve bank main relief valve.

a. Install pressure gage in quick disconnect fitting at inlet to A36 valve bank.

b. Set throttle to 1000 rpm.

c. Move BOOM control lever to DOWN and hold momentarily. Note maximum reading on pressure gage.

d. Adjust relief valve if maximum reading is not 1000 psi (6895 kPa/68.95 bar) ±100 psi (689 kPa/6.89 bar).

e. Shutdown crane. Remove pressure gage.

8-31. Front Steer.

a. Disconnect one hose from front steer cylinder. Install pressure gage in this hose.

b. Set the throttle to 1200 rpm.

c. Turn steering wheel in direction that will pressurize this hose. Continue turning to end of its travel and hold it momentarily. Note the maximum reading on the pressure gage.

d. Adjust relief valve (in steer pump) if maximum reading is not 1200 psi (8274 kPa/82.74 bar).

e. Shut down crane. Remove pressure gage and reconnect hose to steer cylinder.

8-32. 2-SECTION HYDRAULIC PUMP

8-33. REMOVAL AND DISASSEMBLY.

a. Disconnect batteries at negative terminal.

b. Tag and disconnect hydraulic lines to pump assembly.

WARNING

The 2-Section Pump (Figure 8-6) weighs 29 pounds. Exercise caution when removing the pump assembly.

c. Support weight of pump assembly and remove capscrews and washers that secure pump to converter housing. Remove pump assembly with care to avoid damage to splines on pump drive shaft.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

d. Clean outside of pump assembly with solvent and brush.

e. Match mark flange (5, figure 8-6), gear plate (10), connector plate (11), gear plate (17), and cover plate (18) to aid in assembly.

f. Place pump assembly in machinist vise. Protect pump surfaces with wood blocks between pump and vise jaws.

g. Remove allenuts (45). Remove pump assembly from vice.

NOTE

Keep parts from each pump section in separate groups.

h. Use plastic mallet to tap connector bosses and remove cover plate (18).

i. Remove and discard O-ring (8), O-ring (22), and back-up ring (21).

j. Remove pressure plate (23). Remove and discard O-rings (15).

k. Slide idler gear (16) and drive gear (20) straight up and out of gear plate (17).

1. Remove pressure plate (23). Work pressure plate (23) gently back and forth until it will slide out freely. Remove and discard O-rings (15).

m. Remove gear plate (17). If necessary, loosen with plastic mallet.

n. Remove and discard O-ring (8), O-ring (22) and back-up ring (21).

o. Remove connector plate (11). If necessary, use plastic mallet to free connector plate (11).

p. Remove spline coupling (26) with snap ring (14). Remove and discard O-rings (25).

q. Remove and discard O-ring (8), O-ring (22), and back-up ring (21) from gear plate (10).

r. Remove pressure plate (27). Remove and discard O-rings (9).

s. Remove idler gear (4) and drive gear (1).

t. Tap edges of gear plate (10) with plastic mallet. Separate gear plate (10) and flange (5). Remove pressure plate (27). Remove and discard O-rings (9).

u. Remove and discard O-ring (8), O-ring (22), and back-up ring (21).

v. If necessary, remove studs (46).

w. If necessary, remove snap ring (2) and seal (3). Remove seal as follows:

1. Place flange (5) in machinist vice with cardboard between jaws of vise and flange.

2. Drive seal (3) out with punch. Hold punch against seal but away from bearing. Do not allow punch to rest against seal bore or bearing.

NOTE

It is not necessary to disassemble the pump to replace the shaft seal only.

8-34. CLEANING AND INSPECTION

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Avoid breathing in fumes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with a clean cloth dipped in cleaning solvent PD-680.

b. Wipe residue with clean cloth.

c. Dry thoroughly.

d. Inspect gear plates (10 and 17, figure 8-6) for wear and cracks. Check milled groove in center of plates. Nominal depth of this cut is .008 inch. If cut is deeper than .015 inch, replace gear plate(s).

e. Inspect gears (1, 4, 16, and 20) for excessive wear and damaged splines. Replace drive and idler gears in matched sets.

f. Inspect pressure plates (23 and 27) for wear and deep curved marks.

g. Inspect all bushings for wear.

8-35. REPAIR.

a. Repair shall be limited to the replacement of all worn or damage parts.

b. Replace Q-rings and back-up rings prior to asssembly.

8-36. ASSEMBLY.

a. Install seal (3, figure 8-6) with an arbor press. Apply three drops of #290 locktite at outer diameter of seal. Rotate flange (5) until locktite runs around o.d. of seal.

b. Install snap ring (2) and remove excess locktite.

c. Lay two pieces of wood (2 x 4 x 8 inches) on workbench parallel to each other with 4 inch dimension vertical to bench.

d. Position flange (5) on blocks with O-ring groove facing up and match mark facing toward you.

NOTE

Apply a very thin coat of clean heavy grease to all O-rings and back-up rings.

f. If necessary, install dowels (24) in gear plate (10) with dowel guide and press.

g. Install gear plate (10) with its cast recesses facing up and match mark aligned with mark on flange (5). Tap gear plate (10) with plastic mallet until it rests on O-ring in flange (5).

h. Install O-rings (9) in pressure plate (27). With small oblong hole in pressure plate (27) facing discharge side of gear plate (10) and bronze side facing up, slide pressure plate (27) down gear bores until it rests against O-ring (22) and back-up ring (21).

i. Coat splines of drive gear (1) with clean heavy grease. Install drive gear (1) in bore nearest match mark.

j. Install idler gear (4) in opposite bore.

k. Install O-rings (9) in pressure plate (27). Install pressure plate (27) with small oblong hole facing discharge side and bronze side of plate down against gear faces.

l. Install studs (46) if previously removed.

m. Install O-ring (8), O-ring (22), and back-up ring (21) in side of connector plate (11) which has a cast hole extending only part way through.

n. Install connector plate (11) with side with O-rings installed face down on gear plate (10). Align match marks and slide connector plate (11) down until it contacts dowels.

o. Install spline coupling (26) with snap ring (14). Check position of O-rings (8 and 22) and back-up ring (21).

p. Push connector plate (11) down with hand pressure until O-ring (8) is firmly seated against gear plate (lo).

q. Install an O-ring (25) in each dowel bore of connector plate (11). Install new O-ring (8), O-ring (22), and back-up ring (21).

r. If necessary, install dowels (24) in gear plate (17) with dowel guide and press.

s. Install gear plate (17) with its cast recesses facing up and match mark a!igned with match mark on connector plate (11). Tap gear plate (17) with plastic mallet until it rests on O-ring (8).

t. Install O-rings (15) in pressure plate (23). With small oblong hole in pressure plate (23) facing discharge side of gear plate (17) and bronze side up, slide pressure plate (23) down gear bores until it rests against O-ring (22) and back-up ring (21).

u. Install drive gear (20) in bore nearest match mark, Ensure that gear spline engages spline coupling (26).

v. Install idler gear (16) in opposite bore.

w. Install O-rings (15) in pressure plate (23). Install pressure plate (23) with small oblong hole facing discharge side of gear plate (17) and bronze side of pressure plate (23) down against gear faces.

x. Install O-ring (8), O-ring (22), and back-up ring (21) in cover plate (18). Install cover plate (18). Use hand pressure to push cover plate (18) down until O-ring (8) makes contact with gear plate (17).

y. Coat studs with light oil. Install allenuts (45). Torque allenuts (45) to 80 foot pounds using a diagonally opposite sequence of tightening.

z. Use a 12-inch adjustable wrench to turn shaft. Shaft should turn with applied maximum torque of 25 foot pounds.

WARNING

The 2-Section Pump (figure 8-6), weighs 29 pounds,, Exercise caution when installing the pump assembly.

aa. Install pump assembly on converter housing. Install washers and capscrews. Torque capscrews to 75 foot pounds.

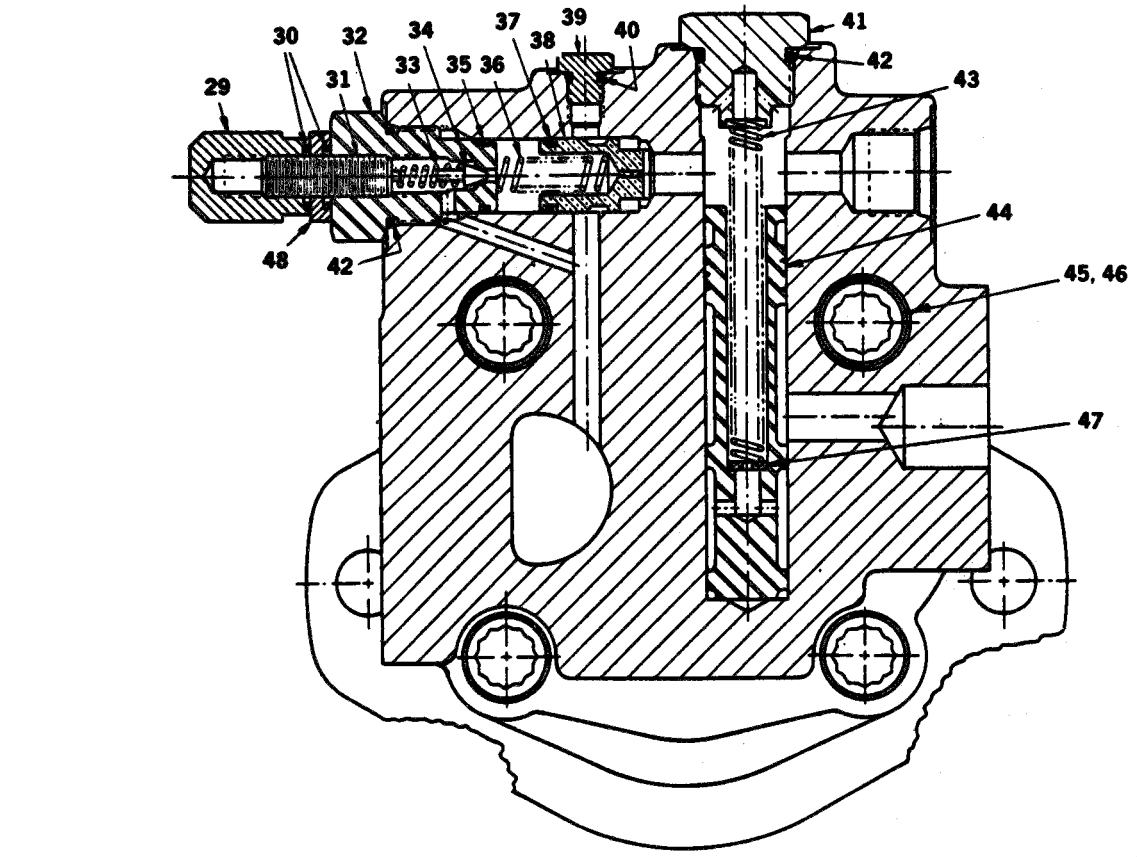
bb. Remove tags and install hydraulic lines to pump.

cc. Connect batteries at negative terminal.

dd. Start crane and check pump assembly for leaks and proper operation.

LEGEND

1 Drive Gear	25 O-Ring
2 Snap Ring	26 Spline Coupling
3 Seal	27 Pressure Plate
4 Idler Gear	28 Ball
5 Flange	29 Nut
6 Bushing	30 O-Ring
7 Bushing	31 Screw
8 O-Ring	32 Plug
9 O-Ring	33 Spring
10 Gear Plate	34 Cone
11 Connector Plate	35 O-Ring
12 Bushing	36 Spring
13 Bushing	37 Back-up Ring
14 Snap Ring	38 Spool
15 O-Ring	39 Plug
16 Idler Gear	40 O-Ring
17 Gear Plate	41 Plug
18 Cover Plate	42 O-Ring
19 Bushing	43 Spring
20 Drive Gear	44 Priority Spool
21 Back-up Ring	45 Allenut
22 O-Ring	46 Stud
23 Pressure Plate	47 Orifice
24 Dowel	48 Lock Nut



SECTION A-A

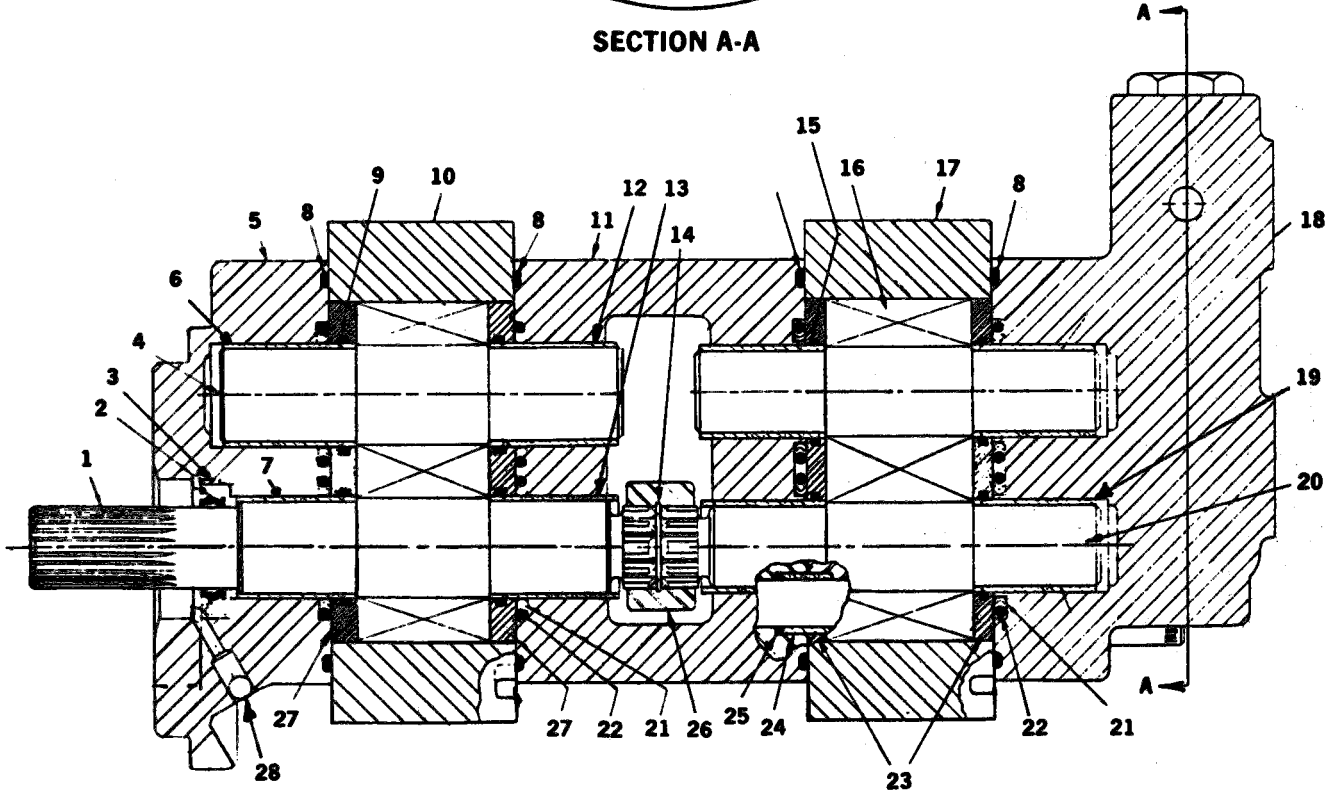
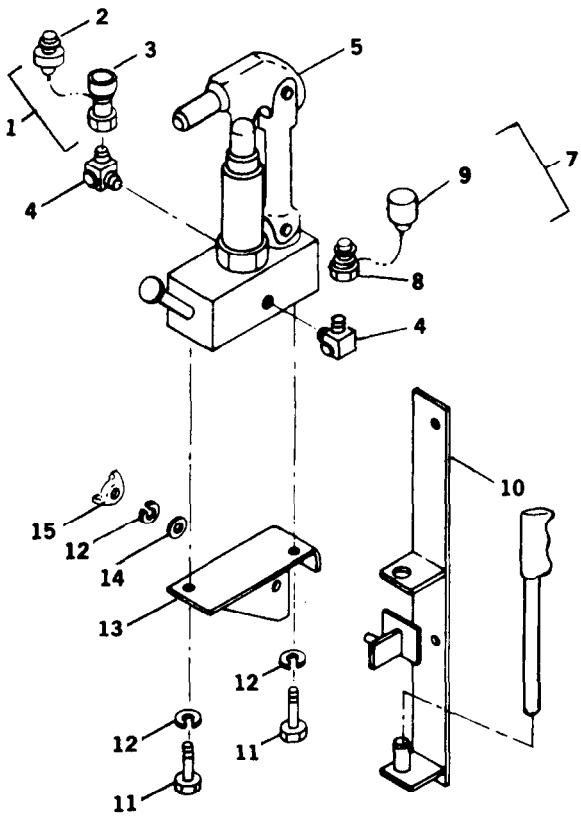


Figure 8-6. 2-Section Hydraulic Pump



LEGEND

1. Female Coupling
2. Dust Plug
3. Female Half
4. Elbow
5. Hand Pump
6. Not Used
7. Male Coupling
8. Male Half
9. Dust Cap
10. Bracket
11. Capscrew
12. Lockwasher
13. Bracket
14. Washer
15. Wingnut

Figure 8-7. Emergency Hand Pump

8-37. EMERGENCY HAND PUMP.

8-38. REMOVAL AND DISASSEMBLY.

NOTE

The emergency hand pump (figure 8-7) is stowed in the right side tool box.

a. Remove wing nut (15, figure 8-7), lockwasher (12), and washer (14).

b. Remove hand pump (5) and bracket (13).

c. Remove capscrews (11) and lockwashers (12). Separate hand pump (5) and bracket (13).

d. Remove female coupling (l), male coupling (7), and elbows (4).

8-39. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Inspect hand pump (5, figure 8-7) for evidence of leakage and damage.

c. Inspect all parts for wear and damage.

8-40. REPAIR.

a. Repair shall be limited to the replacement of all worn parts.

8-41. ASSEMBLY AND INSTALLATION.

a. Install female coupling (1, figure 8-7), male coupling (7), and elbows (4).

b. Assemble hand pump (5) and bracket (13) with capscrews (11) and lockwashers (12).

c. Install hand pump (5) with bracket (13) in right-side tool box. Secure with washer (14), lockwasher (12), and wing nut (15).

SECTION 9

SWING SYSTEM MAINTENANCE INSTRUCTIONS

9-1. TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Boom swing operation erratic in either direction.	a. Damaged relief valve.	a. Replace relief valve (para. 8-13).
	b. Swing brake dragging (not releasing properly).	b. Repair swing brake (para. 9-10).
	c. Low engine rpm.	c. Increase engine rpm to obtain smooth swing operation.
	d. Low hydraulic oil.	d. Increase hydraulic oil to proper level.
	e. Improper movement of control lever to neutral.	e. Feather controls to neutral to maintain smooth stopping action.
	f. Insufficient lubricant on swing bearing.	f. Lubricate bearing properly.
	g. Machine not level.	g. Level the machine.
	h. Damaged orbit motor.	h. Repair or replace orbit motor (para. 9-2).
	i. Excessive overload.	i. Reduce load.
	j. Restricted or partly clogged hydraulic hose or fittings.	j. Clean or replace damaged parts.
	k. Pump cavitation in swing section.	k. Retighten suction hose or replace any damaged fitting.
	l. Improperly torque turntable bolts.	l. Retorque turntable bolts evenly (para. 10-25e).
	m. Excessive preload on upper and lower pinion shaft bearing.	m. Adjust as necessary (para. 9-9t).
	n. Improperly torqued orbit motor attachment bolts.	n. Retorque orbit motor attachment bolts (para. 9-5p).
	o. Malfunction of the Planetary gear reducer.	o. Repair as needed (para. 9-6).
	p. Worn or damaged pump section.	p. Repair pump (para. 8-32).

SYMPTOM	PROBABLE CAUSE	SOLUTION
2. Boom swing operation erratic in one direction only.	a. Relief valve inoperative.	a. Clean, readjust and/or replace relief valve (para. 8-13)
	b. Machine not level.	b. Level machine.
	c. Turntable bearing binding due to continuous limited swing.	c. Rotate machine 360 degrees in both directions several times and lubricate turntable bearing.
	d. Restricted hose or fitting.	d. Clean or replace damaged parts.
	e. Relief valves malfunctioning.	e. Replace relief valves (para. 8-13).
	f. Damaged output shaft.	f. Replace output shaft (para. 9-6).
3. Boom will not swing in either direction.	a. Damaged relief valve.	a. Remove, clean, and repair or replace relief valve.
	b. Damaged orbit motor.	b. Repair or replace orbit motor (para. 9-2).
	c. Broken orbit motor drive coupling.	c. Replace drive coupling (para. 9-2).
	d. Swing brake not releasing properly.	d. Repair as necessary (para. 9-10).
	e. Completely inoperative relief valves.	e. Replace relief valves.
	f. Damaged planetary gear reducer.	f.' Repair as needed (para. 9-6).
	g. Worn or damaged hydraulic pump section.	g. Repair pump (para. 8-32).
4. Swing operation slow in either direction.	a. Damaged relief valve.	a. Adjust, repair, or replace valve.
	b. Improperly adjusted swing brake.	b. Readjust.
	c. Improperly adjusted relief valves.	c. Adjust valves (para. 8-23).
	d. Improperly lubricated swing bearing.	d. Lubricate bearing per recom-mendations.
	e. Improper size hose and/or fittings installed.	e. Remove and replace per parts manual.
	f. Clogged or restricted hydraulic hoses or fittings.	f. Clean or replace damaged parts.

SYMPTOM	PROBABLE CAUSE	SOLUTION
4. Swing operation slow in either direction (cont'd).	g. Worn or damaged output shaft bearings.	g. Replace bearings (para. 9-6).
	h. Worn or damaged orbit motor.	h. Repair or replace motor (para. 9-2).
	i. Worn or damaged hydraulic pump section.	i. Repair pump (para. 8-32).
5. Swing operation slow in one direction only.	a. Machine not level.	a. Level machine.
	b. Damaged relief valve.	b. Repair or replace relief valve.
	c. Improperly adjusted relief valves.	c. Adjust valves (para. 8-23).
	d. Clogged or restricted hose.	d. Clean, or replace damaged part.
	e. Improperly torqued turntable bearing.	e. Retorque turntable bearing (para. 10-25e).
6. Swing brake operation erratic.	a. Improper brake adjustment.	a. Adjust brake.
	b. Air in swing brake system.	b. Bleed brake system.
	c. Dirty or glazed brake pad linings.	c. Clean or replace linings (para. 9-10).
	d. Kinked or bent lines and/or hoses and fittings.	d. Straighten or replace as required.
7. Boom swings slowly.	a. Insufficient hydraulic volume.	a. Check delivery of hydraulic pump. Ensure sufficient fluid is available to pump, Check pump drive speed.
	b. Damaged relief valve.	b. Adjust, repair, or replace valve.
	c. Damaged swing motor.	c. Repair or replace motor (para. 9-2).
8. Swing motor continues to operate when swing control is in neutral position.	a. Control valve spool sticking or valve otherwise damaged.	a. Repair or replace valve (para. 8-13).
9. Swing motor turning in wrong direction.	a. Improper port connections.	a. Reverse port connections (para. 9-2).
10. Swing motor noisy.	a. Air in system.	a. Bleed air from highest point in circuit and replenish fluid.
	b. Motor binding.	b. Repair or replace motor (para. 9-2).

9-2. ORBIT MOTOR.

9-3. REMOVAL AND DISASSEMBLY.

a. Tag and disconnect hydraulic hoses from motor assembly. Cap or plug all openings.

CAUTION

Pull straight down on the motor assembly to avoid damaging the splined shaft.

b. Remove bolts and washers securing motor and remove motor.

c. Cover motor mount opening to prevent dirt from entering drive unit.

CAUTION

Clamp across the front of the motor flange. Excessive pressure on the housing will cause distortion.

d. Place motor in a suitable vise; clamp across front mounting flange (3, figure 9-1).

NOTE

When clamping the motor in a vise, always use some protective material such as soft jaw adapters, hard rubber, or hard board.

e. Remove capscrews (16) and seal washers (15) securing end cap (14) to housing (9); slide end cap from housing using care not to scratch mating surfaces.

f. Remove gerotor set (13).

g. Remove splined drive (11) and spacer plate (12),

h. Reverse motor in vise.

NOTE

Some models incorporate a removable spacer to space the drive. Be sure to secure the spacer when turning the drive.

i. Remove capscrews (1) securing mounting flange (3) to housing; tap flange lightly on underside with a fiber mallet to remove.

j. Remove bearing race (6) and thrust bearing (7).

k. Remove output shaft (8) from housing.

l. Remove seal (4) and O-ring (5) from flange.

m. Using a small screwdriver, remove seal (2) from outside face of mounting flange.

9-4. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Wear goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air,

9-5. ASSEMBLY AND INSTALLATION

NOTE

Lubricate the output shaft with hydraulic oil prior to installation.

a. Carefully place output shaft (8, figure 9-1) in housing (9).

NOTE

Make a mark (with a grease pencil) on output shaft (8) with a forward valving slot to faciltate timing as shown in figure 9-2.

b. Install thrust bearing (7, figure 9-1) and race (6) on shaft. To ensure they are properly installed, pull shaft partially out of housing, install bearing and race, and push all three parts simultaneously into housing.

c. Install new O-ring (5) and seal (4). To provide adequate sealing, seals are slightly larger than their groove and must be compressed into groove with a finger,

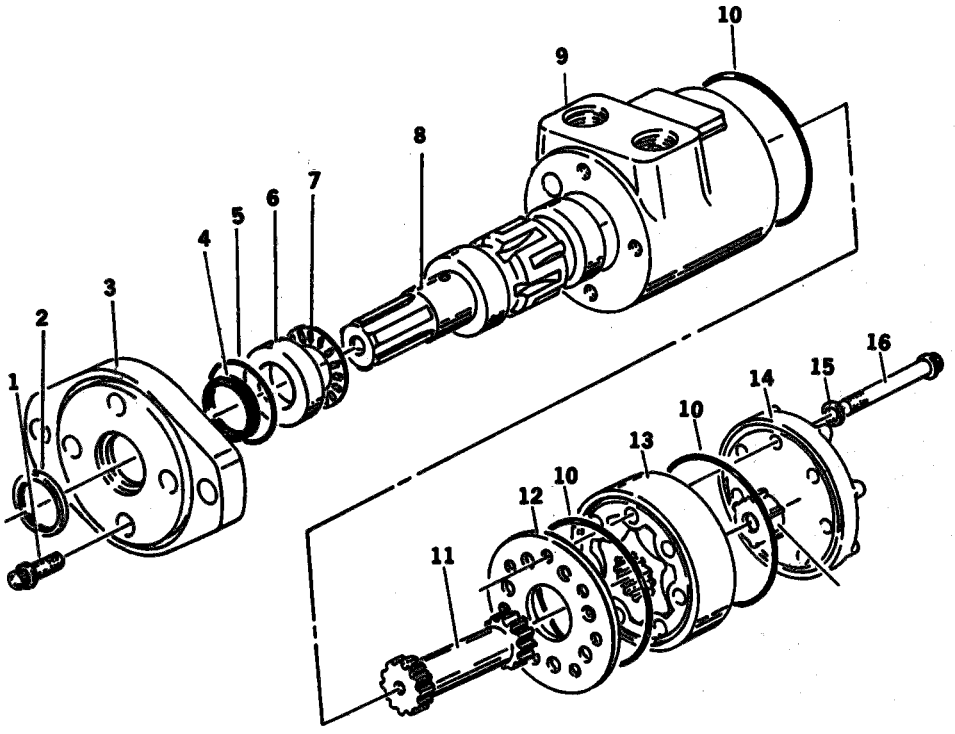
d. Install new seal (2) on outside face of mounting flange (3).

e. Install mounting flange (3). Lubricate shaft and seals with hydraulic oil when assembling. Be careful not to damage seals. Rotate flange slowly while pulling down on shaft.

f. Secure flange (3) to housing with capscrews (1).

g. Torque capscrews to 250 inch-pounds (288 kgcm).

h. Turn motor around in vise and clamp across front flange.



LEGEND

1. Capscrew
2. Seal
3. Mounting Flange
4. Seal
5. O-Ring
6. Bearing Race
7. Thrust Bearing
8. Output Shaft
9. Housing
10. O-Ring Seal
11. Drive
12. Spacer Plate
13. Geroter Set
14. End Cap
15. Seal Washer
16. Capscrew

Figure 9-1. Orbit Motor

i. Install spacer plate (12).

NOTE

The relationship between gerotor star, drive, and spool determines the timing or rotation of the shaft. Ensure the shaft and housing are assembled as shown in the Output Shaft Timing (figure 9-2).

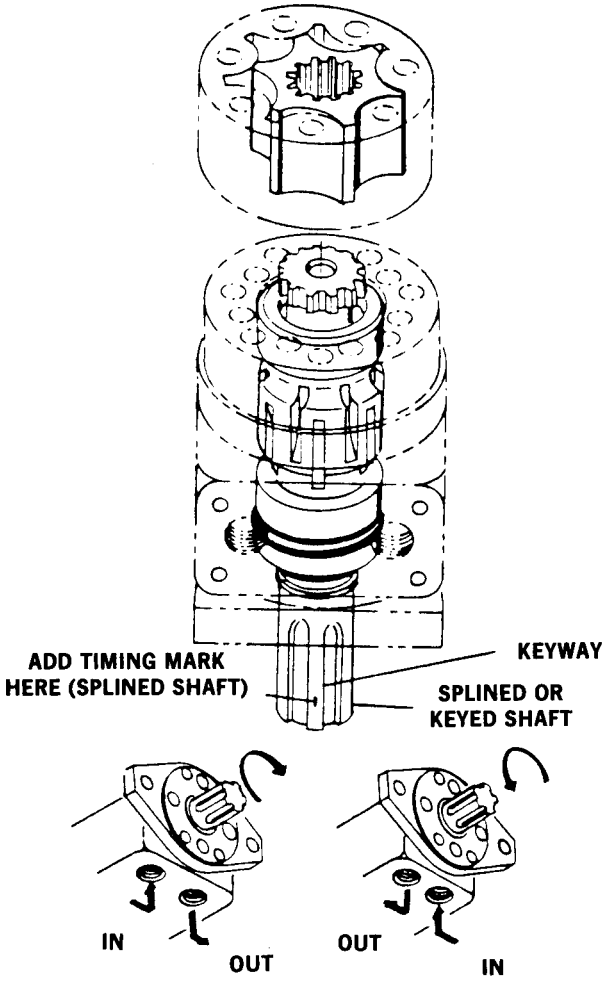


Figure 9-2. Output Shaft Timing

j. Insert drive (11) in housing. Note that the centerline falls between teeth of spline.

k. Place geroter set (13) over drive splines with any one of star points 15 degrees to right of centerline. With this orientation, shaft will rotate in direction shown in the Output Shaft Timing (figure 9-2), with ports pressurized as marked.

l. Place end cap (14) imposition on housing and and realign attach screw holes, being careful not to disengage gerotor from drive splines.

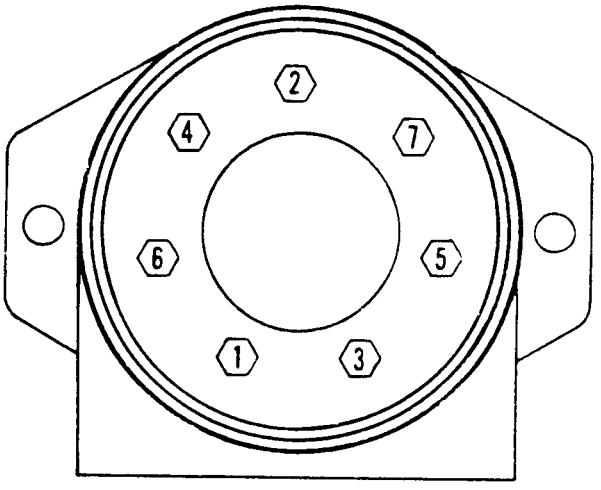


Figure 9-3. Capscrew Tightening Sequence

m. Secure end cap in position with seal washers (15) and capscrews (16); tighten screws fingertight only at this time.

n. Torque capscrews in three phases, in accordance with following procedure with reference to the Capscrew Tightening Sequence (figure 9-3).

1. Torque all capscrews to 50 inch-pounds (57.6 kgcm).

2. Torque ail capscrews to 125 inch-pounds (144.0 kgcm).

3. Torque all capscrews to 175 inch-pounds (201.6 kgcm).

CAUTION

Use care when engaging the swing motor drive gear. Do not force the shaft to engage.

o. Position swing motor on swing brake, engaging shaft with brake input shaft.

P. Secure motor to brake cover with washers and bolts, Torque bolts to 68 foot-pounds (9.3 kgm).

q. Remove tags and connect hydraulic lines to swing motor.

9-6. PLANETARY GEAR REDUCER.

9-7. REMOVAL AND DISASSEMBLY.

NOTE

Turntable must be removed prior to removal of drive pinion from top.

a. Remove capscrews securing drive pinion guard. Remove guard. Remove two retainer screws and retainer washer. Remove drive pinion. In most cases the pinion will lift off easily. If not, provide a slight pry bar assist.

b. Tag and disconnect hydraulic lines from swing motor and swing brake.

c. Install lifting eyes in holes in end of output shaft.

d. Attach a suitable lifting device to lifting eyes.

NOTE

The three sections that make up the swing gearbox assembly, are held together by flanges and bolts. Prior to separation, fine scribe lines should be made at each joint to serve as an alignment guide on assembly. Proceed with removal of bolts. If sections resist separation, tap on sides with fiber or rubber mallet. DO NOT use a pry bar to force separation.

e. Remove bolts and washers securing the planetary gear reducer to carrier plate.

f. Lower assembly to ground and remove assembly from crane.

g. Remove swing brake and orbit motor from planetary gear reducer.

NOTE

Any maintenance involving disassembly of the swing planetary gear reducer should include the replacement of all seals and O-rings.

NOTE

For ease of alignment, scribe or mark a line through the housing cover (4, figure 9-4), ring gear (7) and hub (27).

h. Remove oil drain plug (5) and drain housing completely.

i. Remove capscrews (2) and lockwashers (3).

j. Remove cover (4) and shims (28, 29 and 30) from ring gear (7).

k. Remove O-ring (6).

l. Remove thrust bearing (10), two raceways (8), and spacer (9) from cover (4).

m. Remove ring gear (7) from hub (27).

n. Remove O-ring (6) from hub (27).

o. Remove gear carrier assembly (18).

p. Remove roll pin (16) by punching into center of planet shaft (17) with a punch.

q. Remove planet shafts (17), spacers (12), and planet gear (15) from gear carrier (18).

r. Remove sun gear (19).

s. Remove spacer (20).

t. Remove thrust bearing (10) and two raceways (8).

u. Hold output shaft (23) stationary and using special spanner wrench (figure 9-5) remove locknut (21) and lockwasher (22).

v. Remove internal ring gear (11) from output shaft (23).

w. Using a press from inside hub (27), drive output shaft (23) from bearings (25) and remove shaft (23) from bottom of hub (27).

x. Remove inner tapered bearing (25) and cup (26).

y. Remove oil seal (24) from hub (27).

z. Remove outer tapered bearing (25) and cup (26).

aa. If necessary, remove roller bearings (13) and spacer (14) from the gear carrier (18).

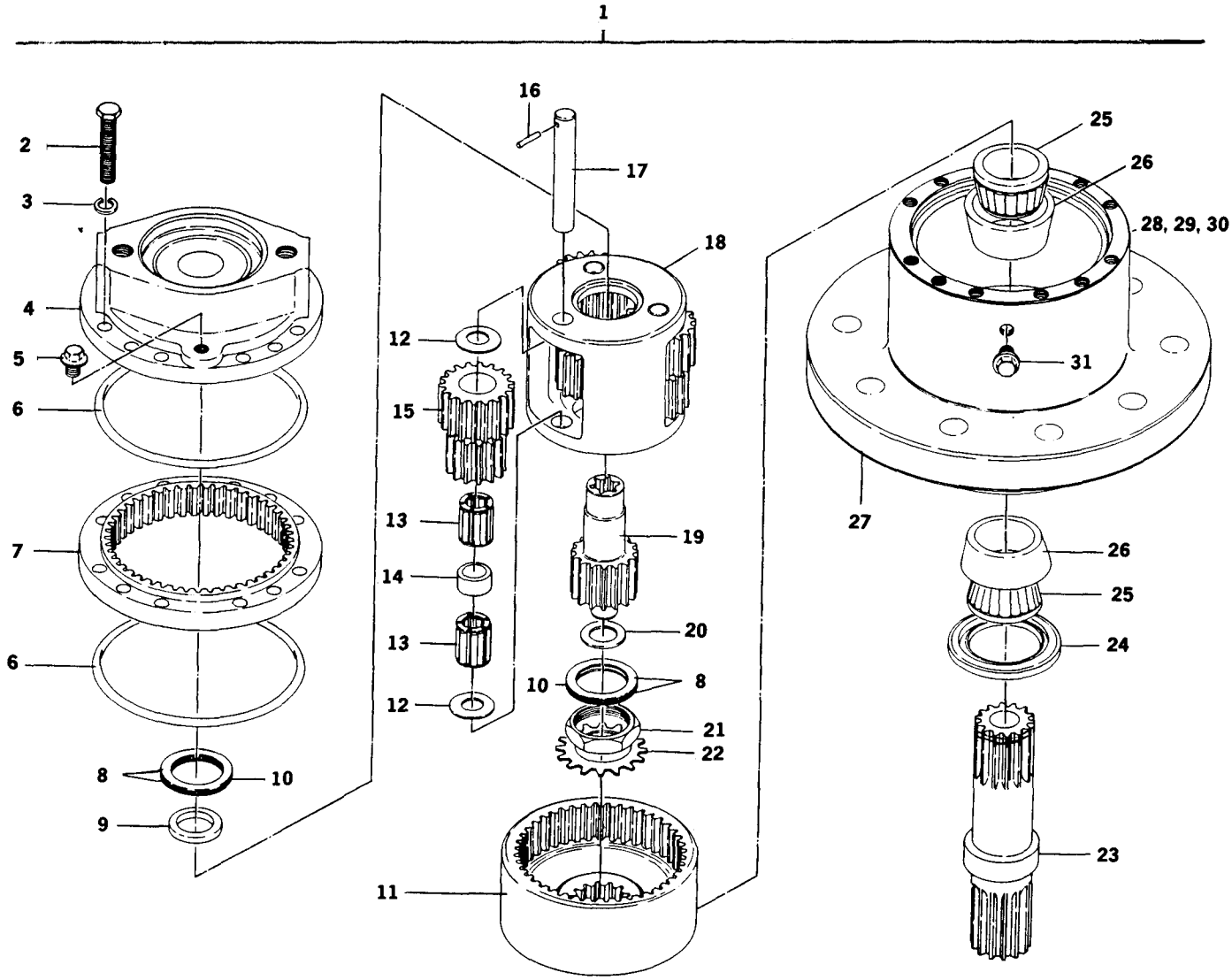
9-8. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. use solvent in a well-ventilated area. Wear' goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.



1. Gearbox Assembly
2. Capscrew
3. Lockwasher
4. Cover
5. Drain Plug
6. O-Ring
7. Large Internal Ring Gear
8. Raceways
9. Spacer
10. Thrust Bearing
11. Small Internal Ring Gear
12. Bearing Spacer
13. Roller Bearing
14. Spacer
15. Planet Gear
16. Roll Pin
17. Planet Shaft
18. Gear Carrier Assembly
19. Sun Gear
20. Spacer
21. Locknut
22. Lockwasher
23. Output Shaft
24. Oil Seal
25. Bearing
26. Cup
27. Hub
28. Shim
29. Shim
30. Shim
31. Fill Plug

Figure 9-4. Planetary Gear Reducer

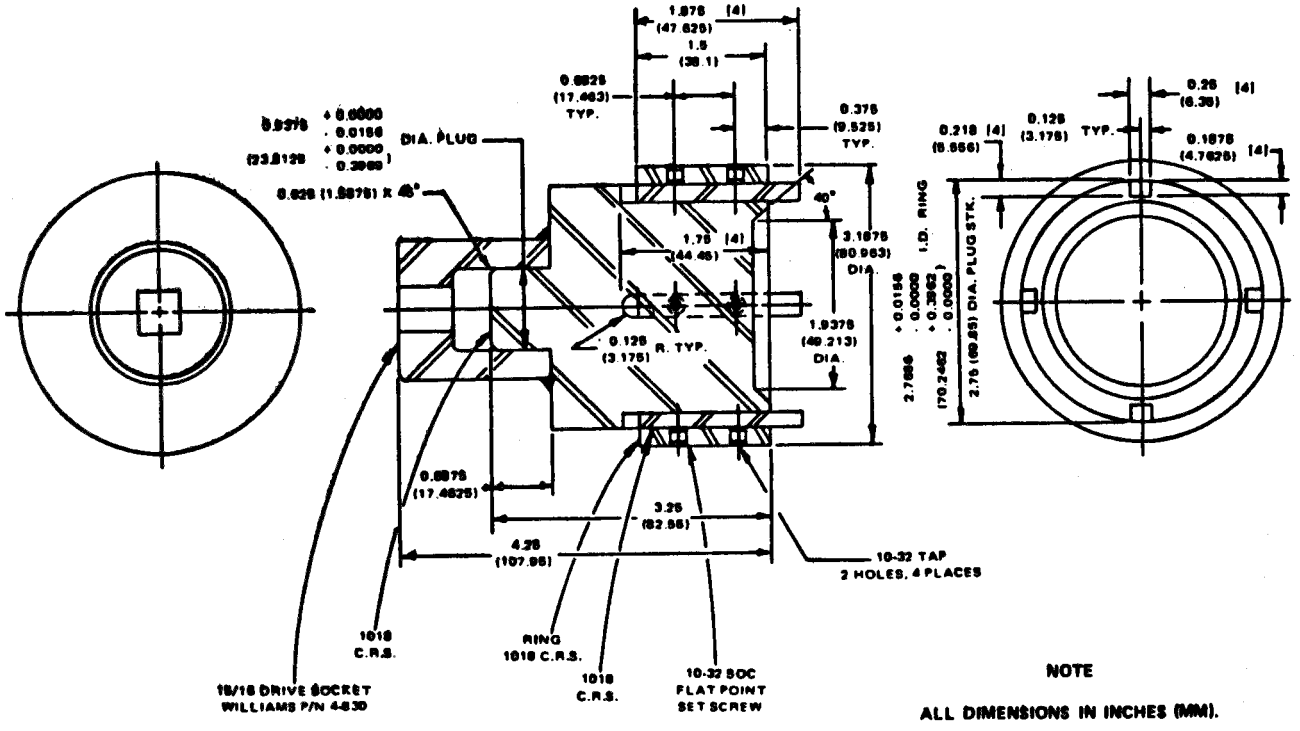


Figure 9-5. Spanner Wrench

9-9. ASSEMBLY AND INSTALLATION.

NOTE

Prior to assembly, lubricate all O-rings and seals with gear oil. Pack all bearings with grease before installation.

a. Press outer tapered bearing (25, figure 9-4) onto output shaft (23) and seat bearing into bearing cup (26) in hub (27).

b. Insert output shaft (23) in hub (27) and press on inner bearing (25) and seat bearing into bearing cup (26).

c. Install seal (24).

d. Install ring gear (11) into hub (27). The ring gear will spline into the output shaft (23).

e. Install lockwasher (22).

f. While holding output shaft (23), install locknut (21).

g. Engage four tabs of lockwasher (22) with slots in locknut (21).

h. Install two raceways (8) and thrust bearing (10) on locknut (21).

i. Install spacer (20) on sun gear (19).

j. Install sun gear (19).

k. Install roller bearing (13) on inside of gear clusters (15) with spacer (14) between them.

l. Install gear cluster (15) and spacers (12) in gear carrier (18).

m. Install planet shafts (17) and insert roll pins (16).

n. Install spacer (9), thrust bearings (10), and raceways (8).

NOTE

Before placing the planetary gear assembly into the hub, it will be necessary to check the timing.

o. Rotate gear 1 (figure 9-6) until timing punch mark is in 12 o'clock position. Repeat with gears 2 and 3.

NOTE

For clarity, the carrier is cutaway in the drawing only.

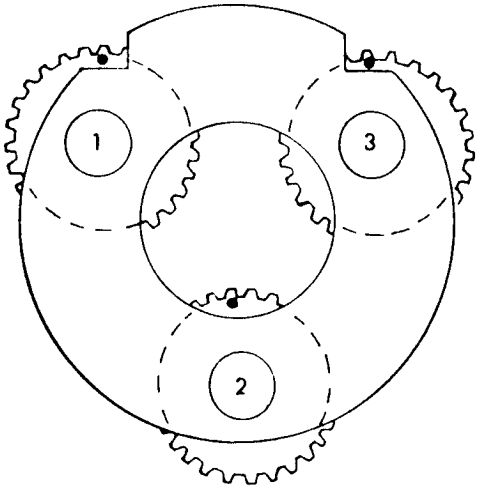


Figure 9-6. Planetary Gear Timing Sequence

p. Holding all gear clusters (15), lower gear carrier assembly (18) into hub (27).

q. Lubricate and install O-ring (6).

r. Install ring gear (7) on top of hub (27), engaging its gear teeth with planetary gears (15).

s. Lubricate and install the O-ring (6).

t. Install same number and size shims (28, 29, and 30) removed during disassembly.

u. Place cover (4) on top of shims. Install lock-washers (3), and capscrews (2). Tighten 12 capscrews (2) from 206 to 226 in tbs.

v. Install drain plug (5) and fill plug (31) after servicing gearbox.

w. Fill through plug opening (31) in accordance with lube chart. After servicing reinstall plug.

9-10. SWING BRAKE ASSEMBLY.

9-11. REMOVAL AND DISASSEMBLY.

a. Tag and disconnect hydraulic lines to motor and brake. Cap or plug all openings.

b. Remove motor and plug ports.

c. Remove brake (plug brake port) and cover opening to ensure no dirt, dust, etc., gets into gear box.

d. Scribe a match mark line across brake housing (1, figure 9-7) and cylinder housing (2) for reassembly purposes.

e. Remove screws (8) and washers (9) from brake housing. Remove bolts together, in stages, so as to provide uniform release of spring pressure.

f. Separate cylinder housing (2) from brake housing (1).

g. Remove compression springs (12), piston (4), and head (3) from cylinder housing.

h. Remove head (3) and springs (12) from piston (4).

CAUTION

Removal of the teflon back-up rings (14 and 16) may cause damage to the teflon rings and should not be attempted unless replacing them.

i. Remove O-rings (13 and 15) and teflon back-up rings (14 and 16) from ring grooves.

NOTE

Before removing stators and brake discs, note and mark order of removal so they can be reinstalled in exact same order.

j. From brake housing (1), remove stators (5 and 7) and brake discs (6) off splined end of shaft (11).

k. Remove splined shaft (11) and bearing (10) from brake housing (1) by tapping the shaft lightly with a plastic mallet.

1. Remove shaft (11) from bearing (10) by supporting inner race and pressing shaft out of race.

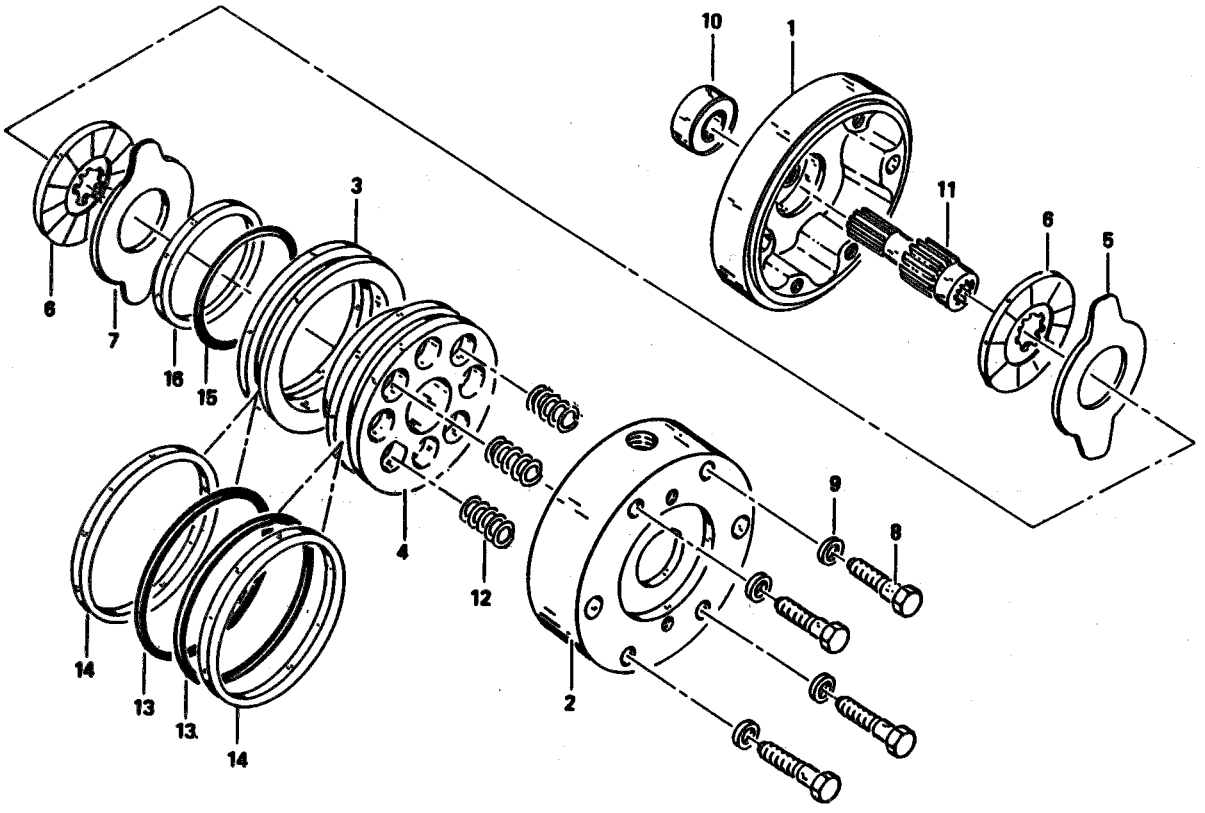
9-12. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Wear goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.



1. Brake Housing
2. Cylinder Housing
3. Head
4. Brake Piston
5. Stator
6. Brake Disc
7. Stator
8. Screw
9. Washer
10. Bearing
11. Shaft
12. Compression Spring
13. O-ring
14. Back-up Ring
15. O-Ring
16. Back-up Ring

Figure 9-7. Swing Brake Assembly

9-13. ASSEMBLY AND INSTALLATION.

NOTE

Worn O-rings and damaged or worn teflon back-up rings must be replaced prior to assembly.

NOTE

The cylinder housing, piston, and O-rings must be clean prior to assembly, and prelubed with the system hydraulic oil.

NOTE

Brake discs must be clean and dry. There should be no oil on lining material or mating surfaces of the stators.

a. Install splined shaft (11, figure 9-7) into bearing (10) by supporting inner race and pressing shaft into race.

b. Install shaft and bearing into brake housing (1).

c. Install brake discs (6) and stators (5 and 7) in the exact reverse order of removal on splined end of shaft(n) and position inside brake housing (1).

d. Install O-rings (13 and 15) and teflon back-up rings (14 and 16) on brake piston (4) and head (3).

e. Assemble head (3) to piston (4).

f. Insert compression springs (12) into recessed holes in face of piston.

g. Insert piston (4) into cylinder housing (2) ensuring springs (12) are in place. Be careful not to damage O-rings during insertion.

h. Position brake housing and related parts and insert shaft (11) through head (3) and piston (4). Match scribe lines on brake and cylinder housings.

i. Start all screws (8) and lockwashers (9) through cylinder housing (2) and screw into brake housing (1).

j. Tighten screws (8) alternately in stages so as to uniformally pressurize all springs (12). Torque screws to 30-32 foot pounds (4.1-4.4 kgm).

k. Lightly coat mounting face of brake with NEVER-SEEZ compound.

l. Place brake shaft into gear reducer with brake bleeder screw in vertical position.

m. Move brake into position with gear reducer. Align mounting bolt holes by rotating engaged brake into position. If this is not possible, the brake maybe rotated after pressure has been applied to brake inlet. This will release brake and allow it to be rotated into position.

n. Similarly apply NEVER-SEEZ compound on flange of motor.

o. Insert shaft of motor into brake and push into position.

p. Insert mounting bolts through motor flange, brake, and into threaded hole in gear reducer mounting flange.

q. Run bolts in alternately to prevent binding, until snug. Then torque the bolts to 75-85 foot-pounds (10.4-11.7 kgm).

NOTE

Both shafts must slide together freely. Do not use bolts to force units together.

r. With motor and brake bolted into position, remove cap plug and connect “inlet” hydraulic line to brake housing.

s. Bleed air from brake via bleeder screw.

SECTION 10

BOOM ASSEMBLY MAINTENANCE INSTRUCTIONS

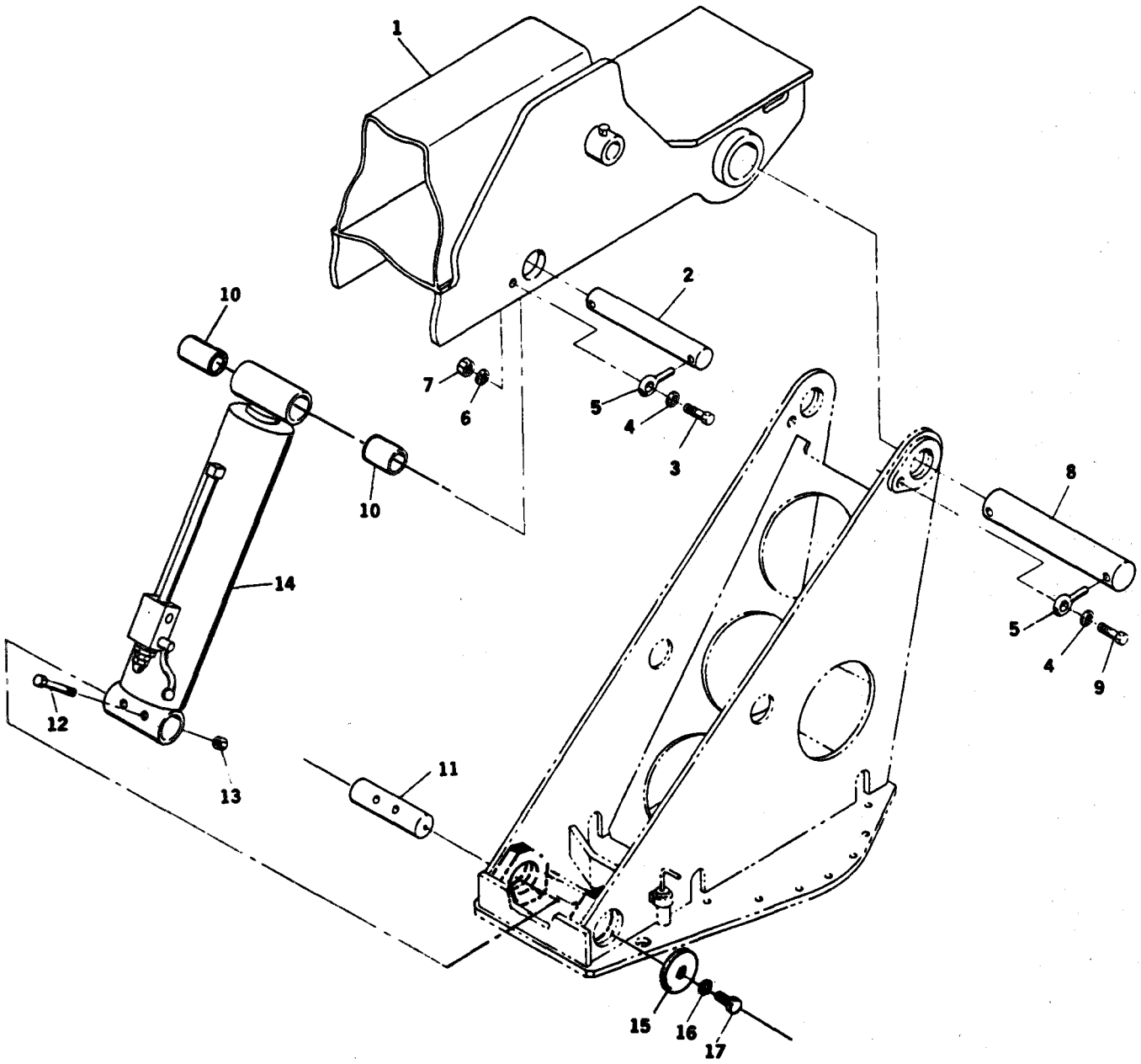
10-1. TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Erratic operation of extending telescoping cylinder.	a. Low hydraulic oil level.	a. Replenish hydraulic oil to proper level.
	b. Damaged relief valves.	b. Repair or replace relief valves (para. 8-13).
	c. Air in telescope cylinder.	c. Bleed by lowering telescope cylinder below horizontal.
	d. Low engine rpm.	d. Increase engine rpm to recommended setting.
	e. Lack of lubrication on boom sections.	e. Properly lubricate all boom sections.
	f. Extremely tight boom nose sheaves.	f. Inspect and properly lubricate boom nose sheaves.
	g. Improper boom alignment caused from side loading.	g. Reduce and properly hoist load.
	h. Worn boom wear pads.	h. Replace wear pads and properly lubricate (para. 10-2).
	i. Distorted boom section.	i. Replace distorted section (para. 10-2).
	j. Damaged telescope cylinder.	j. Repair or replace cylinder (para. 10-7).
	k. Clogged, broken, or loose hydraulic lines or fittings.	k. Clean, tighten, or replace lines or fittings.
	l. Damaged control valve.	1. Repair or replace control valve (para. 8-13).
2. Erratic operation of retracting telescoping cylinder.	a. Low hydraulic oil level.	a. Replenish hydraulic oil to proper level.
	b. Damaged relief valve.	b. Repair or replace relief valve (para. 8-13).
	c. Air in cylinder.	c. Bleed by lowering telescoping cylinders below horizontal and cycle telescope cylinder.
	d. Low engine rpm.	d. Increase engine rpm to recommended setting.
	e. Lack of lubrication.	e. Properly lubricate all boom sections.

SYMPTOM	PROBABLE CAUSE	SOLUTION
2. Erratic operation of retracting telescoping cylinder. (Continued)	f. Check valve malfunctioning.	f. Repair or replace check valve (para. 10-7).
	g. Improper boom alignment caused from side loading.	g. Reduce and properly hoist load.
	h. Extremely tight boom nose sheaves.	h. Inspect and properly lubricate.
	i. Distorted boom section.	i. Replace distorted section (para. 10-2).
	j. Worn boom wear pads.	j. Replace wear pads and properly lubricate (para. 10-2).
	k. Bent cylinder rod.	k. Replace cylinder rod and all cylinder seals (para. 10-7).
	l. Scored cylinder barrel.	l. Repair or replace cylinder barrel (para. 10-7).
	m Damaged piston seals.	m. Replace all cylinder seals (para. 10-7).
	n. Loose or damaged piston.	n. Replace all seals and retorque or replace piston (para. 10-7).
3. Boom raises erratically.	a. Low hydraulic oil.	a. Replenish hydraulic oil to proper level.
	b. Low engine rpm.	b. Increase engine rpm to recommended setting.
	c. Main relief valve damaged.	c. Replace relief valve (para. 8-13).
	d. Air in hydraulic cylinders.	d. Bleed air from cylinders.
	e. Bent boom pivot shaft.	e. Replace pivot shaft (para. 10-2).
4. Boom lowers erratically.	a. Low hydraulic oil.	a. Replenish hydraulic oil to proper oil level.
	b. Low engine rpm.	b. Increase engine rpm to recommended level.
	c. Circuit and/or relief valve inoperative.	c. Repair or replace relief valve (para. 8-13).
	d. Air in hydraulic cylinders.	d. Bleed air from cylinders.
	e. Control valve linkage out of adjustment.	e. Adjust linkage to obtain full spool travel.
	f. Damaged hydraulic pump section.	f. Repair or redate pump section (para. 8-32).

SYMPTOM	PROBABLE CAUSE	SOLUTION
5. Boom raises slowly.	a. Low hydraulic oil level.	a. Replenish hydraulic oil to proper level.
	b. Low engine rpm.	b. Increase and maintain engine rpm.
	c. Damaged relief valve.	c. Repair or replace relief valve (para. 8-13).
	d. Extremely cold hydraulic oil.	d. Operate unit to bring oil to operating temperature.
	e. Control valve linkage out of adjustment.	e. Adjust linkage to obtain full spool travel.
	f. Operating two functions within the same control valve bank assembly.	f. Feather controls to obtain desired speed of both functions.
	g. Restriction in return hose.	g. Replace return hose.
	h. Cylinder piston seals leaking.	h. Replace all cylinder seals (para. 10-12).
	i. Scored cylinder barrels.	i. Hone or replace barrel (para. 10-12).
	j. Worn hydraulic pump section.	j. Repair or replace pump section (para. 8-32).
6. Boom lowers slowly.	a. Low hydraulic oil level.	a. Replenish hydraulic oil to proper level.
	b. Low engine rpm.	b. Increase rpm to recommended level.
	c. Damaged relief valve.	c. Repair or replace relief valve (para. 8-13).
	d. Operating two functions within the same control valve bank assembly.	d. Feather controls to obtain desired speed of both functions.
	e. Extremely cold hydaulic oil	e. Operate unit to bring oil to operating temperature.
	f. Control valve linkage out of adjustment.	f. Adjust linkage to obtain full spool travel.
	g. Restriction in return hose.	g. Replace return hose.
	h. Cylinder piston seals worn.	h. Replace'all cylinder seals (para. 10-12).

SYMPTOM	PROBABLE CAUSE	SOLUTION
6. Boom lowers slowly. (Continued)	i. Scored cylinder barrels.	i. Hone or replace barrel (para. 10-12).
	j. Worn hydraulic pump section.	j. Repair or replace pump section (para. 8-32).
	k. Piston rod broken (loose from piston).	k. Replace piston rod and all cylinder seals (para. 10-12).
7. Boom will not raise.	a. Low hydraulic oil.	a. Replenish hydraulic oil to proper level.
	b. Main relief valve or circuit relief valve damaged.	b. Repair or replace relief valve (para. 8-13).
	c. Excessive load.	c. Reduce load as required.
	d. Improperly adjusted control valve linkage.	d. Adjust linkage to obtain full spool travel.
	e. Worn or damaged hydraulic pump section.	e. Repair or replace pump section (para. 8-32).
	f. Broken pump shaft.	f. Replace pump shaft and seals (para. 8-32).
	g. Broken pump drive coupling.	g. Replace drive coupling (para. 8-32).
	h. Broken control valve spool.	h. Repair control valve (para. 8-13).
8. Boom will not lower.	a. Low hydraulic oil.	a. Replenish hydraulic oil to proper level.
	b. Main relief valve or circuit relief valve damaged.	b. Repair or replace relief valve (para. 8-13).
	c. Improperly adjusted control valve linkage.	c. Adjust linkage to obtain full spool travel.
	d. Worn or damaged hydraulic pump section.	d. Repair or replace pump section (para. 8-32).
	e. Broken pump shaft.	e. Replace pump shaft and seals (para. 8-32).
	f. Broken pump drive coupling.	f. Replace drive coupling (para. 8-32).
	g. Broken control valve spool.	g. Repair control valve (para. 8-13).



LEGEND

1. Boom Assembly
2. Upper Lift Cylinder Shaft
3. Capscrew
4. Hardened Washer
5. Eyebolt
6. Lockwasher
7. Hex Nut
8. Boom Pivot Shaft
9. Capscrew
10. Bushing
11. Lower Lift Cylinder Shaft
12. Capscrew
13. Locknut
14. Lift Cylinder Assembly
15. End Cap
16. Lockwasher
17. Capscrew

Figure 10-1. Boom and Lift Cylinder

10-2. BOOM ASSEMBLY.

10-3. REMOVAL AND DISASSEMBLY.

a. Extend and set the outriggers.

b. Remove hook block. Take up wire rope onto hoist.

c. Elevate boom slightly to allow for withdrawal of lift cylinder rod end from lift cylinder attach fitting.

WARNING

Ensure the blocking and lifting devices are capable of supporting the boom assembly.

d. Attach lifting device to provide equal weight distribution and place block to support boom.

e. Tag and disconnect electrical wiring to boom and remove boom mounted floodlights (38, figure 10-2). To detach floodlights remove nuts (44), washers (43) and discs (42). Disc welds (40) and screws (39) may be removed with, and left assembled to the floodlights.

f. Tag and disconnect hydraulic lines to telescope cylinder. Cap lines and openings.

WARNING

Failure to properly support the boom lift cylinder could result in death or injury to personnel.

g. Block lift cylinder (14, figure 10-1).

h. Remove capscrews (3), washers (4), nuts (7), lockwashers (6), eye bolts (5), and shaft (2).

i. Activate hydraulic system and withdraw lift cylinder rod enough to clear attach fitting.

WARNING

Shutdown the crane before proceeding.

j. Take up slack on boom lifting device.

k. Remove capscrews (9), washers (4), eye bolts (5), and shaft (8).

l. Raise boom clear of crane and lower to ground level for service.

m. Remove capscrew (5, figure 10-2), nut (7), washer (6), and shaft (10).

n. Remove capscrews (2), lockwashers (3), and spacer (1). Remove pads (35), wear pad (15), wear pads (19), screws (11), and wear pads (12) if necessary,

o. Remove setscrews (36) and wear pads (34).

p. Slide fly section (24) with telescope cylinder (37) out of base section (4).

q. Remove capscrews (20), lockwashers (21), plates (22), and drive shafts (23) out of fly section (24).

r. Remove telescope cylinder (37).

s. Remove capscrews (26), nuts (7), washers (6), shafts (25), and sheaves assemblies (27) if necessary. Disassemble sheave assemblies (27) by removing retainers (28), and bearings (29, 30, and 31).

10-4. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Wear goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with a clean cloth dipped in cleaning solvent P-D-680.

b. Wipe residue with clean cloth.

c. Dry thoroughly.

10-5. ASSEMBLY AND INSTALLATION.

a. Assemble sheave assemblies (27, figure 10-2) with sheave (32), bearings (29, 30, and 31), and retainers (28). Grease lube fittings (33).

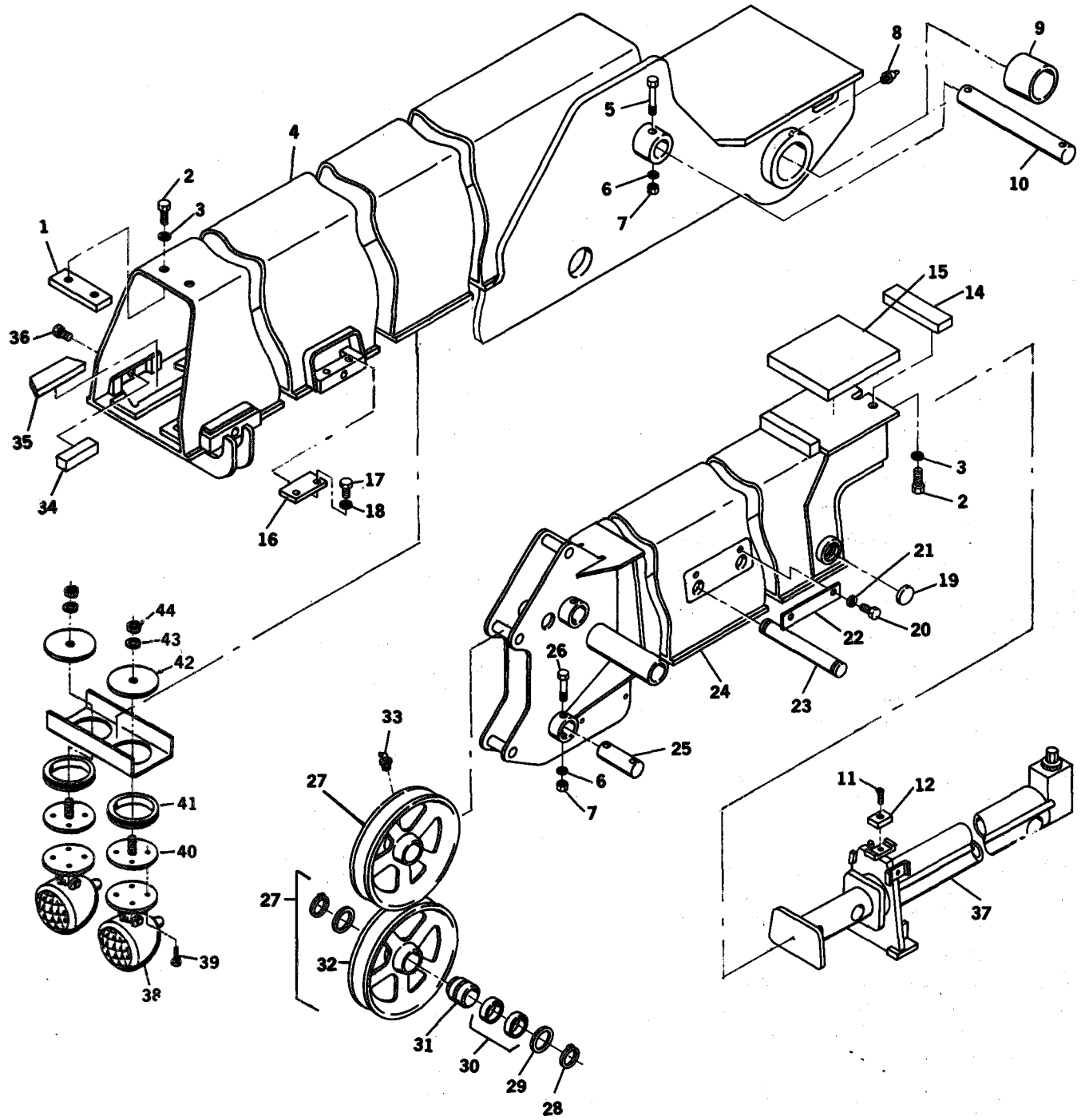
b. Install sheave assemblies (27) with shafts (25), washers (6), nuts (7), and capscrews (26).

c. Install wear pads (12), and screws (11). Install wear pads (19), wear pad (15), and wear pads (35). Grease wear pads.

d. Install telescope cylinder (37) in fly section (24) and secure with shafts (23), plates (22), lockwashers (21), and capscrews (20).

e. Slide fly section (24) into base section (4).

f. Install wear pads (34) with setscrews (36). Install spacer (1) with lockwashers (3), and capscrews (2).



LEGEND

1. Spacer
2. Capscrew
3. Lockwasher
4. Base Section Weldment
5. Capscrew
6. Flat Washer
7. Locknut
8. Lube Fitting
9. Bushing
10. Shaft
11. Capscrew
12. Wear Pad
13. Not Used
14. Retaining Bar
15. Wear Pad
16. Lockplate
17. Capscrew
18. Lockwasher
19. Wear Pad
20. Capscrew
21. Lockwasher
22. Plate
23. Shaft
24. Fly Section Weldment
25. Shaft
26. Capscrew
27. Sheave Assembly
28. Truarc Retainer
29. Needle Bearing
30. Needle Bearing
31. Inner Bearing
32. Sheave
33. Lube Fitting
34. Wear Pad
35. Pad
36. Setscrew
37. Telescope Cylinder Assembly
38. Floodlight Assembly
39. Screw
40. Disc Weld
41. Grommet
42. Disc
43. Washer
44. Nut

Figure 10-2. Boom Assembly

g. install shaft (10), washer (6), nut (7), and capscrew (5).

WARNING

Ensure blocking and lifting devices are capable of supporting the boom assembly.

h. Attach boom lifting device to provide equal weight distribution.

i. Suspend boom over the crane and lower boom into position. Align boom pivot shaft mounting holes for installation of shaft (8, figure 10-1).

j. Lubricate and install shaft (8) and secure with eye bolts (5), washers (4), and capscrews (9).

CAUTION

Extend the cylinder rod end only enough to align it with the holes in the lift cylinder attach fitting.

CAUTION

Before installing the lift cylinder rod end anchor shaft, ensure the lift cylinder rod end is aligned with the lift cylinder attach fitting,

k. Activate hydraulic system to extend lift cylinder rod end aligning it with holes in lift cylinder attach fitting on boom.

CAUTION

Shut down the engine before proceeding.

l. Lubricate and install shaft (2), Install eye bolts (5), capscrews (3), washers (4), lockwashers (6), and nuts (7).

m. Remove tags and install hydraulic lines to telescope cylinder.

n. Remove tags and connect electrical wires to boom.

o. Remove lifting device from boom.

p. Activate hydraulic system and raise boom slightly to remove boom and lift cylinder support blocking.

10-6. TESTING AND INSPECTION.

NOTE

Boom width, height, squareness, sway/sweep, camber, concavity, convexity, and waviness are checked at the factory prior to boom assembly. Boom damage resulting from overloading or other misuse of the crane would be evidenced by binding between the boom sections. Should this occur, the boom should be disassembled and inspected to determine the source of binding and the extent of damage. Contact Grove Manufacturing Company, Service Department, concerning possible repair or replacement of affected parts.

a. Elevate boom and hold in extended position. The boom should stay in position until retracted by the operator.

b. Extend and retract boom several times at various elevations. Check for smooth operation of telescope cylinder.

c. Check operation of all electrical/electronic components affected by boom removal.

d. Visually inspect telescoping sections for adequate lubrication of bottom plates. Observe extended sections for evidence of cracks, warping, or other damage. Periodically check security of boom wear pads. Check, boom nose sheaves for security and freedom of movement.

NOTE

The following procedure is used to inspect channel and plate trapezoidal boom sections. The procedure ensures proper component clearance and freedom from physical contact and interference.

Equipment required is listed below.

Four (4) pieces 1 inch dia. x 3 inches long drill rod or equivalent.

Two (2) spacers, equal thickness.

One (1) four foot level.

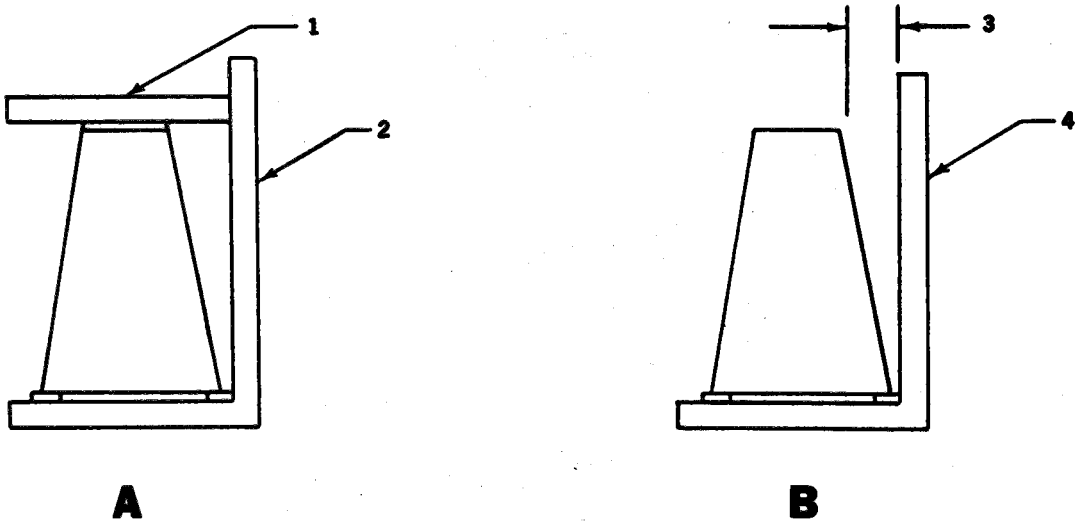
Large square (3 ft. x 4 ft.)

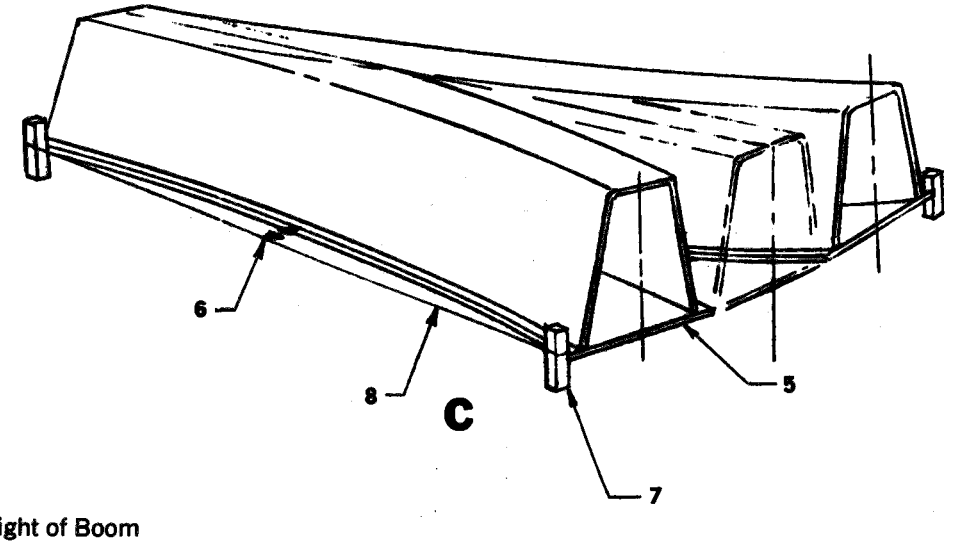
Measuring tape/scale.

One (1) three foot straight edge.

Chalkline (cord) or equivalent.

e. Check width of bottom by measuring across bottom plate. This check shall be made at front and rear end and several places along boom section length.



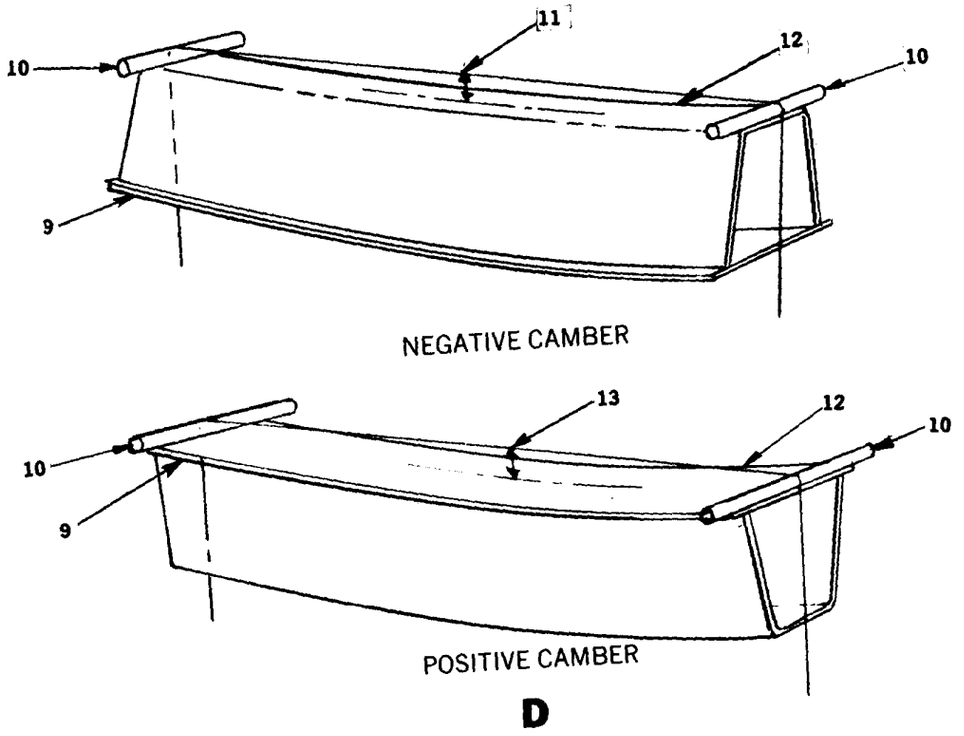


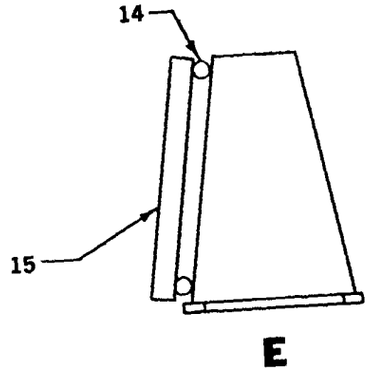
A. Checking Height of Boom
   1. Straight Edge
   2. Square

B. Checking Squareness of Boom Section
   3. Check Dimension
   4. Square

C. Checking Sway/Sweep of Boom Section
   5. Base Plate
   6. Check Dimension
   7. Spacers
   8. Cord

Figure 10-3. Boom Inspection (Sheet 1 of 3)





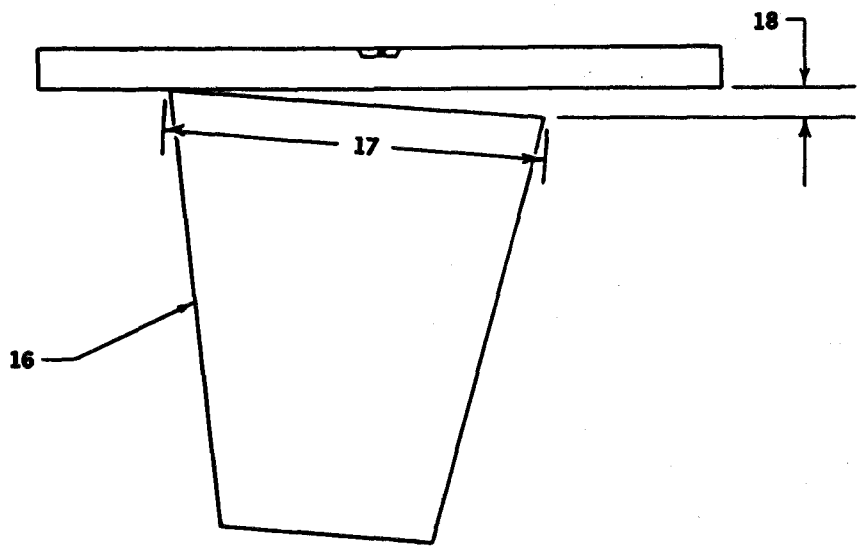
D. Checking Positive and Negative Camber

9. Base
10. Drill Rod
11. Check Negative Camber
12. Cord
13. Check Positive Camber

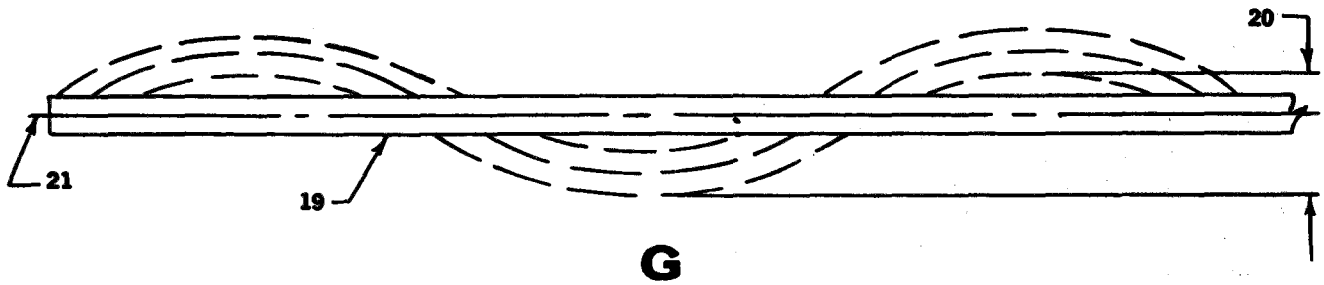
E. Checking Concavity and Convexity

14. Rod
15. Straight Edge

Figure 10-3. Boom Inspection (Sheet 2 of 3)



F



G

F. Checking Bottom Plate Longitudinal Twist
- 16. Front of Section
- 17. Bottom Plate Width
- 18. Longitudinal Twist

G. Longitudinal waviness (Peak-to-Valley)
- 19. Edge View of Member
- 20. Peak-to-Valley maximum
- 21. Mean Center Line

Figure 10-3. Boom Inspection (Sheet 3 of 3)

f. Check height of boom by placing straightedge and square as shown in A, figure 10-3. Measure between the edge of square and straight edge, both sides, at 4 foot intervals, maximum.

g. Check top width at 4 foot intervals along boom section length.

h. Check squareness of boom section by placing square as shown in B, figure 10-3. Measure dimensions from top plate to square on both sides of section at same interval. The amount boom is out of square is 1/2 of difference between left and right check dimensions.

i. Check sway/sweep by placing spacers of equal thickness against base plate edge at both ends and draw a cord tightly over them as shown in C. Check distance between cord and top plate at four foot intervals. Record measurements.

NOTE

The boom must be in travel position when checked.

j. Check camber. An upsweep condition is negative camber and a downsweep condition is positive camber. Use drill rods and cord as shown in D. Check at four foot intervals,

NOTE

The boom must be in the travel position when checked.

k. Check concavity and convexity by placing straight edge over rods, as shown in E. Measure from straightedge to side plate at mid-point, both sides. Record results. Use straight edge and rods to check lacings and top/bottom plates.

1. Position boom section with bottom plate facing up. Level rear end of the section with respect to bottom plate. Check front of boom section to determine amount of longitudinal twist in bottom plate as shown in F.

NOTE

When the fly section is not twisted, the vertical centerline of the boom nose shall be located perpendicular to the center of the bottom plate of the section.

m. Check longitudinal waviness. Waviness shall be smooth with positive/negative arches (no kinks). Peak to peak waviness shall be based upon peak to valley dimensions as shown in G.

10-7. TELESCOPE CYLINDER.

10-8. REMOVAL AND DISASSEMBLY.

NOTE

Telescope cylinder must be removed through the front of the boom, after the boom fly section has been remove

a. Remove hoist assembly (paragraph 11-2).

b. Tag and disconnect hydraulic lines to telescope cylinder.

Remove capscrews (20, figure 10-2), lockwashers (21). plates (22), and shafts (23).

d. Remove locknut (7), washer (6), capscrew (5), and shaft (lo).

e. Remove telescope cylinder (37).

f. If necessary, remove holding valve (15, figure 10-4) from cylinder barrel (16).

g. Remove four hex head capscrews (3) securing head plate (4) to retaining ring (14).

WARNING

Do not use air pressure to remove cylinder rod assembly.

h. Remove cylinder rod (2).

i. Remove lockring (13) and retaining ring (14).

j. Cover end of barrel (16) and port block to prevent dirt from entering.

k. Remove piston locknut (17) from cylinder rod (2.) and remove piston (20), spacer (23), head (9), and head plate (4).

CAUTION

When removing seals and rings, avoid scratching the grooved and gland surfaces.

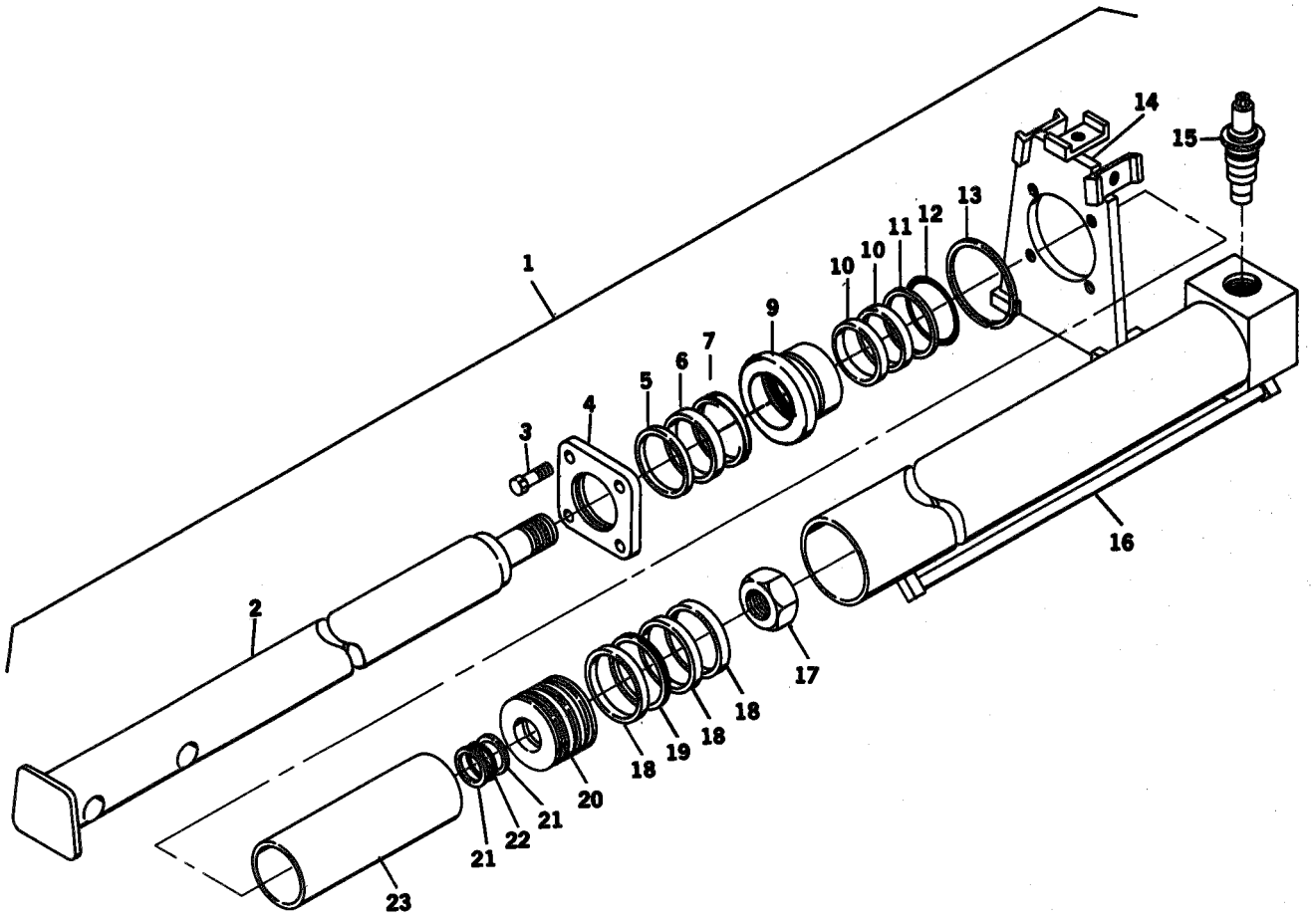
NOTE

Aligning discarded seals and rings in the order of disassembly will facilitate the installation of new items.

1. Remove three wear rings (18) and the G-T ring (19). Remove backup rings (21) and O-ring (22).

m. Remove wiper ring (5).

n. Remove O-ring (12), backup ring (11), wear rings (10), rod seal (7), and backup ring (6).



LEGEND

1. Telescope Cylinder Assembly
2. Cylinder Rod
3. Capscrew
4. Head Plate
5. Wiper Ring
6. Backup Ring
7. Rod Seal
9. Cylinder Head
10. Wear Ring
11. Backup Ring
12. O-ring
13. Lock Ring
14. Retaining Ring
15. Holding Valve
16. Barrel
17. Locking Nut
18. Wear Ring
19. G-T Ring
20. Piston
21. Backup Ring
22. O-ring
23. Spacer

Figure 10-4. Telescope Cylinder

10-9. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Wear goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with a clean cloth dipped in cleaning solvent P-D-680.

b. Inspect all parts for wear.

10-10. REPAIR.

a. Stone out minor blemishes and polish with fine crocus cloth.

10-11. ASSEMBLY AND INSTALLATION.

NOTE

Lubricate all parts with clean hydraulic oil. Use parts kit 9-752-100465 to replace all O-rings and seals.

a. Install wiper ring (5, figure 10-4) and retaining ring (14). Secure with lock ring (13).

b. Install O-ring (12), back-up ring (11), wear rings (10), rod seal (7), and back-up ring (6).

c. Install wear rings (18) and G-T ring (19), back-up rings (21), and O-ring (22).

CAUTION

Do not damage seals and rings when installing head plate (4), head (9), and piston (20).

d. Install head plate (4), head (9), spacer (23), and piston (20).

e. Install piston locknut (17) onto cylinder rod (2) and tighten securely.

f. Install cylinder rod (2) into barrel (16) using a twisting motion.

g. Lubricate four hex head capscrews (3) with NEVER-SEEZ (paste type) compound specification MIL-A-907D and install. Torque bolts to 135 ft. lbs.

h. Install holding valve (15) into cylinder barrel (16).

i. Pressurize and cycle cylinder. Check for proper operation and any leakage.

k. Install telescope cylinder (37, figure 10-2) in boom assembly.

l. Install shaft (10), capscrew (5), washer (6), and locknuts (7).

m. Install shafts (23), plates (22), lockwashers (21), and capscrews (20).

n. Remove tags and install hydraulic lines.

o. Install hoist assembly (paragraph 11-5).

10-12. LIFT CYLINDER.

10-13. REMOVAL AND DISASSEMBLY.

a. Raise boom assembly to its highest angle.

b. Block boom assembly to support its weight.

c. Support weight of lift cylinder (14, figure 10-1) and remove capscrews (3), washers (4), eye bolts (5), and shaft (2).

d. Retract cylinder rod with control valve.

Tag and remove hydraulic lines to lift cylinder (14).

f. Remove capscrews (12), nuts (13), shaft (11), end caps (15), lockwashers (16) and capscrews (17).

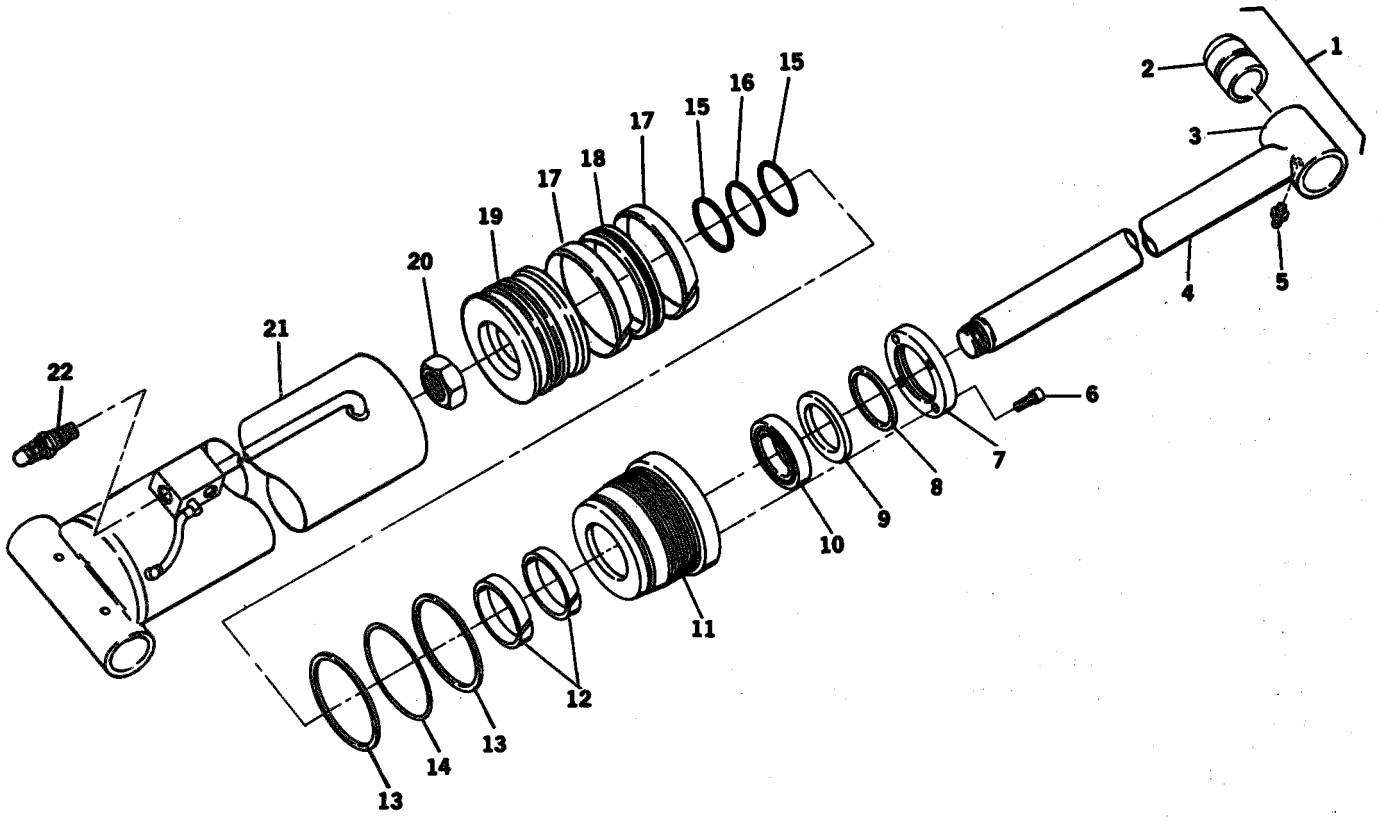
g. Remove lift cylinder to clean work area.

NOTE

The cylinder head is attached to threaded components.

h. Use two half inch diameter steel bars of sufficient length to insert in bored holes in O.D. of cylinder head (11, figure 10-5) and unscrew cylinder head from cylinder barrel (21).

i. Drain hydraulic oil from cylinder.



LEGEND

1. Cylinder Rod Assembly	12. Wear Ring
2. Bushing	13. Back-up Ring
3. Bushing	14. O-ring
4. Cylinder Rod	15. Back-up Ring
5. Grease Fitting	16. O-ring
6. Capscrew	17. Wear Ring
7. Retainer Plate	18. G-T Ring
8. Wiper Ring	19. Piston
9. Back-up Ring	20. Hex Nut
10. Rod Seal	21. Cylinder Barrel
11. Cylinder Head	22. Holding Valve

Figure 10-5. Lift Cylinder

WARNING

Do not use air pressure to remove the cylinder rod assembly.

CAUTION

Exercise extreme care when handling or setting down the cylinder rod. Damage to the rod surface may cause unnecessary maintenance and expense.

j. Withdraw cylinder rod assembly (1) from cylinder barrel (21) and move it to clean work area.

NOTE

It is advisable to cover the cylinder barrel opening to avoid contamination.

k. Secure cylinder rod to prevent it from moving. Unscrew hex nut (20) from end of cylinder rod (4) and remove piston (19).

l. Remove cylinder head (11) with retaining plate (7) from cylinder rod (4).

m. Separate retainer plate (7) and cylinder head by removing capscrews (6).

CAUTION

When removing the seals and rings, avoid scratching the grooved and gland surfaces.

Remove all seals and rings from piston (19), head (11). and retainer plate (7).

NOTE

Aligning discarded seals and rings in the order of disassembly will facilitate installation of new seals and rings.

o. If necessary, remove holding valve (22) from port block. If faulty, replace with a new valve.

10-14. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Wear goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with a clean cloth dipped in cleaning solvent P-D-680.

b. Wipe residue with clean cloth.

c. Dry thoroughly.

d. Inspect all parts for signs of wear or damage.

10-15. REPAIR.

a. Stone out any minor blemishes and polish with fine crocus cloth.

10-16. ASSEMBLY AND INSTALLATION.

NOTE

Steps a, b, c, and d are used only if the holding valve (22, figure 10-5) has been removed.

NOTE

Replace all O-rings and seals with parts kit 9-752-100185. Coat all seals and rings with clean hydraulic oil.

a. Check inside of port block for any sharp edges or burrs and remove as necessary with crocus cloth.

b. Install new O-rings onto holding valve.

c. Lubricate holding valve and O-rings' with clean hydraulic oil.

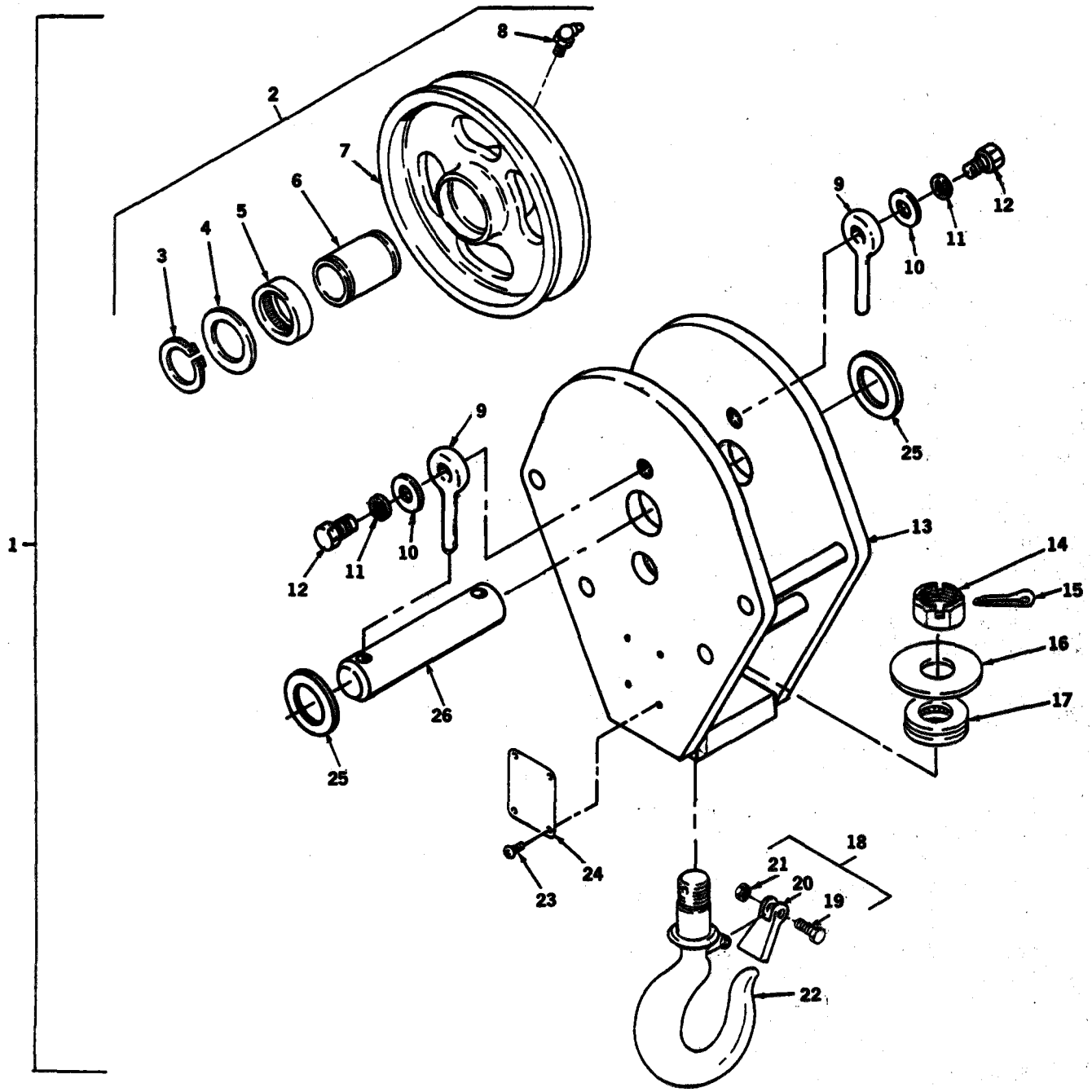
CAUTION

Do not damage the O-rings during installation of the holding valve. If the holding valve turns freely then gets hard to turn, then easy to turn; remove the holding valve and check the O-rings. They have probably been damaged by a sharp edge of a port.

NOTE

The holding valve should turn by hand until compression of the O-rings begins.

d. Carefully install holding valve into port block until fully seated.



LEGEND

1. Hook Block Assembly
2. Sheave Assembly
3. Snap Ring
4. Needle Bearing Washer
5. Needle Bearing
6. Inner Race
7. Sheave
8. Lube Fitting
9. Eyebolt Rivet
10. Flat Washer
11. Lockwasher
12. Capscrew
13. Hook Block Weldment
14. Slotted Hex Nut
15. Cotter Pin
16. Flat Washer
17. Thrust Bearing
18. Safety Hook Kit
19. Screw
20. Latch
21. Nut
22. Hook
23. Drive Screw
24. Rating Plate
25. Spacer
26. Sheave Pin

Figure 10-6. Hook Block Assembly

CAUTION

Avoid stretching seals and rings. Make certain seals and rings are installed in the proper order. Make certain components are clean prior to and during assembly.

e. Install new seals and rings on piston (19), head (11), and retainer plate (7).

f. Install back-up rings (15), O-ring (16), wear rings (17), and G-T ring (18) on piston (19).

g. Install wear rings (12), back-up rings (13), O-ring (14), rod seal (10), and back-up ring (9) on cylinder head (11).

h. Secure retainer plate (7) and wiper ring (8) with four capscrews (6).

i. Lubricate cylinder rod (4) with clean hydraulic oil.

j. Slide the head (11) with retainer plate (7) onto cylinder rod (4).

k. Clean all oil from threads of the cylinder barrel (21) and apply NEVER-SEEZ (paste type) compound.

l. Install piston (19) on rod and secure with hex nut (20). Remove cover on cylinder barrel.

CAUTION

Avoid scratching or damaging the grooved and gland surfaces: or the rings and seals.

CAUTION

Exercise extreme care when handling the cylinder rod. Damage to the rod surface may cause unnecessary maintenance and expense.

m. Install rod assembly (1) into barrel (21) with a twisting motion.

n. Screw cylinder head (11) into cylinder barrel.

o. Pressurize and cycle cylinder. Check for proper operation and any leakage before installation.

p. Position lift cylinder (14, figure 10-1) on turn-table. Insert shaft (11) and install capscrews (12) and nuts (13).

q. Remove tags and install hydraulic lines to lift cylinder (14).

r. Align rod end of lift cylinder with mounting holes in boom assembly. Insert upper lift cylinder shaft (2).

s. Secure upper lift cylinder shaft (2) with eye bolts (5), washers (4), and capscrews (3), lockwashers (6), and nuts (7).

t. Unblock boom assembly (1).

10-17. HOOK BLOCK.

10-18. REMOVAL AND DISASSEMBLY.

a. Lower hook block to ground. Remove wedge socket and unreeve hoist cable.

b. Remove capscrews (12, figure 10-6), lockwashers (11), and flatwashers (10). Lift eyebolt rivet (9) out of sheave pin (26) and withdraw sheave pin from hook block weldment (13). Remove sheave assembly (2) and spacers (25).

c. If sheave assembly (2) is to be disassembled, remove snap rings (3), needle bearing washers (4), needle bearings (5), and inner race (6). If needle bearings and inner race are to be reused, handle with care. Scratches, nicks, burrs, etc. will be cause for replacing with new parts.

NOTE

If needle bearings and inner race are to be replaced, replace as a matched set.

d. Remove cotter pin (15), hex nut (14), flatwasher (16), thrust bearing (17) and hook (22).

10-19. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Wear goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Examine all components for cracks and damage.

c. Ensure safety latch functions properly.

d. Check for spreading of hook.

10-20. ASSEMBLY AND INSTALLATION.

a. Install hook (22, figure 10-6) into hook block weldment. Place thrust bearing (17) and flat washer (16) over threaded shank and tighten slotted hex nut (14). Back off nut allowing 0.01325 inch (0.794mm) free play between flat washer and hook block weldment. Install cotter pin (15) through nut.

b. If sheave assembly (2) was disassembled, install inner race (6) and needle bearings (5) into sheave bore and secure in place with needle bearing washers (4) and snap rings (3) grease fitting (8).

c. Position sheave assembly (2) and spacers (25) in hook block (13) and insert sheave pin (26). Install eyebolt rivets (9) into sheave pin and fasten rivets with flat washers (10), lockwashers (11), and capscrews (12).

d. Reeve hoist cable through hook block. Secure hoist cable to boom point with wedge socket. Refer to figure 10-7.

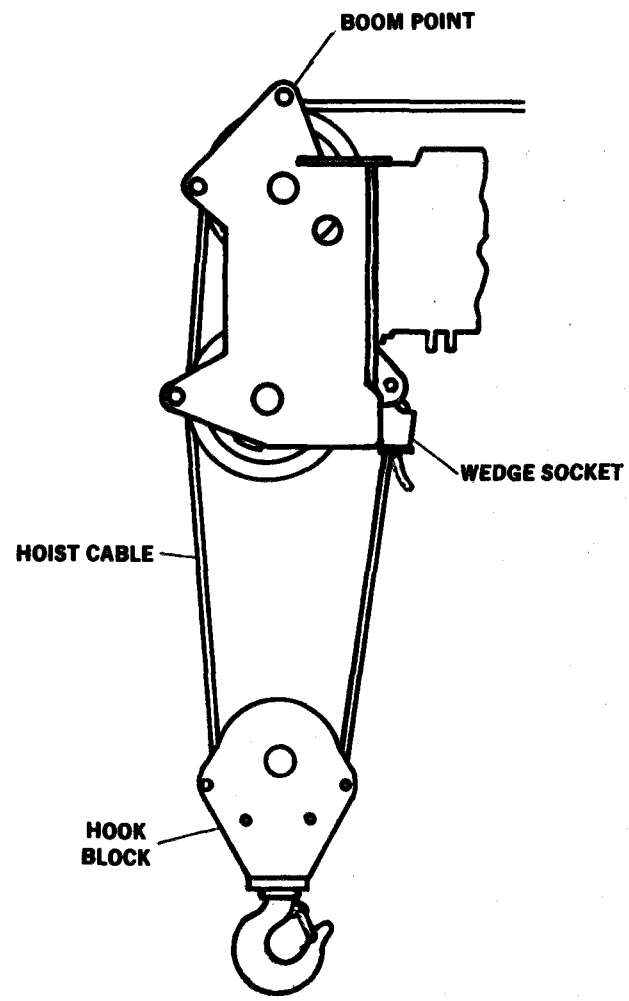


Figure 10-7. Cable Reeving Through Boom Point and Hook Block

10-21. TURNTABLE AND BEARING GEAR.

10-22. REMOVAL.

a. Tag and disconnect all electrical leads and hydraulic hoses to boom, Remove boom harness.

b. Remove hoist.

c. Remove boom assembly.

d. Remove lift cylinder.

e. Remove capscrews (4, figure 10-8) and washers (5).

WARNING

The turntable (3) weighs 450 pounds.

f. With suitable lifting device, remove turntable (3).

g. Remove bushings (13) if necessary. Remove moulding (2).

h. Remove drive gear (10), fitting (8), tubing (11, and adapters (9).

i. Remove capscrews (7) and washers (6).

j. Remove bearing gear (12).

WARNING

The bearing gear (12) weighs 115 pounds.

10-23. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Wear goggles to protect eyes. Avoid breathing in fumes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with a clean cloth dipped in cleaning solvent PD-680.

b. Wipe residue with clean cloth.

c. Dry thoroughly.

d. Inspect all parts for wear and corrosion damage.

e. Inspect bushings (13, figure 10-8) for flat spots and wear.

10-24. REPAIR.

a. Repair shall be limited to the replacement of all damaged components.

10-25. INSTALLATION.

WARNING

The bearing gear (12, figure 10-8) weighs 115 pounds.

a. Install bearing gear (12, figure 10-8). Secure bearing gear with capscrews (7) and washers (6). Install capscrews in sequence shown on figure 10-9. Torque capscrews from 216 to 234 foot pounds.

c. Install adapters (9), tube (11), and fitting (8).

d. Install drive gear (10). Figure 10-10 shows drive gear to bearing ring backlash.

WARNING

The turntable (3) weighs 450 pounds.

e. Install turntable. Secure with new capscrews (4) and washers (5). Tighten capscrews (4) from 161 to 175 foot pounds.

WARNING

Do not re-use old capscrews (4). Always replace with new ones.

f. Install lift cylinder.

g. Install boom assembly.

h. Install hoist.

i. Install boom harness, remove tags and connect electrical leads.

10-26. BOOM ANGLE INDICATOR.

10-27. REMOVAL AND DISASSEMBLY.

a. Remove plug button (2, figure 10-11), bolt (3), bearing (4), washer (5), and bushing (8) with pointer (6).

b. Loosen lock nut (7) and remove pointer (6).

c. Remove screws (9) and indicators (11 and 12). If necessary, remove rivets (14) and scale (13).

10-28 CLEANING AND INSPECTION

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

LEGEND

1. Fitting
2. Moulding
3. Turntable
4. Capscrew
5. Washer
6. Washer
7. Capscrew
8. Fitting
9. Adapter
10. Drive Gear
11. Tubing
12. Bearing Gear
13. Bushing

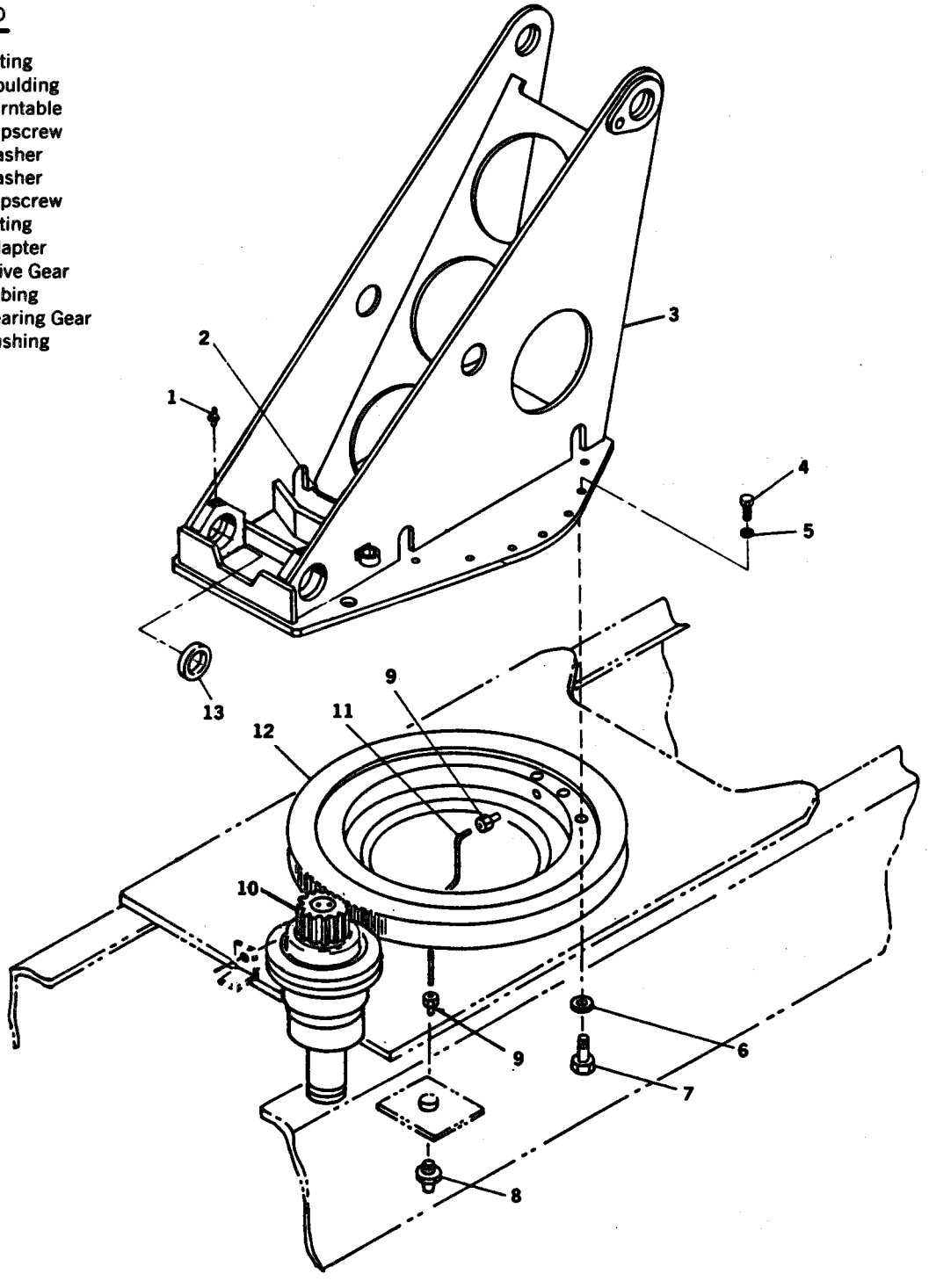


Figure 10-8. Turntable and Bearing Gear

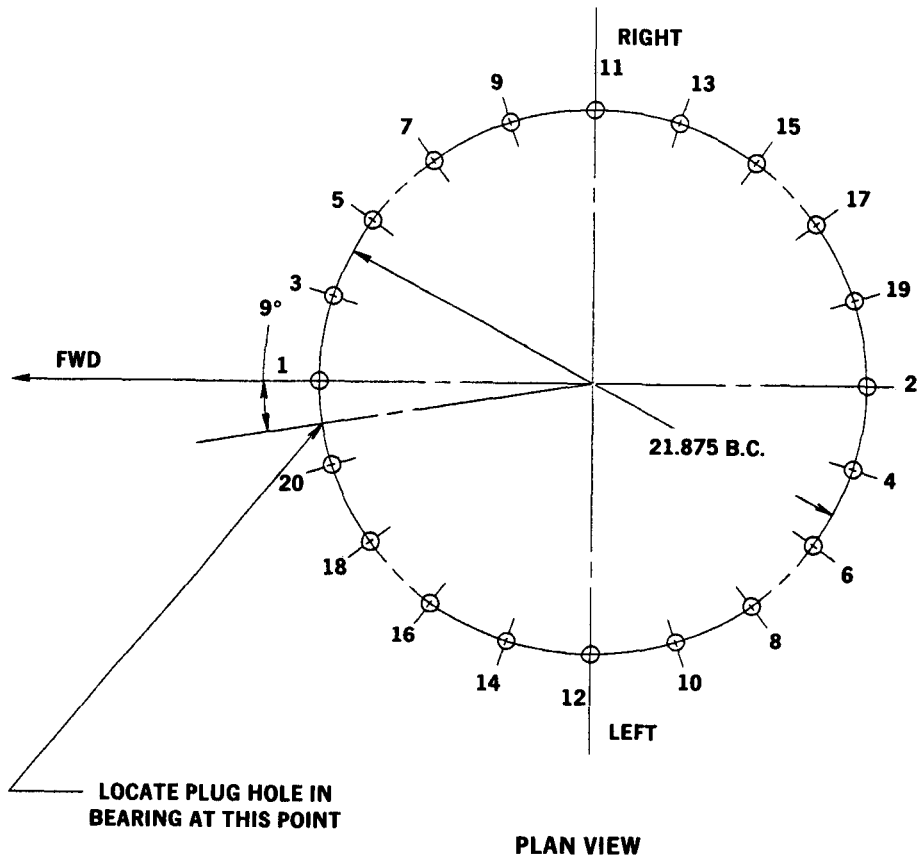


Figure 10-9. Bearing Gear Bolts

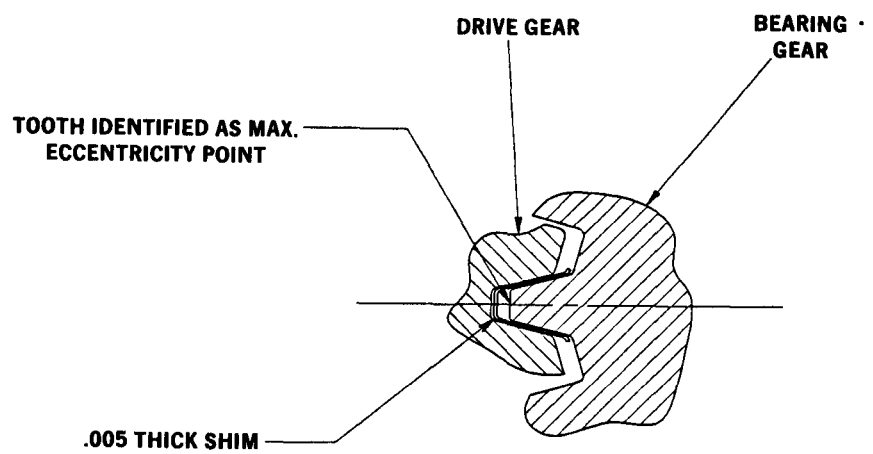


Figure 10-10. Bearing Gear Backlash

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Inspect all parts for damage and corrosion.

10-29. REPAIR.

a. Repair shall be limited to the replacement of all worn parts.

10-30. ASSEMBLY AND INSTALLATION.

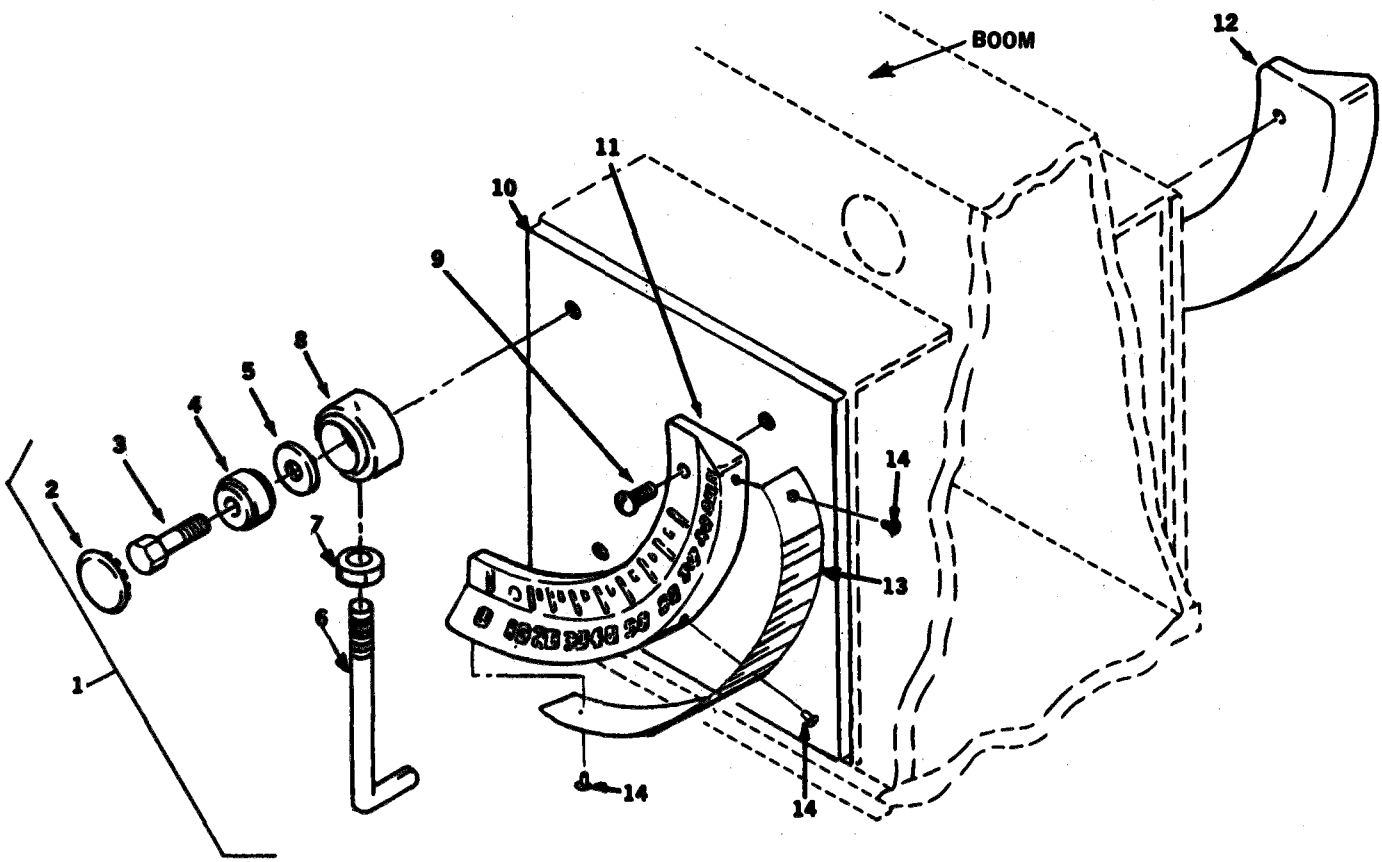
a. Install scale (13, figure 10-11) with rivets (14).

b. Install indicators (11 and 12) and screws (9).

c. Install pointer (6) to bushing (8) and tighten lock nut (7).

d. Assemble bushing (8), washer (5), bearing (4), and bolt (3).

e. Install plug button (2).



LEGEND

1. Boom Elevation Indicator
2. Button Plug
3. Bolt
4. Bearing
5. Washer
6. Pointer
7. Lock Nut
8. Bushing
9. Screw
10. Mounting Plate
11. Left Indicator
12. Right Indicator
13. Scale
14. Rivet

Figure 10-11. Boom Angle Indicator

SECTION 11

HOIST ASSEMBLY MAINTENANCE INSTRUCTIONS

11-1. TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Hoist will raise load.	a. Too much cable on drum.	a. Each layer of cable on the drum reduces the line pull. By reducing the amount of cable on the drum, the lifting pull will increase.
	b. Improper reeving.	b. Multiply the line pull times the number of lines used, adjusting for the amount of cable on the drum; compare with load. Add parts of line if load exceeds results.
	c. Load' capacity exceeded.	c. Reduce load. Refer to Load Chart in operator's cab.
	d. Hydraulic oil low.	d. Replenish system.
	e. Broken hydraulic lines or fittings.	e. Replace lines or fittings.
	f. Damaged relief valve.	f. Repair or replace valve (para. 8-13).
	g. Damaged hoist control valve.	g. Repair or replace valve (para. 8-13).
	h. Damaged primary drive assembly.	h. Repair or replace primary drive assembly (para. 11-2).
	i. Damaged overrunning clutch.	i. Remove brake housing and .associated lines from the primary housing. The clutch assembly is splined to the primary sun gear shaft. The clutch assembly should turn freely in the lifting. mode direction. Repair or replace if damaged (para. 11-2).
	j. Sheared shaft on pump or damaged pump.	j. Install a 0 to 5000 'psi (0 to 34.475 kPa/344.8 bar) gauge in the inlet line of the hoist valve bank. Activate the system. No pressure or excessively low pressure indicates a damaged pump or drive shaft. Repair or replace (para. 11-2).

SYMPTOM	PROBABLE CAUSE	SOLUTION
2. Hoist will not lower.	a. Broken lines or fittings.	a. Replace lines or fittings.
	b. Damaged relief valve.	b. Repair or replace valve (para. 8-13).
	c. Damaged hoist control valve.	c. Repair or replace valve (para. 8-13).
	d. Damaged primary drive assembly.	d. Repair or replace primary drive assembly (para. 11-2).
3. Slow operation down.	a. Low engine rpm.	a. Increase speed.
	b. Damaged circuit relief valve.	b. Replace relief valve (para. 8-13).
	c. Damaged hydraulic pump.	c. Install flow meter in exhaust line of the pump. Under moderate load, check for proper output. Damaged pumps normally build heat. By hand, carefully check the temperature of the pump in relation to the other hydraulic pumps (para. 8-32).
4. Slow operation up.	a. Low engine rpm.	a. Increase engine rpm to recommended setting.
	b. Damaged main relief valve.	b. Replace relief valve (para. 8-13).
	c. Damaged hydraulic pump disconnect.	c. Check speed of other hydraulic functions under load. If all operations are slow, repair or adjust pump disconnect.
	d. Damaged hydraulic pump.	d. Install flow meter in exhaust line of the pump. Under moderate load, check for proper output. Damaged pumps normally build heat. By hand, carefully check the temperature of the pump in relation to the other hydraulic pumps (para. 8-32).
	e. Damaged O-rings in brake valve piston.	e. Install a pressure gauge (O to 5000 psi [0 to 34,475 kPa\344.8 bar]) in the pipe plug hole in the line going into the center of the brake housing. The inability to build or hold pressure at 500 psi (3447.5 kPa/34.48 bar) in this line indicates defective O-rings - replace if damaged (para. 11-2).
	f. Warped brake valve piston.	f. Replace piston (para. 11-11).

SYMPTOM	PROBABLE CAUSE	SOLUTION
5. Erratic operation up.	a. Low engine rpm.	a. Increase speed.
	b. Damaged hoist motor.	b. Install pressure gauge (0 to 5000 psi [0 to 34,475 kPa/344.8 bar]) in the inlet and exhaust line of the motor. Hoist upwards in low speed. Observe meter readings. If the motor has excessively more or less pressure than normal, it is damaged - repair or replace damaged motor (para. 11-6).
6. Erratic operation down.	a. Air in brake release line.	a. Bleed pilot pressure line going into brake housing.
	b. Low engine rpm.	b. Increase speed.
	c. Damaged circuit relief valve.	c. Replace relief valve (para. 8-13).
7. Sticking spool in the control valve.	a. Excessively high oil temperature.	a. Eliminate any restriction in pipe line or filtering system.
	b. Dirt in oil.	b. Change oil and flush system. (para. 8-4).
	c. Valve warped from mounting.	c. Loosen valve and check (para. 8-13).
	d. Excessively high pressure in valve. (Relief valves not working properly).	d. Check pressure at inlet and at working ports (para. 8-13).
	e. Handle or linkage binding.	e. Free linkage.
	f. Spacer bent.	f. Replace valve (para. 8-13).
	g. Spring or valve cap binding.	g. Loosen cap, recenter and retighten (para. 8-13).
	h. Oil not thoroughly warmed up.	h. Allow time for system warm up.
8. Leaking seals.	a. Paint on or under seal.	a. Remove and clean, as necessary.
	b. Dirt under seal.	b. Remove and clean, as necessary.
	c. Scored spool.	c. Replace valve (para. 8-13).
	d. Loose seal plates.	d. Clean and tighten plates (para. 8-13)
	e. Cut or scored seal.	e. Replace faulty parts (8-13).

SYMPTOM	PROBABLE CAUSE	SOLUTION
9. Unable to move spool in or out.	a. Dirt in valve.	a. Clean and flush out valve assembly (para. 8-13).
	b. Spool cap full of oil	b. Replace seals (para. 8-13).
	c. Bind in linkage.	c. Free linkage.
10. Load drops when spool moved from neutral.	a. Dirt in check valve.	a. Disassemble and clean check valve (para. 8-13).
	b. Scored check valve poppet or seat.	b. Replace poppet or lap poppet to seat (para. 8-13).
11. Poor hydraulic system Performance or failure.	a. Damaged pump.	a. Check pressure and repair or replace pump (para. 8-32).
	b. Dirt in relief valve.	b. Disassemble and clean relief valve (para. 8-13).
	c. Relief valve damaged	c. Replace relief valve (para. 8-13)
	d. Worn hoist motor.	d. Repair or replace damaged components (para. 11-6).

11-2. HOIST.

11-3. REMOVAL AND DISASSEMBLY.

a. Remove wire rope from hoist.

NOTE

The hoist weighs approximately 475 pounds (215.5 kg).

b. Attach suitable lifting device to hoist assembly. Tag and disconnect hydraulic supply lines to hoist; cap or plug all lines or openings. Remove nuts, bolts, washers, and hoist.

NOTE

On some SCAMPS shims are used (in varying numbers) for leveling the hoist drum. Note the number and location of shims for installation.

NOTE

Any maintenance involving disassembly of the hoist should include replacement of all gaskets, seals, and O-rings. Use parts kit 61559.

C. With hoist lying on a clean work area, place a short piece of l-inch (25.4 mm) pipe over threads of oil drain plug hole (1, figure 11-1).

d. Use a 3/8 inch drive extension to remove oil drain plug (1) through pipe.

NOTE

If the drain holes were not aligned when the hoist was removed from the hoist bracket, the oil can be drained through the filter plug in the drum support by turning the hoist up on the drum support end.

e. Place hoist on end opposite motor. Tag and remove hydraulic hoses (45, 53, and 81) that connect brake valve (44) and manifold (43) to brake cylinder (2).

f. Remove capscrews securing hoist motor (42) and lift motor from assembly. Remove and discard O-ring (49).

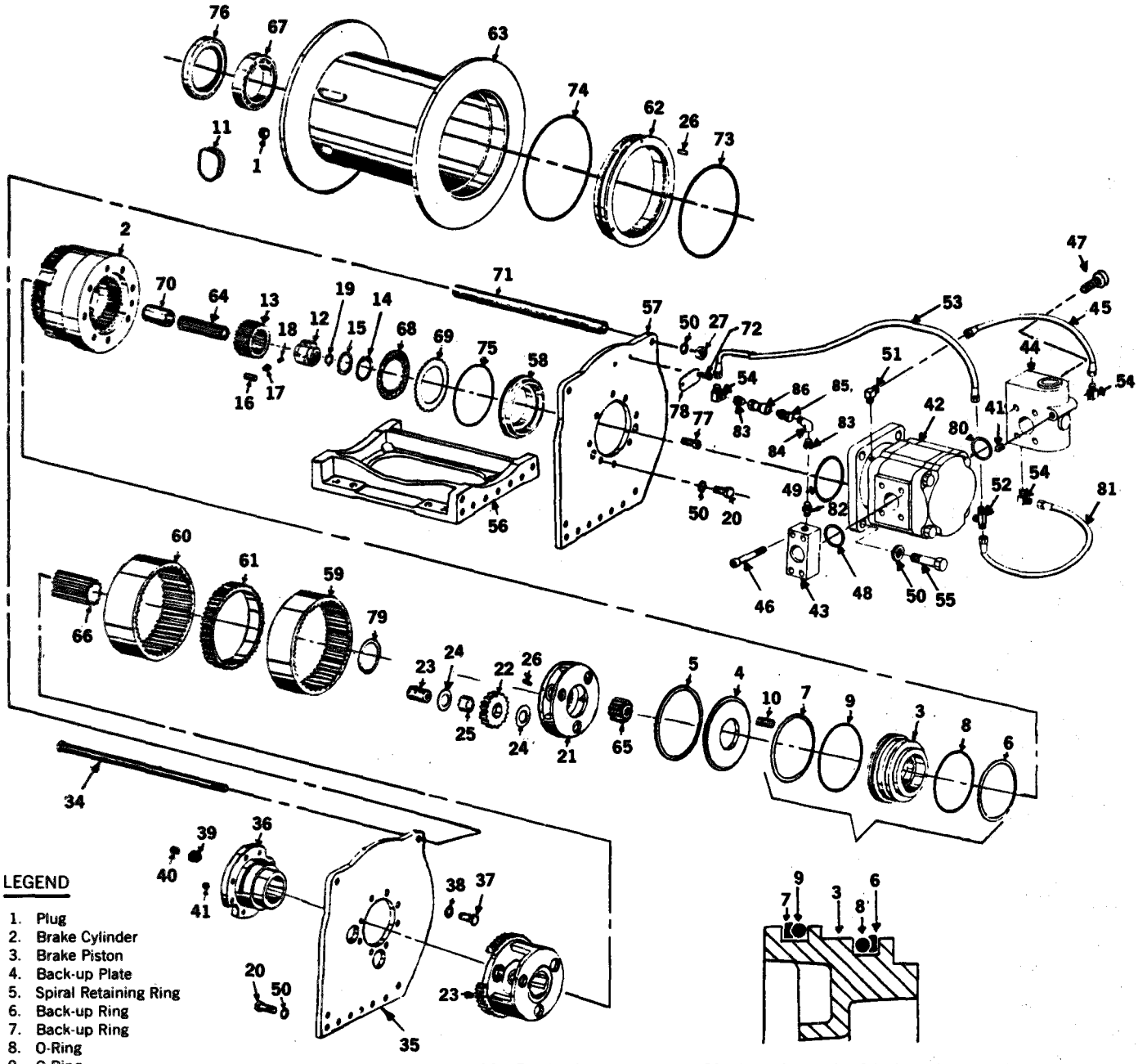
g. Tag and remove hoses and fittings (51 and 52).

h. Remove large tie bolt (34).

i. Remove eight capscrews (20) that hold end plate (57) to base (56). Cover 1/4 inch nipple (77) with a cloth prior to removing four capscrews (20) that hold plate (57) to brake cylinder (2). The cloth should contain the residue of oil that will be discharged from brake release port when capscrews are removed, Remove hex nut (27), lockwasher (50), bolt (34), and end plate spacer (71).

j. Lift motor and plate (57) off hoist assembly.

k. Remove 1/4 inch reducing nipple (77).



LEGEND

1. Plug
2. Brake Cylinder
3. Brake Piston
4. Back-up Plate
5. Spiral Retaining Ring
6. Back-up Ring
7. Back-up Ring
8. O-Ring
9. O-Ring
10. Brake Spring
11. Cable Wedge
12. Brake Cam
13. Brake Race
14. Snap Ring
15. Brake Roller Retainer
16. Roller
17. Plunger
18. Spring
19. Snap Ring
20. Special Capscrew
21. Primary Planet Carrier
22. Primary Planet Gear
23. Primary Planet Gear Shaft
24. Thrust Bearing
25. Roller Bearing
26. Spiral Pin
27. Hex Nut
28. Output Planet Carrier
29. Output Planet Gear
30. Output Planet Gear Shaft
31. Thrust Bearing
32. Roller Bearing
33. Bearing Spacer
34. Bolt
35. Support End Plate
36. Bearing Support
37. Bolt
38. Star Lockwasher
39. Bushing Reducer
40. Vent Plug
41. Pipe Plug
42. Hoist Motor
43. Manifold
44. Brake Valve
45. Hose Assembly 14 Inch
46. Allen Head Capscrew
47. Allen Head Capscrew
48. O-Ring
49. O-Ring
50. Lockwasher 1/2 HD
51. Elbow Street 90 Deg.
52. Tee Male Branch
53. Hose Assembly 10 Inch
54. Elbow Street 90 Deg.
55. Capscrew
56. Base
57. End Plate
58. Motor Pilot
59. Input Ring Gear
60. Output Ring Gear
61. Ring Gear Coupling
62. Drum Bushing
63. Drum
64. Input Shaft
65. Primary Sun Gear
66. Output Sun Gear
67. Ball Bearing
68. Disc Friction (Fiber)
69. Disc Brake (Steel)
70. Input Shaft Spacer
71. End Plate Spacer
72. Drive Screw
73. Quad Ring
74. O-Ring
75. O-Ring
76. Oil Seal
77. Reducer Nipple
78. Warning Plate
79. Thrust Washer
80. O-Ring
81. Hose Assembly 16 Inch
82. Straight Nipple
83. Reducer
84. Elbow
85. Male Connector
86. Female Connector

Figure 11-1. Hoist

NOTE

Use caution not to damage brake discs which are located directly beneath motor pilot.

l. Remove motor pilot (58). Remove and discard O-ring (75).

m. Remove overriding brake race (13) and brake discs (68 and 69) from brake cylinder (2).

n. Use two capscrews that secured the brake cylinder (2) to end plate (57) and insert each through a link of a short length of chain and retighten capscrews. Lift cylinder assembly out of drum (63).

o. If drum bushing (62) does not lift-out with cylinder (2), lift and remove. Discard quad ring (73) and O-ring (74).

p. Remove spacer (70) and input shaft (64).

q. Lift out primary sun gear (65).

r. Pull primary planet carrier (21) from ring gear (61).

s. Remove output sun gear (66) and thrust bearing (31) from output planet carrier (28).

t. Remove input ring gear (59).

NOTE

Welding rod may be bent into a hook to assist in gear and carrier removal.

Remove ring gear coupling (61), output ring gear (60). and output planet carrier (28).

v. Lift coupling and ring gear from planet carrier.

w. Remove drum (63) from bearing support (36).

x. Turn over drum and remove and discard seal (76). Inspect bearing (67) in end of drum.

NOTE

If drum bearing replacement is necessary after inspection, use a bearing driver to remove bearing (67) from the drum.

NOTE

It is not necessary to remove bearing support from plate or the end plate from the base unless these parts show extreme wear or damage.

y. Check bearing support (36) sealing surfaces for nicks and burrs.

CAUTION

Make certain threaded rod of the compression tool fully engages the lower plate. If a press is used, care must be exercised that damage to any parts by exertion on the spring plate is to be avoided. After removing the spiral retaining ring, release compression tool by holding threaded rod stationary while backing off nut.

z. Turn brake cylinder on end with spiral retaining ring (5) on top. Use a compression tool or a shop press to compress spring plate in order to remove spiral retaining ring.

aa. Remove back-up plate (4) from brake cylinder.

bb. Remove twelve springs (10) from brake piston (3), examine for broken coils and measure overall length. The overall length should be 1-1/2 inches (38.1 mm). Any spring measuring less than 1-7/16 inches (36.5 mm) means that all twelve should be replaced.

cc. Turn brake cylinder (2) over. Use a rubber mallet and drift to remove brake piston (3).

CAUTION

Care must be taken not to scratch the surfaces in the O-ring grooves.

dd. Remove and discard back-up rings (6, 7) and O-rings (8, 9).

ee. Remove snap ring (14) and brake roller retainer (15) from one end only.

ff. Use shop cloth to retain springs (18) and plungers (17) as center of cam (12) is pressed from brake race (13).

gg. Remove output planet gears (29) from the output planet carrier assembly by driving spiral pins (26) into center of planet gear shafts (30).

hh. Remove planet gear shaft (30), bearings (32), spacers (33), thrust bearings (31), and gears (29).

ii. Use a punch to drive spiral pins from planet shafts. Discard spiral pins.

jj. Remove primary planet gears (22) by driving spiral pins (26) into center of planet gear shafts (23).

kk. Remove planet gear shaft (23), bearing (25), thrust bearings (31), and gears (22).

ll. Use a punch to drive spiral pins from planet shafts. Discard spiral pins.

11-4. CLEANING

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

11-5. ASSEMBLY AND INSTALLATION.

NOTE

Coat O-rings bearings, bushings and rubber parts of seals with hydraulic oil during assembly. Use a light coat of thread sealing compound or sealing tape on pipe fittings and plugs. Ensure the compound does not enter the inside of parts or passages which are exposed to hydraulic oil.

a. Insert roller bearing (25, figure 11-1) into a planet gear (22). Place a thrust bearing (31) on each side of gear and install in primary planet carrier opening. Slide planet gear shaft (23) through carrier (21), thrust bearings (31), roller baring (25), and gear (22).

b. Align holes in carrier (21) and shaft (23) so spiral pin (26) can be installed. Always use a new 3/16 x 3/4 inch spiral pin when assembling the unit.

NOTE

The spiral pin is slightly recessed in the carrier when it is in its proper place. Use a center punch to dent the carrier next to the hole. This distortion will prevent the pin from working itself out.

c. Drive spiral pin (26) into place.

d. insert two roller bearings (32) and bearing spacer (33) into a gear (29) with spacer between bearings. Place a thrust bearing on each side of gear and install in output planet carrier opening. Slide shaft (30) through carrier (28), thrust bearings (31), roller bearings (32), spacer (33), and gear (29).

e. Align holes in carrier (28) and shaft (30) so spiral pin (26) can be instilled. Always use a new 3/16 x 3/4 inch spiral pin when assembling unit.

NOTE

The spiral pin is slightly recessed in carrier when it is in its proper place. Use a center punch to dent the carrier next to the hole. This distortion will prevent pin from working itself out.

f. Drive spiral pin (26) into place.

g. Insert one snap ring (14) and retaining washer in date, then place cam (12) inside race (13)' with ,centerline of spring holes level with top surface of race. Use a spacer under cam to hold it in this position.

h. Install springs (18) and plungers (17) using race (13) to hold them in place.

i. Use a small screwdriver to compress each spring as rollers (16) are inserted.

j. Install roller retainer (15) and snap ring (14).

NOTE

The snap ring (14) will be seated in groove in' splined hole if installed correctly. The snap ring is used to position the brake assembly in the hoist.

k. Install new O-rings, (8, 9) and back-up rings (6, 7) on brake piston (3).

NOTE

The concave surface of the back-up rings (6, 7) must be next to the O-ring (8, 9). Allow the assembly to set for 10 minutes in order for the O-rings and back-up rings to return to their original shape.

l. Back-up rings (6, 7) must be installed to outside of O-rings (8, 9) as shown in figure 11-2.

m. Lubricate outside of piston (3, figure 11-1), O-rings (8, 9) and back-up rings (6, 7) with all purpose lubricant before inserting 'piston (3) into brake cylinder (2).

NOTE

Use care not to cut O-rings or back-up rings when assembling unit.

n. Insert piston (3) into brake cylinder (2).

o. Install twelve springs (10) in piston (3).

p. Install back-up plate (4) in brake cylinder (2).

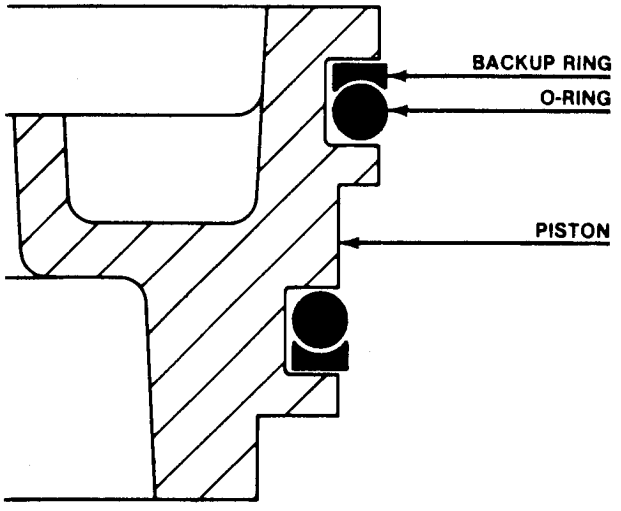


Figure 11-2. Back-up Ring Placement

NOTE

By use of a compression tool or press, compress twelve brake springs (10) making certain that the depressor fully engages lower cylinder plate.

q. Install spiral retaining ring (5).

WARNING

Release the press or compression tool slowly to ascertain the retaining ring has been installed properly. An improper ring fit could result in a free-fly condition which could inflict death or injury to personnel.

r. Apply a pressure check on brake cylinder assembly with a hand pump or suitable equivalent connected to the 1/4 inch brake port. Apply 1000 psi (6895 kPa/68.95 bar) to the port and allow to set for five minutes. If gauge does not register a pressure drop, O-rings (8, 9) and back-up rings (6, 7) have been installed correctly.

NOTE

If bearing support was removed from end plate, install new star lockwashers.

s. Turn end plate (35) and bearing support (36) down, with base in up position. Lubricate sealing and bearing lands on bearing support with a light grade lubricant.

t. Install new bearing (67) in drum, if necessary and use a good grade of sealant on outside diameter of new seal (76). Turn spring side of seal next to bearing then press into drum, using a flat plate.

u. Turn drum over and set it down on bearing support (36) being careful not to damage seal when lowering drum (63) onto bearing support.

v. Lower output planet carrier (28) into drum (63). Ensure teeth on carrier mesh properly with teeth in drum.

w. Insert three piece ring gear. First, long output ring gear (60), then coupling (61), and finally short primary ring gear (59). The output ring gear teeth must mesh with output carrier planet gears. The coupling meshes with each ring gear, and is in contact with shoulder inside each ring gear.

x. Install output sun gear (66) and thrust bearing (31).

y. Position primary planet carrier (21), in ring gear (59) meshing planet gears (22) with ring gear. The hub fits down engaging output sun gear (66).

z. Install sun gear (65).

aa. Insert input shaft (64) into primary sun gear, then slide spacer (70) over input shaft.

NOTE

To install the brake cylinder in the drum, use two capscrews that secure the brake cylinder to the end plate for easy lifting and setting.

bb. Install brake cylinder (2) in drum (63), making certain brake cylinder engages ring gear teeth.

cc. Lubricate and install new quad ring (73) and O-ring (74) on drum bushing (62).

dd. Install drum bushing (62) aligning bushing with three drum pins.

NOTE

When the overriding brake clutch has been installed, the cam (12) and input shaft (64) should turn freely in the same direction the drum turns to retract the wire rope. This should be counterclockwise as viewed from the motor end (42).

ee. Install overriding brake clutch by holding race (13)

in one hand and rotate cam (12) with input shaft (64) before positioning into drum. Install input shaft.

CAUTION

Make certain the snap ring (14) is seated in the groove in the splined hole in the cam. Since the snap ring positions the brake clutch assembly, it is imperative that the snap ring be installed.

ff. Install snap ring (14) and overriding clutch assembly over input shaft (64).

NOTE

Check the condition of the seven steel (69) and six fiber (68) brake discs. They should be flat in a plane perpendicular to the hoist axis. The teeth should not be pointed. The fiber discs should have grooves in the fiber material.

gg. Install brake discs beginning with a steel disc and finish with a steel disc. The alternate lay-in method should produce 6 or 7 fiber discs dependent on manufacturing tolerances.

hh. Install O-ring (75) on motor pilot (58): Lubricate ring with all-purpose lubricant before assembly.

ii. Install motor pilot (58) on top of brake discs (68 and 69).

NOTE

Measure the brake stack-up. The measurement should be a minimum of 19/32 inch from the top of the motor pilot (58) to the top of the brake cylinder (2). If the measurement is less than stated, remove the motor pilot and add a steel disc (69) to the top of the brake package. Replace the motor pilot. Remeasure the stack. Do not exceed an overall height of 21/32 inch.

jj. Install 1/4 inch reducing nipple (77) in brake cylinder (2).

kk. Install end plate (57) and align it on motor pilot (58).

ll. Install four capscrews and lockwashers that hold end plate (57) to brake cylinder (2). Install eight capscrews and lockwashers that hold side plate to base (56). Torque twelve capscrews to 75 toot-pounds (10.3 kgm).

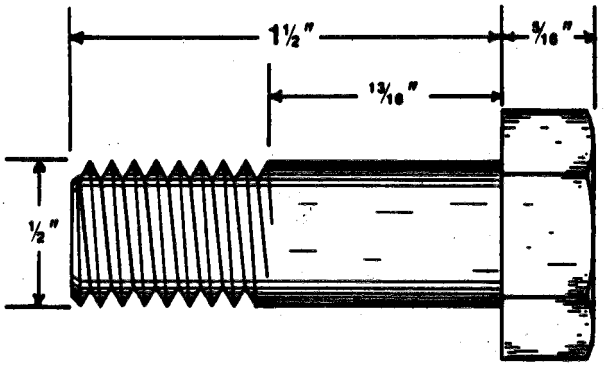


Figure 11-3. Special Capscrew Dimensions

mm. Use only those capscrews provided to fasten brake cylinder and base to end plate. These capscrews (figure 11-3) serve as bolts and dowel pins.

nn. Install long tie bolt (34).

oo. Install tee (52) and hydraulic hoses (45, 53, and 81). Use a good thread sealant, being careful not to get sealant in hydraulic lines since it could block orifice in the brake valve. The long hose should point towards top of hoist if properly installed.

pp. Engage motor shaft in brake cam (12) and lower motor (42) into place. Insert four capscrews (55) and torque to 75 foot-pounds.

qq. Remove tags and install hydraulic supply lines.

rr. Upon assembly completion, check all capscrews (20) and fittings (51, 52, and 54) to ensure tight fit. Refill hoist with hydraulic oil and insert fill plug (1).

11-6. HOIST MOTOR.

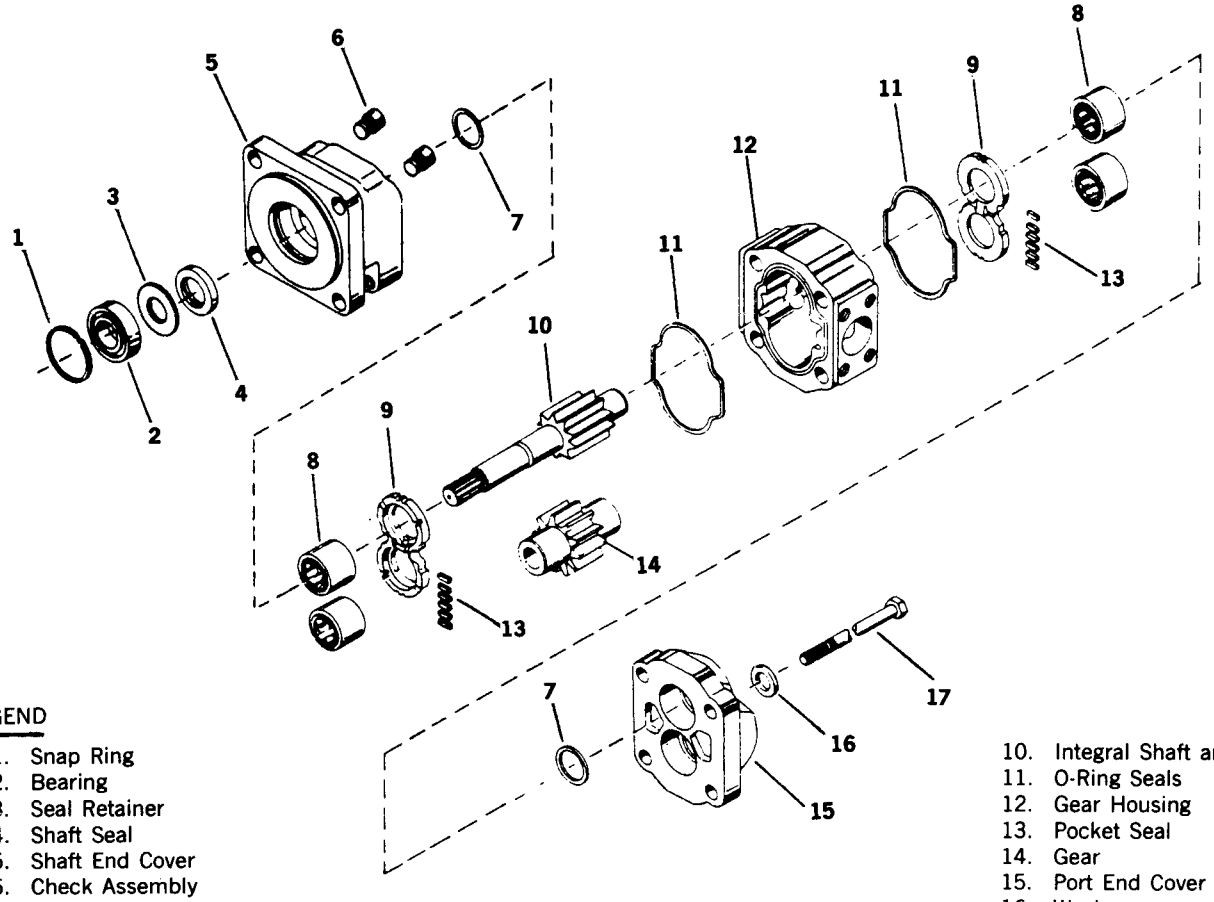
11-7. REMOVAL AND DISASSEMBLY.

a. Tag and remove hydraulic hoses (45, 53, and 81, figure 11-1) that connect brake valve (44) and manifold (43) to brake cylinder (2).

b. Remove capscrews (55) securing hoist motor (42) to end plate (57). Remove and discard O-ring (49). Tag and remove fittings (51 and 52).

c. Remove capscrews (46 and 47), brake valve (44) and manifold (43). Discard O-rings (48 and 80).

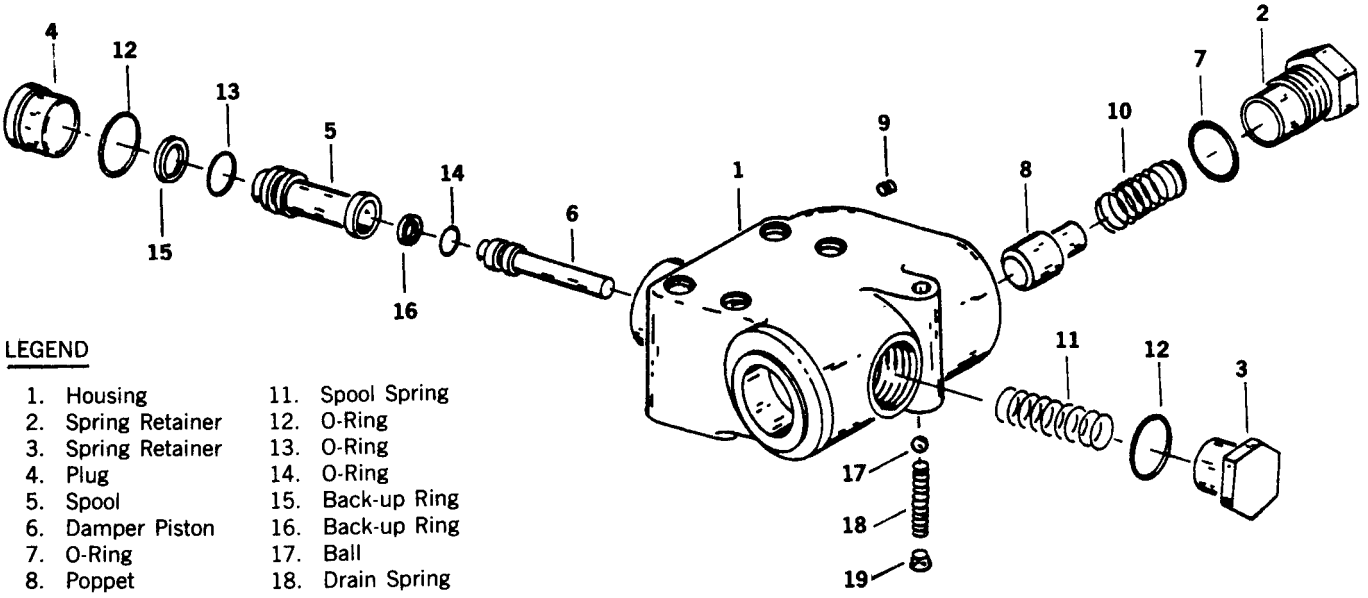
d. Index mark port end cover (15, figure 11-4), gear housing (12), and shaft end cover (5) to facilitate reassembly.



LEGEND

1. Snap Ring
2. Bearing
3. Seal Retainer
4. Shaft Seal
5. Shaft End Cover
6. Check Assembly
7. Ring Seal
8. Roller Bearings
9. Thrust Plate
10. Integral Shaft and Gear
11. O-Ring Seals
12. Gear Housing
13. Pocket Seal
14. Gear
15. Port End Cover
16. Washer
17. Capscrew

Figure 11-4. Hoist Motor



LEGEND

1. Housing
2. Spring Retainer
3. Spring Retainer
4. Plug
5. Spool
6. Damper Piston
7. O-Ring
8. Poppet
9. Pilot Orifice
10. Spring
11. Spool Spring
12. O-Ring
13. O-Ring
14. O-Ring
15. Back-up Ring
16. Back-up Ring
17. Ball
18. Drain Spring
19. Plug

Figure 11-5. Brake Valve

e. Remove four capscrews (17) and washers (16) from port end cover (15).

CAUTION

If the end cover (15) will not lift off, pry it off using care to avoid damaging machined surfaces.

f. Remove port end cover (15) from gear housing (12).

CAUTION

Avoid distorting the thrust plate (9).

g. Pry thrust plate (9) from port end cover (15) carefully with a thin bladed screwdriver. Remove and discard pocket seals (13).

h. Examine roller bearings (8) for spalling and pitting. If replacement is necessary, pull bearings (8) with a bearing puller.

NOTE

To replace ring seal (7), pull the integral shaft and roller bearing (8) with a bearing puller and remove the ring seal (7) from bottom of bearing bore.

i. Check ring seals (7), for wear and replace if necessary.

CAUTION

If the gear housing (12) will not lift off, pry it off using care to avoid damaging machined surfaces.

j. Remove integral shaft and gear (10), gear (14), and gear housing (12) from shaft end cover (5). Keep gears together as they are a matched set.

k. Remove and discard O-ring seals (11) from grooves in housing (12) faces.

CAUTION

Avoid distorting the thrust plate.

l. Pry thrust plate (9) from shaft end cover (5) with a thin bladed screwdriver. Remove and discard pocket seals (13).

m. Examine roller bearings (8) for spalling and pitting. If replacement is necessary, pull bearings (8) with a bearing puller.

NOTE

To replace ring seal (7), pull integral shaft and roller bearing (8) with a bearing puller and remove ring seal (7) from bottom of bearing bore.

n. Check ring seal (7) for wear and replace if necessary.

o. Remove outboard bearing snap ring (1) with a small screwdriver or awl.

p. Pull outboard bearing (2) from shaft end cover (5) with a bearing puller.

q. Remove seal retainer (3) and shaft seal (4) from shaft end cover (5).

r. If necessary remove check assemblies (6) from shaft end cover (5).

11-8. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

NOTE

Wear in excess of 0.005-inch (0. 127 mm) in the gear housing cutout (12, figure 11-4) justifies replacement of the housing.

b. Place a straight edge across housing bore to check for flatness of mating surfaces. If a 0.005-inch (0.127 mm) feeler gauge will slip between straight edge and housing, replace housing (12).

NOTE

Gears (10 and 14) are a matched set, therefore both gears must be replaced even if only one was found damaged.

c. Any wear on gear hubs tnat is detectable by touch, or exceeding 0.002-inch (0.051 mm) justifies replacement. Scoring, grooving, or burring of outside

diameter of gear teeth, as well as nicking, grooving, or fretting of teeth surfaces necessitates replacement.

d. Replace integral shaft and gear (10) if any wear is detectable visibly or by touch in seal areas or at drive coupling. A maximum of 0.002-inch (0.051 mm) wear is allowable. Wear or damage to splines justifies replacement. Wear in shaft seal areas indicates oil contamination.

e. Thrust plates seal gear section at sides of gears. Wear in this area will allow internal slippage, resulting in oil bypassing within motor. Maximum allowable wear is 0.002-inch (0.051 mm). Replace thrust plates (9) if scored, eroded, or pitted.

f. Check center area of thrust plate (9) where gears mesh. Erosion in this area indicates cavitation or oil aeration. Discoloration of plates would indicate overheating, probably as a result of insufficient oil.

11-9. REPAIR.

CAUTION

If gears are replaced, bearings must be replaced also.

a. If bearings have been removed, deburr bearing bores. Clean all parts in solvent P-D-680 and dry them with compressed air.

b. Bearings should fit into bore with a light press fit, however, a neat hand fit is allowable. If bearings tend to fall from bore, bore is oversize.

c. Stone off all machined surfaces with a medium grit Carborundum stone.

11-10. ASSEMBLY AND INSTALLATION.

NOTE

Coat O-rings, bearings, bushings, and rubber parts of seals with hydraulic oil during assembly. Use a light coat of thread sealing compound or sealing tape on pipe fittings and plugs. Ensure the compound does not enter the inside of parts or passages which are exposed to hydraulic oil.

CAUTION

When securing motor in a vise, do not grip on or near machined surfaces.

a. If removed, install check assemblies (6, figure 11-4) into shaft end cover (5).

b. Install shaft seal (4) and seal retainer (3) into end cover (5).

c. Install outboard bearing (2) into shaft end cover.

d. Install snap ring (1) into shaft end cover groove to retain outboard bearing.

e. If removed, install new ring seals (7) into bottom of integral shaft and gear bearing bore on both shaft end cover (5) and port end cover (15).

f. Replace bearings (8) that have been removed from shaft end cover (5) and port end cover (15). Install bearings with an arbor press.

g. Place a small amount of heavy grease into two middle slots in open face of thrust plates (9) and insert pocket seals (13).

h. Position two thrust plates (9) with pocket seal slots toward face of shaft end cover and port end cover over bearings (8). Ensure pocket seals (13) in center slots are still in place and tap thrust plate with a soft mallet to 0.031-inch (0.794 mm) from machined surface.

i. Cut four pocket seals (13) for each thrust plate (9) approximately 0.25-inch (6.35 mm) long from pocket sealstrip. Insert one pocket seal into each slot in thrust plate (9). Push each pocket seal all the way in so that they touch roller bearings (8). Tap thrust plate (9) down firmly against machined surface with a soft mallet. Using a sharp razor blade, trim exposed end of pocket seal square and flush with thrust plate.

j. Grease new O-ring seals (11) and install seals into grooves in both sides of gear housing (12).

k. Install drive gear (14) and integral shaft and gear (10) into shaft end cover roller bearing bores.

CAUTION

Avoid pinching the gasket seal.

1. Slide gear housing (12) over gears and tap with a soft mallet until housing rests tightly against shaft end cover (5).

CAUTION

Ensure index marks are properly aligned.

CAUTION

Avoid pinching the gasket seal.

NOTE

Oil the gears with hydraulic oil to provide initial lubrication when the motor is started.

m. Install port end cover (15) over gears hubs and tap with a soft mallet until cover (15) rests tightly against gear housing (12).

n. Thread four capscrews (17) with washers (16) into shaft end cover (5). Torque diagonally opposed capscrew (17) to 200 foot-pounds.

o. Position O-ring (48, figure 11-1) and assemble manifold (43) to motor (42) with capscrews (46).

p. Position O-ring (80) and assemble brake valve (44) to motor (42) with capscrews (47).

q. Position O-ring (49) and engage motor shaft in brake cam (12). Lower motor (42) into place and fasten to end plate (57) with capscrews (55) and torque to 75 foot-pounds.

r. Install fittings (51 and 52) and connect hydraulic hoses (45, 53 and 81). Use a good thread sealant, being careful not to get sealant into hydraulic lines.

11-11. HOIST BRAKE VALVE.

11-12. REMOVAL AND DISASSEMBLY.

a. Remove hydraulic hose (45, figure 11-1) and fitting (54).

b. Remove capscrews (47) securing brake valve (44) to motor (42). Discard O-ring (80).

c. Unscrew plug (4, figure 11-5) from housing (1) and remove spool (5), and damper piston (6).

d. Remove O-ring (12) from plug (4), and backup ring (15) and O-ring (13) from O.D. of spool (5). Discard O-rings.

e. Withdraw damper piston (6) from inside spool (5). Remove backup ring (16) and O-ring (14) from spool and discard.

f. Unscrew spring retainer (3) and remove spring (11). Discard O-ring (12).

g. Remove plug (19), drain spring (18) and ball (17).

h. Unscrew spring retainer (2), and remove spring (10) and poppet (8). Discard O-ring (7).

11-13. CLEANING.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

11-14. ASSEMBLY AND INSTALLATION.

NOTE

Coat O-rings bearings, bushings, and rubber parts of seals with hydraulic oil during assembly, Use a light coat of thread sealing compound or sealing tape on pipe fittings and plugs. Ensure the compound does not enter the inside of parts or passages which are exposed to hydraulic oil.

a. Place O-ring (7, figure 11-5) against sealing face of spring retainer (2). Insert spring (10) and poppet (8) into spring retainer and screw into housing (1).

b. Insert ball (17), spring (18) into housing (1) and retain in place with plug (19).

c. Place O-ring (12) against sealing face of spring retainer (3) and screw into housing (l). Place O-ring 12 against sealing face of plug (4).

d. Place back-up ring (15) and O-ring (13) on O.D. of spool (5). Place backup ring (16) and O-ring (14) on damper piston (6). Insert piston into spool. Place spool spring (11) around O.D. of piston and enter into housing (1). Ensure spool spring is firmly sealed into spring retainer (3). Retain all parts by screwing plug (4) into housing (1).

e. Position O-ring (80, figure 11-1) and assemble brake valve (44) to motor (42) with capscrews (47).

f. Install fitting (54) and connect hydraulic hose (45).

SECTION 12

OUTRIGGER MAINTENANCE INSTRUCTIONS

12-1. TROUBLESHOOTING.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Outriggers slow or not operating.	a. Extremely cold hydraulic oil.	a. Operate crane to bring oil to operating temperature.
	b. Low hydraulic oil.	b. Replenish hydraulic oil to proper level.
	c. Low engine rpm.	c. Increase engine rpm.
	d. Main relief valve damaged.	d. Repair or replace relief valve (para. 8-26).
	e. Leaking or restricted hydraulic lines.	e. Inspect and replace fitting, o-rings, and hoses as needed. Fill hydraulic reservoir to proper level.
	f. Damaged hydraulic cylinder.	f. Remove and repair hydraulic cylinder (para. 12-7).
	g. Damaged control valve or outrigger selector valve.	g. Remove and repair affected control valve (para. 8-13 or 8-18).
	h. Damaged hydraulic pump section.	h. Remove and repair hydraulic pump (para. 8-32).

12-2. OUTRIGGERS.

12-3. DIASSEMBLY.

a. Lower outrigger arm until pad is within an inch of touching the ground.

b. Shutdown engine and disconnect batteries at negative terminal.

c. Place blocks of wood under outrigger cylinder for support.

d. Remove capscrew (4, figure 12-1), washers (3), and end caps (2).

e. Use a wood dowel or brass drift pinto drive shaft (5) out of arm (6).

f. Brace arm (6) to prevent its falling. Use a wood dowel or brass drift pin to drive shaft (7) from outrigger weldment.

g. Remove arm (6).

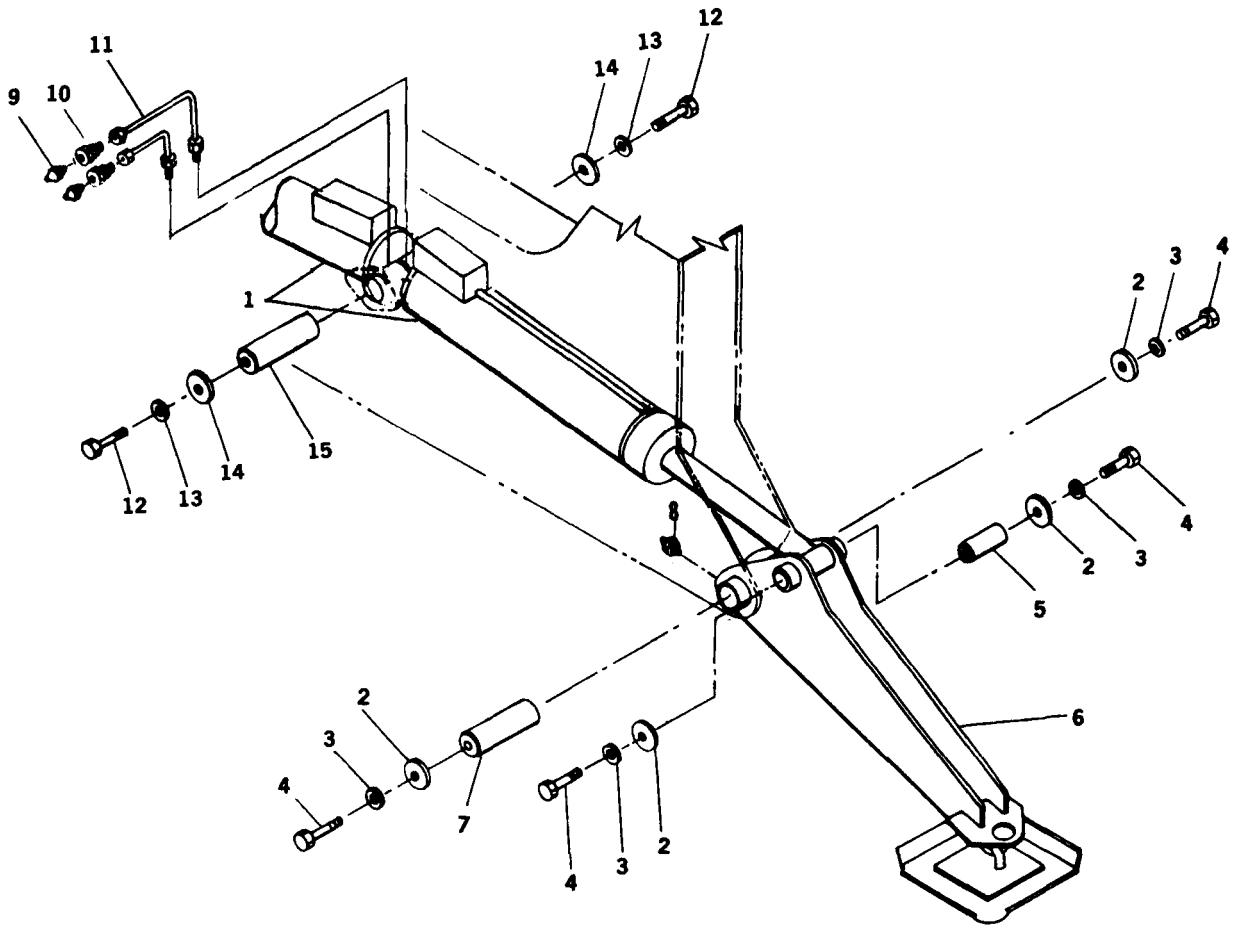
12-4. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes, If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.



LEGEND

1. Outrigger Cylinder
2. End Cap
3. Washer
4. Capscrew
5. Shaft
6. Arm
7. Shaft
8. Grease Fitting
9. Grease Fitting
10. Fitting
11. Hose Assembly
12. Capscrew
13. Washer
14. End Cap
15. Shaft

Figure 12-1. Outrigger Installation

b. inspect arms (6, figure 12-1) forwarding, broken welds, and corrosion.

c. Inspect shafts (5 and 7) for cracks and corrosion.

12-5. REPAIR.

a. Repair shall be limited to the replacement of worn or damaged parts.

12-6. ASSEMBLY.

a. Align arm (6, figure 12-1) shaft holes with outrigger weldment.

b. Install shaft (7) using a wood dowel or brass drift pin. Install end caps (2), washers (3), and capscrews (4).

c. install shaft (5) using a wood dowel or brass drift. Install end caps (2), washers (3), and capscrews (4).

d. Remove wood Mocks supporting outrigger cylinder (1).

e. Connect battery at negative terminal.

f. Operate outrigger arm(s) to ensure proper operation.

12-7. OUTRIGGER CYLINDER.

12-8. REMOVAL AND DISASSEMBLY.

a. Lower affected outrigger arm until pad is within an inch of touching the ground.

b. Shutdown engine and disconnect batteries at negative terminal.

c. Tag and disconnect hydraulic hoses and fittings at outrigger cylinder port blocks, Cap hose ends. Disconnect hose assemblies (11, figure 12-1) from fittings (10).

CAUTION

An outrigger cylinder (1) weighs approximately 125 pounds. Ensure that wood support ramp will support the cylinder.

d. Place soft wood support ramp under outrigger cylinder (1).

e. Attach floor hoist to rod end of outrigger cylinder (1) to support its load.

f. Remove capscrews (4), washers (3), and end cap (2) securing shaft (5). Use a wood dowel or brass drift pin to drive out shaft (5).

g. Remove capscrews (12), washers (13), and end caps (14). Use a wood dowel or brass drift pinto drive out shaft (15).

NOTE

It is not necessary to completely remove the outrigger cylinder (1) to repair it.

h. Using floor hoist to support weight of outrigger cylinder (1), slide outrigger cylinder out of outrigger weldment.

i. Remove retaining ring (4, figure 12-2) with adjustable spanner wrench. Remove wiper ring (3).

j. Carefully remove rod (1) with components. Remove piston ring (11), wear rings (12), and setscrew (13).

k. Unscrew piston (14). Remove back-up rings (15) and o-ring (16).

l. Remove cylinder head (7). Remove back-up ring (10), rod seal (9), and wear rings (8). Remove o-ring (6) and back-up ring (5).

m. If necessary, remove check valve (18).

12-9. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes, If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent from heat and open flame.

a. Clean all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Stone out minor blemishes and polish surfaces with fine crocus cloth.

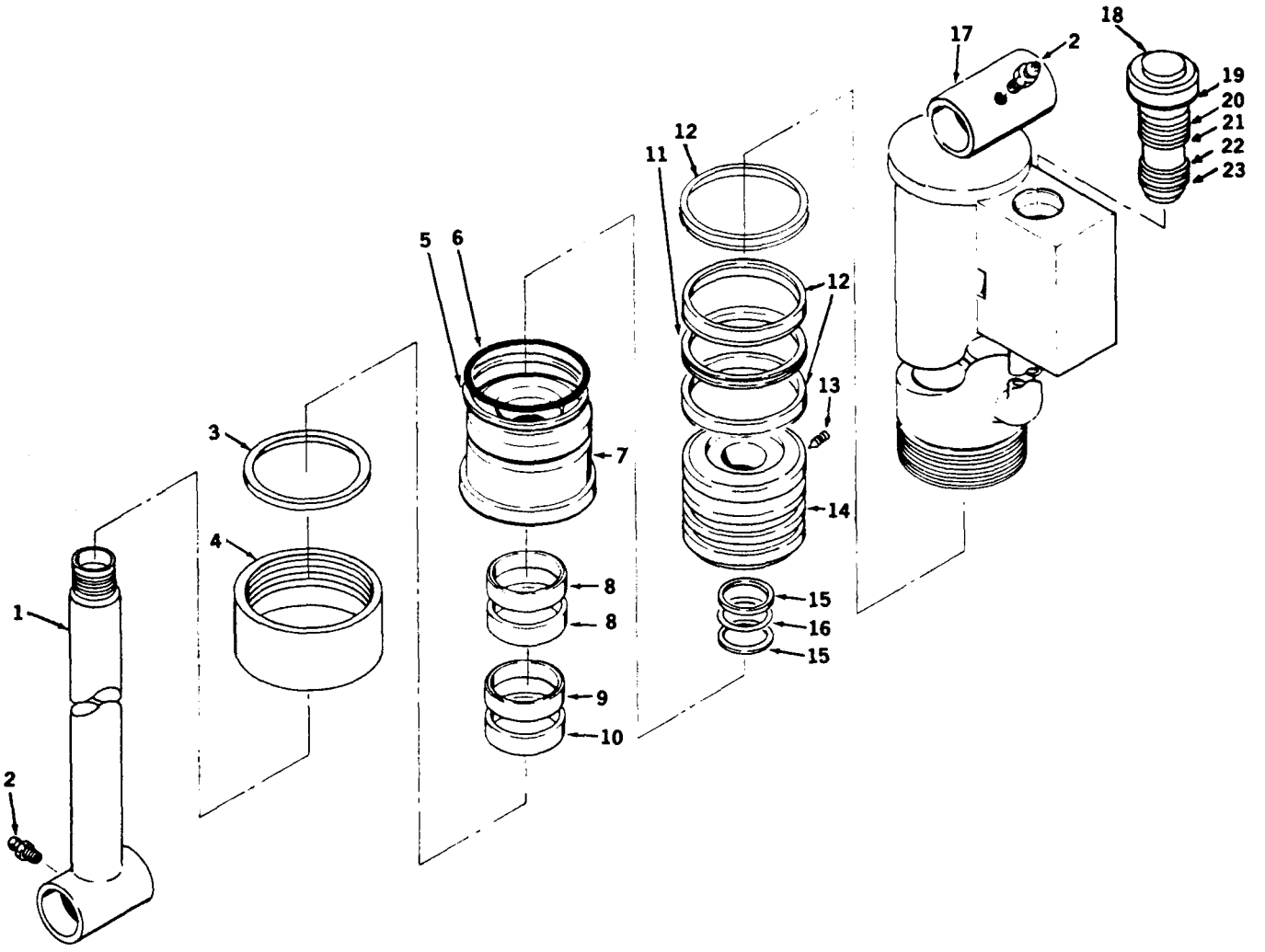
c. Inspect ail parts for wear, damage, and corrosion.

d. Discard all seals, back-up rings, and o-rings.

12-10. REPAIR.

a. Repair shall be limited to the replacement of all worn or damaged parts.

b. Replace seals, back-up rings, and o-rings with repair kit 9-752-100321.



LEGEND

1. Rod
2. Grease Fitting
3. Wiper Ring
4. Retaining Ring
5. Back-up Ring
6. O-ring
7. Cylinder Head
8. Wear Ring
9. Rod Seal
10. Back-up Ring
11. Piston Ring
12. Wear Ring
13. Setscrew
14. Piston
15. Back-up Ring
16. O-ring
17. Barrel
18. Check Valve
19. O-ring
20. Back-up Ring
21. O-ring
22. Back-up Ring
23. O-ring

Figure 12-2. Outrigger Cylinder

12-11. ASSEMBLY AND INSTALLATION.

a. Coat all parts with clean oil MIL-L-2104 SAE 10 prior to assembly.

b. Install check valve (18, figure 12-2) if previously removed.

c. Fit wiper ring (3) in groove of retaining ring (4). Slide retaining ring (4) over rod (1).

d. Install wear rings (8), rod seal (9), and back-up ring (10) in cylinder head (7).

e. Install back-up ring (5), and o-ring (6). Slide cylinder head (7) over rod (1).

f. Install back-up rings (15) and o-ring (16) inside piston (14).

g. Coat threads of rod (1) with NEVER-SEEZ lubricant. Install piston (14) on rod (1). Install setscrew (13). Install piston ring (11) and wear rings (12) on piston (14).

h. Carefully slide assembled rod into barrel (17) with slight twisting motion.

i. Chat external threads of retaining ring (4) with NEVER-SEEZ lubricant. Tighten ring (4) with adjustable spanner wrench.

j. Using floor hoist, carefully slide outrigger cylinder (1, figure 12-1) into outrigger weldment.

k. Install shaft (15) with wood dowel or brass drift pin. install end caps (14), washers (13), and capscrews (12).

l. Install shaft (5) with wood dowel or brass drift pin. Install end caps (2), washers (3), and capscrews (4).

m. Remove wood support ramp.

Remove hydraulic hose caps and tags and install hoses at port end of outrigger cylinder. Install grease fitting (9).

o. Connect battery at negative terminal.

p. Operate outrigger arm(s) to ensure proper operation.

12-12. OVERSIZE OUTRIGGER PADS.

12-13. INSTALLATION.

a. Remove hitch pin (1, figure 12-3) and remove oversize outrigger pads (2).

b. Install oversize outrigger pads (2) by mating pins with holes in standard outrigger pads.

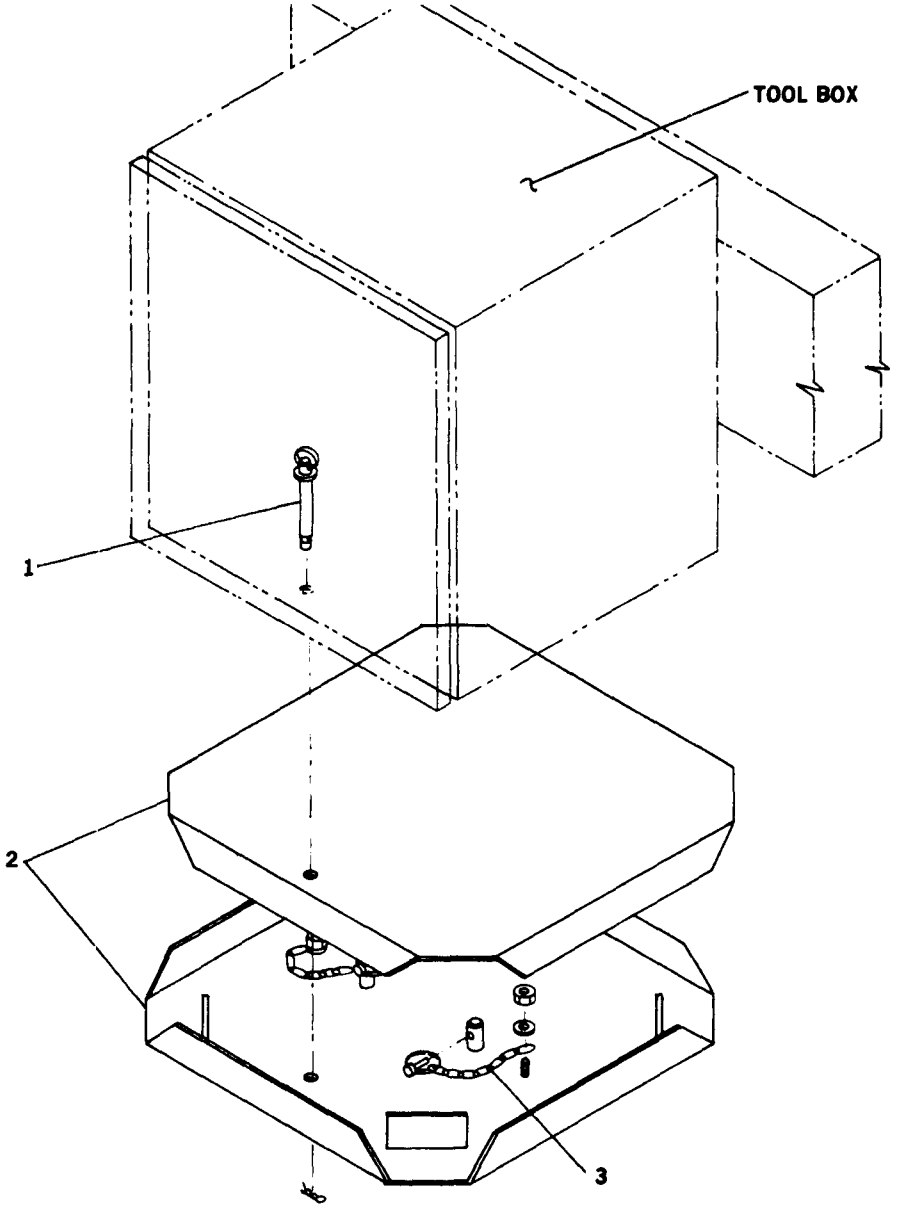
c. Insert quick release pins (3) to secure oversize outrigger pads.

12-14. REMOVAL AND STOWAGE.

a. Remove quick release pins (3, figure 12-3). Remove oversize outrigger pads (2).

b. Stow two oversize outrigger pads (2) under each tool box.

c. Secure in place with hitch pins (1).



LEGEND

1. Hitch Pin
2. Oversize Outrigger Pad
3. Quick-release Pin

Figure 12-3. Oversize Outrigger Pads

SECTION 13

ELECTRICAL SYSTEM MAINTENANCE INSTRUCTIONS

13-1. TROUBLESHOOTING.

NOTE

Refer to figure 13-0 Electrical Schematic for aid in troubleshooting the electrical system.

SYMPTOM	PROBABLE CAUSE	SOLUTION
1. Cranking motor does not operate.	a. Weak or dead battery.	a. Charge or replace battery(s) (para. 13-12).
	b. Damaged wiring between cranking motor and batteries.	b. Replace wiring as needed. Clean and tighten all connections.
	c. Defective magnetic switch, solenoid, or starting switch.	c. Replace failed component (para. 13-2).
	d. Defective cranking motor.	d. Remove and test cranking motor (para. 13-2).
2. Alternator charging low or unsteady.	a. Loose fan belt.	a. Adjust fan belt to deflect 3/4-inch midway between fan and crankshaft pulleys.
	b. Worn fan belt.	b. Replace fan belt. Adjust as above.
	c. Loose or corroded alternator or regulator terminal.	c. Clean and tighten connectors.
	d. Worn brushes.	d. Replace brushes (para. 13-7).
	e. Defective voltage regulator.	e. Replace voltage regulator (para. 13-7).
	f. Defective diode panel.	f. Replace diode panel (para. 13-7).
	g. Defective alternator.	g. Replace alternator (para. 13-7).
3. Battery voltage low.	a. Battery electrolyte level low.	a. Fill battery cells to 3/4-inch above separation plates with distilled water.
	b. Battery cables or terminals corroded.	b. Remove cables and clean cable connectors and battery posts. Apply petrolatum to battery terminals and reinstall battery cables.
	c. Batteries run down.	c. Charge or replace batteries (para. 13-12).
	d. Defective alternator brushes, diode panel, or voltage regulator.	d. Repair alternator (para. 13-7).
	e. Defective alternator.	e. Replace alternator (para. 13-7).

SYMPTOM	PROBABLE CAUSE	SOLUTION
4. External light(s) not operating.	a. ignition switch OFF.	a. Turn on ignition switch.
	b. Blown bulb in light assembly.	b. Replace bulb.
	c. Corroded or loose connection at light fixture.	c. Clean or replace connector.
	d. Defective light switch.	d. Replace light switch in front console.
	e. Circuit breaker tripped.	e. Check circuit breakers (under front console).
	f. Short in lighting circuit.	f. Test circuit for breaks from point of inoperative light.

13-2. CRANKING MOTOR.

13-3. REMOVAL AND DISASSEMBLY.

a. Disconnect negative battery cable at battery box.

b. Tag and disconnect connections at solenoid and cranking motor.

c. Support cranking motor from underneath. Remove three nuts and lockwashers that secure cranking motor.

d. Remove cranking motor.

e. Perform No-load Test as follows:

1. Connect voltmeter from motor terminal to motor frame and use r.p.m. indicator to measure armature speed.

2. Connect motor and ammeter in series with fully charged 24-volt battery source and switch in open position from solenoid battery terminal to solenoid switch terminal. Refer to figure 13-1. Use carbon pile to reduce battery voltage to 20 VDC.

3. Close switch and compare r.p.m. current and voltage reading with following specifications and record results:

a) Min. Amps - 50

b) Max. Amps - 70

c) Min. RPM - 7000

d) Max. RPM - 9500

4. Disconnect test connections with switch open.

5. Interpret test results per table 13-1.

f. Match mark end frame (63, figure 13-2), lever housing (42), and drive housing (33) to aid in assembly.

g. Remove nut (6), lockwasher (7), and connector (8).

h. Remove screws and lockwashers (17).

i. Remove screws (66) and lockwashers (67). Remove screws (40) and lockwashers (41).

j. Remove end frame (63) and field frame (not shown).

k. Remove screws (32) and separate lever housing (42) and drive housing (33).

l. Remove ring (31), collar (37), and motor drive (38).

m. Remove solenoid switch (16).

13-4. CLEANING AND INSPECTION.

a. Clean all parts except motor drive (38, figure 13-2) in volatile mineral spirits TT-T-291. Wipe motor drive with clean cloth.

b. Clean commutator end armature (51) with No. 00 sandpaper. Do not use emery cloth to clean commutator.

c. Wipe all parts with clean cloth to remove residue.

d. Inspect brushes (3) for wear. If worn, replace brushes. Ensure that full brush surface is in contact with commutator.

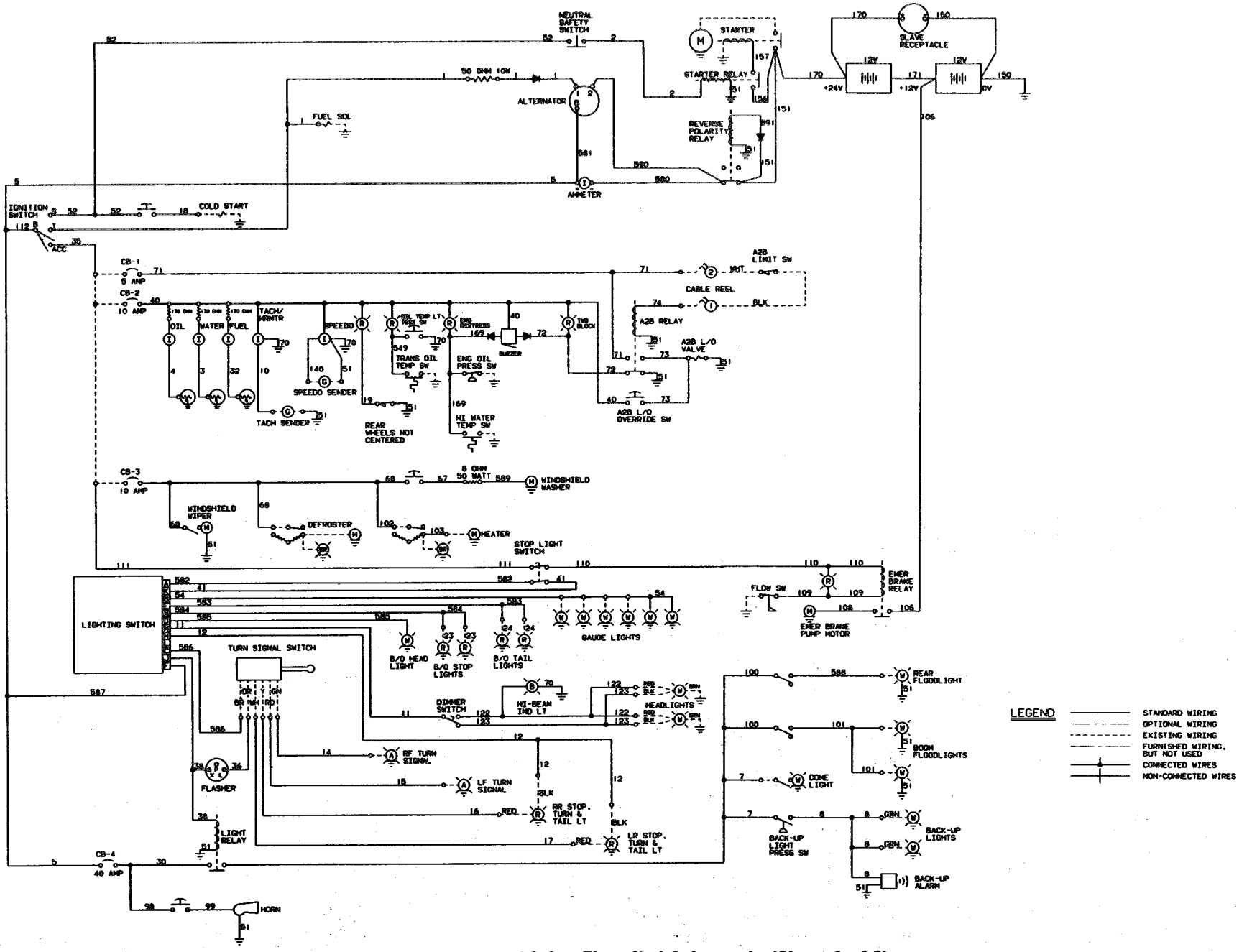


Figure 13-0. Electrical Schematic (Sheet 1 of 3)

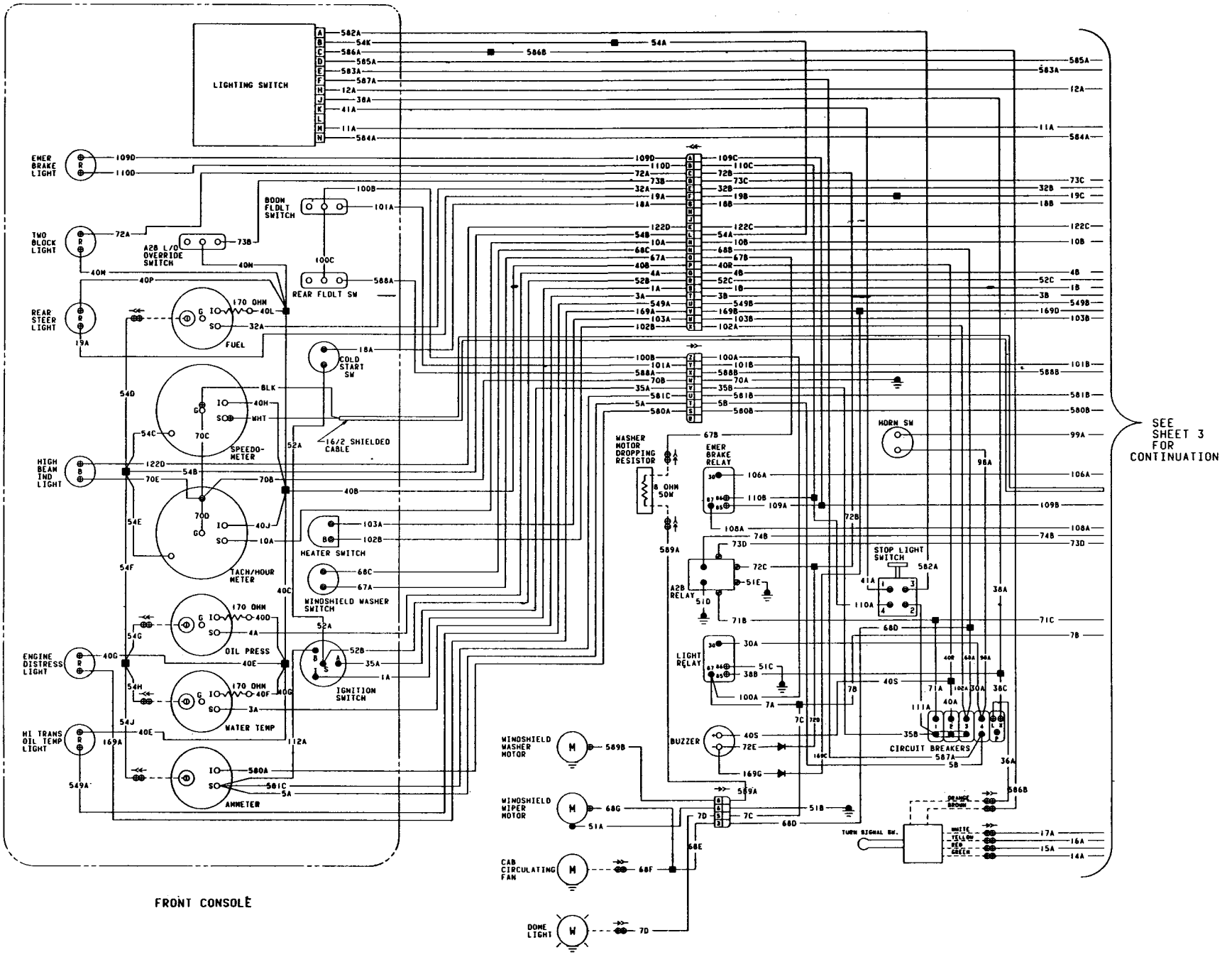


Figure 13-0. Electrical Schematic (Sheet 2 of 3)

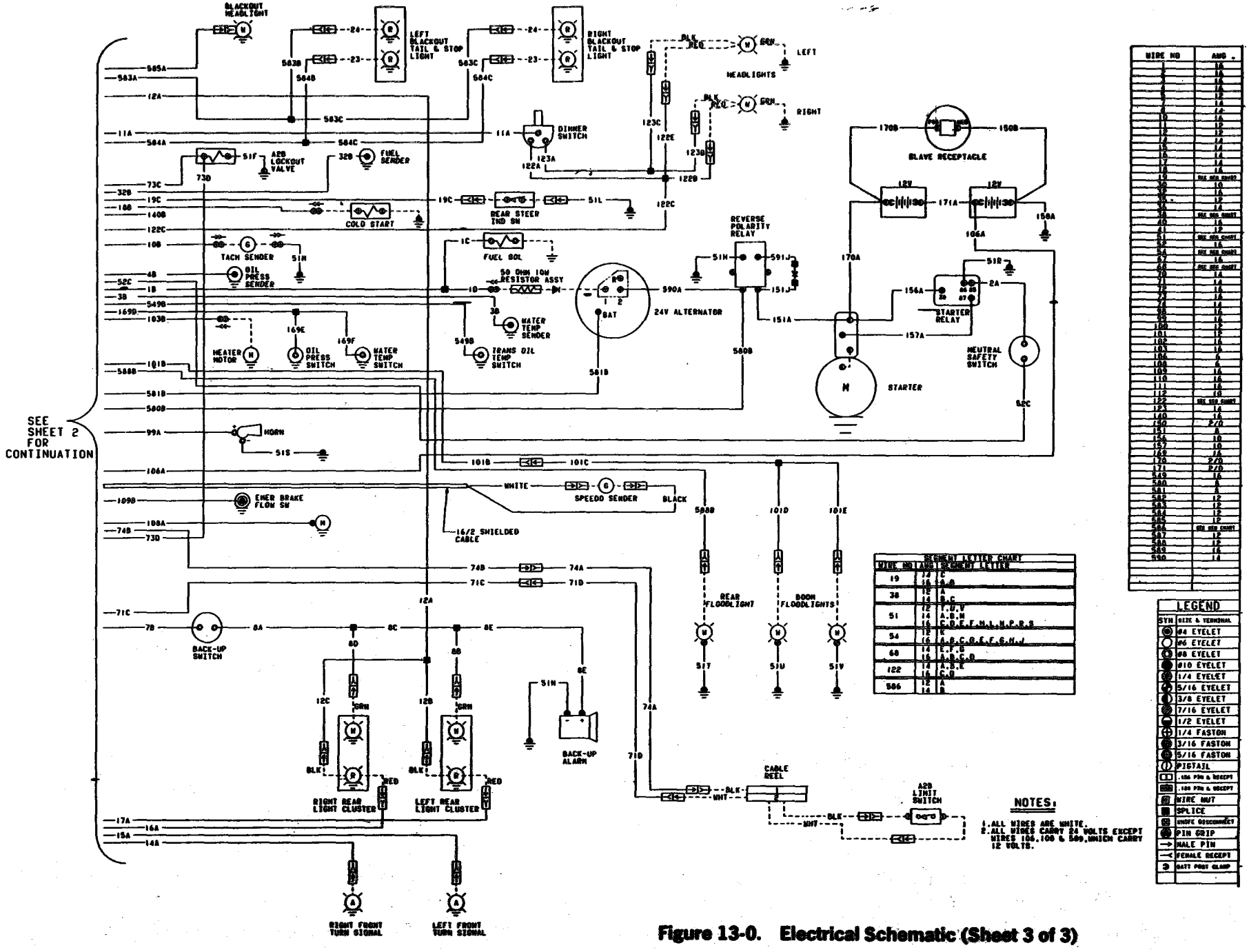


Figure 13-0. Electrical Schematic (Sheet 3 of 3)

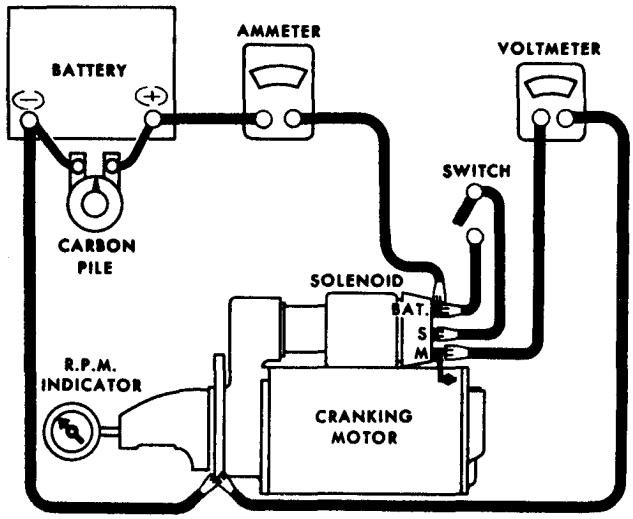


Figure 13-1. No-load Test Circuit

e. Inspect springs (1) for distortion or discoloration. If weak, replace springs.

f. Inspect armature (51). If commutator is worn, dirty, out of round, or has high insulation, it should be turned down with a lathe. Undercut insulation 1/32-inch wide and 1/32-inch deep. Clean slots to remove dirt and copper dust. Lightly sand commutator with No. 00 sandpaper to remove burrs resulting from undercut procedure.

g. Inspect armature (51) for opens at commutator riser bars. Inspect points where conductors join commutator bars for loose connections. Resolder burned commutator bars. Turn down commutator to remove burned material.

h. Use a growler to check armature (51) for short circuits. When armature is revolved in a growler, a hacksaw blade held above it will vibrate above area of armature core where short is located. Clean armature as required.

TABLE 13-1. NO-LOAD TEST RESULTS

RESULT	PROBABLE CAUSE
1. Rated current draw and no load speed indicates normal condition of cranking motor.	
2. Low free speed and high current draw.	a. Too much friction. Tight, dirty, or worn bearings. Bent armature shaft or loose pole shoes. b. Shorted armature. c. Grounded armature.
3. Failure to operate with high current.	a. Direct ground in terminal or fields. b. Frozen bearings.
4. Faiure to operate with no current draw.	a. Open field circuit b. Open armature coils. c. Brushes worn, springs broken, high insulation on commutator.
5. Low no-load speed and low current draw.	a. High internal resistance due to poor connections, defective leads and dirty commutator.
6. High free speed and high current draw.	a. Shorted fields. Replace field coil assembly.

i. Check armature (51) by use of a 110-volt test lamp. Place one test point on commutator and other point on core or shaft. If lamp lights, armature is grounded. Grounds are result of failed insulation.

j. Disconnect ground connection to field coil (49). Using 110-volt test lamp, check field coil for grounds. Connect one lead of test lamp to field frame and one lead to field connector. If lamp lights, at least one field coil is grounded. Repair or replace field coil as needed.

k. Using 110-volt test lamp, check field coil (49) for opens. Connect test lamp to ends of field coils. If lamp does not light, field coils are open.

l. Inspect motor drive gear (38) for broken or worn teeth.

m. Inspect shift lever (26) for cracks and distortion.

n. Inspect spring (23) for distortion.

o. inspect bushings (36, 46, and 64) for excessive wear and distortion.

13-5. REPAIR.

a. Repair all loose connections by soldering.

b. Replace all d-rings and gaskets.

13-6. Assembly and Installation.

a. Lubricate bushings (36, 46, and 64, figure 13-2) with oil MIL-L-2104 SAE 20 before assembly. Insert wick first, then press bushings.

b. Install motor drive (38), collar (37), and ring (31).

c. Assemble drive housing (33) and lever housing (42) with screws (32) aligning match marks.

d. Assemble lever housing to field frame (not shown) with screws (40) and lockwashers (41) aligning match marks.

e. Assemble end frame (63) and field frame with screws (66) and lockwashers (67) aligning match marks.

f. Install solenoid switch (16) with screws and washers (17).

g. Install connector (8), lockwasher (7), and nut (6).

h. Check pinion clearance as follows:

1. Make connections to assembled cranking motor as shown in figure 13-3.

2. Momentarily flash jumper lead.

3. Push motor drive (38) back towards commutator end.

4. Measure distance between motor drive and collar (37). See figure 13-4.

5. Remove plug (48) and turn nut (25) to adjust clearance from .010 to .070-inch.

6. Install plug (48).

i. Install cranking motor in engine flywheel housing.

j. Remove tags and connect leads to solenoid and cranking motor.

k. Connect negative battery cable at battery box.

13-7. ALTERNATOR.

13-8. REMOVAL AND DISASSEMBLY.

a. Disconnect ground cable at battery compartment.

b. Tag and disconnect electrical leads to alternator.

c. Tag diode wire to alternator battery terminal' and remove boot (15, figure 13-5), nut (13), lockwasher (14), and wire (16).

d. Remove capscrew (18), lockwasher (11), flat washer (12), and spacer (17). Loosen nut (6) and pivot alternator toward engine to relieve belt tension.

e. Remove nut (6), lockwasher (7), and capscrew (5), and separate alternator from bracket (2).

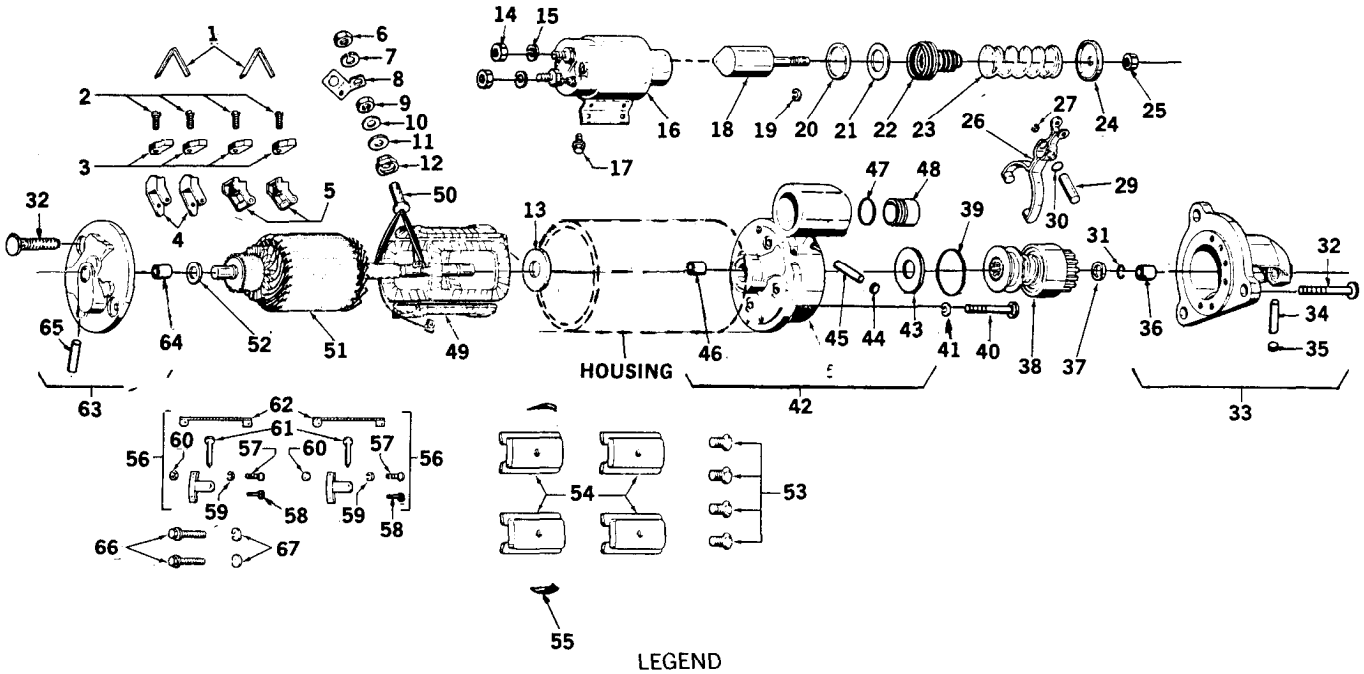
f. Refer to figure 13-6 and remove nut (11) and lock-washer (12). Remove pulley (1, figure 13-5). Remove fan (20) and collar (13, figure 13-6).

g. Make scribe marks on slip ring end frame (23) and drive end frame (14) to help locate parts in same position during assembly.

h. Remove through bolts (30) and separate end frame (14) from end frame (23). Withdraw rotor (9).

i. Remove nuts (20), diode trio (21) and stator assembly (10) from end frame (23). Disconnect stator leads from diode trio.

j. Remove screw and washer (18). Disconnect capacitor lead from screw (19) and disconnect lead (3) from rectifier bridge (22) by removing nut (1). Remove rectifier bridge from end frame (23).



LEGEND

1. Spring
2. Screw & Lockwasher
3. Brush
4. Holder
5. Holder
6. Nut
7. Lockwasher
8. Connector
9. Nut
10. Washer
11. Washer
12. Bushing
13. Washer
14. Nut
15. Lockwasher
16. Solenoid Switch
17. Screw and Lockwasher
18. Plunger Assembly
19. Snap Ring
20. Retainer
21. Washer
22. Boot
23. Spring
24. Retainer
25. Nut
26. Shift Lever Assembly
27. Snap Ring
28. Not Used
29. Lever Shaft
30. O-ring
31. Ring
32. Screw
33. Drive Housing
34. Wick
35. Plug
36. Bushing
37. Collar
38. Motor Drive
39. O-ring
40. Screw
41. Lockwasher
42. Lever Housing
43. Washer
44. Plug
45. Wick
46. Bushing
47. Gasket
48. Plug
49. Field Coil
50. Stud
51. Armature
52. Washer
53. Screw
54. Pole Shoe
55. Insulation
56. Brush Support Package
57. Screw
58. Rivet
59. Lockwasher
60. Nut
61. Pin
62. Lead
63. Commutator End Frame
64. Bushing
65. Wick
66. Screw
67. Lockwasher

Figure 13-2. Cranking Motor

k. Remove screw and lockwasher (19), capacitor bracket (27), and capacitor (26).

l. Remove screw (8) and brush holder assembly (5). Remove screws (7) and brush and arm (6) from brush holder.

m. Remove screw and lockwasher (4) and regulator (2).

n. Press bearing (24) from end frame (23).

o. Remove screws (17), retainer (16). Press bearing (25) and slinger washer (15) from end frame (14).

13-9. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all parts except electrical components, with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

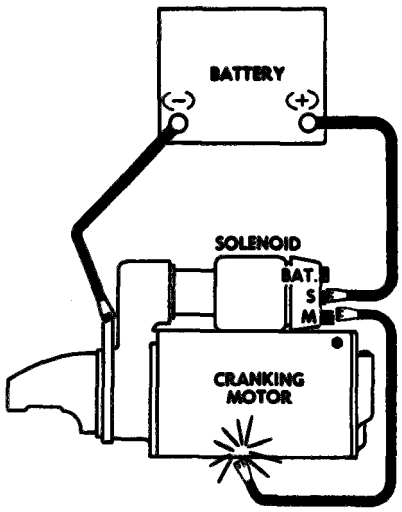


Figure 13-3. Circuit for Checking Pinion Clearance

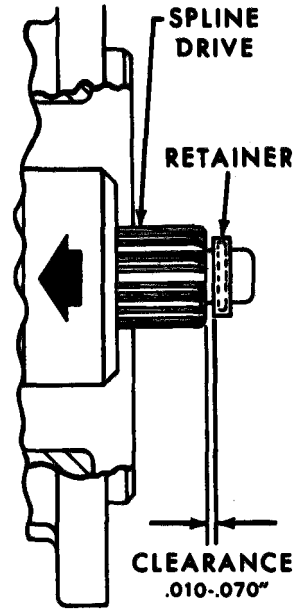


Figure 13-4. Checking Pinion Clearance on Motor Drive

b. Visually inspect all parts for evidence of overheating, wear, or other damage.

c. Check rotor (9, figure 13-6) field windings as follows

1. To check for opens, connect test lamp or ohmmeter to each slip ring. If lamp fails to light, or ohmmeter reading is high (infinite), winding is open.

2. Connect test lamp or ohmmeter from one slip ring to shaft. If lamp lights or ohmmeter reading is low, rotor winding is grounded.

3. Check winding for short circuits or excessive resistance by connecting a 24 VDC battery and ammeter in series with edges of the two slip rings. Ammeter reading above 5.0 amps indicates shorted windings; reading below 4.0 amps indicates excessive resistance.

NOTE

Ammeter readings will vary slightly with winding temperatures.

NOTE

If alternator does not supply rated output, and rotor is not defective, the defect is in the diode trio, rectifier bridge, stator, or regulator.

d. Check diode trio as follows:

1. Connect ohmmeter with a 1-1/2 volt cell to the single connector and to one of the three connectors. Set ohmmeter to the lowest range scale and observe reading. Reverse ohmmeter leads to same two connectors. If both readings are the same, replace diode trio. A good diode trio will show one high and one low reading. Repeat test between single connector and other two connectors.

2. Connect ohmmeter to each pair of the three connectors. If any reading is zero, replace diode trio.

e. Check rectifier bridge as follows:

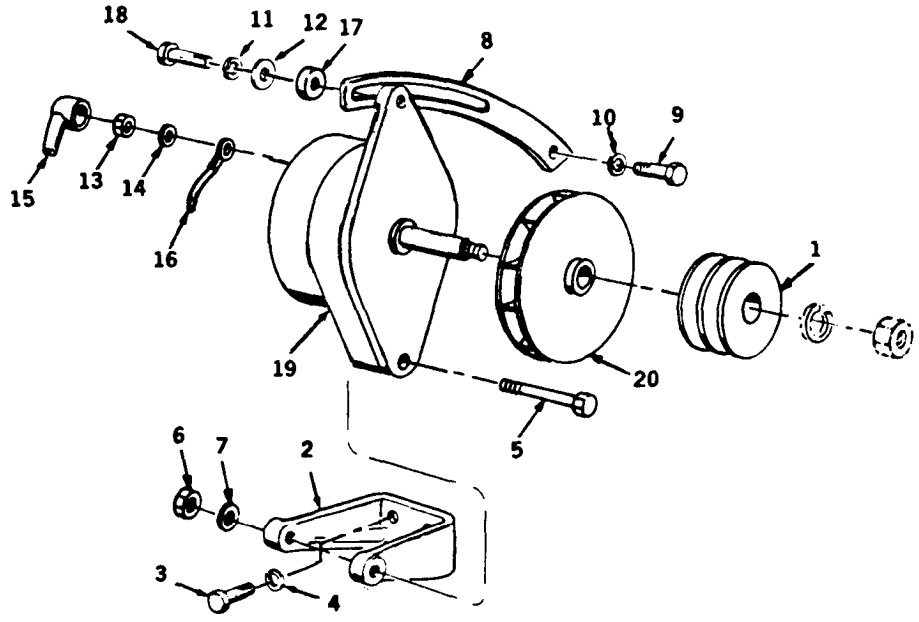
NOTE

The rectifier bridge has a grounded heat sink and an insulated heat sink connected to the output terminal.

1. Connect ohmmeter to grounded heat sink and one of three terminals. Observe reading. Reverse lead connections to grounded heat sink and same terminal. If both readings are the same, replace rectifier bridge. A good rectifier bridge will show one high and one low reading. Repeat this same test between grounded heat sink and other two terminals, and between insulated heat sink and each of the three terminals. This totals six checks, with two readings taken for each check.

f. Check stator windings as follows:

1. Connect test lamp or ohmmeter to any stator lead and stator frame. If test lamp lights or reading is low, the windings are grounded. If test lamp fails to light or meter reading is high when successively connected between each pair of stator leads, windings are open.



LEGEND

1. Pulley
2. Bracket
3. Capscrew
4. Lockwasher
5. Capscrew
6. Hex Nut
7. Lockwasher
8. Adjusting Arm
9. Capscrew
10. Lockwasher
11. Lockwasher
12. Flat Washer
13. Hex Nut
14. Lockwasher
15. Boot
16. Diode/Wire Assembly
17. Spacer
18. Capscrew
19. Alternator
20. Fan

Figure 13-5. Alternator Installation

NOTE

If all other electrical checks are normal and alternator fails to supply rated output, a shorted stator winding or an open Delta winding is indicated. Also, a shorted stator can cause the indicator lamp to be on with engine operating at low speed. Check regulator before replacing stator.

g. The only known effective way to test the regulator is by substitution with a known serviceable regulator.

h. Inspect slip rings for surface roughness and for out of round condition.

13-10. REPAIR OR REPLACEMENT.

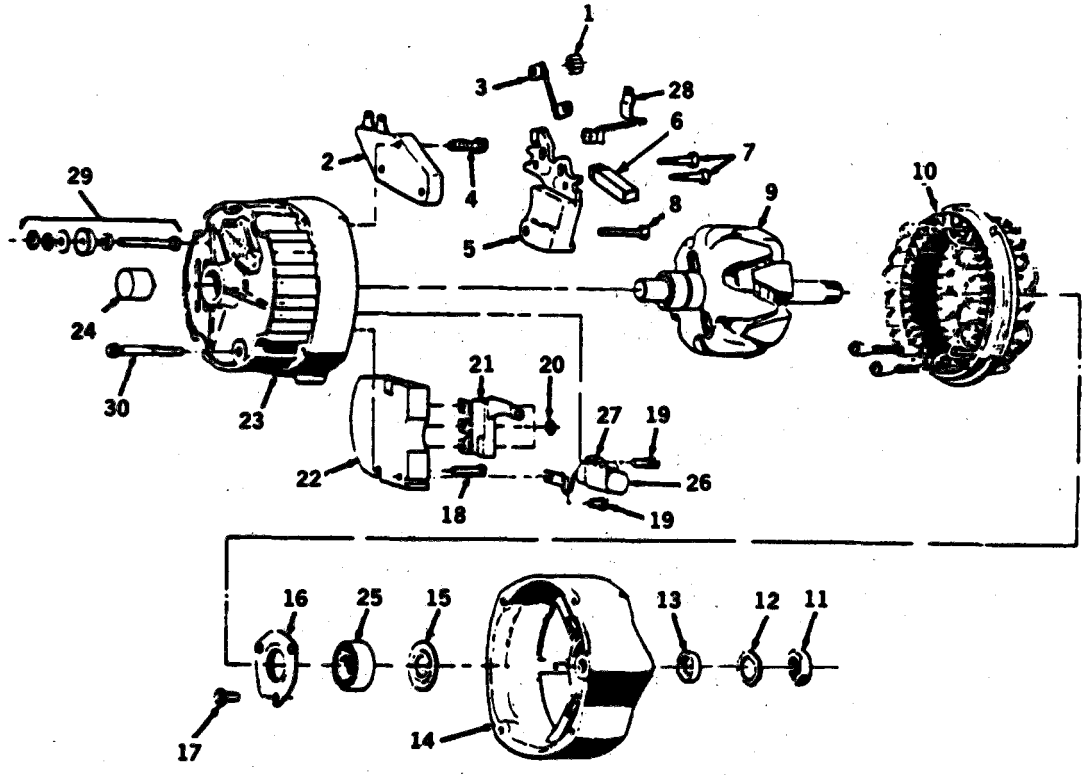
a. Component parts of alternator cannot be repaired effectively. Replace all items which are defective.

b. Replace removed brushes (6, figure 13-6) with new brushes.

c. If one diode in positive or negative rectifier assembly is defective, the entire rectifier assembly must be replaced.

d. Replace bearings if rough when rotated or if other defects are visible.

e. Replace defective stator (10) or rotor (9).



LEGEND

1. Nut
2. Regulator
3. Lead
4. Screw and Lockwasher
5. Brush and Holder Assembly
6. Brush and Arm
7. Screw
8. Screw
9. Rotor
10. Stator
11. Hex Nut
12. Lockwasher
13. Collar
14. Frame
15. Slinger Washer
16. Retainer
17. Screw
18. Screw and Washer
19. Screw and Lockwasher
20. Nut
21. Diode Trio
22. Rectifier Bridge
23. Frame
24. Bearing
25. Bearing
26. Capacitor
27. Bracket
28. Relay Terminal
29. Terminal
30. Bolt

Figure 13-6. Alternator Assembly

f. The cover/regulator assembly must be replaced if defective.

g. If slip rings are out of round or are rough, true in a lathe to .002 inch maximum indicator reading. Remove as little material as possible. Finish with 400 grain or finer polishing cloth.

13-11. ASSEMBLY AND INSTALLATION.

a. Install slinger washer (15, figure 13-6) and press bearing (25) into drive end frame (14). Fasten bearing retainer (16) with screws (17) to end frame.

.b. Press bearing (24) into slip ring end frame (23).

c. Install regulator (2) to end frame with screw and lockwasher (4).

d. Install new brush and arm (6) to brush holder (5) with screws (7). Install brush holder assembly to end frame (23) with pivot screw (8).

e. Install capacitor (26) and capacitor bracket (27) to, end frame (23) with screw and lockwasher (19).

f. Install rectifier bridge (22) to end frame (23) with screw and washer (18). Connect capacitor lead to screw (31).

g. Connect leads from stator assembly (10) to diode trio (21). Install stator assembly into end frame (23). Install diode trio to end frame with nuts (20).

h. Insert pins in brush holder (5) to hold brushes clear of commutator. Install rotor (9) into slip ring end frame. Align scribe marks and install drive end frame (14). Install bolts (30) through end frame (23) and thread into end frame (14).

i. install collar (13), fan (20, figure 13-5), pulley (1), lockwasher (12, figure 13-6) and nut (11) on drive end of rotor shaft. Torque nut to 40-60 foot-pounds.

j. Position alternator in bracket (2, figure 13-5) and install capscrew (5), lockwasher (7), and nut (6). Do not tighten nut.

k. Install lockwasher (11), flat washer (12), spacer (17), and capscrew (18) through slotted adjusting arm (8). Thread capscrew (18) into end frame (14, figure 13-6). Do not tighten.

1. Install drive belts. Slide adjusting arm (8, figure 13-5) to adjust belt tension. Belts should deflect 3/4-inch at midspan between pulleys. Tighten capscrew (18).

m. Install diode/wire assembly (16), lockwasher (14), nut (13) and boot (15) on alternator battery terminal. Remove wire tag.

n. Connect all electrical leads to alternator.

o. Connect ground cable at battery compartment.

13-12. BATTERIES.

13-13. REMOVAL AND DISASSEMBLY.

WARNING

Batteries generate explosive gases. Keep sparks, flames or other ignition sources away at all times. Always shield eyes when working near batteries.

WARNING

Electrolyte splashed into eyes is extremely dangerous. If this should happen, force eye open and flood with cool, clean water for approximately five minutes. Call doctor immediately.

a. Before disconnecting cables and removing batteries, determine condition of batteries. Check specific gravity of each cell with a hydrometer. With temperature of electrolyte at 80°F, the reading for each cell of a fully charged battery should indicate between 1.260 and 1.275. If specific gravity readings between highest and lowest cells exceed 50 points (0.050), or reading of highest cell is below 1.200, the battery should be replaced.

b. Tag and disconnect ground cable terminal (4, figure 13-7) and positive cable terminal (15) from batteries (13).

c. Disconnect and remove jumper cable (16) and terminals (4 and 15) from batteries).

d. Remove wing nuts (2), lockwashers (1), and holdowns (3).

CAUTION

Battery weight is approximately 80 pounds. Use care when lifting.

e. Remove batteries (13) from battery compartment.

13-14. CLEANING AND INSPECTION.

a. Clean terminals (4 and 15, figure 13-7) with a solution of baking soda and water. Rinse with clean water and wire brush. Inspect battery cables for broken, cracked, or deteriorated insulation. Inspect cable terminal for eroded or broken condition.

b. Clean batteries (13) with a solution of baking soda and water. Rinse with clean water. Wire brush negative and positive terminal posts. Ensure terminal posts are solid. Check battery case for signs of cracks or electrolyte leakage.

c. If battery is to be charged, observe all safety precautions. Charge battery using best commercial practices.

13-15. REPAIR AND REPLACEMENT.

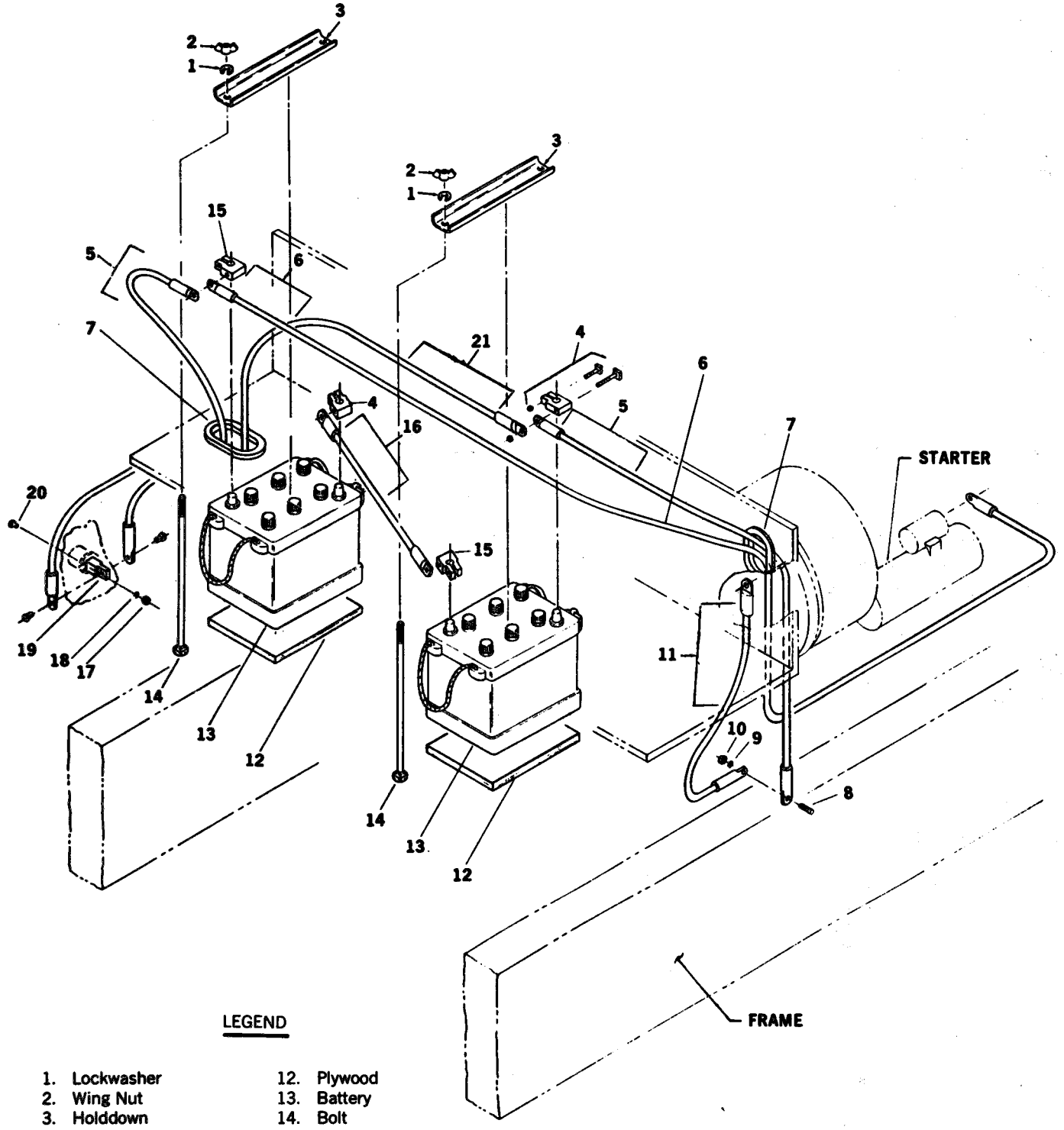
a. Replace terminal clamp on battery cable if found defective.

b. Replace battery cables that have broken wires or damaged insulation. Make battery cables in accordance with figure 13-7 sheet 2.

13-16. ASSEMBLY AND INSTALLATION.

a. Carefully install batteries (13, figure 13-7) on top of plywood panels (12). Do not tilt while lowering into place.

b. Position holddowns (3) on bolts (14) and secure in place with lockwashers (1) and wing nuts (2). Tighten securely to ensure batteries not moving out of position.



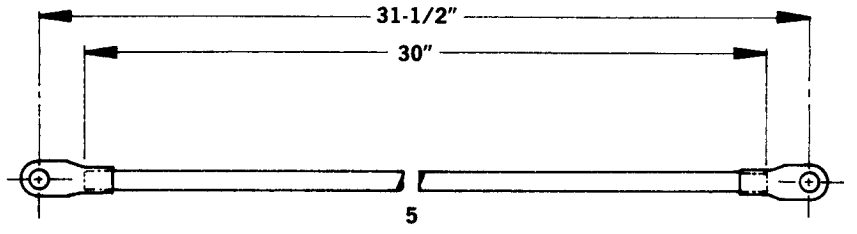
LEGEND

1. Lockwasher
2. Wing Nut
3. Holddown
4. Terminal
5. Battery Cable
6. Battery Cable
7. Moulding
8. Stud
9. Lockwasher
10. Nut
11. Battery Cable
12. Plywood
13. Battery
14. Bolt
15. Terminal
16. Battery Cable
17. Nut
18. Lockwasher
19. Connector
20. Screw
21. Battery Cable

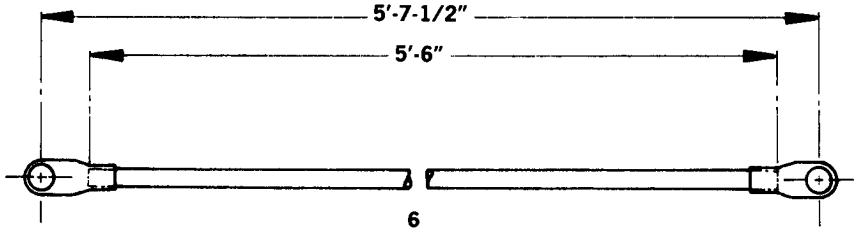
Note

Refer to sheet 2 for details on battery cables 5, 6, 11, 16, and 21.

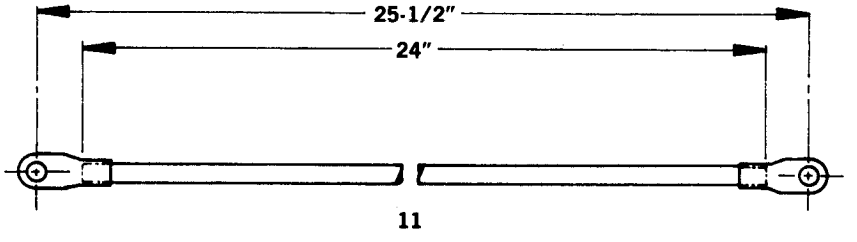
Figure 13-7. Battery Installation (Sheet 1 of 2)



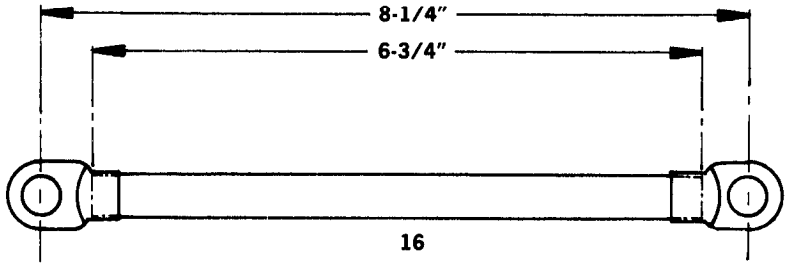
6-246-000695



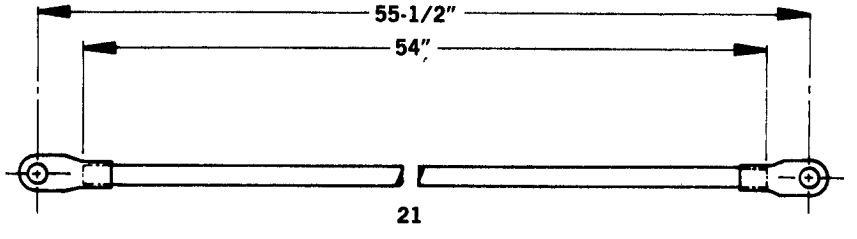
6-246-000352



6-246-000561



6-246-000547



6-246-000994

NOTES

Manufacture battery cable(s) as follows:

1. Cut cable to length indicated by figure.
2. Strip 7/8-inch insulation off each end.
3. Slide shrinkable tubing (3/4 x 1-1/2 in.) over each cable end.
4. Power crimp terminals to cable ends.
5. Pull shrinkable tubing over crimped section of terminal and cable. Heat shrinkable tubing until secure.

Figure 13-7. **Battery Installation (Sheet 2 of 2)**

c. Install battery jumper cable (16) and connect terminals (4 and 15) to position and negative battery posts.

d. Remove tags and connect cable terminals (4 and 15) to positive and negative posts on battery.

13-17. ANTITWO-BLOCK INSTALLATION.

13-18. DISASSEMBLY.

a. Remove cotter pin (18, figure 13-8) clevis pin (17), and antitwo block assembly (10). Disassemble if necessary.

b. Tag and disconnect leads to two block switch (21).

c. Remove capscrews (22), nuts (23), and two block switch (21).

d. Remove shackle assembly (13, figure 13-9), screw (9), washers (10), and lever (11).

e. Remove spring (5), nuts (8), lockwashers (7). and switch (6).

13-19. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Cleaning all metal parts with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Inspect all parts for wear and corrosion.

13-20. REPAIR.

a. Repair shall be limited to the replacement of all damaged parts.

13-21. ASSEMBLY.

a. Install switch (6, figure 13-9), lockwashers (7), nuts (8), screws (2), washer (24), and chain (25).

b. Install lever (11), spring (5), screw (9), washers (10), and shackle (13).

c. Install two block switch (21, figure 13-8) with capscrews (22) and nuts (23).

d. Remove tags and connect leads to switch (21).

e. Install anti-two block assembly (10) with clevis pin (17) and new cotter pin (18).

13-22. CABLE REEL.

13-23. REMOVAL AND DISASSEMBLY.

a. Disconnect batteries at negative terminal.

b. Tag and disconnect leads from cable reel to boom harness.

c. Tag and disconnect leads to two-block switch (21, figure 13-8).

d. Remove nut (24), lockwasher (25), cable clamp (26) and straps (8) securing cable. Take up cable on cable reel.

WARNING

Cable reel weighs approximately 50 pounds. Use care when removing the cable reel assembly.

e. Support weight of cable reel. Remove nuts (3), and washers (2).

f. Remove cable reel (4).

g. Ensure that cable reel tension is relieved.

h. Remove nuts (29, figure 13-10). Remove cover (13) with gasket (14).

i. Remove brushes (11).

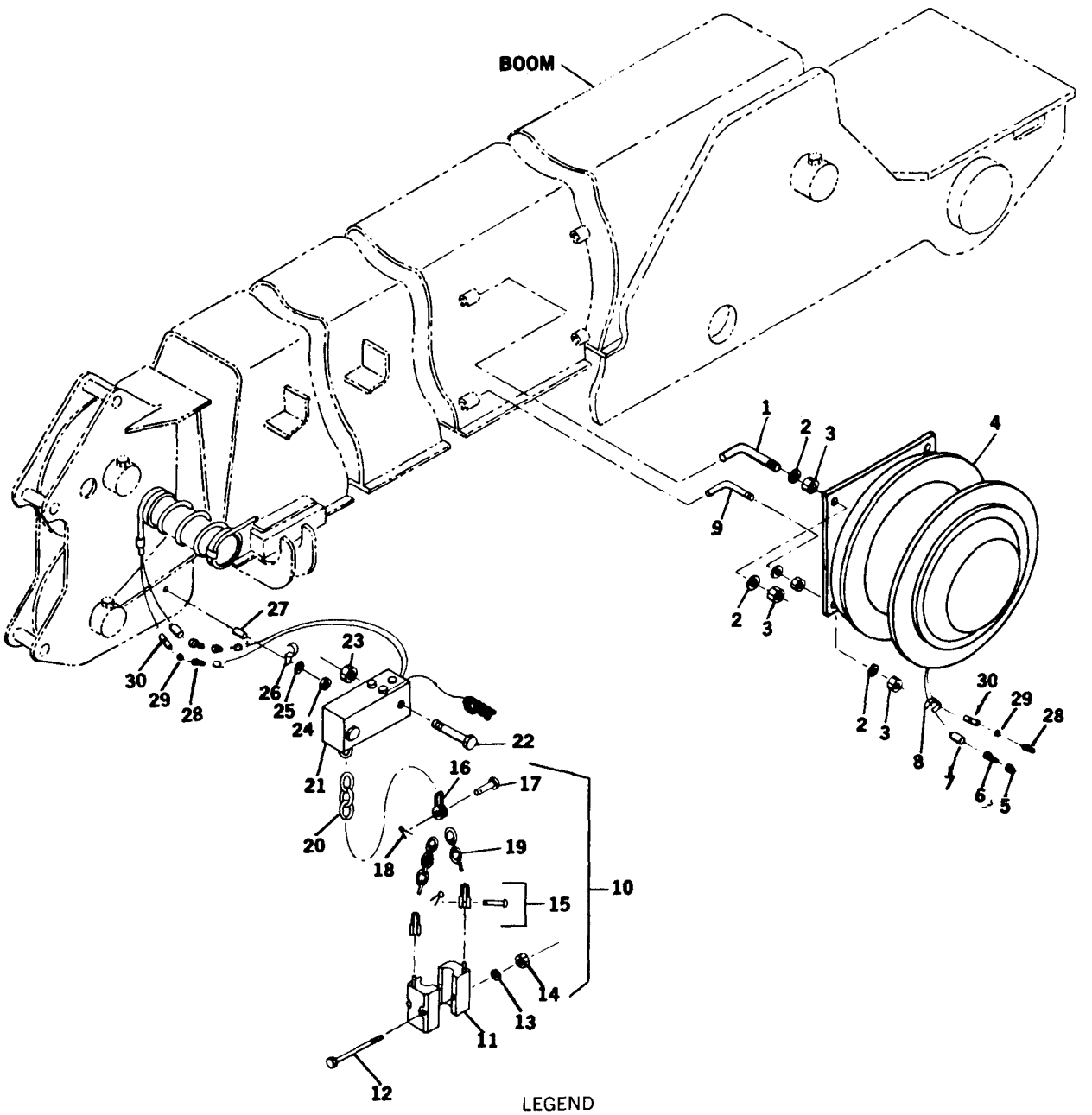
j. Remove setscrew (12), collector ring (15), and washer (19).

k. Remove cable (5), nut (6), washer (7), and packing (8) if necessary.

l. Remove screws (16), lockwashers (17), and drum (20) with gasket (10).

m. Remove nuts (4), flange and ring (21), nuts (4), collar (27), and cup and ratchet (28).

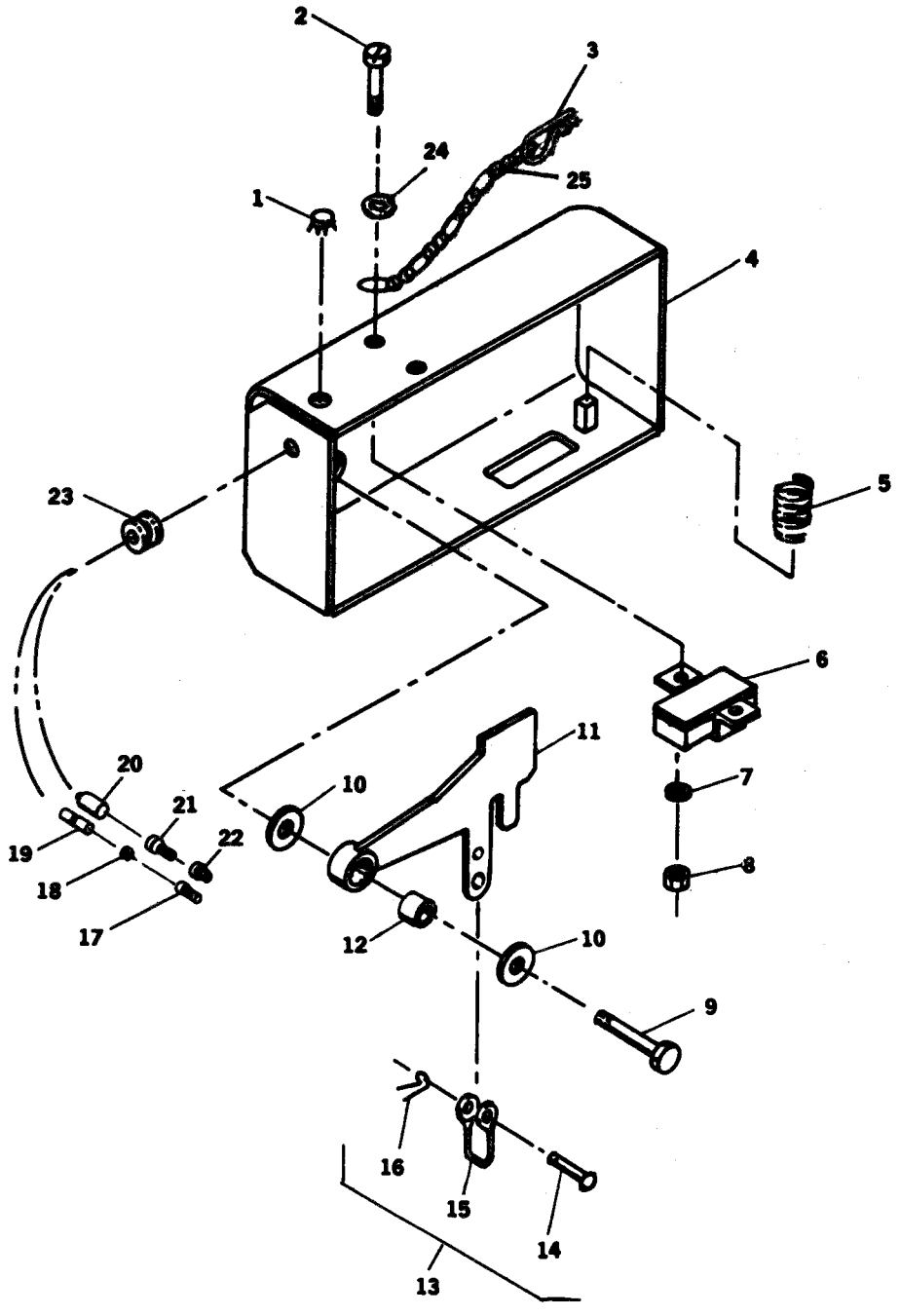
n. Loosen nut (3), and remove setscrew (2) and shaft (26).



LEGEND

1. Hook Bolt
2. Washer
3. Nut
4. Cable Reel
5. Bullet
6. Washer
7. Connector
8. Strap
9. Hook Bolt
10. Antitwo Block Assembly
11. Weight
12. Bolt
13. Lockwasher
14. Nut
15. Shackle Assembly
16. Shackle
17. Clevis Pin
18. Cotter Pin
19. Chain
20. Chain
21. Two Block Switch
22. Capscrew
23. Nut
24. Nut
25. Lockwasher
26. Clamp
27. Stud
28. Connector
29. Terminal
30. Terminal

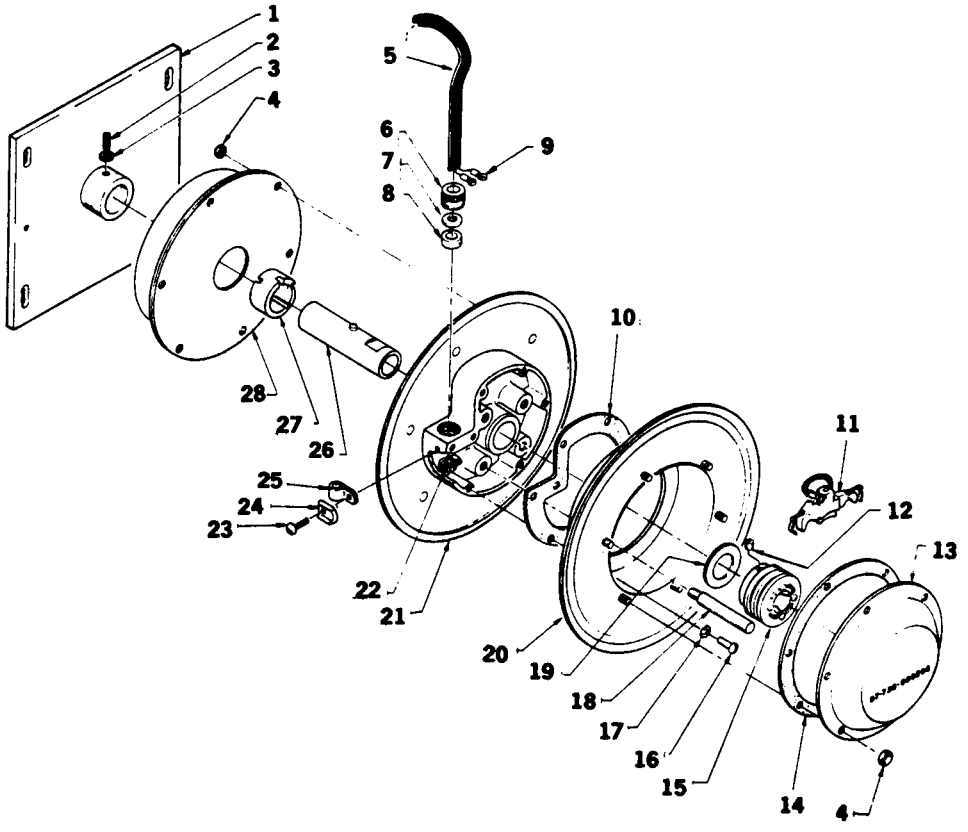
Figure 13-8. Antitwo Block Installation



LEGEND

1. Button
2. Screw
3. Pin
4. Enclosure
5. Spring
6. Switch
7. Lockwasher
8. Nut
9. Screw
10. Washer
11. Lever
12. Bearing
13. Shackle Assembly
14. Clevis Pin
15. Shackle
16. Cotter Pin
17. Terminal
18. Washer
19. Connector
20. Connector
21. Socket
22. Sleeve
23. Grommet
24. Washer
25. Chain

Figure 13-9. Antitwo Block Switch



LEGEND

1. Mounting
2. Setscrew
3. Nut
4. Nut
5. Cable
6. Nut
7. Washer
8. Packing
9. Terminal
10. Gasket
11. Brush
12. Setscrew
13. Cover
14. Gasket
15. Collector Ring
16. Screw
17. Lockwasher
18. Stud
19. Washer
20. Drum
21. Flange and Ring
22. Clamp
23. Screw
24. Washer
25. Grip
26. Shaft
27. Collar
28. Cup and Ratchet

Figure 13-10. Cable Reel

13-24. CLEANING AND INSPECTION.

WARNING

Solvent fumes are toxic. Use solvent in a well-ventilated area. Use goggles to protect eyes. If solvent is splashed on bare skin, rinse skin with fresh water immediately.

Solvent is flammable. Keep solvent away from heat and open flame.

a. Clean all metal parts except collector ring (15, figure 13-10) with clean cloth dipped in cleaning solvent P-D-680. Dry with compressed air.

b. Inspect brushes (11) for wear. Replace brushes worn to less than 1/4 inch.

c. Inspect collector ring (15) for scoring and corrosion. Remove pits and minor surface blemishes with fine emery cloth. Wipe collector ring with clean cloth.

d. Inspect all parts for damage, wear, and corrosion.

13-25. REPAIR.

a. Repair shall be limited to the replacement of all worn or damaged parts.

b. Replace gaskets (10 and 14, figure 13-10).

13-26. ASSEMBLY AND INSTALLATION.

a. Install shaft (26, figure 13-10) and secure with setscrew (2) and nut (3).

b. Install cup and ratchet (28) with collar (27).

c. Install flange and ring (21) and secure with nuts (4).

d. Install drum (20) with new gasket (10). Install screws (16) and lockwashers (17).

e. Install washer (19) and collector ring (15). Secure with setscrew (12).

f. Install brushes (11). Connect leads to brushes.

g. Install cover (13) with new gasket (14). Install nuts (4).

h. Secure cable (5) with nut (6), washer (7), and packing (8).

i. Turn drum (20) three times to set spring pressure,

j. Mount cable reel (4, figure 13-8) on boom and secure with washers (2) and nuts (3).

k. Reel out cable and attach it to boom point as shown in figure 13-8 with straps (8) and cable clamp (26).

l. Remove tags and connect leads at two block switch (21).

m. Remove tags and connect leads from cable reel to boom harness.

n. Connect batteries at negative terminal.

SECTION 14

Supplemental Operating,
Maintenance And Repair
Parts Instruction
(SOMARPI)

For

Crane, Self Propelled
Aircraft Maintenance (SCAMP): 4 Ton
Model RT41 AA
Contract No. DAAE07-82-C-6602
NSN 3810-144-4885

WARNING

Use only manufacturer's recommended tires. Use of incorrect tires will void warranty and may cause tire failure. Correct tires are: Tire 9.000 X 20 Tube Type Bias Ply, Part Number 579-314, FSCM 83187.

WARNING

Once turntable bolts are removed, or loosened, replacement by NEW BOLTS is mandatory.

SUPPLEMENTAL OPERATING MAINTENANCE AND REPAIR PARTS INSTRUCTIONS FOR

CRANE, SELF PROPELLED, 4 TON MODEL RT41AA (SCAMP)

TABLE OF CONTENTS

TABLE OF CONTENTS

SECTION I

G E N E R A L

1. Purpose: To provide user and support personnel supplemental maintenance and repair parts instructions that have special application to Military Adopted Commercial Items (MACI).

2. Scope: This publication applies to Department of the Army Units, organizations and activities that use and/or support the MACI Crane, Wheel Mounted, Rough Terrain, Hydraulic, 4 Ton, SCAMP, Model RT41AA.

3. Military Adopted Commercial Item (MACI): The term "MACI Item" used in this publication applies to a standard commercial item of construction equipment that ‘has been approved and adopted by the Army for a specific TOE requirement and is procured and supported under the CCI system plan. The plan permits maximum utilization of the civilian construction industry’s competitive research and development, manufacturer’s equipment publications and commercial sources for repair parts.

4. Description: The SCAMP Crane is manufactured by the Grove Manufacturing Company, Shady Grove, Pennsylvania. It is a commercially designed, diesel-, engine-driven, 4x4 Wheel Mounted, 360° “stop to stop rotation”, hydraulically operated 4 ton crane. The crane is a Military Adopted Commercial Item (MACI). It consists essentially of four (4) wheels, two (2) rear wheel drive and steer and two (2) front wheel drive and steer (pneumatic-tired). The carrier is equipped with an anti-friction ball bearing turntable that supports the super-structure on the machine, allowing a 360° degree stop to stop rotation and a fully hydraulic, two section trapezoidal type boom, that is 19 feet when fully retracted and 33 feet when extended to its limits. A single telescope cylinder provides the power for extension and retraction. The boom is equipped with an anti-two-block system designed to warn the operator of two-block conditions. The system provides a warning sound, a warning indicator light, and in addition, also activates the control lever lockout system. The electrical system is 24 volts, consisting of two 12 volt batteries wired in series, equipped with a 45 ampere alternator. The carrier is equipped with a Clark powershift (12.6 HR18327) transmission that provides 3 speeds forward and 3 speeds in reverse. The carrier outriggers are the cantilever type and are controlled from the operators cab. They are provided with quick attached oversized floats for greater GVW distribution. The oversized floats are stowed under the tool boxes. The operational and maintenance procedures are covered in TM 5-3810-302-10 and TM 5-3810-302-24. The repair parts information is covered in TM 5-3810-302-24P. The category of maintenance for the SCAMP Crane will be in accordance with the Maintenance Allocation Chart (MAC). (See Appendix A of this supplemental Maintenance and Repair Parts Instructions).

5. Operational Concept: The crane is intended for use in a variety of aircraft maintenance tasks.

a. Removing
b. Replacing
c. Positioning Components
d. Positioning Assemblies
e. Lifting Army Aircraft
f. Towing
g. Spotting Aircraft

Terrain:

h. Improved Highways
i. Unimproved Airfields
j. Heliports

6. Equipment Publications: The initial overpacked publications were commercial manuals. They were shipped with each end item. The 3 Department of the Army Technical Manuals, cite-d- in paragraph 4, supersede the initial overpacked commercial manuals and are available through the normal publications supply channels.

7. Personnel and Training:

a. MOS Requirements: In accordance with (AR 611-201)

(1) Crane Operator: MOS 62F
(2) Organizational Maintenance: MOS 62B
(3) Direct/General Support Maintenance: MOS 62B

b. New Equipment Training: Training will be determined by the using organization. New Equipment Training Teams (NETTs) are available to Major Commands. Training teams should be requested only when trained personnel are not available in the command to operate and/or maintain the crane. Requests for (NETTs) should be forwarded to Commander US Army Tank-Automotive Command (TACOM), ATTN: AMSTA-MLT, Warren, MI 48397-5000.

8. Logistics Assistance: Logistic Assistance Representatives (LARs) are stationed a CONUS and OCONUS installations and are available to provide on-site technical assistance, upon request from the installation.

9. Warranty: Warranty period for the crane SCAMP, Model RT41 AA is 15 months or 1500 hours of operation following date of acceptance by the Government. All warranty claims will be procured through US Army Tank-Automotive Command, ATTN: AMSTA-MVB, Warren, MI 48397-5000 (See Appendix I).

10. Recommending Publication Change: You can improve this publication by recommending improvements, using DA Form 2028. (Recommended Changes to Publications and Blank Forms) and mail direct to Commander US Army Tank-Automotive Command, ATTN: AMSTA-MBS, Warren, MI 48397-5000.

SECTION II

MAINTENANCE

1. Maintenance Concept:

a. Operator/Crew Maintenance: Operator and crew maintenance is limited to daily preventive maintenance and services.

b. Unit Maintenance: Unit Maintenance consists of scheduled preventive maintenance services, minor repairs and adjustments.

c. Intermediate Direct Support Maintenance: Direct support maintenance consists of all the repairs required to restore an unserviceable end item of assembly to a serviceable condition.

d. Intermediate "General Support Maintenance: General support maintenance will repair and return to the supply system designated assembled modules which overflow from or exceed the capability of direct support maintenance.

2. Maintenance Allocation Chart (MAC): "(See Appendix A) Units may exceed their authorized scope and function in the MAC when approved by the support maintenance commander.

3. Modification: The only authorized end item modifications will be in accordance with official Department of Army Modifications Work Orders (MWO).

4. Equipment Improvement Recommendations (EIR): Equipment Improvement Recommendations will be submitted in accordance with DA PAM 738-750.

5. Shipment and Storage: Refer to the manufacturer's operating instructions, service manual, and TB 740-97-2.

6. Destruction to Prevent Enemy Use: Refer to TM 750-244-3 for instructions governing destruction of equipment to prevent enemy use.

7. Basic Issue Items List (BIIL): N/A

8. Tools and Equipment: See Section III of Appendix A (MAC) for those tools necessary to perform maintenance on the SCAMP.

9. Maintenance and Operating Supplies: See Appendix E for a list of maintenance and operating supplies required for initial operation.

10. Maintenance Forms and Records:

a. Operational Records: Operational records (DD Form 1970 and DA Form 240 1) will be used to control the use and record operators and locations of equipment operation.

b. Maintenance Records:

(1) DA Form 2402, Exchange Tag.
(2) DD Form 314, preventive Maintenance Schedule and Records
(3) DA Form 2404, Equipment Inspection and Maintenance Worksheet
(4) DA Form 2405, Maintenance Request Register
(5) DA Form 2407, Maintenance Request

c. Historical Records:

(1) DA Form 2408, Equipment Log Book Assembly
(2) DA Form 2408-1, Equipment Daily and Monthly Log
(3) DA Form 2408-9, Equipment Control Records
(4) DA Form 2408-20, Oil Analysis Log

11. Lubrication: To insure proper operation of this machine, all points requiring lubrication must be serviced with the correct lubrication, at the proper time intervals. All lubrication points requiring service are shown on the lubrication chart (Appendix K).

a. Points not equipped with lubrication fittings (clevis, pins, lever, linkages) should be lubricated according to working and climate conditions, with an oil squirt can DE-10.

b. Intervals specified are for normal operations where moderate temperatures, humidity, and atmospheric conditions prevail. In areas of extreme condition the service periods should be adjusted accordingly.

C A U T I O N

The multipurpose grease installed during manufacture is of a lithium base. Use of a non-compatible grease could result in damage to the equipment.

12. Wire Rope:

Vendor: Grove, part number 6-247-402120, FSCM 12361

Type	Strand	Core
½ "	6 X 4 1	I W R C

a. Any of the following conditions will render the wire rope unserviceable and should be replaced:

(1) Crushing - Because of loose windings on a drum, rope was pulled in between under lying wraps and crushed out of shape.

(2) Birdcaging - Individual strands open/pull away from each other, displacing the core; caused by the sudden release of the load.

(3) Locking - Premature breakage of wires resulting from locking of strands due to insufficient lubrication.

(4) Abrasion - Resulting in rope being in service too long.

(5) Reverse Bending - Caused by running the rope over one sheave and under another, causing wires to break.

(6) Corrosion and Pitting - Caused by lack of lubrication combined with excessive exposure to the elements.

(7) Pinch - Caused by undersized sheave grooves, breaking wire strands.

(8) Wear of one-third the original diameter of outside individual wires.

(9) Reduction from nominal diameter of more than 1/32 inch for diameters ½ inch inclusive.

b. Methods of field lubrications for wire rope are on page 6-11 of the operators manual.

SECTION III

REPAIR PARTS SUPPLY

1. General:

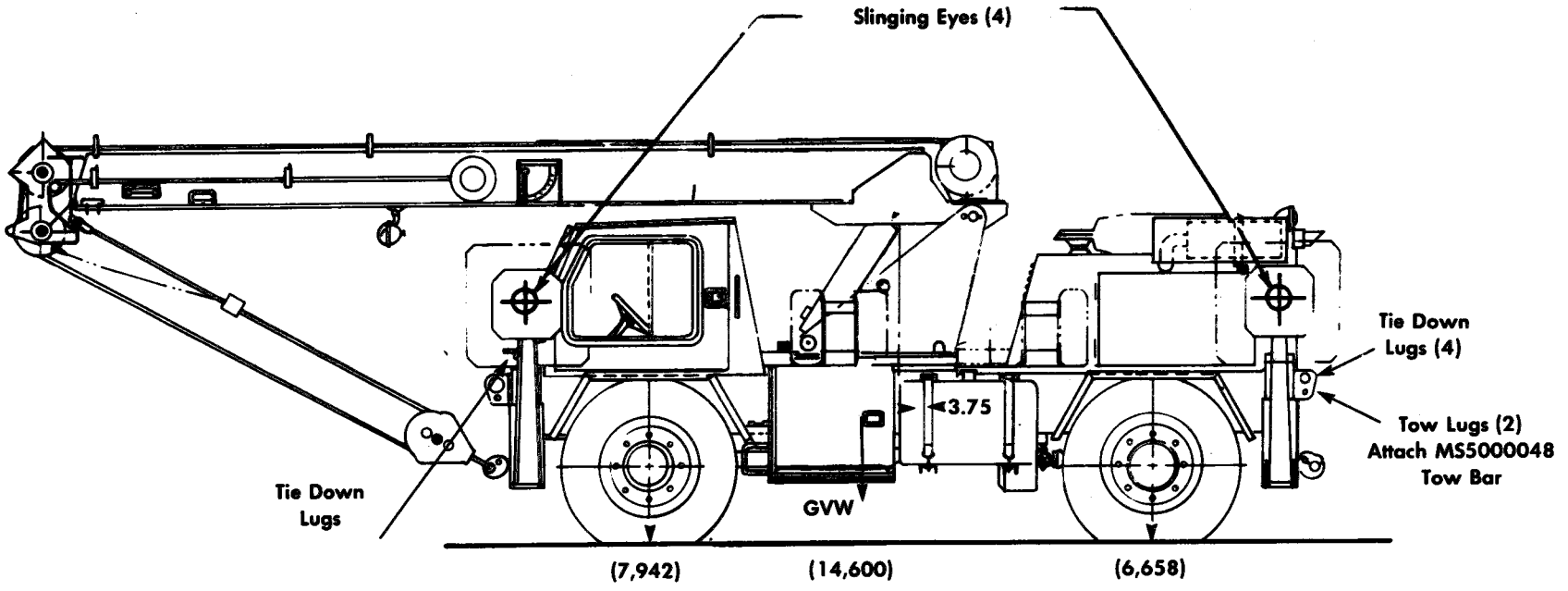
a. The basic policies and procedures in AR 710-2 and AR 725-50 are generally applicable to repair parts management items.

b. National Stock Numbers (NSNs) are initially assigned only to PLL/ASL parts and major assemblies, i.e., engines transmissions, etc. Additional NSNs are assigned by the supply support activities as demands warrant.

c. Proper use of Direct Support System (DSS) project codes and weapon systems designator codes on parts requisitions is essential.

d. Repair parts are available from commercial sources for CONUS units and may be purchased locally in accordance with AR 710-2 and AR 735-110.

e. See TM 5-3810-302-24P for complete repair parts ordering information.



Note: GVW & Distribution Is Based On Crane In Travel Mode With 25% Fuel

APPENDIX A

MAINTENANCE ALLOCATION CHART
for
Crane, Self-propelled Aircraft Maintenance and Positioning (SCAMP)
4 Ton Model RT41AA

SECTION I: Introduction

1. General: The Maintenance Allocation Chart (MAC) designates responsibility for performance of maintenance functions to specific maintenance categories.

2. Maintenance Functions:

a. Inspect: To determine the serviceability of an item by comparing its physical, mechanical and/or electrical characteristics with manufacturers standards.

b. Test: To verify serviceability and to detect electrical and/or mechanical failures by use of test equipment.

c. Service: Operations required periodically to keep an item in proper operating conditions, to clean, preserve, drain, paint or to replenish fuel, lubricants, hydraulic fluids and drain air reservoirs.

d. Adjust: To rectify to the extent necessary to bring or position at specified tolerance.

e. Align: To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate: To determine the corrections to be made in the readings of instruments of test equipment used in precise measurements. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared with the certified standard.

g. Install: The act of emplacing, seating or fixing into position an item, part or module (component or assembly) in a manner to allow the proper functioning of an equipment system.

h. Replace: The act of substituting a serviceable like type part, subassembly or module for an unserviceable counterpart.

i. Repair: The necessary maintenance to restore serviceability to an item by correcting specific damage, fault, malfunction or failure in a part subassembly or system.

j. Overhaul: The maintenance effort (service/action) necessary to restore an item to a complete serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. Rebuild: Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturer standards. Rebuild is the highest degree of material maintenance applied to Army equipment. The retbuild operation includes the act of returning to zero those age measurements (hours/miles, etc.) considered in classifying Army equipment/components.

3. Column Entries: Columns used in the Maintenance Allocation Chart are explained below:

a. Column 1, Group Number: Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column 2, Component/Assembly: Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions: Column 3 lists the functions to be performed on the item listed in Column 2.

d. Column 4, Maintenance Category:

This column specifies the average total manhours required to do the job. For example, if it takes two people five hours to complete the job the figure would be ten. This figure represents the time required to perform the job at the lowest indicated category of maintenance and restore the item to a serviceable condition. It includes disassembly. troubleshooting, quality assurance and assembly.

e. Column 5, Tools and Equipment: Column 5 specifies by code, those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated function.

f. Column 6, Remarks: Column 6 contains an alphabetic code which leads to the remark in Section IV, Remarks, which is pertinent to the item opposite the particular code.

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	MAINT LEVEL * (4) UNIT C	UNIT O	INTMED F	INTMED H	D	TOOLS & EQUIP (5)	REMARKS (6)
01	Engine								
0100	Engine Assembly	Inspect			1.0				
	Diesel	Test				3.0			
		Service		0.8					
		Replace			4.0				
		Repair				20.0			
		Overhaul				60.0			
	Engine Mounting	Replace			2.0				
0101	Crank Case Block								
	Cylinder Head	Inspect			1.0				
		Replace			6.0				
		Overhaul				12.0			
	Cylinder Block	Inspect				4.0			
		Repair				8.0			
0102	Crankshaft	Inspect			1.0				
		Replace				10.0			
		Repair				8.0			
	Bearings, Main	Inspect			1.0				
		Replace				10.0			
	Pulley, Damper	Inspect		3.0					
		Replace			1.0				
0103	Flywheel Assembly								
	Flywheel	Inspect			0.3				
		Replace			6.0				
		Repair				2.5			
	Flywheel Housing	Inspect			0.3				
		Replace			6.0				
		Repair				2.5			
	Ring Gear	Inspect			0.1				
		Replace			1.5				

*MAINTENANCE LEVELS:
C - OPERATOR/CREW
O - ORGANIZATIONAL = UNIT
F - INTERMEDIATE DIRECT SUPPORT
H - INTERMEDIATE GENERAL SUPPORT
D - DEPOT

STA FORM 668-1
1 NOV 83

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	MAINT LEVEL * (4) UNIT C	UNIT O	INTMED F	INTMED H	INTMED D	TOOLS & EQUIP (5)	REMARKS (6)
0104	Piston & Connecting Rod Assembly								
	Piston & Connecting Rods	Inspect			1.0				
		Replace				12.0			
	Bearing & Rings	Inspect			1.0				
		Replace				12.0			
0105	Valves,Camshaft & Timing System								
	Rocker Arm Assembly	Adjust			0.5				
		Replace			1.0				
		Repair			2.0				
	Valves Intake & Exhaust	Inspect		1.0					
		Replace				6.0			
		Repair				2.0			
	Camshaft Bearings & Timing Gears	Inspect				1.0			
		Replace				2.0			
0106	Engine Lubrication System								
	Oil Pan	Replace			2.0				
		Repair			1.0				
	Oil Pump	Replace			3.0				
		Repair			3.0				
	Filter, Assy	Replace		0.5					
	Cooler, Oil	Replace		2.0					
0108	Manifolds								
	Manifolds Intake & Exhaust	Replace		3.0					
02	Clutch	Repair			1.6				
0203	Torque Converter	Overhaul				3.0			
03	Fuel System								
0301	Fuel Injectors	Test			1.0				
		Replace			1.5				

*MAINTENANCE LEVELS:
C - OPERATOR/CREW
O - ORGANIZATIONAL
= UNIT
F - INTERMEDIATE DIRECT SUPPORT
H - INTERMEDIATE GENERAL SUPPORT
D - DEPOT

STA FORM 668-1
1 NOV 83

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	MAINT LEVEL * (4) UNIT C	UNIT O	INTMED F	INTMED H	D	TOOLS & EQUIP (5)	REMARKS (6)
0302	Fuel Pump	Replace			1.0				
		Repair			2.0				
	Fuel Lines & Fitting	Replace		1.0					
	Pump, Fuel Transfer	Replace		0.5					
		Repair		1.0					
0304	Air Cleaner								
	Element, Air Cleaner	Service		0.5					
		Replace		0.5					
0306	Fuel, Tank, Lines & Fitting	Service		0.5					
		Replace		1.0					
		Repair			1.0				
0309	Fuel Filters								
	Element, Fuel Filter	Replace		0.5					
	Element, Water Separator	Replace		0.5					
0311	Engine, Starting Aid								
	Quick Start Cyl	Replace		0.2					
	Lines & Fittings	Replace		0.5					
0312	Accelerator, Throttle Control								
	Throttle Control Cable	Service		0.2					
		Adjust		0.2					
		Replace		1.0					
04	Exhaust System								
0401	Muffler & Pipes	Replace		2.0					
05	Cooling System								
0501	Radiator Assembly	Inspect	0.1						
		Service	0.5						
		Replace		2.0					
		Repair			2.0				

*MAINTENANCE LEVELS:
C - OPERATOR/CREW
O - ORGANIZATIONAL
= UNIT
F - INTERMEDIATE DIRECT SUPPORT
H - INTERMEDIATE GENERAL SUPPORT
D - DEPOT

STA FORM 668-1
1 NOV 83

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENTI/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	MAINT LEVEL * (4) UNIT c	UNIT o	INTWED F	INTWED H	INTWED D	TOOLS & EQUIP (5)	REMARKS (6)
0502	shroud Radiator	Replace		1.0					
		Repair			1.0				
0503	Water Manifolds, Headers Thermostat								
	Thermostat	Replace		0.2					
	Hoses, Lines, Fittings	Replace		1.0					
0504	Water Pump								
	Pump Assembly	Service		o.2					
		Replace		1.0					
		Repair			1.5				
0505	Fan Assembly								
	Fan	Inspect	0.1						
		Replace		o.5					
06	Electrical System								
0601	Alternator	Test		o.5					
		Replace		1.0					
		Repair			2.0				
	Belts, Drive	Adjust		o.2					
		Replace		o.5					
0603	Starter Motor								
	Starter	Test		o.5					
		Replace		1.0					
		Repair			1.5				
	Solenoid	Replace		1.0					
0607	Instrument or Engine Control Panel								

*MAINTENANCE LEVELS:

C - OPERATOR/CREW = UNIT
O - ORGANIZATIONAL = UNIT
F - INTERMEDIATE DIRECT SUPPORT
H - INTERMEDIATEGENERAL SUPPORT SUPPORT
D - DEPOT

STA FORM 668-1
1 NOV 83

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	MAINT LEVEL * (4) UNIT C	UNIT O	INTMED F	INTMED H	D	TOOLS & EQUIP (5)	REMARKS (6)
0607	Instrument or Engine Control Panel								
	Instrument Panel	Replace		1.0					
		Repair		2.0					
	Instrument Guages & Meters	Replace		1.0					
0609	Lights								
	Headlights	Inspect	0.1						
		Test		0.1					
		Repair		0.5					
	Taillights	Inspect	0.1						
		Test		0.1					
		Repair		0.5					
	Stoplights	Inspect	0.1						
		Test		0.1					
		Repair		0.5					
0610	Horn	Test	0.1						
		Replace		0.2					
	Horn Switch	Test		0.1					
		Replace		0.2					
0612	Batteries, Storage								
	Batteries	Test		0.2					
		Service	0.1						
		Replace		0.2					
		Repair			1.0				
	Battery Box	Service	0.2						
		Replace		0.2					
		Repair		0.2					
	Battery Cables & Clamps	Inspect	0.1						
		Service	0.1						
		Replace		0.2					
		Repair		0.2					

*MAINTENANCE LEVELS:

C - OPERATOR/CREW
O - ORGANIZATIONAL
= UNIT

F - INTERMEDIATE DIRECT SUPPORT
H - INTERMEDIATE GENERAL SUPPORT
D - DEPOT

STA FORM 668-1
1 NOV 83

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	MAINT LEVEL * (4) UNIT C	UNIT O	INTMED F	INTMED H	D	TOOLS & EQUIP (5)	REMARKS (6)
0613	Hull or Chassis								
	Wiring	Inspect		0.1					
	Wiring Harness	Test		1.0					
		Replace			2.0				
		Repair		1.0					
07	Transmission								
0705	Shifting Levers	Service	0.5						
		Replace			1.0				
0710	Transmission Assy	Inspect		0.2					
		Service	0.5						
		Replace			12.0				
		Repair				3.0			
		Overhaul				10.0			
09	Propeller Shafts								
0900	Drive Shaft Assy	Inspect	0.2						
		Service	0.2						
		Replace		1.0					
	Slip Joints/U-Joints	Inspect	0.2						
		Service	0.2						
		Replace		0.5					
10	Front Axle								
1000	Front Axle Assy	Service		0.2					
		Replace			4.0				
		Repair				4.0			
		Overhaul				6.0			

*MAINTENANCE LEVELS:

C - OPERATOR/CREW
O - ORGANIZATIONAL
= UNIT

F - INTERMEDIATE DIRECT SUPPORT
H - INTERMEDIATE GENERAL SUPPORT
D - DEPOT

STA FORM 668-1
1 NOV 83

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	MAINT LEVEL * (4) UNIT C	UNIT O	INTMED F	INTMED H	D	TOOLS & EQUIP (5)	REMARKS (6)
1002	Differential								
	Differential Assy	Service	0.2						
		Replace			3.0				
		Repair			3.0				
		Overhaul				4.0			
1004	Steering Mechanism								
	Arm Spindle, Bearings,								
	Seals, Gear Box	Inspect		0.2					
		Service	0.2						
		Replace			1.5				
		Repair			1.5				
11	Rear Axle								
1100	Rear Axle Assy	Service		0.2					
		Replace			4.0				
		Repair				4.0			
		Overhaul				6.0			
1102	Differential	Service	0.2						
	Differential Assy	Replace			3.0				
		Repair			3.0				
		Overhaul				4.0			
12	Brakes								
1201	Hand Brake, Park	Service	0.2						
		Adjust		0.2					
		Replace		1.0					
		Repair		1.0					
1202	Service Brake	Service	0.2						
		Adjust		0.2					
		Replace		1.0					
		Repair		1.0					

*MAINTENANCE LEVELS:

C - OPERATOR/CREW
O - ORGANIZATIONAL = UNIT

F - INTERMEDIATE DIRECT SUPPORT
H - INTERMEDIATE GENERAL SUPPORT

D - DEPOT

STA FORM 668-1
1 NOV 83

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	MAINT LEVEL (4) UNIT C	UNIT O	INTMED F	INTMED H	D	TOOLS & EQUIP (5)	REMARKS (6)
1202	Brake Booster	Service	0.2						
		Replace		1.0					
		Repair			1.0				
13	Wheels								
1311	Wheel Assembly	Inspect	0.2						
		Replace	0.5						
	Rim	Inspect	0.1						
		Replace		0.5					
1313	Tires	Inspect	1.0						
		Service	0.2						
		Replace		0.5					
		Repair				0.5			
14	Steering								
1401	Steering Wheel	Inspect	0.1						
		Replace		0.6					
	Steering Gear & Column	Service	0.2						
		Adjust		0.2					
		Replace		1.0					
		Repair			1.0				
1410	Hydraulic Pump, Steering	Test			0.5				
		Replace			1.5				
		Repair			1.5				
1411	Hose, Lines Fittings	Inspect	0.2						
		Replace		1.0					
1412	Hydraulic Cylinders	Inspect	0.2						
		Replace			1.0				
		Repair			1.5				

*MAINTENANCE LEVELS:

C - OPERATOR/CREW
O - ORGANIZATIONAL
= UNIT

F - INTERMEDIATE DIRECT SUPPORT
H - INTERMEDIATE GENERAL SUPPORT

D - DEPOT

STA FORM 668-1
1 NOV 83

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	MAINT LEVEL * (4) UNIT C	UNIT O	INTMED F	INTMED H	D	TOOLS & EQUIP (5)	REMARKS (6)
1414	Steering System Valves								
	Control Valve	Inspect	0.1						
		Test			0.2				
		Adjust			0.3				
		Replace			0.8				
		Repair			1.0				
	Control Valve Rear Steer	Inspect	0.1						
		Test			0.2				
		Adjust			0.3				
		Replace			0.8				
		Repair			1.0				
15	Frame								
1501	Frame Assembly	Inspect		0.2					
		Repair				4.0			
1503	Pintles & Towing Attachment	Service	0.1						
		Replace		0.3					
1504	Spare Wheel								
	Tire Carrier	Inspect	0.1						
		Replace		0.2					
		Repair		0.2					
1507	Leveling Jacks								
	Outriggers & Pads	Service	0.1						
		Replace			4.5				
		Repair			4.0				
18	Body, Cab, Hood								
1801	Cab & Hood Assy	Inspect	0.1						
		Replace			6.0				
		Repair			5.0				

*MAINTENANCE LEVELS:
C - OPERATOR/CREW
O - ORGANIZATIONAL
= UNIT
F - INTERMEDIATE DIRECT SUPPORT
H - INTERMEDIATE GENERAL SUPPORT
D - DEPOT

STA FORM 668-1
1 NOV 83

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	MAINT LEVEL * (4) UNIT C	UNIT O	INTMED F	INTMED H	INTMED D	TOOLS & EQUIP (5)	REMARKS (6)
1801	Door Assembly	Replace		0.5					
		Repair		0.5					
1802	Windshield	Replace			1.5				
1806	Seats								
	Seat & Back Assembly	Replace		1.0					
		Repair			1.0				
1808	Box Tool	Inspect	0.1						
		Replace		0.5					
		Repair		0.5					
22	Miscellaneous Chassis or Hull Accessory Items								
2202	Accessory Items								
	Mirror Reflectors	Inspect	0.1						
		Replace		0.2					
	Wiper Blades	Inspect	0.1						
		Replace		0.1					
	Wiper Motor	Test	0.1						
		Replace		0.2					
2207	Heater, Personnel	Replace		2.0					
		Repair			2.0				
2210	**Data &** Instruction Plates								
	Data Plates	Inspect	0.1						
		Replace		0.1					

*** MAINTENANCE LEVELS:**

C - OPERATOR/CREW
O - ORGANIZATIONAL = **UNIT**
F - INTERMEDIATE DIRECT SUPPORT
H - INTERMEDIATE GENERAL SUPPORT
D - DEPOT

STA FORM 668-1
1 NOV 83

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	MAINT LEVEL* (4) UNIT C	UNIT O	INTMED F	INTMED H	INTMED D	TOOLS & EQUIP (5)	REMARKS (6)
2210	Instruction Plates	Inspect	0.1						
		Replace		0.1					
24	Hydraulic & Fluid Sys								
2401	Pump & Pump Drives	Test			0.5				
		Replace			3.0				
		Repair			4.0				
	Hydraulic Motors	Inspect	0.1						
		Test			0.5				
		Replace			1.0				
		Repair			1.5				
2403	Control Valves	Inspect	0.1						
		Test			0.5				
		Replace			1.0				
		Repair			1.5				
2407	Hydraulic Cylinders								
	Boom Hoist Cyl	Inspect	0.1						
		Replace			4.0				
		Repair			5.0				
	Boom Extension Cyl	Inspect	0.1						
		Replace			4.0				
		Repair			5.0				
	Outrigger Cyl	Inspect	0.1						
		Replace			4.0				
		Repair			5.0				
74	Crane Component								
7403	Gear Box Swing	Inspect	0.1						
		Service	0.1						
		Replace			3.0				
		Repair			3.0				

* MAINTENANCE LEVELS:

C - OPERATOR/CREW
O - ORGANIZATIONAL
= UNIT

F - INTERMEDIATE DIRECT SUPPORT
H - INTERMEDIATE GENERAL SUPPORT
D - DEPOT

STA FORM 668-1
1 NOV 83

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	MAINT LEVEL I (4) UNIT c	UNIT o	INTMED F	INTMED H	D	TOOLS & EQUIP (5)	REMARKS (6)
7411	Crane Attachments								
	Boom Assembly	Inspect	0.1						
		Service	0.1						
		Replace			6.0				
		Repair			8.0				
	Hook Block	Inspect	0.1						
		Service	0.1						
		Replace		1.0					
		Repair			1.0				
	Wire Rope	Inspect	0.1						
		Replace	0.5						
	Drum	Inspect	0.1						
		Service	0 2						
		Replace			1.5				
		Repair			2.0				
7419	Turntable and Bearing	Service		0.1					
		Replace				4.0			
		Repair				4.0			
76	Fire Fighting Equip Components	Inspect	o.1						
7603	Fire Extinguisher	Replace	o.1						

*MAINTENANCE LEVELS:

C - OPERATOR/CREW
O - ORGANIZATIONAL
= UNIT

F - INTERMEDIATE DIRECT SUPPORT
H - INTERMEDIATE GENERAL SUPPORT

D - DEPOT

STA FORM 668-1
1 NOV 83

APPENDIX A PART 2
MAINTENANCE ALLOCATION CHART

for

Crane, Self-Propelled, 4 Ton
Model RT41AA, (SCAMP)

All maintenance functions can be accomplished with the tools contained in the following tool sets, test sets and those furnished with the crane.

SECTION III. TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOL OR TEST EQUIPMENT REFERENCE CODE	MAINTEN-ANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER	FSCM OR LINE NUMBER
1	F,H	Shop Eq Fuel &Elec Sys Eng; SC4910-95-CL-A01	4940-00-754-0714		T30414
	F,H	Shop Set, Fuel & Elec Sys supp No 2 SC4910-95-CL-A65	4940-00-390-7775		T30688
	F,H	Test Set, Diesel Injector; SC4910-IL	4910-00-317-8265		19204 V73742
	F,H	Shop Eq Auto Maint & Repair, Org Supp No 1 (less power) SC4910-95-CL-A73	4910-00-754-0653		W32867
	F,H	Shop Eq Mach Shop Trk-Mtd SC3470-95-CL-A02	3470-00-754-0708		T15644
	F,H	Tool Kit, Machinist SC5280-95-CL-A02	5280-00-511-1950		W44512
	O,F,H	Shop Eq Weld Set SC3U70-95-CL-A08	4940-00-357-7268		T16714
	F,H	Tool Kit, Body & Fender Repair SC5180-90-CLN-34	5180-00-754-0643		W33689
	F,H	Multimeter AN/USM-223	6625-00-999-7465		M80242
	o	Tool Kit, Auto Supp No 1 SC4910-95-CL-A73	4910-00-754-0653		W32867
	o	Tool Set, Veh Full Tracked Supp No 2 SC4940-95-CL-A08	4940-00-754-0743		W65747

MAINTENANCE ALLOCATION CHART

FOR

Crane, Self Propelled, 4 Ton

Model RT41AA (SCAMP)

Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOL TEST EQUIPMENT REFERENCE CODE	MAINTENANCE CATEGORY	NOMENCLATURE	STOCK NUMBER	TOOL NUMBER	FSCM OR LINE NUMBER
	H	Shop Set, Internal Combustion, Engine Repair SC4910-95-CL-A59	4910-00-262-7532		T15618
	F, H	Shop Eq Contact Maint. Trk-Mtd SC4940-95-CL-B04	4940-00-294-9518		T10138
	F,H	Shop Eq Gen-Pur Repr, Semitrl Mtd SC4940-95-CL-B02	4940-00-287-4894		T10549
	F,H	Shop Eq Org Repr Light Trk-Mtd SC4940-97-CLE04	4940-00-294-9516		T13152
	F,H	TOOL Kit, Auto Fuel & Elec Sys Repr SC4910-95-CL-A50	5180-00-754-0655		W32456
	O,F,H	Tool Kit, Auto Maint: Org Maint Common No 1 SC4910-95CL-A74	4910-00-754-0654		W32593
	F,H	TOOL KIT, AUTO MAINT Org Maint. Common No 2 SC4910-95-CL-A72	4910-00-754-0650		W32720
	O,F,H	TOOL KIT, AUTO Mech: Light Wt SC5180-90-CLN26	5180-00-177-7033		W33004
	O,F,H,	TOOL KIT, Master Mechanic: Eq Maint & Repair SC5180-90-CL-N05	5180-00-699-5273		W45060
	O,F,H,	Tool Kit, Rigging	5180-00-596-1513		W50266

APPENDIX B

ORGANIZATIONAL
PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

GENERAL

To make sure that your vehicle is ready for operation at all times, inspect it systematically so you can discover any defects and have them corrected before they result in serious damage or failure. The charts on the next few pages contain your organizational PMCS. The item numbers indicate the sequence of minimum inspection requirements. If you're operating the vehicle and notice something wrong which could damage the equipment if you continue operation, stop operation immediately.

Record all deficiencies and shortcomings, along with the corrective action taken, on Form 2404. The Item Number column is the source for the numbers used on the TM Number column on DA Form 2404.

ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

1. The item numbers of the table indicate the sequence of the PMCS. Perform at the intervals shown below:

(a) Do your (Q) PREVENTIVE MAINTENANCE quarterly (every three months).
(b) Do your (S) PREVENTIVE MAINTENANCE semiannually (every six months).
(c) Do your (A) PREVENTIVE MAINTENANCE annually (once every year).
(d) Do your (B) PREVENTIVE MAINTENANCE biannually (once every two years).
(e) Do your (H) PREVENTIVE MAINTENANCE at the hour interval listed.
(f) Do your (Mi) PREVENTIVE MAINTENANCE at the mile interval listed.

2. If something doesn't work, troubleshoot it with the instructions in this manual or notify your supervisor.

3. Always do your preventive maintenance in the same order, so it gets to be a habit. Once you've had some practice, you'll spot anything wrong in a hurry.

4. If anything looks wrong and you can't fix it, write it down on your DA Form 2404. If you find something seriously wrong, report it to direct support as soon as possible.

WARNING

Dry cleating solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and we only in well ventilated area. Avoid contact with skin, eyes and clothes and don't breathe vapors. Do not use near open flame or excessive heat. If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with skin or clothing is made, flush with water. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

WARNING

Air - Compressed air, used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personnel protective equipment (goggles/shield/gloves, etc.).

(a) Keep it clean: Dirt, grease, oil and debris only get in the way and may cover up a serious problem. Clean as you work and as needed. Use dry cleaning solvent (P-D-680) to clean metal surfaces. Use soap and water when you clean rubber or plastic material.

(b) Bolts, nuts and screws: Check that they are not loose, missing, bent or broken. You can't try them all with a tool, of course, but look for chipped paint, bare metal or rust around bolt heads. Tighten any that you find loose.

(c) Welds: Look for loose or chipped paint, rust or gaps where parts are welded together. If you find a bad weld, report it to direct support.

(d) Electric wires and connectors: Look for cracked or broken insulation, bare wires and loose or broken connectors. Tighten loose connections and make sure the wires are in good condition.

(e) Hoses and fluid lines: Look for wear, damage and leaks. Make sure clamps and fittings are tight. Wet spots show leaks, of course, but a stain around a fitting or connector can mean a leak. If a leak comes from a loose fitting or connector, tighten it. If something is broken or worn out, either correct it or report it to direct support (refer to MAC Chart).

5. It is necessary for you to know how fluid leaks affect the status of your equipment. The following are definitions of the types/classes of leakage you need to know to be able to determine the status of your equipment. Learn and be familiar with them and REMEMBER - When in doubt, notify your supervisor.

LEAKAGE DEFINITIONS FOR ORGANIZATIONAL PMCS

Class I	Seepage of fluid (as indicated by wetness or discoloration) not great enough to form drops.
Class II	Leakage of fluid great enough to form drops, but not enough to cause drops to drip from the item being checked/inspected.
Class III	Leakage of fluid great enough to form drops that fall from the item being checked/inspected.

NOTE

Perform Operator/Crew PMCS prior to or in conjunction with Organizational PMCS if:

1. There is a delay between the daily operation and the Organizational PMCS.
2. Regular operator is not assisting/participating.

ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Q - QUARTERLY S - SEMIANNUALLY A - ANNUALLY B - BIENNIALLY H - HOURS MI - MILES

ITEM NO	INTERVAL						ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED **PERFORM ALL OPERATOR PMCS FIRST**
	Q	S	A	B	H	MI	
1	X						Lubricate in accordance with the lubrication chart (Appendix K).
2					150		Change oil filter every 150 hours of operation for the duration of the warranty period. After warranty period, refer to TB 43-0210, Oil Analysis Program. (Ref. Paragraph 3-19).
3	X						Change fuel filter every 3 months or 250 hours. (Ref. Para 3-37).
4	X						Check condition of hoses and clamps on cooling system. WARNING Compressed air used for cleaning purposes will not exceed 30 PSI. Always use goggles and gloves.
5A		X					Replace air safety element. (Ref. Para 3-4).
5B		X					Clean primary air element (Ref. Fig 3-1, Page 3-13).
6		X					Wheel Bearings: Clean, inspect and repack. (Ref. Para 5-7). WARNING The cooling system is pressurized. Personal injury may result when removing the radiator cap after operating temperature is reached. If it becomes necessary to check coolant level during operation, use proper protection when removing the radiator cap.
7			X				Cooling System: Check for Antifreeze protection, contaminants and, if necessary, drain and flush. Replenish with a mixture of 50% water and 50% anti freeze. (Ref. TB 750-65).
8			X				Brakes: Inspect linings for wear and contamination. Replace if necessary. (Ref. Section 7). CAUTION When checking swing gearbox oil level, place dipstick into sleeve and check when cap is flush with sleeve. Do not screw cap onto sleeve to check oil level.

STA FORM 667
1 NOV 83

ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Q - QUARTERLY S - SEMIANNUALLY A - ANNUALLY B - BIENNIALLY H - HOURS MI - MILES

ITEM NO	INTERVAL						ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED **PERFORM ALL OPERATOR PMCS FIRST**
	Q	S	A	B	H	MI	
9			X				Swing gearbox: Drain first time after 250 hours of operation. Check annually after that.

STA FORM 667
1 NOV 83

APPENDIX C

GENERAL AIRCRAFT TOWING INSTRUCTIONS FOR THE SCAMP

CAUTION

Use extreme care if positioning aircraft within hanger. Use the front tow only with the boom positioned to the rear, with hook locked into pintle. Flightline towing can only be performed with the rear tow, with boom positioned to the front and the hook locked into the pintle.

CAUTION (CH 47 Towing)

Extreme care shall be observed when towing the CH 47 Helicopter. Damage to the ramp extension and right side of the aircraft will occur if a right turn in excess of 45 degrees is made.

CAUTION (UH 60 Towing)

Extreme care shall be observed when towing the UH 60 Helicopter. Damage to the aircraft will occur if either a right or left turn in excess of 45 degrees is made.

General instructions, as prescribed by AR 95-1 for towing and hand-moving Army aircraft are contained herein. For specific instructions on a particular aircraft, refer to applicable operator's manual or maintenance manual. Aircraft shall not be moved where, or in such a manner that, injury to personnel or damage to the aircraft or property could result. Visual signals for movement of Army aircraft are contained in FM 1-105 or FM 21-60.

a. General instructions for all ground movements are as follows:

(1) Disconnect and move clear all ground support, ground servicing and maintenance equipment not essential to movement of aircraft.

(2) Assign an authorized ground crewmember to operate aircraft brakes as required, from the time chocks are removed until they are reinstalled.

(3) Assign a ground crewmember to stand near tip of each wing to act as a guide during ground movements.

(4) Stand clear of aircraft immediately prior to and during movement.

(5) Assign a qualified ground crewmember to direct departure from or approach to, a parking position. Only approved standard signals will be used. Use a flashlight or luminescent wand to signal instructions at night.

(6) Do not stand, sit or lie on any external portion of an aircraft while it is in motion. Do not jump from, or board a moving aircraft.

(7) When moving aircraft, avoid sudden stops and starts.

(8) No person, vehicle, or aircraft shall approach close to an oncoming taxiing aircraft, pass closer than 200 feet to the rear of an operating turbine-powered aircraft, or pass closer than 100 feet to the rear of other operating aircraft.

(9) Do not taxi or tow aircraft or start or runup engines within 50 feet of any fuel, oil, or water-alcohol servicing operation or within 50 feet of any spill until the spill has been removed and the area rendered safe.

b. General instructions for towing aircraft are as follows:

(1) Prior to towing aircraft, ensure that towing attachments, lines and bars are of adequate capacity, serviceable and secured firmly to designated tow fittings of aircraft and tow vehicle.

(2) Never exceed five miles per hour and tow with extreme care over ice, snow, rough, rocky or muddy ground and in congested areas.

Cooling System Capacity in Quarts	Anti-Freeze Coolant Required*(in Quarts)												
	2	3	4	5	6	7	8	9	10	11	12	13	
5	-12°	-62°			Anti-Freeze		25%	33%	40%	50%	60%	68%	
6	0°	-34°											
7	6°	-17°	-54°		Protects To		+10°	0°	-12°	-34°	-62°	-90°	
8	10°	- 7°	-34°	-69°									
9		0°	-21°	-50°									
10		4°	-12°	-34°	-62°								
11		8°	- 6°	-23°	-47°								
12		10°	0°	-15°	-34°	-57°							
13			3°	- 9°	-25°	-45°	-66°						
14			6°	- 5°	-17°	-34°	-54°						
15			8°	0°	-12°	-26°	-43°	-62°					
16			10°	2°	- 7°	-19°	-34°	-52°					
17				5°	- 4°	-14°	-27°	-42°	-58°				
18				7°	0°	-10°	-21°	-34°	-50°	-65°			
19				9°	2°	- 7°	-16°	-28°	-42°	-56°			
20				10°	4°	- 3°	-12°	-22°	-34°	-48°	-62°		
21					6°	0°	- 9°	-17°	-28°	-41°	-54°	-68°	
22					8°	2°	- 6°	-14°	-23°	-34°	-47°	-59°	
23					9°	4°	- 3°	-10°	-19°	-29°	-40°	-52°	
24					10°	5°	0°	- 7°	-15°	-24°	-34°	-46°	

NOTE: Do Not Use Without Some Water.
68% Concentration Gives Maximum Protection.

* Use at least 33% concentration for protection against rust and corrosion.

MAINTENANCE AND OPERATING SUPPLY LIST

NOMENCLATURE: CRANE, WHEEL MTD, RT 4 Ton, SCAMP	MAKE: Grove	MODEL: RT41AA
MFR PART NO: E1-104-0-00001	NSN: 3810-01-144-4885	SERIAL NO. RANGE: ——— TO ———
		DATE:

(1) COMPONENT APPLICATION	(2) MFR PART NO. OR NAT'L STOCK NO.	(3) DESCRIPTION	(4) QTY REQ F/INITIAL OPN	(5) QTY REQ F/8 HRS OPN	(6) NOTES
Wire Rope	8415-00-274-2433	Gloves, Leather KK-G-476	2 Pr.	2 Pr.	Used when working with wire rope.
Oil Sampling	8125-01-082-9697	Bottle, Sampling	none	none	Oil analysis program
	6515-00-727-0008	Syringe	none	none	"
	4720-00-580-6055	Tubing 3/8 inch Dia.	none	none	"
	8105-00-290-0340	Sack, Shipping	none	none	"
	8105-00-837-7754	Bag, plastic	none	none	"
Cleaning		Solvent, Dry Cleaning SO-2 (P-D680)			
	6850-00-281-1985	1 Gal Can			
	6850-00-264-9038	5 Gal Can			
	6850-00-285-8012	55 Gal Drum			

APPENDIX F

PETROLEUM SUPPLY LIST

Grease, Multipurpose Auto (MPG)

Military (GAA)

Specification	Range	Container	NSN
MIL-G-10924	-12° to 52°C	Cart - 14 oz.	9150-00-935-1017
		Can 1.75 lb.	9150-00-190-0904
		Can 6.5 lb.	9150-00-190-0905
		Can 35 lb.	9150-00-190-0907
		DR 120 lb.	9150-00-530-7369

Diesel Fuel (Grade 2)

32° and above

Specification	Range	Container	NSN
Federal Spec.	32°F & above	Bulk	9140-00-286-5294
VVF800		5 Gal.	9140-00-286-5295
Graded F2RE		55 Gal.	9140-00-286-5297
For Winter use below 32°F use Fuel Grade 1 or add De-Icing additive			
Graded DF-1WI, Winter use below 32°F		Bulk	9140-00-286-5286
		5 Gal.	9140-00-286-5287
		55 Gal.	9140-00-286-5289
Additive Fuel De-Icing		4 oz. Aerosol	6850-01-016-1914
MIL-I-27686, NATO Code S-748		5 Gal Can	6850-00-753-5061
Use with Fuel Grade 2 only		55 Gal Drum	6850-00-060-5312

Cooling System Treatment

Specification	Container	NSN
Antifreeze, Engine Cooling System MIL-A-46153B used 32°F to 40°F	1 gal.	6850-00-181-7929
	5 gal.	6850-00-181-7933
	55 gal.	6850-00-181-7940
MIL-A-11755D used -40°F to 90°F	55 gal.	6850-00-174-1806
Federal Spec: 0-1-490 Corrosion inhibitor, Cooling System	6 oz. Can	6850-00-753-4967
	8.5 oz. Can	6850-00-584-2707
	12 oz. Can	6850-01-076-8810

Brake Fluid Silicone

Military (BFS)

Specification	Container	NSN
MIL-B-46176 Brake Fluid	1 gal.	9150-01-102-9455
MIL-B-46176 Brake Fluid	5 gal.	9150-01-123-3152
Decal formatter Cylinder	ea.	7690-01-111-2265 12302516(19207)
TB 43-0002-87		

Gear Oil (GO)

Specification	Range	Container	NSN
MIL-L-2105C	-10° & below 75w	qt.	9150-01-035-5390
		5 gal.	9150-01-035-5391
	-10° & above 80W-90	qt.	9150-01-035-5392
		5 gal.	9150-01-035-5393
		55 gal.	9150-01-035-5394
	above 90°F 85w-140	qt.	9150-01-048-4591
		5 gal.	9150-01-035-5395
		55 gal.	9150-01-035-5396

Open Gear and Wire Rope Lubricant (OG)

Military (CW-11)

Specification	Container	NSN
Federal Spec VVL751	5 lb.	9150-00-234-5197
	35 lb.	9150-00-261-7891
	120 lb.	9150-00-530-7293

Hydraulic Torque Converter Fluid

Military (OE10)

Specification	Range	Wt.	Container	NSN
MIL-L-2104C	-13°F to 95°F	10	qt.	9150-00-189-6727
			5 gal.	9150-00-186-6668
			55 gal.	9150-00-191-2772
	140°F & above	30	qt.	9150-00-186-6681
			5 gal.	9150-00-188-9858
			55 gal.	9150-00-188-9859

Oil Engine Lubrication (MO)

Military (HDO)

Specification	Range	Grade	Container	NSN
MIL-L-2104	-13°F to 95°F	10	qt.	9150-00-189-6727
			5 gal.	9150-00-186-6668
			55 gal.	9150-00-191-2772
	14°F & above	30	qt.	9150-00-186-6681
			5 gal.	9150-00-188-9858

Specification	Range	Grade	Container	NSN
			55 gal.	9150-00-188-9859
MIL-L-46167	-13° & below		qt.	9150-00-402-4478
			5 gal.	9150-00-402-2372
			55 gal.	9150-00-491-7197

APPENDIX G

FRACTIONS FOR COMMON HARDWARE

- DECIMALS - FRACTIONS - MILLIMETERS

DECIMAL	mm
.0156	0.396
.0312	0.793
.0468	1.190
.0625	1.587
.0781	1.984
.0937	2.381
.1093	2.778
.125	3.175
.1406	3.571
.1562	3.968
.1718	4.365
.1875	4.762
.2031	5.159
.2187	5.556
.2343	5.953
.250	6.350
.2656	6.746
.2812	7.143
.2968	7.540
.3125	7.937
.3281	8.334
.3437	8.731
.3593	9.128
.375	9.525
.3906	9.921
.4062	10.318
.4218	10.715
.4375	11.112
.4531	11.509
.4687	11.906
.4843	12.303
.500	12.700
.5156	13.096
.5312	13.493
.5468	13.890
.5625	14.287
.5781	14.684
.5937	15.081
.6093	15.478
.625	15.875
.6406	16.271
.6562	16.668
.6718	17.065
.6875	17.462
.7031	17.859
.7187	18.256
.7343	18.653
.750	19.050
.7656	19.446
.7812	19.843
.7968	20.240
.8125	20.637
.8281	21.034
.8437	21.431
.8593	21.828
.875	22.225
.8906	22.621
.9062	23.018
.9218	23.415
.9375	23.812
.9531	24.209
.9687	24.606
.9843	25.003
1.000	25.400

TAP DRILL SIZES

Nominal size and number threads per inch	Commercial tap drill to produce approx. 75% full thread	Decimal equivalent of tap drill
0—80	3-64	0.0469
1—64	53	0.0595
72	53	0.0595
2—56	50	0.0700
64	50	0.0700
3—48	47	0.0785
56	45	0.0820
4—40	43	0.0890
48	42	0.0935
5—40	38	0.1015
44	37	0.1040
6—32	36	0.1065
40	33	0.1130
8—32	29	0.1360
36	29	0.1360
10—24	25	0.1195
32	21	0.1590
12—24	16	0.1770
28	14	0.1820
1/4—20	7	0.2010
28	3	0.2130
5/16—18	F	0.2570
24	I	0.2720
3/8—16	5-16	0.3125
24	Q	0.3320
7/16—14	U	0.3680
20	25-64	0.3906
1/2—13	27-64	0.4219
20	29-64	0.4531
9/16—12	31-64	0.4844
18	33-64	0.5156
5/8—11	17-32	0.5312
18	37-64	0.5781
3/4—10	21-32	0.6562
16	11-16	0.6875
7/8— 9	49-64	0.7656
14	13-16	0.8125
1— 8	7-8	0.8750
14	15-16	0.9375
1 1/8— 7	63-64	0.9844
12	1 3-64	1.0469
1 1/4— 7	1 7-64	1.1094
12	1 11-64	1.1719
1 3/8— 6	1 7-32	1.2187
12	1 19-64	1.2969
1 1/2— 6	1 11-32	1.3437
12	1 27-64	1.4219
1 3/4— 5	1 9-16	1.5625
2 — 4 1/2	1 25-32	1.7812
2 1/4 — 4 1/2	2 1-32	2.0312
2 1/2 — 4	2 1-4	2.2500
2 3/4 — 4	2 1-2	2.5000
3 — 4	2 3-4	2.7500
3 1/4 — 4	3	3.0000
3 1/2 — 4	3 1-4	3.2500
3 3/4 — 4	3 1-2	3.5000
4 — 4	3 3-4	3.7500

PIPE THREAD SIZES

1/8...	27	0. 405
1/4...	18	0. 540
3/8...	18	0. 675
1/2...	14	0. 840
3/4...	14	1. 050
1...	11 1/2	1. 315
1 1/4..	11 1/2	1. 660
1 1/2..	11 1/2	1. 900
2...	11 1/2	2. 375
2 1/2..	8	2. 875
3...	8	3. 500
3 1/2..	8	4. 00
4...	8	4. 500

MACHINE SCREW SIZES

1/16-64	3/64
5/64-60	1/16
3/32-48	49
7/64-48	43
1/8-32	3/32
1/8-40	38
9/64-40	32
5/32-32	1/8
11/64-32	9/64
3/16-24	26
3/16-32	22
13/64-24	20
7/32-24	16
15/64-24	10
1/4-20	7
1/4-28	3
5/16-18	F
5/16-24	I
3/8-16	5/16
3/8-24	Q
7/16-14	U
7/16-20	25/64
1/2-12	27/64
1/2-13	27/64
1/2-20	29/64
9/16-12	31/64
9/16-18	33/64
5/8-11	17/32
5/8-18	37/64
11/16-11	19/32
11/16-16	5/8
3/4-10	21/32
3/4-16	11/16
13/16-10	23/32
49/64	7/8-9
13/16	7/8-14
53/64	15/16-9
7/8	1-8
15/16	1-14
63/64	1 1/8-7
1 1/64	1 1/8-12
1 7/64	1 1/4-7
1 11/64	1 1/4-12
1 13/64	1 3/8-6
1 19/64	1 3/8-12
1 11/32	1 1/2-6
1 27/64	1 1/2-12
1 29/64	1 5/8-5 1/2
1 9/16	1 3/4-5
1 11/16	1 7/8-5
1 25/32	2-4 1/2

TAP DRILL SIZES

BASED ON APPROXIMATELY 75% FULL THREAD

THREAD	DRILL
1 1/16-64	3/64
5/64-60	1/16
3/32-48	49
7/64-48	43
1-8-32	3/32
1/8-40	38
9/64 40	32
5/32-32	1/8
11/64-32	9/64
3-16-24	26
3-16-32	22
13/64 24	20
7 32 24	16
15/64-24	10
1/4-20	7
1/4-28	3
5-16-18	F
49/64	7/8-9
13 16	7 8 14
53/64	15 16-9
7/8	1-8
15-16	1 14
63/64	1 1/8-7
1 1/64	1 1/8-12
1 7 64	1 1 4-7
1 11/64	1 1/4-12
1 13/64	1 3/8-6
1 19/64	1 3/8-12
1 11 32	1 1/2-6
1 27/64	1 1/2-12
1 29/64	1 5/8-5 1/2
1 9/16	1 3/4-5
1 11/16	1 7/8-5
1 25/32	2-4 1/2
5-16-24	1
3/8-16	5-16
3/8-24	Q
7/16-14	U
7-16-20	25/64
1/2-12	27/64
1/2-13	27/64
1/2-20	29/64
9-16-12	31/64
9-16-18	33/64
5/8-11	17/32
5/8-18	37/64
11/16-11	19/32
11/16-16	5/8
3/4-10	21/32
3/4-16	11/16
13/16-10	23/32

LETTER SIZES

Size	Drill Diameter
A	234
B	238
C	242
D	246
E	250
F	257
G	261
H	266
I	272
J	277
K	281

Twist Drill Sizes

Size	Drill Diameter
1	2280
2	2210
3	2130
4	2090
5	2055
6	2040
7	2010
8	1990
9	1960
10	1935
11	1910
12	1890
13	1850
14	1820
15	1800
16	1770
17	1730
18	1695
19	1660
20	1610
21	1590
22	1570
23	1540
24	1520
25	1495
26	1470
27	1440
28	1405
29	1360
30	1285
31	1200
32	1160
33	1130
34	1110
35	1100
36	1065
37	1040
38	1015
39	0995
40	0980
41	0960
42	0935
43	0890
44	0860
45	0820
46	0810
47	0785
48	0760
49	0730
50	0700
51	0670
52	0635
53	0595
54	0550
55	0520
56	0465
57	0430
58	0420
59	0410
60	0400
61	0390
62	0380
63	0370
64	0360
65	0350
66	0330
67	0320
68	0310
69	0292
70	0280
71	0260
72	0250
73	0240
74	0225
75	0210
76	0200
77	0180
78	0160
79	0145
80	0135

L	.290
M	.295
N	302
O	.316
P	323
Q	.332
R	.339
S	.348
T	358
U	.368
V	.377
W	386
X	.397
Y	.404
Z	413

APPENDIX H

REFERENCES

YOU NEED TO BE FAMILIAR
WITH THESE ADDITIONAL DA EQUIPMENT
PUBLICATIONS

EQUIPMENT PUBLICATION		
NOMENCLATURE	NUMBER	DATE
Utilization of Construction Equipment	TM 5-331B	May 68
Safe use of cranes	TB 385-101	Jan 71
Procedures for Licensing Operators of Construction Equipment	TB 600-2	Sep 78
Safety Inspection and Testing of Lifting Devices	TB 43-0142	Apr 79

APPENDIX I

WARRANTY GUIDELINES

1. This warranty applies to end item components and all supplies furnished under the contract. The SCAMP crane, procured in accordance with Contract Number DAAE07-82-C-6602, is under Warranty for a period of 15 months after delivery to the Government.

2. Using units must report all warranty claims to the National Maintenance Point (NMP) as indicated in paragraph 3a.

3. General information:

a. DA Form 2407 (prepared in accordance with warranty claim actions in TM 38-750) will be used to submit warranty claims actions for end items when compnents, parts or assemblies are defective and are covered by a manufacturer's warranty. End items under warranty are identified by a decal date on the vehicle. Contractual warranty clauses are in the commercial manual. All warranty actions settled or unsettled will be reported to the National Maintenance Point (NMP) on DA Form 2407.

b. Maintenance activities in support of organizational maintenance are the responsible points of contact between the originator of warranty claims and the National Maintenance Point (US Army Tank-Automotive Command, ATTN: AMSTA-MVB, AUTOVON 786-8901, Warren, MI 48397-5000) which serves as the DA Representative with the contractor in warranty matters.

NOTE: In certain instances, the originating organization and the support activity are one and the same.

c. Before you take your equipment to a dealer for repair, whether or not it was necessary for you to go through the NMP (TACOM), check with your local procurement office to see if a funds commitment document is needed. sometimes, even though the majority of the repairs are covered by the warranty, there may be a small charge for normal maintenance costs, i.e., oil filters, oil, etc. Further, the cause of damage could be determined by the dealer to be directly related to operator abuse". In that case, the Goverment may be obligated to pay for teardown services even if the repairs are no longer desired; or for the complete cost, if repairs are to be completed by the dealer.

d. When the equipment is given to the dealer fo repairs, find out how long the work will take, the extent of the problem, if possible, and the charges, if any, which may be involved. Leave the name and telephone number of the person to be contacted for pickup of the equipment and specifically state that he should be called as soon as the repairs are finished. In addition, state that he should be telephoned if unexpected problems, costs, and/or delays are encountered. Get the name and telephone number of the Service Manager, for any required follow-up purposes.

e. When you arrive to pick up your equipment after completion of services, make certain that you know exactly what repairs were performed and/or parts replaced. This is required for overall problems, trend evaluation, by the NM P and must be identified upon completion of warranty services.

f. Telephone the NMP at TACOM, AUTVON 786-8901 if:

(1) Your equipment requires repairs and you cannot obtain these services using the procedures listed above.

(2) The length of time required for repairs may seriously hamper your mission, or if the dealers overall response to your requirements are not satisfactory.

(3) You have any questions regarding warranty procedures - either in general or about a specific job. Do not wait until your problems become critical.

g. Do not attempt to conduct negotiations regarding a breach of warranty. This is a function of the Contracting Officer, through the NMP at TACOM.

4. Contractual Warranty Clauses.

a. Warranty. Notwithstanding inspection and acceptance by the Government of the supplies furnished under the contract or any provision of this contract concerning the conclusiveness thereof, the contractor hereby warrants that the supplies are free from defects in design, material, and workmanship and will conform with the specifications and all other requirements of this contract for a period of 15 months from date of acceptance, as shown on the Material Inspection and Receiving Report (DD Form 250), or 1500 hours of operation, whichever occurs first. Further, if the Government, prior to placing vehicles in service, elects to place quantities of such newly delivered vehicles in Government depot storage, the contractor agrees that the time period of the warranty will not begin to run for such stored vehicles until each vehicle is withdrawn from Government storage or until six months from date of acceptance, whichever occurs first. The Government, prior to placing each new vehicle in storage and again at time of its withdrawal, shall notify the contractor thereof and identify each vehicle at its time in and out of storage. Vehicles designed as Production Samples shall be treated as vehicles placed in storage for warranty purposes.

If a Safety Recall defect occurs during vehicles warranty period, the contractor agrees to extend the term of the warranty by a period to time equal to the time period required to make necessary safety defect corrections. Additionally, to the extent the contractor or his supplier(s) provide to commercial customers a greater warranty for the supplies furnished herein, the contractor hereby likewise provides such greater warranty to the Government. To the extent the terms of such greater warranty are inconsistent with or conflict with this warranty the provisions of this warranty shall govern.

b. Remedies

(1) New Replacement Supplies. With respect to defective supplies, wherever located, the warranty shall include the furnishing, without cost to the Government, F.O.B. contractor's plant, branch *or* dealer facility, or F.O.B. original CONUS destination, or F.O.B. US Port of Embarkation, at the Government's option, new supplies to replace any that prove to be defective within the warranty period.

(2) Corrective Action Options. In addition, the Government shall have the option (a) to return the vehicles or parts thereof to the contractor's plant, branch, or dealer facility for correction, or (b) to correct the supplies itself. When the Government elects to return the vehicle or parts to the Contractor's plant, branch or dealer facility, the cost of labor involved in the correction of the defective supplies shall be borne by the contractor. When the vehicle or parts thereof are returned to the contractor for correction, the contractor shall bear all transportation costs to the contractor's plant and return. With respect to defective supplies located within the 50 states, when the Government elects to correct them itself, the cost of labor involved in the correction of defects shall be borne by the contractor and shall be computed at the contractor's then prevailing hourly rate for such services in that geographical area, based upon the number of labor hours appearing in the contractor's flat rate time schedule manual, or the Government's actual cost, whichever is less. With respect to defective supplies located outside the 50 states, when the Government elects to correct them itself, the cost of labor involved shall be borne by the contractor at the then prevailing hourly rate in the geographical area for such services, based upon the number of labor hours appearing in the contractor's flat rate time schedule manual or the Government's actual cost, whichever is less. Additionally, the contractor shall be responsible for reasonable costs of disassembly/reassembly of items necessarily removed in connection with repair or replacement on vehicles wherever located.

c. Notification. If the Government elects to have warranty repair or replacement performed by the contractor, the Government shall deliver the vehicle to contractor's local facility or dealership for warranty corrective repair or replacement. Receipt for such vehicle by the contractor's local facility or dealership will be deemed proper notification by the Government of any breach of the warranty provided by this provision. If the Government elects to effect warranty repairs or replacement itself, the contractor shall be notified in writing of any breach in the warranty within 30 days after discovery of the defect. Within 10 days after receipt of such notices, the contractor shall submit to the Contracting Officer a written recommendation as to the corrective action required to remedy the breach. In any event, the Contracting Officer may, upon the expiration of the 10 day period set forth above, proceed with correction or replacement as set forth in paragraph (c) above. The contractor shall, notwithstanding any disagreement regarding the existence of breach or warranty, comply with any Contracting Officer directions related to such correction or

replacement. After the notice of breach, but not later than 30 days after receipt of the contractor's recommendation for corrective action, the Contracting Officer will, in writing, notify the contractor of the parts used by the Government in repair or replacement and all other costs or expenses required for Government correction of warranty, defect as set forth in the paragraph (c) above. The contractor shall respond within 30 days after receipt of this notice, of his intention to furnish identified replacement parts and/or cost reimbursement to the Government. In the event it is later determined that the contractor did not breach the warranty in paragraph (b) above, the contract price will be equitably adjusted pursuant to the terms of the "Changes" clause of the contract. Failure to agree to such an equitable adjustment or upon any determination to be made under this clause shall be a dispute concerning a question of fact within the meaning of the "Disputes" clause of this contract.

d. Corrected or Replaced Supplies. Any supplies or parts thereof corrected or furnished in replacement pursuant to this clause shall also be subject to all the provisions of this clause to the same extent as supplies initially delivered.

APPENDIX J

CONVERSION CHART

	Manufacturer	Military
Chassis Grease	M P G	G A A
Hydraulic Oil	EO IOW	OE/HDO 10
Engine Oil	EO 15W40	O E / H D O
Gear Oil	M P L	G O
Silicone Brake Fluid	S B F	Brake Fluid (Auto)
Anti Freeze Coolant	A F C	Anti Freeze

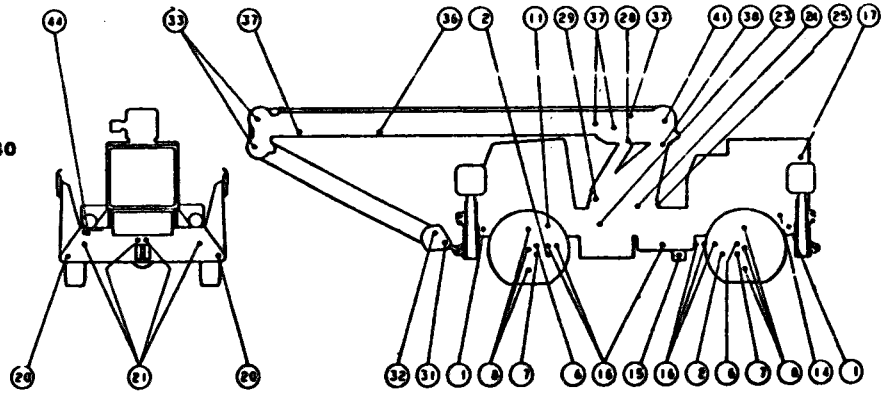
GROVE RT41AA LUBRICATION CHART

SERV. HRS.	REF. NO.	IDENTIFICATION	SERVICE	LUBE.	SERV. PTS.
10 OR DAILY	14	ENGINE CRANKCASE	CHECK & FILL	EO-15W40	1
	15	TRANS. & TORQUE CONVERTER	CHECK & FILL	EO-10W	1
	24	T/T GEAR & DRIVE PINION	COAT TEETH	MPG	1
	28	TOP LIFT CYLINDER PIVOT	LUBE	MPG	2
	29	BOTTOM LIFT CYLINDER PIVOT	LUBE	MPG	2
	38	BOOM PIVOT SHAFT	LUBE	MPG	2
	44	HYDRAULIC TANK	CHECK & FILL	EO-10W	1
25	20	O/R ARM PIVOT PINS	LUBE	MPG	4
	21	O/R CYLINDER PIVOT PINS	LUBE	MPG	12
	36	ADJ. WEAR PADS	BRUSH ON PAD	MPG	2
	37	BOOM SECTION WEAR PADS	BRUSH ON PAD	MPG	8
SEE SERV. MAN.	6	DIFFERENTIALS	CHECK & FILL	MPL	1
	14	ENGINE CRANKCASE	DRAIN & FILL	EO-15W40	1
	17	ENGINE COOLING SYSTEM	CK/DR/FILL	AFC	1

SERV. HRS.	REF. NO.	IDENTIFICATION	SERVICE	LUBE.	SERV. PTS
50 OR WEEKLY	1	STEER CYLINDER PIVOT SHAFT	LUBE	MPG	2
	2	TIE RODS	LUBE	MPG	2
	8	TRUNNION BEARING	LUBE	MPG	16
	11	BRAKE MASTER CYLINDER	CHECK & FILL	SBF	1
	16	DRIVELINE & "U" JOINTS	LUBE	MPG	6
	23	T/T GEARBOX	CHECK & FILL	MPL	1
	25	T/T BEARING	LUBE	MPG	1
	32	HOOKBLOCK SHEAVES	LUBE	MPG	1/SHV.
	33	BOOM NOSE SHEAVES	LUBE	MPG	1/SHV.
100	31	HOOK SWIVEL BEARING	LUBE	MPG	1
250	41	BRADEN HOIST	CHECK & FILL	MPL	1
	23	T/T GEARBOX (INITIAL SERVICE)	DRAIN & FILL	MPL	1
500 OR 12 MOS.	7	WHEEL BEARINGS	DISASSEM/REPK.	MPG	4
	15	TRANS. & TORQUE CONVERTER	DRAIN & FILL	EO-10W	1
	23	T/T GEARBOX	DRAIN & FILL	MPL	1

LUBE	DESCRIPTION	MIL SPEC
SBF	SILICONE BRAKE FLUID	MIL-B-46176
EO-15W40	ENGINE OIL 15W40	MIL L 2104 MULTIGRADE 15W40
MPL	MULTIPURPOSE TYPE GEAR LUBE 85W140	MIL-L-2105
EO-10W	ENGINE OIL 10W	MIL-L-2104 GRADE 10W*
AFC	ANTI FREEZE COOLANT	MIL-A-46153
MPG	MULTIPURPOSE GREASE	MIL-G-10924

*SEE OPERATOR'S MANUAL WHEN AMBIENT TEMPERATURES ARE EXPECTED BETWEEN +40° F AND -25° F.



1507

APPENDIX L

TROOP INSTALLED ITEMS LIST

a. Extinguisher, Fire	4210-00-555-8837	1 ea
b. Hammer, Engineer, 2½ lb.	5120-00-900-6118	1 ea
c. Brush, Cleaning/Oil Application, 9 in.	5120-00-297-6657	2 ea
d. Oiler, Hand, 8 oz.	4930-00-985-2604	1 ea
e. Case, Rifle	2590-00-045-9611	1 ea
f. Log Bookbinder	7510-00-889-3494	1 ea
g. Cotton Duck Case	7520-00-559-9618	1 ea
h. Cutter, Wire Rope	5110-00-224-7058	1 ea
i. Marlin Spike	5120-00-224-9443	1 ea
j. Gun, Grease	4930-01-028-1442	1 ea
k. Wrench, 7/16"	5120-00-228-9505	1 ea
l. Socket, 3/4 drive, 1¼"	5120-00-235-5871	1 ea
m. Breaker Bar	5120-00-221-7959	1 ea

APPENDIX M

TORQUE VALUES

TORQUE VALUES.

Torque values as shown are for nut-bolt combinations that have not been plated and have not had: pecial lubrications applied to then. (Discount the residual lubricant present that was applied at time of manufacture).

FINE OR COURSE THREAD FASTENER	GRADE DESIGNATION	TENSILE STRENGTH MINIMUM	MATERIAL	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1 1/4	1 3/8	1 1/2
				TORQUE POUNDS-FOOT										
 CAP SCREW	S.A.E 2 A.S.T.M. A-307 STEEL	64,000 P.S.I.	Low Carbon Steel	19	30	45	66	93	150	202	300	659		1067
 CAP SCREW	S.A.E. 3 STEEL	100,000 P.S.I.	Medium Carbon Steel	30	47	69	103	148	234	372	551	1211		1943
 CAP SCREW	A.S.T.M. A-449 S.A.E. 5 STEEL	105,000 P.S.I.	Medium Carbon Steel or Low Alloy Heat Treated	31	50	75	110	150	250	378	583	1097		1748
 CAP SCREW	A.S.T.M. 35488 STEEL													
 CAP SCREW	A.S.T.M.A. A-325					100		200	355	525	790	1495		2600
 CAP SCREW	A.S.T.M A-354-BC STEEL	125,000 P.S.I.	Low Alloy or Med. Carb. Quenched Tempered	34	54	81	119	167	269	427	644	1392		2234
 CAP SCREW	S.A.E. 6 STEEL	133,000 P.S.I.	Med. Carbon Steel Quenched Tempered	43	69	106	150	209	350	550	825	1815		2913
 CAP SCREW	S.A.E. 7 STEEL		Med. Carbon Alloy, Quenched Tempered Roll Threaded											
 CAP SCREW	S.A.E. 8 STEEL	150,000 P.S.I.	Med. Carbon Alloy Quenched Tempered	46	75	115	165	225	370	591	893	1964	2[illegible]33	3160
 SOCKET CAP SCREW	SOCKET HEAD CAP SCREW ALSO N.A.S. AIRCRAFT STD.	160,000 P.S.I.	High Carbon Alloy Quenched Tempered	50	81	121	176	240	395	629	964	2120		3402
 CAP SCREW	N.A.S. 144 AIRCRAFT STD. MS 20000 MIL.STD.													
 CAP SCREW	N.A.S. 624 NATIONAL AIRCRAFT STANDARD STEEL	180,000 P.S.I.	High Carbon Alloy Quenched Tempered	56	91	136	198	270	444	708	1085	2385		3827

Torque Values (Sheet 1 of 2)

APPENDIX M
TORQUE VALUES

Torque values as shown are for nut-bolt combinations that have been plated or have had lubrication applied and/or with use of flat or split ring type of washers.

FINE OR COURSE THREAD FASTENER	GRADE DESIGNATION	TENSILE STRENGTH MINIMUM	MATERIAL	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1 1/4	1 3/8	1 1/2
				TORQUE POUNDS-FOOT										
 CAP SCREW	S.A.E. 2 A.S.T.M. A-307 STEEL	64,000 P.S.I.	Low Carbon Steel	17	27	40	59	84	135	182	270	593		951
 CAP SCREW	S.A.E. 3 STEEL	100,000 P.S.I.	Medium Carbon Steel	27	42	62	93	131	211	335	496	1090		1748
 CAP SCREW	A.S.T.M. A-449 S.A.E. 5 STEEL	105,000 P.S.I.	Medium Carbon Steel or Low Alloy Heat Treated	28	45	63	99	135	225	360	524	987		1573
 CAP SCREW	A.S.T.M. 35488 STEEL													
 CAP SCREW	A.S.T.M.A. A-325					90		180	320	473	711	1346		2340
 CAP SCREW	A.S.T.M. A 354-BC STEEL	125,000 P.S.I	Low Alloy or Med. Carb. Quenched Tempered	31	49	71	107	150	242	344	580	1253		2010
 CAP SCREW	S.A.E. 6 STEEL	133,000 P.S.I.	Med. Carbon Steel Quenched Tempered	39	62	95	135	188	315	495	743	1634		2620
 CAP SCREW	S.A.E. 7 STEEL		Med. Carbon Alloy, Quenched Tempered Roll Threaded											
 CAP SCREW	S.A.E. 8 STEEL	150,000 P.S.I.	Med. Carbon Alloy Quenched Tempered	41	68	104	149	203	333	532	804	1768	2367	2835
 SOCKET CAP SCREW	SOCKET HEAD CAP SCREW ALSO N.A.S. AIRCRAFT STD.	160,000 P.S.I	High Carbon Alloy Quenched Tempered	45	73	109	158	216	356	566	868	1903		3062
 CAP SCREW	N.A.S. 144 AIRCRAFT STD MS 20000 MIL. STD.													
 CAP SCREW	N.A.S. 624 NATIONAL AIRCRAFT STANDARD STEEL	180,000 P.S.I.	High Carbon Alloy - Quenched Tempered	50	82	122	178	243	400	637	977	2147		3444

Torque Values (sheet 2 of 2)

By Order of the Secretary of the Army:

JOHN A. WICHAM, JR.
General, United States Army
Chief of Staff

Official:

R.L. DILWORTH
Brigadier General, United States Army
The Adjutant General

Distribution:

To be distibuted in accordance with DA Form 12-31, AVUM and AVIM maintenance requirements for All Rotary Wing Aircraft.

☆ U. GOVERNMENT PRINTING OFFICE: 1987 742-019/60033

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

SOMETHING WRONG WITH THIS PUBLICATION?

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

YOUR MAILING ADDRESS.

DATE SENT: DATE YOU FILLED OUT FORM.

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE
TM5-XXXX-XXX-XX	DATE OF TM	TITLE OF TM

BE EXACT. . .PIN-POINT WHERE IT IS

PAGE NO	PARA-GRAPH	FIGURE NO	TABLE NO
400		183	
512		191	

IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:

CHANGE ILLUSTRATION. REASON: TUBE END SHOWN ASSEMBLED ON WRONG SIDE OF LEVER CAM.

FIGURE 191, ITEM 3 HAS THE WRONG NSN. SUPPLY REJECTS ORDERS FOR THIS ITEM. THE NSN SHOWN HERE IS NOT LISTED IN THE AMDF OR THE MCRL.

PLEASE GIVE US THE CORRECT NSN AND P/N.

PRINTED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER

JOHN SMITH, S.SGT. 793/XXXXX

SIGN HERE: John Smith

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE.

P S --IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

SOMETHING WRONG WITH THIS PUBLICATION?

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE
TM5-3810-302-24	29 JAN 87	CRANE, Wheel-Mounted, Self-Propelled for Aircraft Maintenance and Positioning (SCAMP): 4 Ton

BE EXACT. . .PIN-POINT WHERE IT IS

PAGE NO	PARA-GRAPH	FIGURE NO	TABLE NO

IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:

PRINTED NAME. GRADE OR TITLE. AND TELEPHONE NUMBER

SIGN HERE

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE.

P S --IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS

REVERSE OF DA FORM 2028-2

FILL IN YOUR UNIT'S ADDRESS

FOLD BACK

DEPARTMENT OF THE ARMY

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

POSTAGE AND FEES PAID
DEPARTMENT OF THE ARMY
DOD 314

U.S. MAIL

TEAR ALONG PERFORATED LINE

Commander
US Army Tank-Automotive Command
ATTN: AMSTA-MB
Warren, Michigan 48397-5000

THE METRIC SYSTEM AND EQUIVALENTS

LINEAR MEASURE

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

WEIGHTS

1 Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 Lb
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq Centimeter = 100 Sq Millimeters = 0.155 Sq Inches
1 Sq Meter = 10,000 Sq Centimeters = 10.76 Sq Feet
1 Sq Kilometer = 1,000,000 Sq Meters = 0.386 Sq Miles

CUBIC MEASURE

1 Cu Centimeter = 1000 Cu Millimeters = 0.06 Cu Inches
1 Cu Meter = 1,000,000 Cu Centimeters = 35.31 Cu Feet

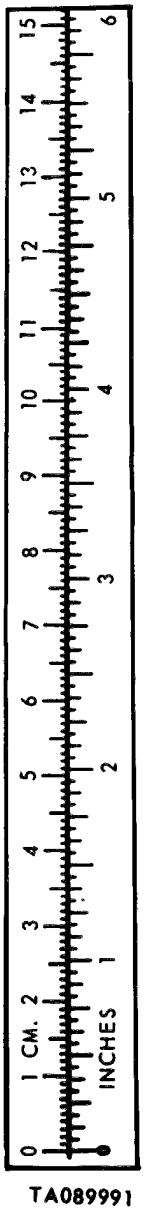
TEMPERATURE

$5/9\ (^0F - 32) = {}^0C$
212^0 Fahrenheit is equivalent to 100^0 Celsius
90^0 Fahrenheit is equivalent to 32.2^0 Celsius
32^0 Fahrenheit is equivalent to 0^0 Celsius
$9/5\ C^0 + 32 = F^0$

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
Pints	Liters	0.473
Quarts	Liters	0.946
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Grams	Ounces	0.035
Kilograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pound-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
Kilometers per Liter	Miles per Gallon	2.354
Kilometers per Hour	Miles per Hour	0.621



TA089991

PIN: 061086-000